State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Euclid Creek Watershed

Final Report
August 5, 2005

Bob Taft, Governor
Joseph P. Koncelik, Director

TABLE OF CONTENTS

Acknowledgments . . . . . **iv**

Executive Summary . . . . . **v**

Fact Sheet . . . . . **vi**

Components of the Euclid Creek TMDL Process . . . . . **vii**

1.0 Introduction **1**

2.0 Waterbody Overview **4**
- 2.1 Description of the Study Area 4
- 2.2 Water Quality Assessment 6
- 2.3 Causes and Sources of Impairment 12

3.0 Problem Statement **16**
- 3.1 Target Identification 16
- 3.2 Identification of Current Deviation from Target 20
- 3.3 Source Identification 25

4.0 Total Maximum Daily Loads **28**
- 4.1 Background 28
  - 4.1.1 Objective 28
  - 4.1.2 Application of Water Quality Targets 28
  - 4.1.3 Linkage between Water Quality and Impairments 29
- 4.2 Method of Calculation 29
  - 4.2.1 Load Duration Curve 30
  - 4.2.2 STEPL Model 31
  - 4.2.3 Habitat, Siltation, and the QHEI 32
  - 4.2.4 TMDL for Euclid Creek 35

5.0 Public Participation **37**

6.0 Implementation and Monitoring Recommendations **38**
- 6.1 Reasonable Assurances 38
  - 6.1.1 Minimum Elements of an Approvable Implementation Plan 38
  - 6.1.2 Draft Implementation Plan 52
  - 6.1.3 Expected Effectiveness of Example Restoration Scenario 52
- 6.2 Process for Monitoring and Revision 53

References 54

Figure	Title	Page
Figure 1	Euclid Creek Basin Attainment status	3
Figure 2	Iron Concentrations	9
Figure 3	Euclid Creek Historic Conductivity	10
Figure 4	Land Use Map	15
Figure 5	Euclid Creek QHEI Scores	21
Figure 6	Northeast Ohio Regional Sewer District CSO Location Map	25
Figure 7	Map of Septic Systems in Euclid Creek Watershed	26
Figure 8	Flow Duration Curve	30
Figure 9	Load Duration Curve	31
Figure 10	Rain Barrel	41
Figure 11	Rain Garden	42

Table	Title	Page
Table 1	Components of the Euclid Creek TMDL Process	vii
Table 2	Summary of the 2004 303(d) listed segments included in this TMDL report	2
Table 3	Summary of the Components and Examples of Ohio's Water Quality Standards	7
Table 4	Land use distribution in the Euclid Creek Basin	14
Table 4a	Park land in the Euclid Creek TMDL Area	14
Table 5	Euclid Creek Biological Attainment Table	17
Table 6	Nutrient Target Concentrations	18
Table 7	Habitat Targets	19
Table 8	Cuyahoga RAP Beneficial Use Impairments	22
Table 9	QHEI TMDL Components	34
Table 10	Phosphorus TMDL	36
Table 11	Description of Implementation Actions and Measures	48
Table 12	Time Line and Reasonable Assurances	50
Table 13	Time Line: Monitoring, Tracking and Implementation	51

APPENDICES

Appendix A - Biological Assessment Data Sheets

Appendix B - TMDL Calculation Methodology

Appendix C - QHEI Data Sheets

Appendix D - Ohio EPA Chemical Analysis Data

Appendix E - NEORSD Chemical Analysis Data

Appendix F - Ohio EPA and NEORSD Bacteria Analysis Data

Appendix G - Water Quality Standards Use Designations

Appendix H - NPDES Permits within the Euclid Creek Watershed

Appendix I - Response to Public Comments

ACKNOWLEDGMENTS

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

Biology and Chemical Water Quality - Jack Freda, Charles Boucher, Steve Tuckerman, and Bob Davic
Nonpoint Source Issues - Dan Bogoevski, Mark Bergman
Point Source Issues - Sandra Cappotto, Donna Kniss, and Marie Underwood
Project Leader - Bill Zawiski
Water Quality Standards - Chris Skalski
Cuyahoga RAP - Kelvin Rogers

The Euclid Creek Watershed Council has provided a forum for discussion of the water quality issues in Euclid Creek. In particular, Lynn Garrity of the Cuyahoga County Soil & Water District, who serves as the Euclid Creek Watershed Coordinator, is acknowledged for her contribution to the TMDL project.

Acknowledgment is made of the property owners who allowed Ohio EPA personnel access to the study area.

Executive Summary

The Euclid Creek watershed is located in northeast Ohio, flowing through Lake and Cuyahoga Counties on its way to Lake Erie. This watershed appears on Ohio's 303(d) list (Ohio's impaired waters listing) based on findings from Ohio EPA's monitoring of the Euclid Creek watershed. These findings indicate that organic enrichment, nutrients, bacteria, flow alteration and degraded habitats are the primary causes of impairment. Major sources of impairment include combined sewer overflows (CSOs), septic tanks, storm water and nonpoint sources.

Stream surveys were conducted in 2000; impairments were found for some biological communities as well as elevated phosphorus. Urban and suburban land use contribute nutrients to the Euclid Creek watershed. Ohio's water quality standards include numerical biological criteria which form the basis of the numerical targets for the TMDLs. The success of the implementation actions resulting from the TMDLs will be evaluated through further monitoring looking for changes in the biological scores. 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 an Ohio EPA technical bulletin (OEPA, 1999) which relate in-stream nutrient concentrations to aquatic community performance.

TMDLs were prepared for phosphorus, habitat, and siltation.

Reasonable assurances proposed for the Euclid Creek watershed include implementation of Long Term Control Plans for combined sewer overflows in the Northeast Ohio Regional Sewer District service area. Phase II of the storm water regulations will involve 100% of the watershed area and will be an essential part of water quality restoration. Riparian protection is also important for stream integrity to be restored. Protection of headwater streams is also recommended as important to watershed integrity. This TMDL recommends that additional storm water controls be implemented by watershed communities, such as green roof design, rain barrels, rain gardens, and increased infiltration capacity. The intent of additional controls is to reduce instantaneous runoff peaks and reduce pollutants including temperature increases due to impervious surfaces.

State of Ohio Environmental Protection Agency

Fact Sheet

January 2005

Euclid Creek Watershed TMDL

The Watershed

Euclid Creek is a small Lake Erie tributary flowing through Cuyahoga County and a small part of Lake County. Approximately 43 miles of stream are included in the 23 square mile watershed. The watershed is dominated by urban and suburban land use.

Within Euclid Creek's watershed live 68,000 people.

Originating in the communities of Beachwood, Pepper Pike and Willoughby Hills, Euclid Creek changes elevation from 1,200 feet above sea level to 570 feet above sea level at Lake Erie. At a gradient of 55 feet per mile, Euclid Creek is considered a very high-gradient stream. Much of the stream flows over bedrock and has steep valley walls.

Water Quality

Water quality in Euclid Creek has shown improvements during the time Ohio EPA has been monitoring the stream.

Bacteria

Discharges from septic tanks, wastewater treatment plants, combined sewer overflows, and urban runoff contribute bacteria to the watershed. Violations of the water quality standard were common in the 1970s and into the 1980s. Recently, detections of fecal coliform violations have decreased.

Phosphorus

Current data indicate that phosphorus in the stream is above target goals. In Ohio EPA's 2000 watershed survey, 60 percent of the samples were above the target level. In 2002 and 2003, 30 percent of the samples collected by the Northeast Ohio Regional Sewer District were above the target.

Aquatic Life

Ohio EPA also evaluates streams based on the organisms living in them. By analyzing fish communities and macroinvertebrates (bugs, crayfish and other creatures without backbones) we can determine compliance with water quality standards and identify potential sources and causes of stream impairment.

Euclid Creek currently does not meet Ohio EPA's standards for aquatic life. Fish populations appear to be more impacted than the macroinvertebrates. Fish found above the dam near East 185th Street in our surveys were mostly pollution-tolerant minnows.

Below the dam additional fish species were found including rainbow trout and bass.

The aquatic macroinvertebrates have improved to a point that they generally meet Ohio EPA standards.

Restoring the Watershed

Several methods are used to restore a watershed to meet standards for bacteria, chemicals, and biological communities.

Control of industrial and sanitary wastewater discharges, including septic tank elimination, will improve water quality. Septic tank elimination is an ongoing project. In the case of Euclid Creek, control and elimination of these discharges has not resulted in complete restoration of water quality. Other human induced influences are impacting the stream.

Development and loss of streamside habitat can be a major source and cause of problems. Runoff contained in storm water can contain many of the same pollutants found in industrial and sanitary wastewater. Addressing issues such as habitat alteration and land use patterns requires local government support.

Watershed Action Plans and the Total Maximum Daily Load process are able to achieve restoration, when supported and implemented at a local level.

Table 1. Components of the Euclid Creek TMDL Process	
Study Area	Euclid Creek watershed from headwaters to mouth
2004 303(d) Listed Watersheds **(*see Table 2 for segments*)**	04110003 010 Lake Erie tributaries (East of Cuyahoga River to West of Grand River); excluding Chagrin River Assessment Unit Category - 5 Assessment Unity Priority Points - 5
Target Identification	Nutrients, sediment, bacteria, and biological and habitat indices
Applicable Water Quality Criteria	OAC 3745-1-04 (A) 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. OAC 3745-1-07 Dissolved Oxygen, instantaneous minimum: 4.0 (WWH) mg/l, 24-hour average: 5.0 (WWH) mg/l Fecal Coliform Bacteria: Geometric Mean 1000 mpn Maximum 2000 mpn *E. Coli* Bacteria Geometric Mean 126 mpn Maximum 298 mpn Ecoregion Biocriteria, refer to Table 5
Current Deviation from Target	Nutrients above target goals. Biological communities fail to achieve biocriteria, refer to Table 5. *E. Coli* is above target levels.
Sources and Causes	Combined sewer overflows (CSO), septic systems, habitat modification, loss of riparian zones, spills, suburbanization, and urbanization.
Load Allocation	Refer to Section 4
Critical/Season Conditions	Critical conditions involve storm events initiating combined sewer overflows. Storm events also result in increased nonpoint loadings as well as high velocity flow.
Safety Margin	Implicit in calculations.
Implementation Plan	Of importance to Euclid Creek is the control of CSOs. Long Term Control Plans have been submitted for all CSOs in TMDL area. Addressing storm water control in the watershed is also very important. Elimination of failing septic systems will help remove some nutrient loadings. Habitat improvement will be necessary to address growing impervious area in watershed.
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, public notice and meeting on draft report, stakeholder groups, the Euclid Creek Watershed Council and a Watershed Action Plan.

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 (U.S. EPA) in even-numbered year. The Ohio Environmental Protection Agency (Ohio EPA) identified the Euclid Creek watershed (part of a larger assessment unit) as a priority impaired water on the 1998, 2002, and 2004 303(d) list. A summary of the Euclid Creek watershed portion of the 2004 303(d) list is included in Table 2. A general overview of Ohio's water quality standards is included in Table 3. A map indicating aquatic life use attainment status is included as Figure 1. Specific use designations for Euclid Creek (OAC 3745-1-26) are included in Appendix G.

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. 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. Watershed-wide implementation of certain management practices (riparian protection for example) is important when addressing streams with multiple nonpoint source related impacts.

This report documents the Euclid Creek TMDL process and provides for tangible actions to restore and maintain this water body. The main objectives of the report are to 1) describe the water quality and habitat condition of Euclid Creek and 2) 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 prescribed. The report is organized in sections forming the progression of the TMDL process.

This report will also provide detailed water quality information and summarize some of the available water quality information for the stream (Section 2.2). Sources of this information include Ohio EPA surveys (1989 and 2000) and Northeast Ohio Regional Sewer District surveys (chemical and biological).

The primary causes of impairment in the Euclid Creek watershed are organic enrichment, nutrient enrichment, flow alteration, and habitat degradation. Nutrient enrichment and organic enrichment are closely tied to each other in the TMDL area. CSOs and septic tanks appear to be sources of impairment. Low dissolved oxygen previously detected has not been found in the most recent sampling efforts. Correcting CSOs or mitigating their effects will help reduce organic enrichment. Combined sewer overflows are located only in the lower section of Euclid Creek (below RM 1.6) and do not impact the upper reaches. Areas of the watershed with home sewage treatment systems have been identified and are

part of continuing community planning projects for central sewer construction. Runoff from both urban and suburban land is also an important source of nutrients and cause of habitat degradation in the watershed. The implementation plan includes numerous actions which specifically focus on runoff issues.

TMDLs were calculated for phosphorus. Habitat degradation is not a load based quantity; however, the regulations provide for these types of impairing causes and TMDL numbers were calculated for these as well. Habitat survey methods used by Ohio EPA can detect levels of sedimentation and overall habitat quality. Improvements, reductions in siltation, are able to be identified utilizing the QHEI. Additional discussion on habitat and siltation is found in Section 4.2.3.

Table 2. Summary of the 2004 303(d) listed segments included in this TMDL report

Waterbody Segment Description [Identification Number]	303 (d) Status[1] 2004	Major causes 303(d)	TMDL in this report?[2]	Sources (Significance of Impairment)
Lake Erie tributaries (East of Cuyahoga River to West of Grand River); excluding Chagrin River 04110003 010; priority points: 5				
Lake Erie tributaries (East of Cuyahoga River to West of Grand River); excluding Chagrin River [OH 90 16]	✔	Organic Enrichment/ D.O. Flow Alteration[3]	Yes for phosphorus, habitat, and siltation	Combined Sewer Overflow Urban Runoff/Storm Sewers

1 The 2004 303(d) list was based on data collected in 2000.

2 TMDL numbers are included for total phosphorus and sediment. 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 analogous to a "TMDL" for load-based parameters.

3 Cause applies to other streams in this assessment unit; does not apply to Euclid Creek.

Checkmarks indicate inclusion in this report. For example: a checkmark next to organic enrichment means that the specific impairment is directly addressed in this TMDL.

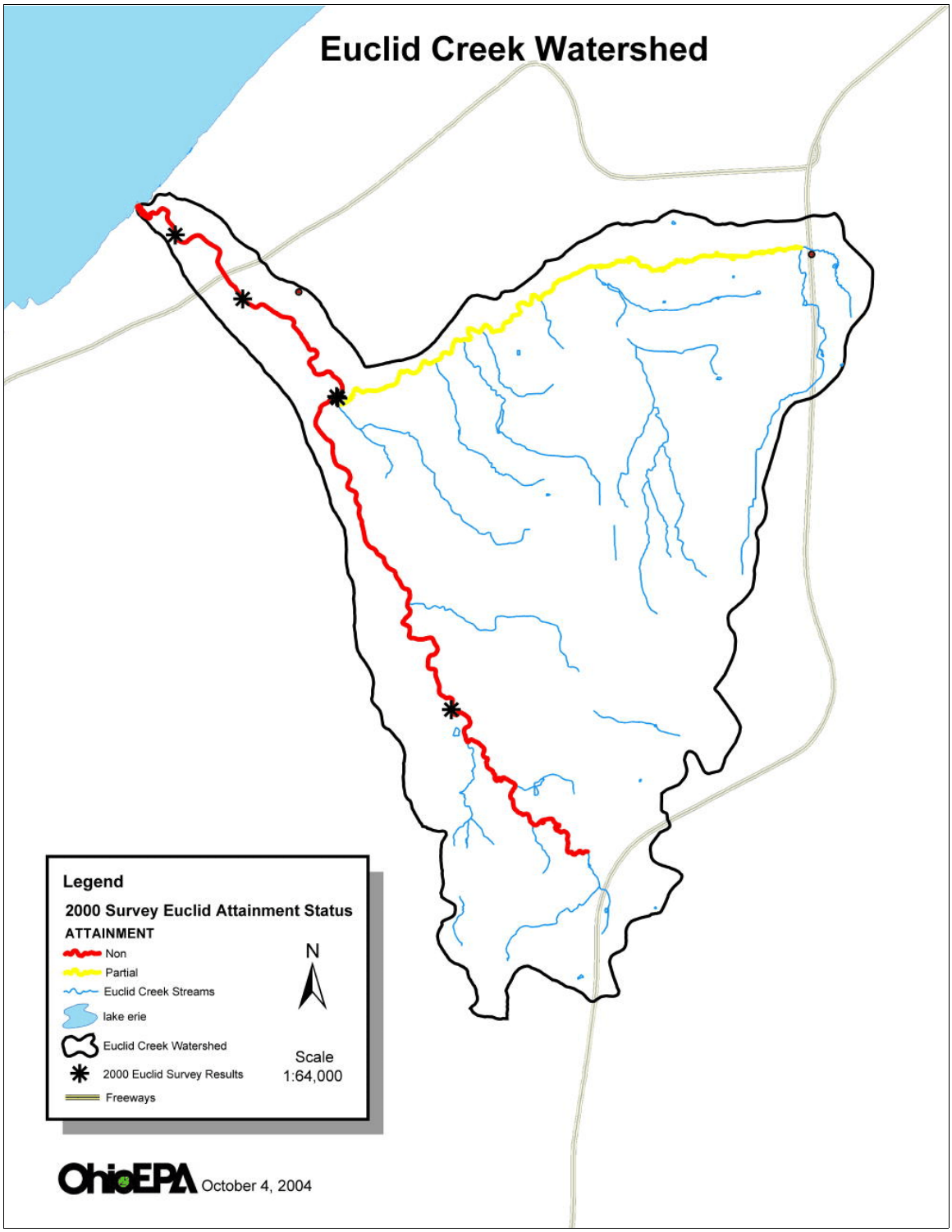

Figure 1 - Euclid Creek Attainment Status

2.0 WATERBODY OVERVIEW

2.1 Description of Study Area

Euclid Creek is a relatively small Lake Erie tributary located in parts of Cuyahoga and Lake Counties. Euclid Creek is placed in the Erie-Ontario Lake Plain, formerly glaciated, which is characterized by low rounded hills, scattered end moraines, kettles, and areas of wetlands. The watershed drains approximately 23 square miles and contains 43 miles of stream. Euclid Creek is typically divided into a main branch, east branch, and west branch. The west branch is also referred to as the south branch or considered a continuation of the main branch. This report considers the main branch and south branch/west branch as the same stream segment, which is consistent with past Ohio EPA work in this watershed. The east branch drains approximately 12.5 square miles and contains over 19 miles of stream. The main branch is 11.5 miles long and extends from its mouth at Lake Erie thru the Euclid Creek Metroparks Reservation and continues south towards Beachwood draining an additional 8.5 square miles and containing about 16 miles of stream. Headwaters elevation in Beachwood is 1,200 feet MSL with an elevation at the mouth (Lake Erie) at 570 feet MSL. Stream gradients range from 37 feet per mile in the upper watershed to 58 feet per mile within the park to 0.1 feet per mile in the lacustuary area.

The Euclid Creek watershed is relatively urbanized, with a population of 68,000 people. Some free flowing portions of the watershed have been culverted and range from 9.0% of the main branch (lower 3 miles of mainstem), 18% of the east branch, and 32% of the "west" branch (upper 8.5 miles of mainstem). Channelization has also occurred in portions of the main stem for flood control purposes. The Euclid Creek basin contains approximately 32.6% impervious surface area.

<u>Geology</u>
The Euclid Creek watershed geologic rock formations consist of Devonian and Mississippian age rocks. In ascending stratigraphic order they are: the Chagrin Shale, the Cleveland Shale, the Bedford Formation and the Cleveland Formation. These rocks were deposited between 350 to 360 million years ago.

The bedrock found in the Euclid Creek watershed contributes to the great diversity in appearance and texture which helps to form the unique features of Euclid Creek. The oldest layer exposed in the Euclid Creek watershed includes the Chagrin Shale. While dating back almost 400 million years ago, the Chagrin Shale extends from several hundred feet below the surface of Lake Erie, to approximately 175 feet above the lake. As this material weathers, it becomes soft and mud-like in texture.

The next layer of bedrock is the Cleveland Shale which is characterized as a hard, brittle shale that weathers into thin, sharp-edged sheets. This layer measures approximately 40 feet in thickness. The next layer of bedrock includes the Bedford Formation, which is home to the greatly valued deposits of Euclid Bluestone. This material was quarried extensively throughout the end of the 19th century for use of in numerous building applications, many of which can be seen throughout the watershed today as in older sidewalks. Also included

in this formation is a combination of red shale interspersed with sandstone. The Bedford Formation is approximately 60 feet in thickness.

Underlying the Bedford Formation is the erosion resistant Berea sandstone. Its resiliency has led it to contribute to the steepest waterfalls in the watershed. The final layers of bedrock are referred to as the Cuyahoga Formation including Orangeville Shale, Sharpsville sandstone and Meadville shale. This final layer includes glacial deposits and glacial erratics. The Devonian and Mississippian bedrock is covered in most places by a veneer of glacial deposits.

The Devonian rocks (Chagrin Shale through the Berea Sandstone) contain fossils deposited when the area was marine and teaming with aquatic life. The headwaters of the watershed are in elevated uplands which are part of the Allegheny Plateau. The watershed then descends to the lower Lake Plain by way of a steep gradient called the Portage Escarpment. The general relief of land was shaped by the glaciers, most recently the Wisconsin glaciers 10,000 years ago, that covered Ohio in the last ice age.

Soils

The headwaters of Euclid Creek collect on the rounded hummocky knolls and hillsides of Beachwood, Pepper Pike and Willoughby Hills. These hills were deposited as end moraines of silty and loamy glacial till during the late Wisconsin age (10-12,000 to 28,000 years before present). Over time, these materials evolved through soil-forming processes into the present day soils classified and delineated using USDA's "Soil Taxonomy" as soil series, such as, Ellsworth silt loam, Darien silt loam and associated urban land complexes. Urban land complexes of these series are mapped in areas where units are covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that identification is not feasible. The above noted soil series are very deep, moderately well to somewhat poorly drained, which means that wetness periodically restricts growth of mesophytic (upland) plants, and have permeability that range from slow to moderately slow.

The headwaters of Euclid Creek converge and traverse the gently undulating to nearly level plateau of Lyndhurst, Mayfield Heights, Richmond Heights and South Euclid. Mapped soil series, such as Allis silt loam, Hornell silt loam, Mahoning silt loam, Mitiwanga silt loam and associated urban land complexes may be found here. The precursor to these soils is silty and loamy glacial till deposited as ground moraine during the aforementioned Wisconsinan age. These soil series are moderately deep, poorly to somewhat poorly drained, which means that wetness markedly restricts mesophytic plant growth, and have permeability that range from very slow to slow.

The main stem of Euclid Creek meanders through valleys cut through glacial drift (deposited by glacial ice or outwash) and into sedimentary rock, such as sandstone and thin bedded shale and siltstone. As a result, mapped soils have evolved from variations of glacial drift, sedimentary rock and/or alluvial materials (deposited by running water). These dissected areas within the limits of Euclid, Richmond Heights and South Euclid have mapped soil series, such as Brecksville silt loam, Loudonville silt loam, Tioga loam and associated urban land complexes. These soils are well drained, which mean that wetness does not inhibit growth of mesophytic plant roots for significant periods during most growing

seasons, and have permeability that range from moderately slow to moderately rapid for Brecksville silt loam formed from sedimentary rock (residuum) and Tioga formed in recent alluvium, respectively.

Euclid Creek flows through a deltaic area of loamy fine sand lacustrine (lake) sediments of the late Wisconsinan age, ultimately discharging into Lake Erie. This final soil association begins north of Interstate 90. The Urban land-Elnora-Jimitown association is formed of water deposited materials and loamy glacial outwash. These sediments have evolved through soil-forming processes into the present day Elnora series. The Elnora loamy fine sand series is very deep, moderately well drained, and rapidly permeable.

2.2 Water Quality 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) or on the web at: (http://www.epa.state.oh.us/dsw/wqs/criteria.html).

In the Euclid Creek study area, the aquatic life use designations that apply to its segments are Warmwater Habitat (WWH) and Limited Resource Water (LRW). The section of Euclid Creek which flows between Anderson Road (river mile 5.6) and U.S. Route 20 (river mile 2.4) is also designated a State Resource Water. Waters designated as WWH are capable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms. Attainment of WQS is measured utilizing both biological communities and chemical sample analysis. 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, and requires a TMDL, whereas a stream that meets all of the biocriteria benchmarks, it is said to be in full attainment. Figure 1 depicts the attainment status of the Euclid Creek watershed. A more detailed explanation of Ohio's biocriteria can be found in the Ohio EPA publication *The Role of Biological Criteria in Water Quality Monitoring, Assessment, and Regulation* (OEPA, 1995).

Another designated use set forth in WQS is for recreational purposes. The recreational use for the majority of the Euclid Creek study area is Primary Contact Recreation (PCR). The criterion for the PCR designation is being suitable for full-body contact recreation. Ohio EPA assigns the PCR use designation to a stream unless it is demonstrated through a use attainment analysis that the combination of remoteness, accessibility, and depth makes full-body contact recreation by adults or children unlikely. In those cases, the Secondary Contact Recreation (SCR) designation is assigned. The attainment status of PCR and

SCR is determined using bacterial indicators; the criteria for each are specified in the Ohio WQS. Ohio uses both fecal coliform bacteria and *E. coli* as measures of recreational attainment.

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 Rule	This rule 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.	

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

Euclid Creek was most recently surveyed by Ohio EPA in 2000. Additional surveys were conducted in 1989. Water quality studies have been conducted in the stream by the Northeast Ohio Regional Sewer District (bacteriological, biological, chemical, and habitat), the Cuyahoga County Board of Health (bacteriological, biological, chemical, and habitat), and Cleveland Metro Parks (Headwater Habitat). Information from the Cleveland Metro Parks is currently not available.

Chemistry

The water chemistry analysis of Euclid Creek indicates that the watershed is influenced by human activities. Ohio EPA began data collection at a in 1977 at a USGS stream gaging station (USGS 04208690) located near St. Clair Road. Ohio EPA monthly sampling at the above site ended in 1981, additional chemical sampling was conducted in 1989 and 2000 as part of Ohio EPA watershed surveys.

Chemistry data was collected by the Northeast Ohio Regional Sewer District in 1987, 1989, 1991, 1996, 1997, 1998, 1999, 2000, 2002, and 2003. These data are in general agreement with Ohio EPA sampling results and make significant contributions to this relatively large pool of data.

Sampling was conducted at four sites throughout much of this time period. Lakeshore Boulevard at RM 0.7 is the most downstream site. Proceeding upstream along the mainstem is St. Clair Road (RM 1.6), Highland Park (RM 3.3) and Mayfield Road (RM 7.1). The East Branch of Euclid Creek is also a standard sampling site, located near its mouth in Euclid Creek Metropark.

Trends observed in the water quality data generated from 1977 through 2003 show reductions in a number of pollutants. Some of this is due to elimination of illegal and illicit discharges from industrial sources. Also, a number of sewage treatment plants discharges have been eliminated by connection to larger regional facilities.

Specific water quality parameters are discussed below. Available water quality data is included as Appendix D and E.

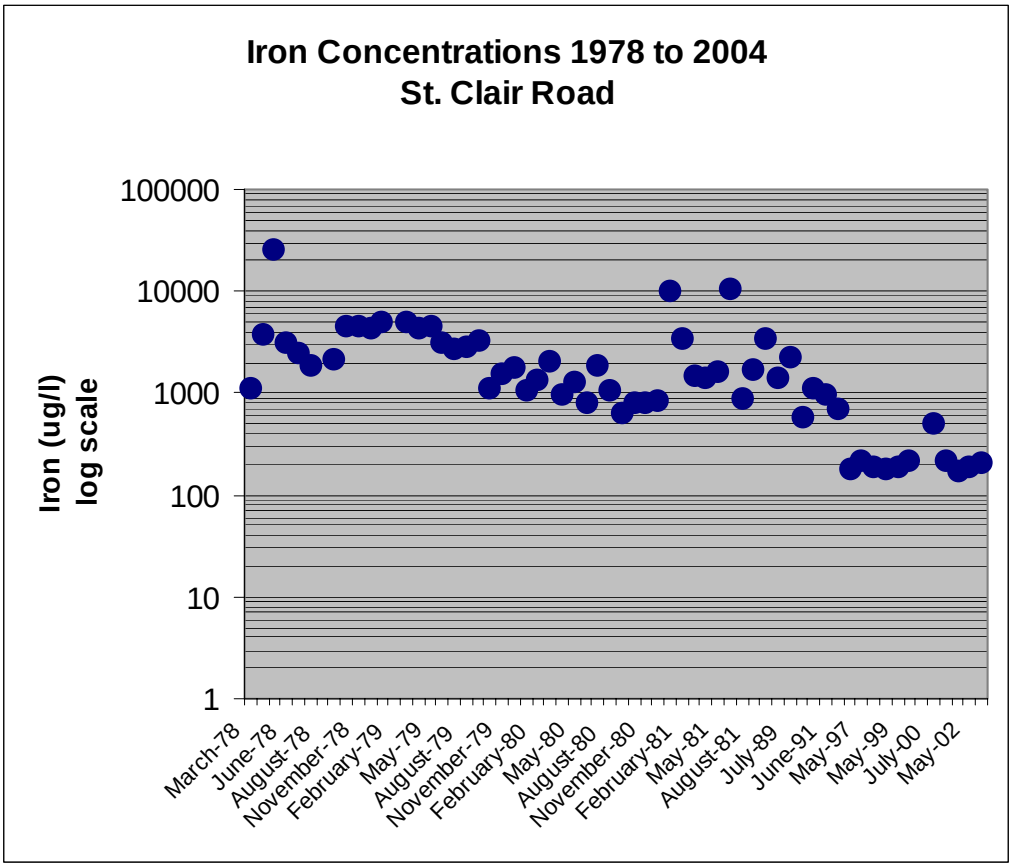

Figure 2 - Iron Concentrations

Iron

Iron had been detected at elevated levels in earlier sampling events. As indicated by the graph (Figure 2) reductions have occurred. This is most likely due to the elimination of several illegal discharges to the stream. There is no water quality standard for iron. Extremely elevated iron concentration can negatively impact biological communities. Current iron concentrations are similar to other streams in the area.

Conductivity

Conductivity, while not a direct chemical measurement, can be an indicator of cumulative impacts. Increased impervious area results in higher conductivity due to runoff of salts in the winter and additional ions in the summer (e.g., from fertilizers). Conductivity can also be used as a surrogate to determine if the water quality standard for total dissolved solids (TDS) is met. The TDS standard is 1500 mg/l which is equivalent to a specific conductance of 2,400 microhms at 25° C. The graph in Figure 3 depicts monthly conductivity values collected from 1977 to 1981 at the St. Clair Road site. It shows a cyclical pattern with increases observed during the winter, as might be expected due to salt runoff from deicing activities. Specific conductivity results collected by Ohio EPA during the sampling season (June - October 2000) are at levels found in other streams in the area. The monitoring plan recommends establishing a weekly or bimonthly sampling regime to gather additional data

for this parameter to determine if seasonal fluctuations exist. This data is needed to determine if deicing activities are a stressor to the aquatic system.

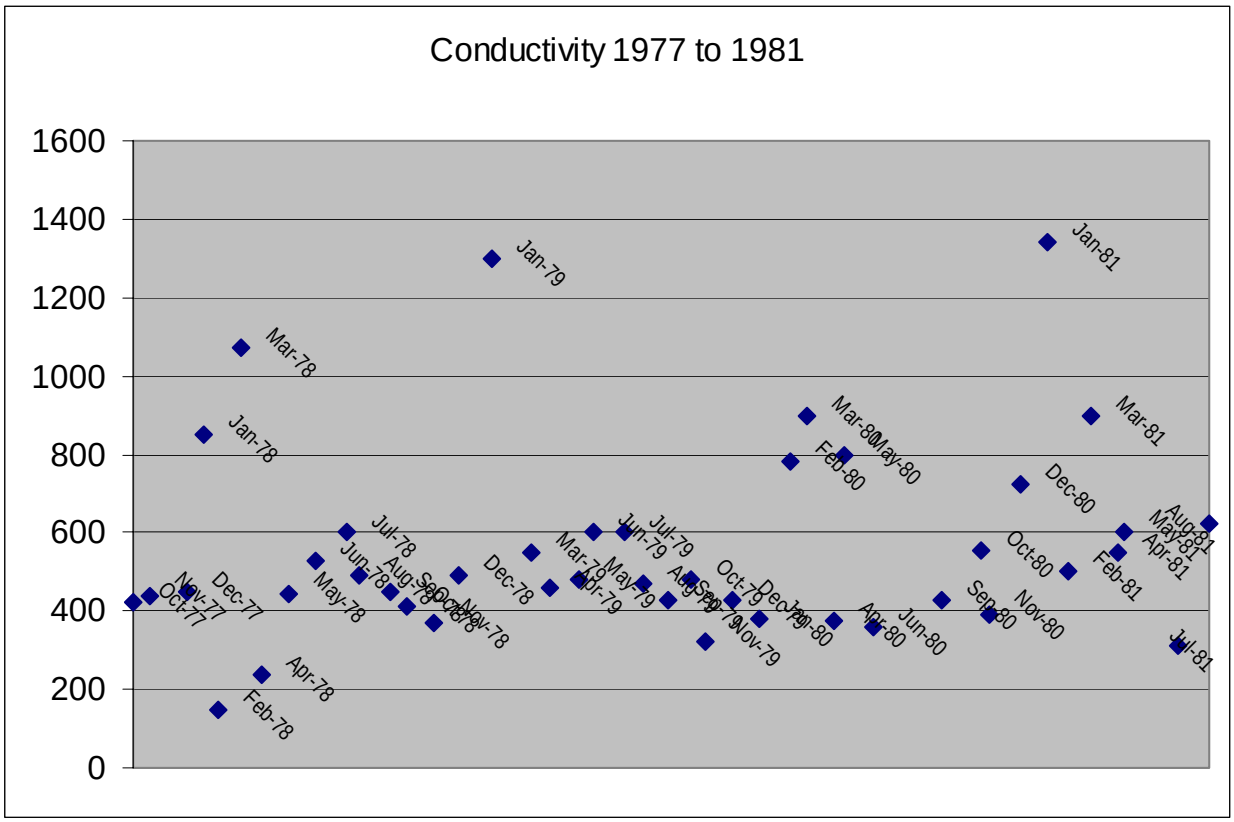

Figure 3 - Euclid Creek Historic Conductivity

<u>Phosphorus</u>

Data collected for phosphorus indicate a decrease in concentration from 1977 to present. Much of this is due to better control of sewer systems and elimination of wastewater treatment plant discharges. Phosphorus continues to be detected at levels which are above concentrations associated with aquatic system impacts. Concentrations were highest at the East Branch site. A target level of 0.07 mg/l has been established (Section 3.1). Of the sites sampled in 2000, 60% were above the target, compared to the time period 1977 - 1989 when 78.5% of the sites were above the target. Median phosphorus concentrations have decreased by almost 50%: from 0.19 mg/l for the time frame 1977-1989 to 0.1 mg/l for the 2000 assessment. Of the sites sampled by NEORSD in 2002 and 2003, 30% were above the target level.

<u>Biological</u>

Both fish and aquatic macroinvertebrate communities show signs of impairment. As previously mentioned, Ohio EPA utilizes these organism groups to determine compliance with Ohio's water quality standards.

Fish

Fish communities exhibit low diversity and a high percent composition of tolerant species. Top carnivores are also generally absent from sampling sites, a sign of disturbed systems. Darters are also absent from Euclid Creek, they can be normally found in healthy streams. Fish IBI scores range from 24 to 32 within the basin, all are below the applicable biocriteria standard of 38 for wading sites. The modified Index of Well Being (MIwb), used to evaluate functional stability of the fish community, also show scores below applicable Miwb standard of 7.9. Euclid Creek is considered a headwater stream (<20 mi^2 drainage area) for part of its watershed. The MIwb is not utilized for headwater streams.

It should be noted that the number of species collected downstream of a dam located on the mainstem was consistently greater than the number of species located above the dam. Data from Ohio EPA biological survey work is presented in Appendix A.

Macroinvertebrates

While the fish communities remain impaired, macroinvertebrate communities are in attainment for the lower watershed and in nonattainment for the upper watershed. Ohio EPA has found that macroinvertebrate communities can recover faster than fish communities, a similar trend has been observed in the Cuyahoga River. The lower two sites on Euclid Creek (RM 0.7 and RM 1.8) are meeting the water quality standard of 34 (Invertebrate Community Index, ICI). The Lake Shore Boulevard site (RM 0.7) had a score of 32 which is considered a nonsignificant departure from the water quality standard of 34. Samples collected by the NEORSD also show similar results. The upper watershed sites at Mayfield Road and Euclid Park Blvd. (RM 7.1 and 3.7 respectively) are in non attainment. The Mayfield Road site (RM 7.1), when sampled by NEORSD, in 1998, had an ICI score of 36.

Samples tend to be dominated by tolerant groups such as oligochetes and midges and contain low numbers of the more sensitive mayfly, caddisfly, and stonefly (EPT) taxa.

Dissolved Oxygen

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. Sampling conducted in 2000 by Ohio EPA and by the NEORSD in 2000, 2002, and 2003 indicate that dissolved oxygen criteria are consistently met. The presence of CSOs, wastewater treatment plants, and septic tanks within the watershed most likely contributed to this listing in the 303(d) report. Dissolved oxygen will not be addressed in this TMDL report as recent evaluations indicate it is no longer a problem. This TMDL will not address dissolved oxygen.

Bacteria

Euclid Creek has historically experienced numerous violations of the bacterial water quality standards. Causes of this included unsewered areas, numerous small wastewater plants (since eliminated), combined sewer overflows, urban run-off, and frequent sewer breaks or other maintenance issues.

Recent fecal coliform bacteria concentrations at the five sites historically sampled indicate that fecal coliform bacteria levels have decreased to the point where they meet the water

quality standard. Samples collected by the Cuyahoga County Board of Health have been more extensive in nature and indicate that there are still problems in many of the smaller tributaries in the watershed. Current there are efforts to bring sanitary sewers into these areas and eliminate septic system discharges.

2.3 Causes and Sources of Impairment

The primary determination of impairment in rivers and streams in Ohio is straightforward – the biocriteria standards which 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, 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) along 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.

The Euclid Creek watershed is impacted by nonpoint sources (e.g., runoff from urban areas, septic tanks) and combined sewer overflows (lower 1.6 miles). The lower Euclid Creek main stem receives combined sewer overflows from the Northeast Ohio Regional Sewer District. Sewage treatment plant point source discharges have been eliminated from the watershed. The final permitted WWTP discharging into Euclid Creek, Lake County Pleasant Hills was eliminated in June 2004. Other treatment plants, Cuyahoga County Scottish Highlands and Cuyahoga County Richmond Park, had been eliminated prior to the 2000 Ohio EPA survey. There are no effective NPDES permits existing within the watershed with NPDES permitted loads for pollutants of concern (phosphorus). A recently identified unpermitted discharge in the East Branch has been issued a draft NPDES permit. The 4,000 gpd sewage treatment plant is owned by the Willoughby Eastlake City Schools. It is anticipated that sewers will be available within three years at which time the plant will be eliminated. CSO permitted outfalls do not have associated wasteloads. A list of NPDES permits in the basin is included as Appendix H.

Physical habitat attributes in much of the free flowing main stem and tributaries show some characteristics of high quality which typically include natural stream morphology, 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 and sediment production which impacts aquatic life.

In addition to increasing volumes of sewage needing treatment, changing land use patterns are altering the types of non point pollutants and the rates at which they are discharged

within the watershed. Most sewage within the basin is treated outside the basin boundaries. The land use distribution for the watershed is shown in Figure 4 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 accelerated rates and volume of runoff that contribute a variety of pollutants including solids, nutrients, oils, increased temperature, and pesticides to streams.

Predicting the degree which a specific source results in water quality impairment can be difficult in a watershed with multiple sources. Some impairments, such as dams, are more easily assigned a magnitude. A dam blocks fish passage for non-salmonids upstream. Removal of a dam can result in attainment if it is the source of impact and other upstream contributions are nonexistent or moderate in their impacts. Other sources and impairments are more difficult to assess.

Combined sewer overflows cause water quality impairments, but assigning a magnitude of impact is also difficult because it varies with rainfall and river stage. 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 operates a few times per year at very high stream flows. As the NEORSD combined sewer overflows become better controlled, water quality improvements are expected to follow. The sewer overflows impact only the lower 1.6 miles of stream.

Habitat changes associated with man-induced impacts can be very great. Parts of this watershed have been channelized, bank surfaces hardened, and smaller tributaries culverted. These negative impacts continue today. Riparian vegetation is compromised or removed which adds to channel destabilization and increased sediment production. Construction in the floodplain can also further impact the stream. In an effort to protect structures within in the floodplain the stream has been channelized or dredged. Dredging streams exacerbates problems associated with high flow events. Ongoing, long-term maintenance of the dredged area is required. Dredged channels tend to incise more rapidly and cause bank failure which adds both suspended material and bedload to a stream. Maintaining a healthy stream corridor and controlling impervious surfaces helps to address storm water management issues.

Development practices often result in the destruction of soil structure which only exacerbates urbanization impacts. Soil structure is an often overlooked, under appreciated component of a watershed. The infiltration rate and storage capacity associated with an undisturbed site is much greater than that found in a typical compacted construction site. Natural infiltration will help to moderate high flow and maintain base flow. Urbanized streams lose some ability to self-regulate following storm events. The result of this rapid runoff, accelerated by increased impervious surface areas are flash flows associated with a lower base flow. These extremes in high and low flows stresses both physical habitat

and biological communities. Long-term temperature changes can also occur in urbanized streams caused by decreased base flow and increases in heated runoff from pavements and storm ponds due to solar insolation and riparian removal.

Table 4. Land use distribution in the Euclid Creek Basin

Land Use	Acres	% of Total
Streams / Open Water	19.011	0.13
Agricultural / Open Urban	2761.105	18.87
Urban	4562.9135	31.18
Wooded	4581.5983	31.31
Suburban	2531.0453	17.30
Shrub / Scrub	36.4845	0.25
Barren	99.2268	0.68
Unknown	41.7429	0.29
Total:	14633.1273	

Table 4a
Park land in the Euclid Creek TMDL Area (in TMDL watershed area)

	Acres	% of TMDL Area
Cleveland Metroparks	345	2.3

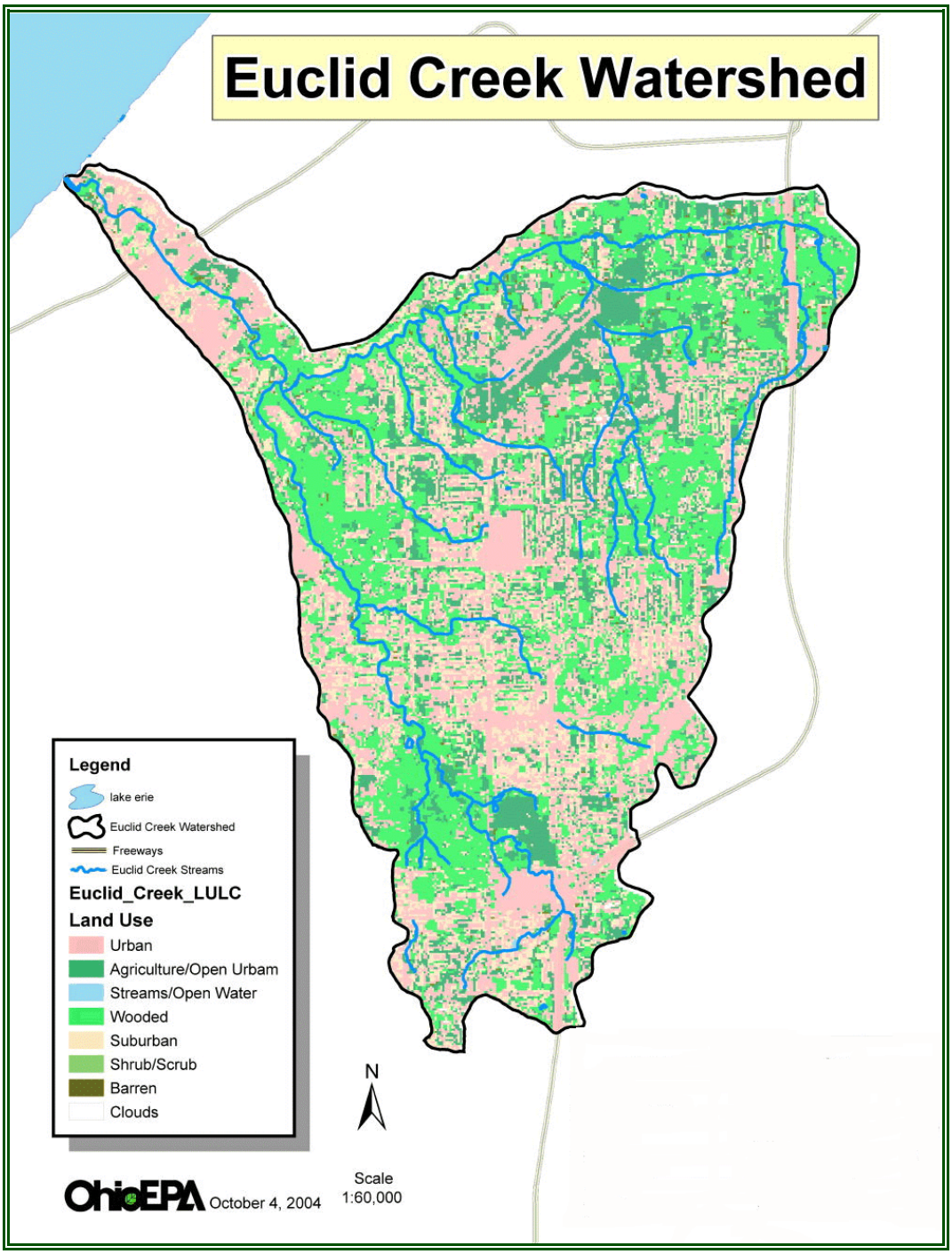

Figure 4 - Land Use Map

3.0 PROBLEM STATEMENT

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

3.1 Target Identification

The establishment of load reduction and habitat improvement goals (or targets) is a significant component of the TMDL process. 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>Biocriteria</u>
Biocriteria are the final arbiter of attainment of a use designation. Once 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 Table 5.

Table 5 - Euclid Creek Biological Attainment Table (2000 Ohio EPA Data)

River Mile Fish/Invert.	IBI	MIwb[a]	ICI[b]	QHEI	Attainment Status	Comment
Euclid Creek (19-041)						
			WWH Use Designation (Existing)			
7.1[H]/7.1	32*	na	F*	55.5	**NON**	At SR 322 (Mayfield Road)
3.3[H]/3.7	28*	na	F*	53.0	**NON**	At Euclid Park Blvd.
1.6[w]/1.8	24*	5.7*	40	70.0	**NON**	St. Clair Ave.
0.7[w]/0.7	24*	7.2*	32[ns]	68.0	**NON**	Lake Shore Blvd.
East Branch Euclid Creek (19-056)						
			WWH Use Designation (Existing)			
0.2[H]/0.1	30*	na	MG[ns]	58.0	PARTIAL	At mouth

Ecoregion Biocriteria: Erie/Ontario Lake Plain (EOLP)

INDEX - Site Type	WWH	EWH	MWH[c]
IBI - Headwaters	40	50	24
IBI - Wading	38	50	24
IBI - Boat	40	48	24
Mod. Iwb - Wading	7.9	9.4	6.2
Mod. Iwb - Boat	8.7	9.6	5.8
ICI	34	46	22

* Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.
ns Nonsignificant departure from biocriteria (≤4 IBI or ICI units, or ≤0.5 MIwb units).
a The Modified Index of Well-being is not applicable (na) to headwater site types (<20 sq. mi.).
b A qualitative narrative evaluation based on best professional judgement and sampling attributes such as community composition, EPT taxa richness, and total taxa richness are used when quantitative macroinvertebrate data are not available to derive an ICI score (F-fair, MG-marginally good)
c Modified Warmwater Habitat criteria for channel modified habitats.
H Headwater site type
W Wading method

Nutrients

Numeric targets are derived directly or indirectly from state narrative and 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 6. 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. Nitrate targets are consistently met within the watershed.

A phosphorus target of 0.07 mg/l was chosen for this watershed. The entire watershed is greater than 20 mi^2. It has been shown that habitat quality also influences a streams ability to process nutrients. This TMDL also focuses on habitat quality, both instream and riparian. It is anticipated that improvements in habitat coupled with phosphorus reductions to the target level will result in aquatic biological community attainment.

Table 6 - Nutrient Targets

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 mi^2 <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	1.00
Wadable	>20 mi^2 <200 mi^2	1.05
Small Rivers	>200 mi2 <1000 mi^2	1.42

<u>Habitat</u>

Habitat loss has been identified as a cause of impairment in the Euclid Creek. 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 six habitat components need to be improved to reach the QHEI target score. The "substrate"

parameter accounts for the source and texture of the sediment and its proportional distribution an the substrate. It also accounts for the overall quality of the substrate in the embeddedness metric. These measurements provide a numeric target for sedimentation.

The Warmwater Habitat use designation QHEI target is 60. In addition, since habitat is strongly correlated with the IBI biocriteria, 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 Euclid Creek TMDL area. Targets for habitat characteristics for Euclid Creek are presented in Table 7 and have been taken from the technical report entitled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (OEPA, 1999). Ohio EPA QHEI data is presented in Appendix C. 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 . 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

Table 7 - Habitat Targets

Area of Concern

Euclid Creek 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 Euclid Creek 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.

3.2 Identification of Current Deviation from Target

<u>Bacteria</u>
Fecal coliform violations have been detected at sites in the Euclid Creek TMDL area, most recently in 1997 at St. Clair Road. 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.”

Water quality standards also exist for *E. Coli* bacteria. The 2003 sample results collected by NEORSD indicate *E. Coli* violations of the maximum standard of 298 mpn (10% of samples in a 30 day period). Samples collected during 2003 were also collected during a year of higher than average stream flows. When evaluating this data it should be noted that water quality standards require 5 samples in a 30-day period to determine a geometric mean violation. None of the data collected for bacteria meet this test. At this time additional data is needed to determine if an actual water quality standard violation is occurring in Euclid Creek. This TMDL does not address bacteria.

<u>Habitat</u>
Deviations from habitat goals are those QHEI values less than 60 for Warm Water Habitat streams. The graph in Figure 5 lists Euclid Creek QHEI scores. Sections of Euclid Creek have had habitat impacts associated with dredging, bank hardening, excess bedload, and culverting.

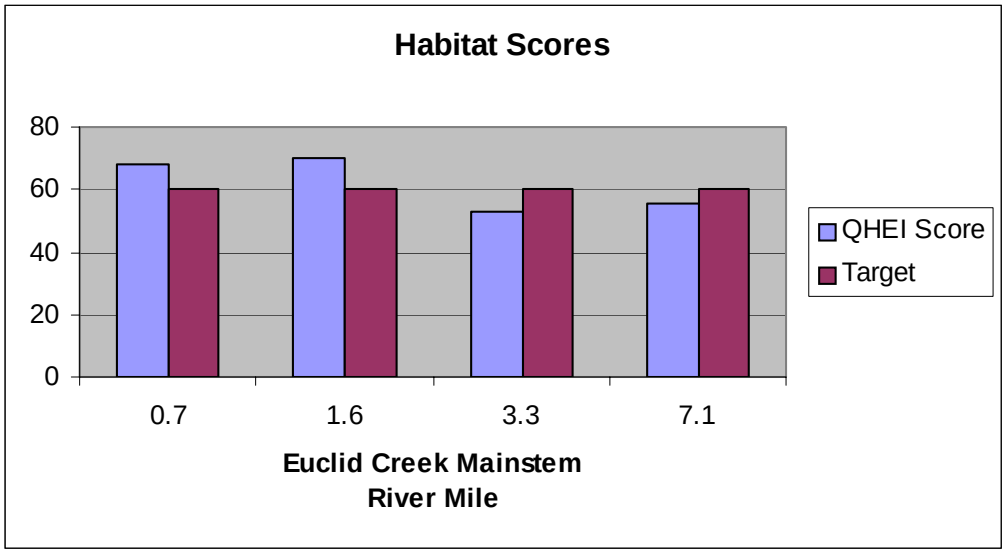

Figure 5 - Euclid Creek QHEI Scores

Phosphorus

Target phosphorus values are those discussed in Section 3.1 and presented in Table 6. The phosphorus target is 0.07 mg/l. Achieving this TMDL target, in conjunction with recommended habitat improvements, dam removals, and the implementation of Phase II storm water programs, should result in attainment of applicable biocriteria standards.

Biocriteria

The most recent biological survey conducted by Ohio EPA found that Euclid Creek is not meeting biological criteria set forth in Ohio Water Quality Standards, as previously noted in Table 5. 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 8 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*). The Beneficial Use Impairments are currently being reviewed by a working group. It is possible that in the near future specific use impairments may be revised. Delisting procedures for use impairments are also under development. The TMDL may be revised to include changes when they become finalized.

Table 8– 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.*

Table 8 (cont.)

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*

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 navigation 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.

Table 8 (cont.)

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

Combined sewer overflows contribute oxygen demanding substances, nutrients, pathogens, and other pollutants to the Euclid Creek TMDL area. Combined sewer overflows are part of the Northeast Ohio Regional Sewer District.

The Northeast Ohio Regional Sewer District has one service area which discharges combined sewage to the Euclid Creek TMDL area (see Figure 6). Discharges of combined sewage occur only in the lower 1.6 miles of Euclid Creek and do not influence areas upstream.

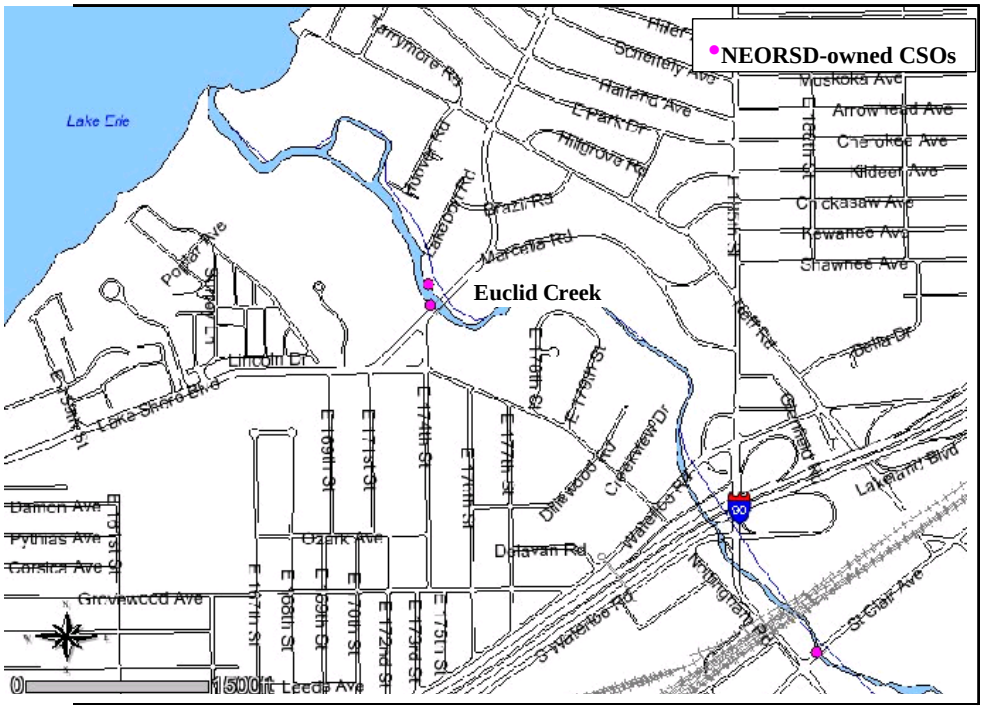

Figure 6 - Northeast Ohio Regional Sewer District Combined Sewer Overflows Tributary to Euclid Creek

Failing or malfunctioning home sewage disposal systems are also identified as a source contributing to non-attainment in the Euclid Creek TMDL area. Home sewage disposal systems consist of both on-lot (e.g. 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. A map of septic systems in the watershed is included as Figure 7. Approximately 494 septic systems exist within the watershed.

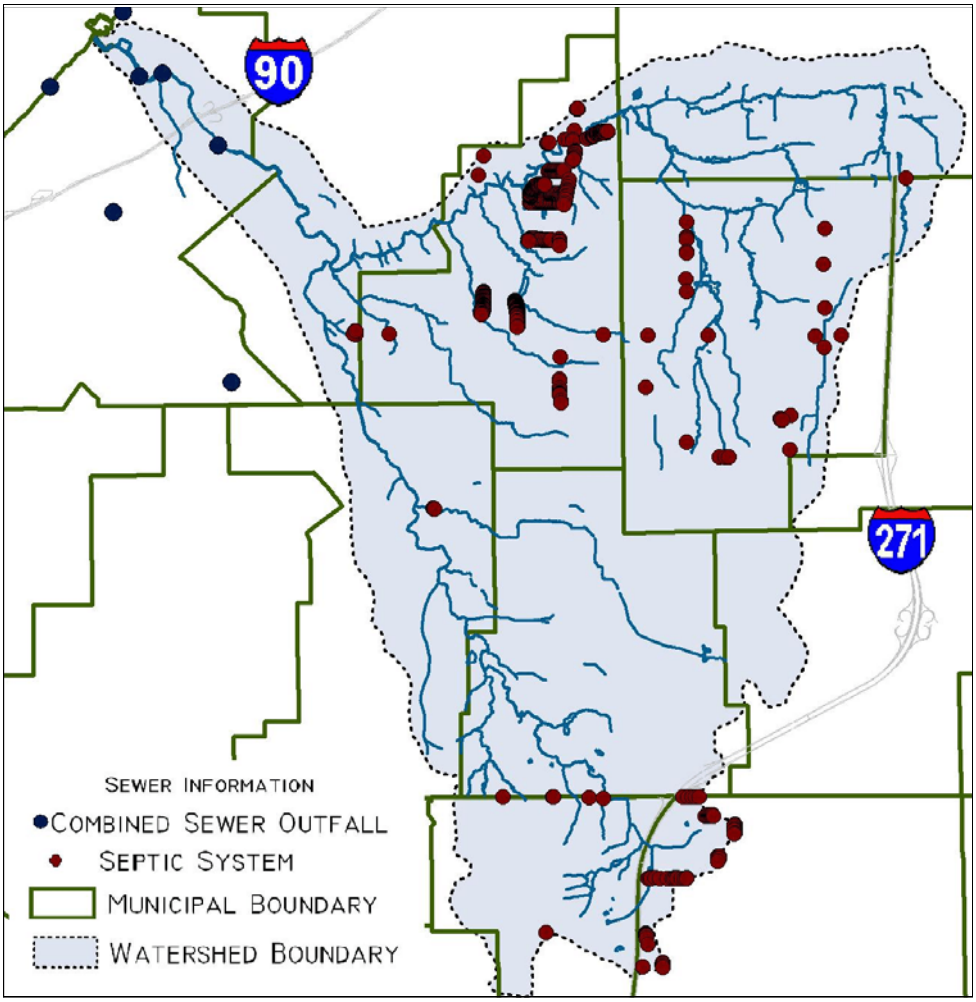

Figure 7 - Septic Systems in the Euclid Creek Watershed

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

Dams also cause water quality impacts in the Euclid Creek TMDL area. Adverse impacts from dams can include a change in thermal and hydraulic regime, chemical water quality degradation, and impaired habitat in the stream. Dams also impede or block migration routes of native fish.

There are currently five identified dams within the watershed. The dams do not serve to generate power nor do they provide flood control. Some of the dams impound water for golf clubs and have aesthetic and irrigation water supply functions. All dams in Euclid Creek should be evaluated for removal.

Changes in the watershed have also impacted the hydrology and nature of runoff events. Increases in impervious surfaces coupled with riparian zone impacts have created a stream system subject to rapid fluctuations in flow volume. This flashiness can accelerate streambank degradation and create additional hydrologic problems. Responses to

changes in runoff patterns including channelization often serve to exacerbate the magnitude of problems and cause an accumulation of downstream impacts such as excess sediment resulting in siltation.

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 (U.S. EPA, 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 exceedences occur. The TMDL also utilizes the U.S. EPA model STEPL (U.S. EPA, 2004) to allocate nonpoint source loads within the watershed. Groundwater load allocations were generated utilizing the USGS HYSEP (USGS, 1996) sliding-interval method.

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). 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 (Ohio EPA, 1999) .

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 (Hynes, 1970).

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 phosphorus pollutant loads and improving 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 is identified as a cause of impairment in this watershed. TMDLs are calculated for phosphorus (see Table 10). Many implementation actions to reduce phosphorus are geared toward reducing sediment since the primary mechanism will also reduce sediment loads since phosphorus binds to sediment as a delivery mechanism to the stream.

Degraded or poor habitat is also a non-load based cause of impairment in the Euclid Creek 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 used to initially examine phosphorus in relation to stream flow for this TMDL. The 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 causes of impairment;
- All types of pollutant sources are considered which is the intent of the TMDL process;
- Yearly, seasonal, and daily variations are captured; and,
- A clear and understandable method which provides a framework with which to communicate data and results to stakeholders and other interested parties.

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 (Figure 10).

LDCs provide guidance and a framework with which to express load allocations. Other techniques that are described in Sections 4.2.2, 4.2.3 and 4.2.4 were also used in determining load allocations and were selected based on their suitability relative to the causes and sources of impairment, the level of load reduction, and the available data.

4.2.1 TMDL Development: Load Duration Curve

The first step of this method is to calculate a flow duration curve using continuous flow data at the stream 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 8 illustrates a flow duration curve using data from the Euclid Creek at the St. Clair Road 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 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 (Figure 9). 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 target used in the development of the phosphorus load duration curves was 0.07 mg/l.

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

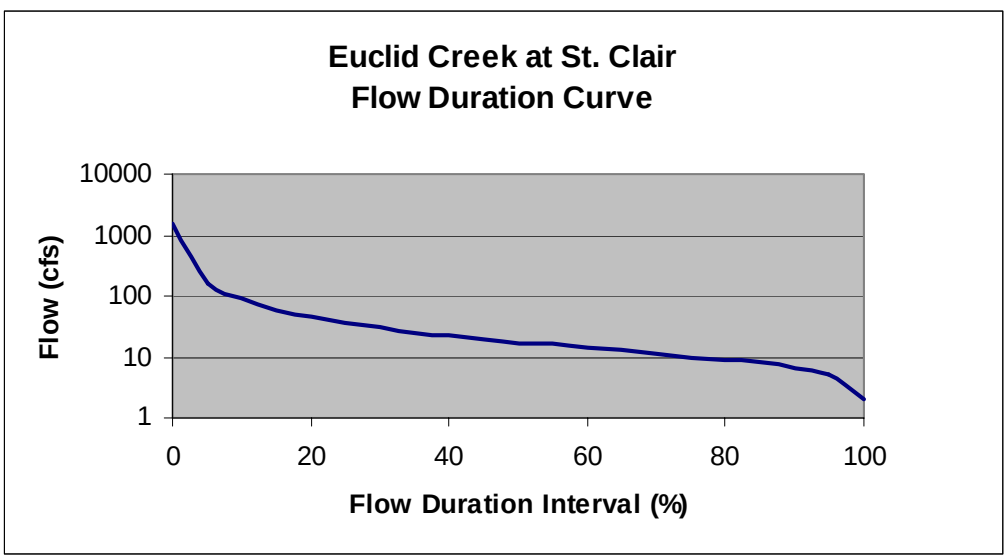

Figure 8 - Euclid Creek flow duration curve

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 exceedences from the target load, and points on or below the curve indicate when the target is being met. This is demonstrated in Figure 9. These

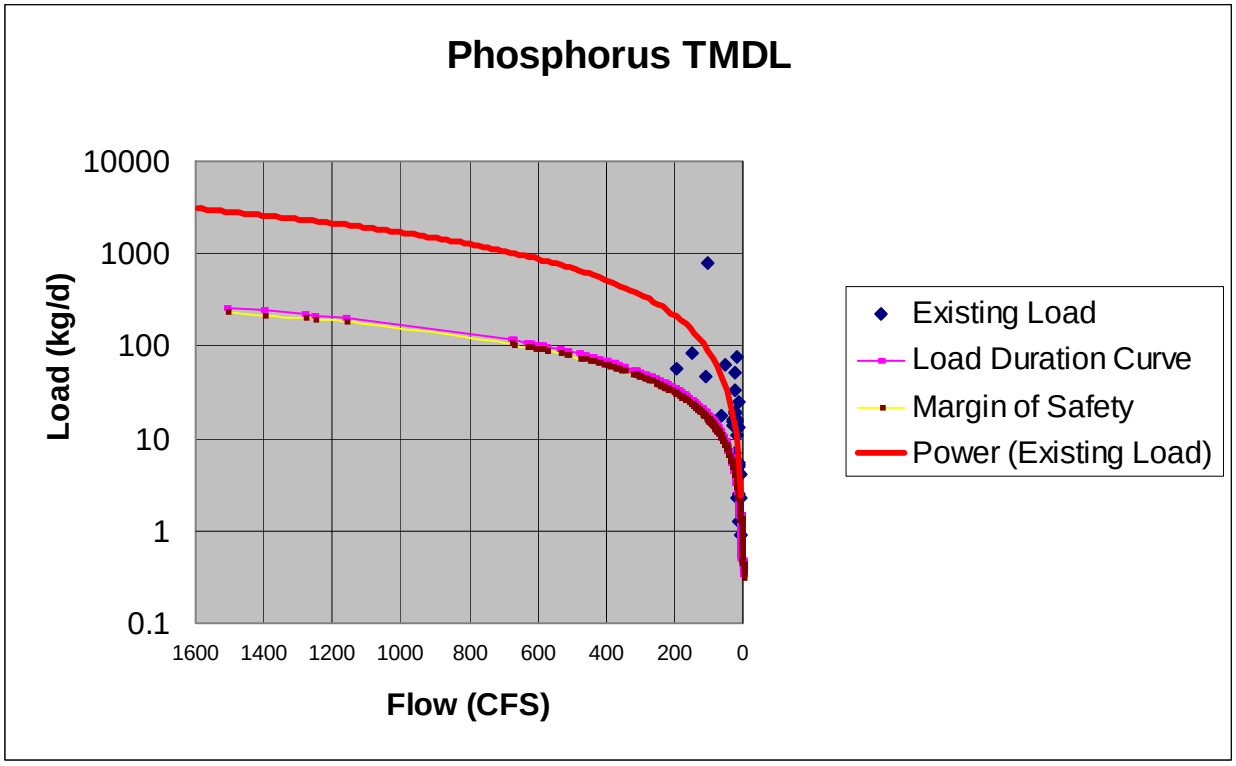

Figure 9 - Load Duration Curve

graphs show that the total phosphorus TMDL is not being met at all flow conditions under either daily or summer conditions. Existing loads at flows greater than 200 cfs were computer generated from the data.

4.2.2 TMDL Development: STEPL Model

The Spreadsheet Tool for Estimating Pollutant Load (STEPL) employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). STEPL provides a user-friendly Visual Basic (VB) interface to create a customized spreadsheet-based model in Microsoft (MS) Excel. It computes watershed surface runoff, nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5), and sediment delivery based on various land uses and management practices. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

The STEPL model was chosen based on several criteria. A key factor influencing model selection was compatibility with work currently done for Watershed Action Plan. STEPL has been utilized for watershed plans and is an accepted model for 319 grant projects (such as Euclid Creek). The model allows for easy demonstration of loading reductions utilizing different BMPs at a subwatershed level. Currently there is one draft NPDES permit within the Euclid watershed for a 4,000 gpd sewage treatment plant. Phosphorus is the

pollutant currently above target levels. Reductions in phosphorus will be achieved by septic tank elimination and BMPs, both which are addressed by STEPL.

The STEPL model utilizes land use data, precipitation data, and runoff concentrations to generate annual loading for phosphorus, nitrogen, biochemical oxygen demand, and suspended solids. Output of the model includes tables and graphs depicting loadings with and without BMP implementation. Additional discussion of the model is presented in Appendix B.

4.2.3 Habitat, Siltation, and the QHEI

Description of Method

The QHEI is a quantitative expression of a qualitative, visual assessment of habitat in free flowing streams, and was developed by the Ohio EPA to assess available habitat for fish communities (Rankin 1989, 1994). It is a composite score of six physical habitat categories: 1) substrate, 2) in-stream cover, 3) channel morphology, 4) riparian zone and bank erosion, 5) pool/glide and riffle/run quality, and 6) gradient. Each of these categories are subdivided into specific attributes that are assigned a point value reflective of the attribute's impact on the aquatic life. Highest scores are assigned to the attributes correlated to streams with high biological diversity and integrity and lower scores are progressively assigned to less desirable habitat features. A QHEI evaluation form is used by a trained evaluator while in the stream itself. Each of the components are evaluated on site, recorded on the form, the score totaled, and the data later analyzed in an electronic database. QHEI scores can range from 12 to 100. Scores greater than 75 indicate excellent stream habitat, scores between 60 and 75 indicate good habitat quality, and scores less than 45 demonstrate habitat not conducive to WWH. Scores between 45 and 60 need separate evaluation by trained field staff to determine the potential aquatic life use for the stream.

In free flowing typical riverine streams, a concept analogous to a loading capacity for habitat is the use of a target QHEI score. The appropriate target QHEI score was determined by statistical analysis of Ohio's statewide database of paired QHEI and IBI scores. Simple linear and exponential regressions and frequency analyses of combined and individual components of QHEI metrics in relation to the IBI were examined. The regressions indicated the QHEI is significantly correlated with the IBI with the exponential model providing a better fit to the data than the linear. Sites with QHEI scores greater than or equal to 60 were generally associated with IBI scores supportive of a WWH use designation.

Further analysis of the QHEI components as they relate to IBI scores led to the development of a list of attributes that are associated with degraded communities. These attributes are modifications of natural habitat and were classified as high influence or moderate-influence attributes based on the statistical strength of the relationships. The presence of these modified attributes can strongly influence aquatic biology to a degree which the QHEI score itself may not reflect. The analysis indicates that a stream with more than one high-influence or more than four moderate-influence attributes usually precludes attainment of the WWH biocriteria (using an IBI of 40 as a representative WWH biocriterion). The implication of which is a stream segment can be impaired even with a QHEI score above 60 (because other less-influential habitat components are in place).

The habitat TMDL equation presented below reflects the relationship between the QHEI score, modified attributes, and aquatic community performance. It is based upon a target of three (3), and is the sum of three component scores. Individual component scores exist for the observed QHEI score to target QHEI score ratio, and for the presence/absence of high and/or moderate-influence attributes. A QHEI score less than the target, the presence of more than one high-influence attribute, or more than four moderate-influence attributes will prevent a stream segment from achieving the target.

The sediment TMDL equation presented below is a subset of those factors of the QHEI most directly related to sediment type, quality, build up, and source origin. The sediment TMDL is based upon a target score of 33, which is analogous to a loading capacity. The individual components of the sediment TMDL (substrate, channel, and riparian) have individual targets that are analogous to allocations.

- Habitat TMDL = QHEI Score to Target Ratio + Modified Attribute Score + High Influence Attribute Score
  = 1 + 1 + 1
  = 3

- Sediment TMDL = Substrate + Channel Morphology + Riparian Zone/Bank Erosion
  = 14 + 14 + 5 (minimum numbers)
  = 33 (greater than or equal to)

Table 9 provides additional detail describing the habitat and sediment TMDLs.

Table 9 - Details of Habitat and Sediment TMDLs

QHEI Categories		**Modified Attributes**			
Category	Target	High Influence		Moderate Influence	
Substrate	≥14	• Channelized or No Recovery • Silt/Muck Substrate •Low Sinuosity • Sparse/No Cover • Max Pool Depth < 40 cm		• Recovering Channel • Sand Substrate (boat sites) • Hardpan Substrate Origin • Fair/Poor Development • Only 1-2 Cover Types • No Fast Current • High/Moderate Embeddedness • Ext/Mod Riffle Embeddedness • No Riffle	
Channel	≥14				
In-Stream Cover	≥12				
Riparian	≥5				
Pool/Current	Sum of these ≥15				
Riffle/Run					
Gradient					
QHEI Score	≥60				
QHEI to target ratio ≥1	+1	One or less high influence attributes present	+1	Four or less moderate influence attributes present	+1

Method Evaluation and Assumptions

The QHEI is a macro-scale approach that measures the emergent properties of habitat (sinuosity, pool/riffle development) rather than the individual factors that shape these properties (current velocity, depth, substrate size). 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.

This method assumes that the significant variables that influence fish communities are included in the index, and that the index is able to distinguish between the relative effects of habitat versus water quality issues. The index is empirically derived and assumes that the empirical relationships remain similar for streams of similar size and type within an ecoregion. The evaluation is somewhat subjective and requires the evaluator to be experienced in the use of the index. The variability between evaluations from different trained investigators and the variability in time at a particular site have been determined to be minimal within the same season and if the investigators are experienced with the method (Rankin, 1989).

The QHEI provides a thorough evaluation of the physical habitat in a quantitative manner. Many of the metrics which comprise the QHEI are surrogate measures of load-based stressors. Some of the metrics may also provide a measure of a cause of impairment, such as the substrate category as a measure of siltation, or the QHEI itself when habitat

is listed as the cause of impairment. Because habitat is strongly correlated with the IBI biocriterion, the QHEI can be an indicator for pollutants such as sediment. Therefore, the QHEI can provide a numeric target and framework to help evaluate how habitat or surrogate issues affect attainment of the aquatic life use designations.

The empirical nature of the QHEI and the data that underlie it provide measurable targets that are parallel concepts to a loading capacity for a pollutant. The components provide a way to evaluate whether habitat is a limiting factor for the fish community and which attributes are the likely stressors. It can assess both the source of the sediment (riparian corridor, bank stability) and the effects on the stream itself (i.e., the historic sediment deposition) and thus has aspects of both a loading model and a receiving stream model. When used with biological indices, the index provides a means to monitor progress when implementing a TMDL and to validate that a target has been reached. Because stream physical habitat quality is influenced by surrounding land use, and because non-point load reductions are accomplished by changing land uses, habitat quality can be an important measure of TMDL success even when degraded habitat is not the cause of impairment.

Siltation has not historically been listed as a high magnitude cause of impairment in Euclid Creek. As development in the upper watershed increases it is anticipated that siltation will increase in the smaller low gradient streams. The sediment TMDL will allow for assessment of this issue.

4.2.4 Phosphorus TMDL for the Euclid Creek Watershed

The TMDL for Euclid Creek was prepared utilizing the equation:

Total Maximum Daily Load (TMDL) = Waste Load Allocations ($\sum$WLA) + Load Allocations) $\sum$LA + Margin of Safety (MOS)

As was previously discussed, sewage treatment plants discharging to the stream have been eliminated. The discharge from Lake County Pleasant Hills was eliminated in June 2004. For purposes of this TMDL a WLA for Lake County Pleasant Hills WWTP was included because it still contributed phosphorus during the 2000 survey. A calculated WLA is included for the draft NPDES permit for a Willoughby Eastlake City Schools package treatment plant.

An explicit margin of safety of 10% was included in the calculations for this TMDL.

Load allocations were determined utilizing the STEPL model for surface runoff and 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 St Clair Road. The existing baseflow load was calculated by multiplying daily groundwater flow rate (from the HYSEP calculation) by the estimated groundwater concentrations of total phosphorus (0.01 mg/l).

Table 10 presents the Phosphorus Total Maximum Daily Load for Euclid Creek.

Table 10 - Phosphorus TMDL

Phosphorus TMDL for Euclid Creek				
TMDL (lb/year)	Existing Point Source Load (lb/year)	Existing Nonpoint Source Load (lb/year)		MOS (lb/year)
		STEPL	HYSEP	
5545.13	1316.6	7472.64	404.49	554.51
Reductions needed to achieve Phosphorus TMDL				
TMDL (with MOS)	WLA (lb/year)	LA (lb/year)		WLA note: Load reduction of 754.7 lbs/yr will be achieved by WWTP elimination
4990.62	229.59	3218.59		
The TMDL of 4990.62 lb/yr represents 59.14% of the total phosphorus load. A phosphorus reduction of 40.86% (3448.41 lbs/yr) is needed to achieve the TMDL goal, 754.7 lbs will be reduced by WWTP abandonment (Lake Co. plant already eliminated).				

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. The Euclid Creek watershed TMDL project has been completed utilizing the process endorsed by the advisory group.

The initial Euclid Creek TMDL stakeholders public meeting was held on October 27, 2004. Additional TMDL and Watershed Action Plan meetings were held on November 17, 2004, January 19, 2005, January 26, 2005, March 2, 2005.

A meeting on the Draft TMDL report was held on May 11, 2005. Ohio EPA issued a news release on April 29, 2005 providing notification of the May 11, 2005 meeting.

The public outreach activities also included a public comment period associated with the 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 May 5, 2005. A response summary to the public comments received is included as Appendix I in this final report.

Public involvement is key 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 Euclid Creek 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 Euclid Creek are primarily nutrient enrichment, sedimentation, and stream habitat degradation. Therefore, an effective restoration strategy would include habitat improvements and reductions in pollutant loads combined with additional stream protection through land purchase, easements, and protective riparian zoning.

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 any new point sources, 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 among all parties within the watershed.

6.1.1 Minimum Elements of an Approvable Implementation Plan

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

- Implementation actions/management measures (Table 11),
- Time line for implementation (Table 12),
- Reasonable assurances (Table 12),
- Legal or regulatory controls (Table 12),
- Time required to attain water quality standards (Table 13),
- Monitoring plan (Table 13),
- Milestones for attaining water quality standards (Table 13),
- TMDL revision procedures.

Reasonable Assurances Summary

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

Regulatory:

- Phase I and II storm water requirements
- riparian ordinances (model language is currently available from several sources)
- 208 plans- NOACA , http://www.noaca.org/Clean_Water_2000/clean_water_2000.html)
- 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 as resources are available.
- Development and implementation of a watershed action plan.

Incentive-based:

- 319-funded projects for the Euclid Creek basin which support the goals of this TMDL.
- Pursue various loan opportunities for CSO, WWTP, septic system, and riparian/habitat improvements (e.g. WRRSP, Revolving Loan Fund, Clean Ohio, conservation easements)

Implementation Actions, Time line, and Reasonable Assurances

The implementation actions and measures are described in the following section and Table 11, reasonable assurances are described in Table 12. A time line for implementation actions is included in both Tables 12 and 13.

Combined Sewer Overflow

The Euclid Creek watershed receives combined sewer overflows from 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, nutrients, suspended solids, and toxics from industrial wastewaters. The U.S. 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 i.e., 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. The Northeast Ohio Regional Sewer District must develop Long Term Control Plans to address CSOs. A long term control plan has been submitted to address combined sewer overflows in the Euclid Creek TMDL area.

While not the sole source of pollution to the watershed, CSOs have significant impacts. Addressing CSOs in conjunction with issues associated with urbanization and suburbanization will help to restore the integrity of Euclid Creek. CSOs contribute to impacts in the lower 1.6 miles of Euclid Creek.

Storm Water Management

On December 8, 1999, U.S. EPA 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 were 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. 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 ordinances 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 ordinances 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.

Storm water control measures will help to improve water quality in the Euclid Creek watershed. 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.

It is also recommended that watershed stakeholders and citizens investigate and implement, when possible, additional storm water control measures. Human induced changes have dramatically altered watershed hydrology. In most cases restoration to a pre-disturbance condition is not possible. This TMDL will list several innovative techniques which can be implemented at a local and even household level to help restore watershed functions.

Rapid runoff is associated with increases in impervious surface area. Such surfaces include roofs, parking lots, roads, as well as many grassed areas. Development often pursues a course of removing topsoil over a site prior to construction. While necessary where roads and structures are to be built, remaining areas are compacted and soil structure, essential to water retention, is destroyed. Fields and forested areas are not uniform in their surface structure. These variations allow for some areas to be lower than others resulting in what is known as depressional storage. Regrading a site removes this valuable function.

Alternate methods of managing storm water should be used when possible. Methods should be geared to address water quality and water quantity.

Rain Barrels

For residential properties the use of rain barrels (Figure 10) is encouraged. They are intended to help with storm flow control. Nutrient reduction is not associated with rain barrels as a BMP. On site use of rainwater however will aid in groundwater recharge and nutrient load reduction due to decreased overland flow, which is a dominant transport mechanism.

Rain barrels are low-cost, effective, and easily maintainable retention devices applicable to both residential and commercial/industrial sites. Rain barrels operate by retaining a predetermined volume of rooftop runoff (i.e., they provide permanent storage for a design volume); an overflow pipe provides some detention beyond the retention capacity of the rain barrel. Rain barrels also can be used to store runoff for later reuse in lawn and garden watering

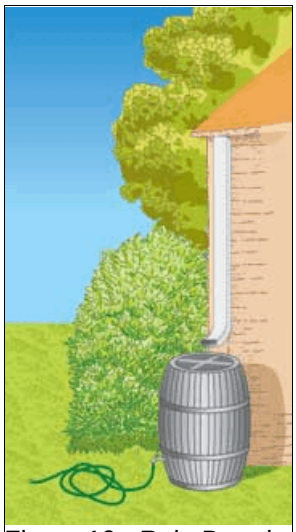

Figure 10 - Rain Barrel

Rainwater from any type of roofing material can be directed to rain barrels. To be aesthetically acceptable, rain barrels can be incorporated into the a landscaping plan, patio or decking design. Rain barrels placed at each corner of the front side of the house should be landscaped for visual screening. Gutters and down spouts are used to convey water from rooftops to rain barrels. Filtration screens should be used on gutters to prevent clogging of debris. Rain barrels should also be equipped with a drain spigot

that has garden hose threading, suitable for connection to a drip irrigation system. An overflow outlet must be provided to bypass runoff from large storm events. Rain barrels must be designed with removable, child-resistant covers and mosquito screening on water entry holes. The size of the rain barrel is a function of the rooftop surface area that drains to the barrel, as well as the inches of rainfall to be stored. For example, one 42-gallon barrel provides 0.5 inch of runoff storage for a rooftop area of approximately 133 square feet. This method is most useful for small runoff events and will help to reduce peak flows. Large storm events will generate runoff volumes greater than the available capacity of rain barrels.

Rain Gardens/Bioretention

Bioretention (rain gardens) is possibly one of the most recognized alternative storm water management practices. Used in residential, commercial, and certain industrial settings, bioretention has the potential to offer developers significant cost savings and environmental benefits over conventional storm water management systems. Bioretention areas (Figure 11) are shallow, topographic depressions filled with engineered soils and vegetation that retain, treat, and infiltrate water.

Bioretention systems are designed for the temporary storage of rainwater. They successfully remove pollutants through increased contact time with soils and plant materials. As compared with conventional storm water management systems, bioretention areas more closely mimic the natural hydrologic cycle, allowing soils and plants to filter pollutants from storm water and permitting the processes of infiltration, evaporation, and transpiration to occur. The systems can also create wildlife habitat, minimize erosion, and recharge local groundwater supplies.

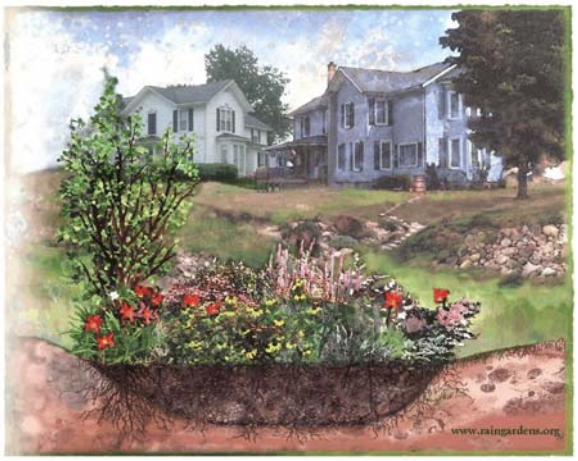

Figure 11 - Rain Garden (courtesy of Rain Gardens of Western Michigan)

In parking lots, storm water should be conveyed directly to the bioretention area through a system of grassed swales. For residential applications, treatment areas are generally located some distance away from houses to increase flow paths and treat runoff from rooftops and driveways. In either case, bioretention systems route storm water to bioretention areas that are designed to accumulate water to depths not exceeding six to12 inches. In the event that storm water volumes exceed treatment capacities, bioretention areas are usually equipped with overflow drop inlets routed to municipal storm water systems. In certain industrial and commercial areas, pollutant loadings may be too concentrated for the successful use of bioretention areas. In such areas, termed “hotspots,” the use of structural practices to infiltrate storm water may be deleterious to groundwater supplies. In these instances, designers are advised to use alternative practices, such as exfiltration trenches, to convey filtered water into a conventional storm water management system for proper treatment. A manual for home rain garden installation may be found on the internet at:

http://clean-water.uwex.edu/pubs/raingarden/rgmanual.pdf. Rain Gardens of Western Michigan also maintains an informative web page with useful information for Great Lake States (http://www.raingardens.org/Index.php).

Additional information will be presented as part of the Low-Impact Development discussion later in this section.

Evaluation of dams within the Euclid Creek watershed for removal

Adverse impacts from dams can include a change in thermal and hydraulic regimes, chemical water quality degradation, 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. Habitat quality expected in a healthy stream is degraded by impoundments by elimination of riffles, increased substrate sedimentation, and an overall decrease in QHEI scores. Dams can also impede or block migration routes of native fish.

All dams within the Euclid Creek TMDL study area should be evaluated for the feasibility of removal. The process will 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 and feasibility.

Semipublic Sewage Disposal Systems

Improperly maintained small (generally less than 25,000 gallons) sewage treatment systems can contribute oxygen demanding substances, nutrients, and bacteria to the Euclid Creek TMDL area. House Bill 110 programs are in place in Cuyahoga and Lake 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, allowing for corrective actions. 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 and failure rates can be fairly high (**Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems**, April 2001). The Euclid Creek watershed contains approximately 494 home sewage disposal systems. Ongoing programs have resulted in the elimination of systems in the Beachwood area. Additional elimination efforts are ongoing and will result in the elimination of most systems. These systems account for 10% of the calculated phosphorus load. Complete elimination could result in achieving 28% of the recommended phosphorus load reduction.

Improvements in treatment systems and elimination of discharges from unsewered areas will results in decreased 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) 208 plan.

208 Plan Updates

Currently 208 (Areawide Waste Treatment Management Plan prepared pursuant to Section 208 of the Clean Water Act) plans for the Euclid Creek TMDL area have been completed. The purpose of the plan is to address municipal wastewater treatment issues and nonpoint source pollution. The Euclid Creek TMDL area involves the Northeast Ohio Areawide Coordinating Agency (NOACA) for Cuyahoga and Lake 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 Euclid Creek 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 Euclid Creek 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.

Riparian Protection

Protection of riparian zones plays an important role in stream integrity. Small streams are able to maintain thermal regimes with riparian protection. Open streams 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 mitigate 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. 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 plan.

Evaluation of all 401/404 permit applications in the Euclid Creek 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.

Headwater Streams

Headwater streams are a critical water resource within the Euclid Creek watershed. They provide a source of perennial cold groundwater that maintains the summer baseflow of larger downstream segments and can harbor many unique species of fish, amphibians, and benthic macroinvertebrates. The Ohio EPA (2002) has developed a three tiered classification scheme for the smallest headwater streams of watersheds, termed "primary headwater habitats" (PHWH). Additional information may be found at: http://www.epa.state.oh.us/dsw/wqs/headwaters/PHWHManual_2002_102402.pdf.

Class III PHWH streams are unique water resources that may be directly connected to groundwater springs with biological communities having a large number of cold to cool water adapted species not present in other types of environments. Vertebrate species of Class III-PHWH streams include fish such as mottled sculpins, redside dace, brook stickleback and salamander species with long-lived larval periods such as the spring salamander, red salamander, and two-lined salamander. A large number of cool water and pollution sensitive benthic macroinvertebrates such as mayflies, stoneflies, and caddisflies also are uniquely adapted to the habitat conditions provided by Class III-PHWH streams (Ohio EPA, 2002). It is a recommendation of this TMDL that the location of Class III-PHWH streams should be identified within small watershed units (e.g., the HUC-14 spatial level) for the entire Euclid Creek basin using the Ohio EPA (2002) assessment techniques. Where Class III-PHWH streams are identified, all efforts should be made to ensure that their biological and hydraulic functions are protected and maintained. In situations where impacts to Class III-PHWH streams are required under Section 401 water quality certification, a high priority should be given to ensure that mitigation of impacts occurs within the local HUC-14 watershed unit. Impacts to other classes of PHWH streams should follow standard Section 401 mitigation protocols.

Watershed Action Plan

A watershed action plan is an itemization of the problems, priorities and activities the local watershed group would like to address. To access funding from U.S. EPA, Ohio EPA or ODNR, the overall purpose of the watershed plan is to restore and maintain the chemical, physical and biological integrity of waterbodies within the watershed, an objective of the Clean Water Act of 1972. Currently Euclid Creek has a funded Watershed Coordinator and a Watershed Action Plan is being developed. The process will follow guidance set forth in the Ohio EPA document: *A Guide to Developing Local Watershed Action Plans in Ohio* which may be found on Ohio EPA's website, http://www.epa.state.oh.us/dsw/nps/wsguide.pdf. Additions to the plan requirements (Appendix 8) can be found at: http://www.epa.state.oh.us/dsw/nps/NPS_WAP_APP8.pdf. The plan is scheduled to be submitted to Ohio EPA and Ohio DNR in June of 2005 for review and approval, it is available on the internet at: http://www.cuyahogaswcd.org/watershed_action_plan.htm.

Point Source Control

Adequate point source control mechanisms shall be utilized for all existing and proposed direct discharges in the Euclid Creek TMDL area. NPDES permits for existing and proposed point sources shall be prepared and issued with limits and conditions necessary to protect and restore water quality in the Euclid Creek TMDL area. When appropriate, Ohio EPA shall take enforcement actions necessary to maintain compliance with discharge

permit limits. Currently there are no permitted publicly-owned NPDES sewage treatment plants in the watershed. A draft permit has been recently issued to an existing previously unpermitted discharge. The 4,000 gpd package plant has an estimated WLA of 24.35 lbs./year of phosphorus. This discharge is anticipated to be eliminated within three years when sewers become available. Phosphorus is not contained as a permit based load limit in any current permits.

Low Impact Development

The following discussion was taken from "Low-Impact Development Design Strategies An Integrated Design Approach", Prince George's County, Maryland, Department of Environmental Resources Programs and Planning Division, June 1999

The primary goal of Low Impact Development methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff. Use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. Since every aspect of site development affects the hydrologic response of the site, LID control techniques focus mainly on site hydrology.

There is a wide array of impact reduction and site design techniques that allow the site planner/engineer to create storm water control mechanisms that function in a manner similar to that of natural control mechanisms. If LID techniques can be used for a particular site, the net result will be to more closely mimic the watersheds natural hydrologic functions or the water balance between runoff, infiltration, storage, groundwater recharge, and evapotranspiration. With the LID approach, receiving waters may experience fewer negative impacts in the volume, frequency, and quality of runoff, so as to maintain base flows and more closely approximate predevelopment runoff conditions.

The goals of low-impact development are discussed and demonstrated throughout the manual. The list below highlights some of the main goals and principles of LID:

- *Provide an improved technology for environmental protection of receiving waters.*
- *Provide economic incentives that encourage environmentally sensitive development.*
- *Develop the full potential of environmentally sensitive site planning and design.*
- *Encourage public education and participation in environmental protection.*
- *Help build communities based on environmental stewardship.*
- *Reduce construction and maintenance costs of the storm water infrastructure.*
- *Introduce new concepts, technologies, and objectives for storm water management such as micromanagement and multifunctional landscape features (bioretention areas, swales, and conservation areas); mimic or replicate hydrologic functions; and maintain the ecological/biological integrity of receiving streams.*
- *Encourage flexibility in regulations that allows innovative engineering and site planning to promote .smart growth. principles.*

- *Encourage debate on the economic, environmental, and technical viability and applicability of current storm water practices and alternative approaches.*

LID is a comprehensive technology-based approach to managing urban storm water. Storm water is managed in small, cost- effective landscape features located on each lot rather than being conveyed and managed in large, costly pond facilities located at the bottom of drainage areas. The source control concept is quite different from conventional treatment (pipe and pond storm water management site design). Hydrologic functions such as infiltration, frequency and volume of discharges, and groundwater recharge can be maintained with the use of reduced impervious surfaces, functional grading, open channel sections, disconnection of hydrologic flowpaths, and the use of bioretention/filtration landscape areas. LID also incorporates multifunctional site design elements into the storm water management plan. Such alternative storm water management practices as on- lot microstorage, functional landscaping, open drainage swales, reduced imperviousness, flatter grades, increased runoff travel time, and depression storage can be integrated into a multifunctional site design.

The above document may be located on the US EPA web site at: http://www.epa.gov/owow/nps/lid/lidnatl.pdf.

For this reason, the TMDL recommends that new development in the watershed utilize low impact development principles. Ideally, this could be achieved by cooperative agreement through the Euclid Creek Watershed Council. Formalization through individual community ordinances or a watershed overlay could follow. A main objective of LID development practices should ensure that post-development runoff should be less than or equal to pre-development runoff.

Table 11. Description of Implementation Actions and Measures

#	Implementation Actions & Management Measure	Affected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
1	Combined Sewer Control, Long Term Control Plans (LTCP)	Euclid Creek / Northeast Ohio Regional Sewer District	CSO control programs will address oxygen demanding substances, bacteria, nutrients	CSO control is expected to be effective, effectiveness may be impacted by available finances to complete the program.
2	Phase II Storm water	Euclid Creek TMDL area.	Storm water control will reduce sediment loading, eliminate illicit discharges to MS4s	Very good.
3	Educational Programs	Entire Euclid Creek TMDL area	Educational programs within the area are existing and relatively strong. Education allows the public to better understand the processes within the watershed and their impacts to it.	Informed citizens and public officials will be effective in restoring water quality in the Euclid Creek TMDL area
4	Evaluation of all dams in Euclid Creek TMDL area for removal.	Euclid Creek and its tributaries.	Biological communities will be improved by addressing impacts associated with the dam. Dissolved oxygen deficits often found in the impounded areas behind dams will be eliminated. Recreational opportunities will be enhanced and made safer.	Dam removal will be effective at removing one barrier to upstream attainment of water quality standards
5	House Bill 110 program	Euclid Creek 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.	Very good. Properly functioning sewage disposal systems will reduce pollution. Unsewered areas and streams within them will benefit.
6	Household sewage disposal systems - Inspection and maintenance programs	Euclid Creek 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.	Very good. Proper functioning sewage disposal systems will reduce pollution. Unsewered areas and streams benefit.
7	208 updates	Euclid Creek and tributaries/ NOACA,	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 with development.	Very good.
8	Wetlands protection	Euclid Creek and tributaries	Wetlands benefit the watershed by improving water quality and providing flood protection.	Preservation, restoration, and enhancement of wetlands will be effective.

Table 11. Description of Implementation Actions and Measures

#	Implementation Actions & Management Measure	Affected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
9	Riparian protection	Euclid Creek and tributaries	Streambank stability, water quality, biological integrity	Very good, if communities adopt riparian protection ordinances.
10	Headwater stream protection	Euclid Creek and tributaries	Streambank stability, water quality, thermal regime stability, biological integrity.	Very good, if the guidance, statutes, and regulations are followed, and communities adopt riparian protection ordinances
11	NPDES permit limits	Euclid Creek and tributaries / All NPDES permit holders in TMDL area potentially effected	Pollutant reduction.	Very good when main source of impairment is from NPDES permitted dischargers.
12	Watershed Action Plan	Euclid Creek and its tributaries/ All watershed stakeholders	Establish stream protection and restoration targets, provide watershed education, possible source of funding.	Very good.
13	Low Impact Development Practices	Euclid Creek and its tributaries/ All watershed stakeholders	Practices when implemented will promote better land use decisions. Associated storm water controls will help to reduce impacts associated with development.	Very good.

Table 12. Time line and Reasonable Assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics
1	Approve Easterly LTCP	Ohio EPA	Submitted March of 2002	Both Ohio EPA and US EPA have CSO programs. Existing CSO permit for NEORSD.
2	Phase II Storm water programs	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.
4	Evaluation of all dams in Euclid Creek 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.
7	208 updates	NOACA	NOACA completed in Nov. 2000 (for Cuyahoga and Lake 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, Cleveland Metroparks	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	Headwater stream protection	Ohio EPA, US Army Corps of Engineers, Local Governments	Ongoing	Sections 401 and 404 of the Clean Water Act.
11	NPDES permit limits	Ohio EPA	Ongoing	Section 402 of the Clean Water Act, State of Ohio (ORC Chapter 6111)

Table 12. Time line and Reasonable Assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics
12	Watershed Action Plan	Ohio DNR/ Local Watershed Coordinator	Ongoing	319 Funding obligations
13	Low Impact Development Practices	Local Governments	Proposed	Local Ordinances

Table 13. Time line: Monitoring, Tracking and Implementation

Action	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Approve Easterly LTCP	LTCP submitted March 28, 2002.									
Phase II Storm water	Compliance by March 2003. Program ongoing.									
Educational	Educational programs strong and ongoing.									
House Bill 110	Program approved for Cuyahoga and Lake Counties. Ongoing.									
Household sewage disposal systems	Local Health Departments currently conduct inspections of home sewage disposal systems. Not all systems are inspected by all local health departments.									
208 updates	NOACA 208 finalized in November 2000.									
Wetlands protection	Program ongoing.									
Riparian Protection	Work with and assist local governments to enact riparian protection ordinances.									
Watershed Action Plan	Watershed Action Plan currently in development. Draft plan expected in April/May 2005. Submission of draft to Ohio EPA/Ohio DNR expected in June 2005.									

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

6.1.2 Draft Implementation Plan

The draft implementation plan depends greatly upon the local communities for its success. Euclid Creek does not have existing NPDES regulated facilities within the watershed contributing nutrients as do many other streams in this area. Combined sewer overflows are confined to the lower mainstem. Land use is the biggest factor influencing water quality within the watershed. Implementation of Phase II Storm Water regulations and BMPs stand to provide the greatest water quality benefits and protections in the watershed. This impact is anticipated to be due in part to phosphorus and sediment reductions. Additional improvements in the stream will result from habitat protection and restoration activities. High energy in the immediate time period following a runoff event can create flash flows. Improved storm water controls will help to reduce these events which have been shown to negatively impact stream biology and habitat.

BMP implementation should be based on a plan developed within the context of the Euclid Creek Watershed Council. The council can work on a watershed-wide scale and prioritize implementation areas and techniques to be used. Utilizing an optimization approach guided by a local university the use and placement of BMPs can be prioritized for economic and environmental effectiveness.

The plan is to be implemented as follows:

- Euclid Creek Watershed Council presented with opportunity to work through optimization model for BMPs within the watershed,

- BMPs, habitat improvements, and other reasonable assurances are prioritized and a time line for implementation prepared; and

- BMPs will be integrated with riparian setback requirements into Phase II Storm Water permit renewals.

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. CSOs impact only the lower section of Euclid Creek within the City of Cleveland.

Recovery will continue with improvements to the Northeast Ohio Regional Sewer District collection system. However, this improvement 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 and watershed protection needs to be compatible with economic development, they are not mutually exclusive. 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 formation of watershed based groups promotes 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 Euclid Creek. Their continued involvement is crucial to restoring the water quality in Euclid Creek. The following is a list of watershed based groups in Euclid Creek:

- Cuyahoga River Remedial Action Plan
  www.cuyahogariverrap.org
- Friends of Euclid Creek
  http://friendsofeuclidcreek.nhlink.net/
- Euclid Creek Watershed Council

The above groups are to be commended for their efforts towards improving Euclid Creek and its tributaries.

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 2010. Revisions to the TMDL report would be completed the following year.

Upon reassessment of the stream in the next monitoring cycle, stream segments remaining in non-attainment will go through the TMDL process.

Local involvement in monitoring is encouraged. The Watershed Action Plan will help to strengthen and encourage additional community involvement. Valuable educational resources currently exist in the Euclid Creek area. Local universities and colleges have collected data and studied the stream. Expansion of programs and curricula can encourage watershed-based educational opportunities. Grade schools can also offer opportunities for education. Efforts have already begun to help students better understand their watershed. The watershed coordinator is in an ideal position to facilitate this interaction. Water quality data will be collected in accordance with the credible data rules when they are finalized.

Citizen monitoring of the watershed will also prove useful. Tools such as the use of sediment sticks and the ODNR Scenic River stream survey methods will help to increase our understanding of Euclid Creek. In addition to providing data, more frequent stream observations can help to alert Ohio EPA and other regulatory agencies to observed water quality impacts, enabling quicker response times to potential impacts.

Additional monitoring for fecal coliform bacteria and *E. coli* is recommended to determine if an actual water quality problem exists for recreational use attainment. Monitoring shall conform to requirements outlined in Ohio Water Quality Standards (Ohio Administrative Code 3745-1-07). If needed a TMDL will be prepared for bacteria.

References

Cuyahoga River Remedial Action Plan stage One Update Report - Impairment of Beneficial Uses and Sources of Pollution in the Cuyahoga River Area of Concern, November 1995.

Cuyahoga River Remedial Action Plan - Progress in Restoring the Environmental Quality of the Cuyahoga River: An Early Implementation Report, October 1995.

Cuyahoga River Remedial Action Plan State of the River Report and Proceedings of the October 25, 2001 Symposium, January 2002.

Hynes, H.B.N., 1970, *The Ecology of Running Waters*, University of Toronto Press

Low-Impact Design Strategies: An Integrated Design Approach, Prince George's County Maryland Department of Environmental Resources, June 1999

OEPA, 1995, *The Role of Biological Criteria in Water Quality Monitoring, Assessment, and Regulation*, Ohio EPA Technical Report MAS/1995- l-3

OEPA, 1989, *The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application*

OEPA. 1999. *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams*. OEPA Technical Bulletin MAS/1999-1-1. Columbus, OH.

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

The Cuyahoga River Remedial Action Plan Stage One Report - Impairments of Beneficial Uses and Sources and Causes in the Cuyahoga River Area of Concern, June 1992.

U.S. EPA, 2004, User's Guide: Spreadsheet Tool for the Estimation of Pollutant Load (STEPL) ,Version 3.0. The document was prepared by Tetra Tech, Inc., of Fairfax Virginia

USGS, 1996, HYSEP: A Computer Program for Streamflow Hydrograph Separation and Analysis, Water Resource Investigations Report 96-4040. Lemoyne, PA.