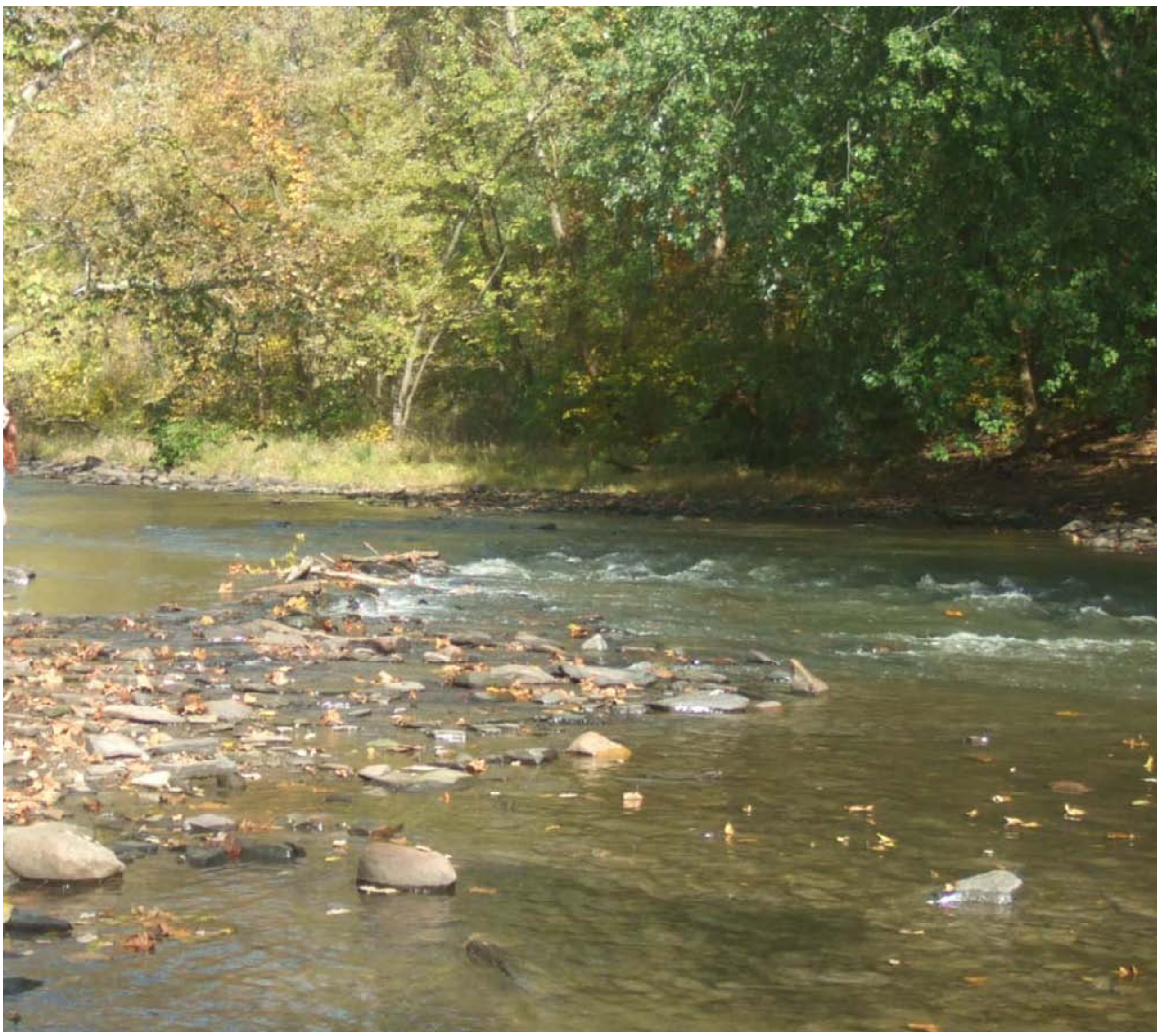
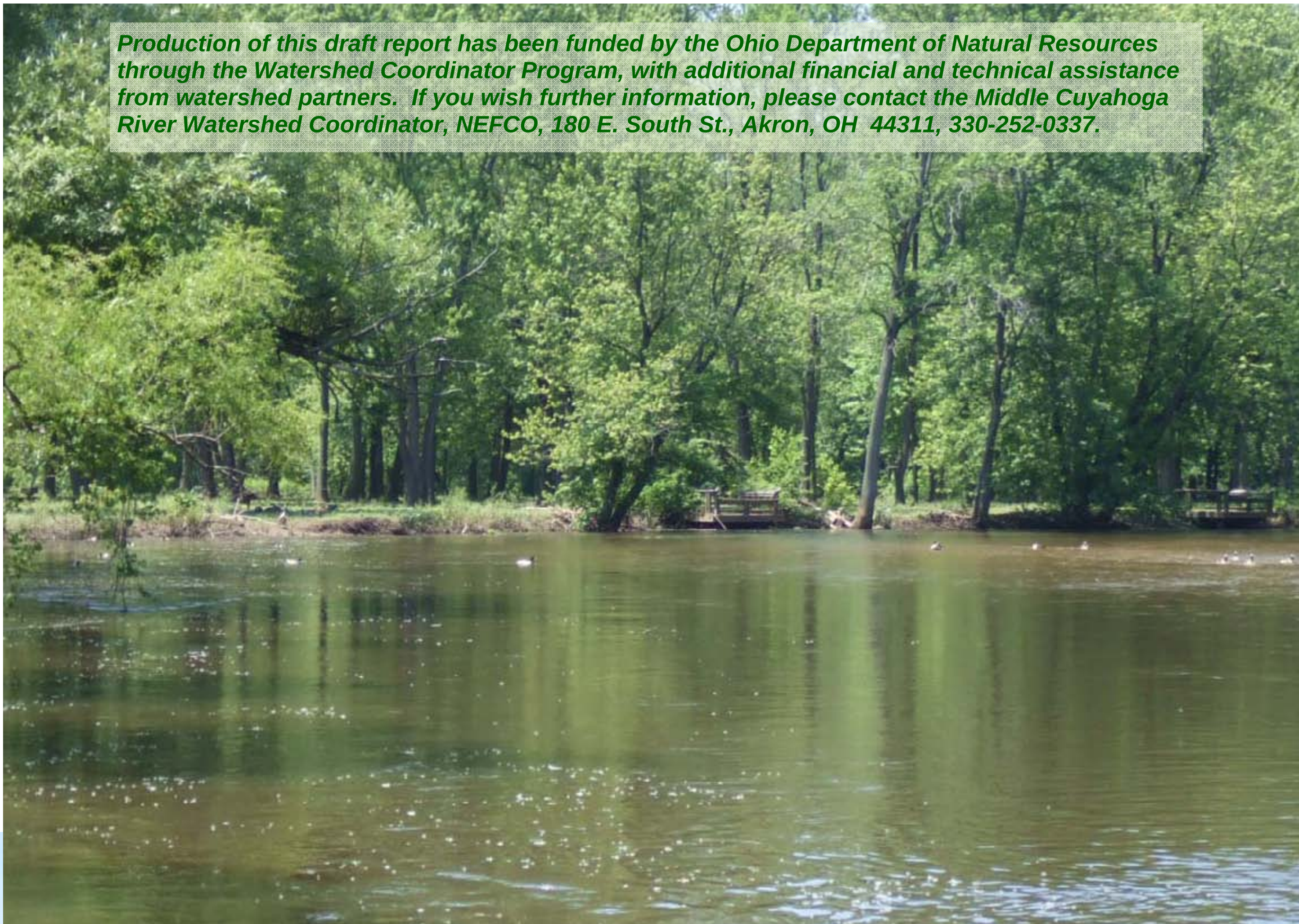
Middle Cuyahoga River Watershed Action Plan

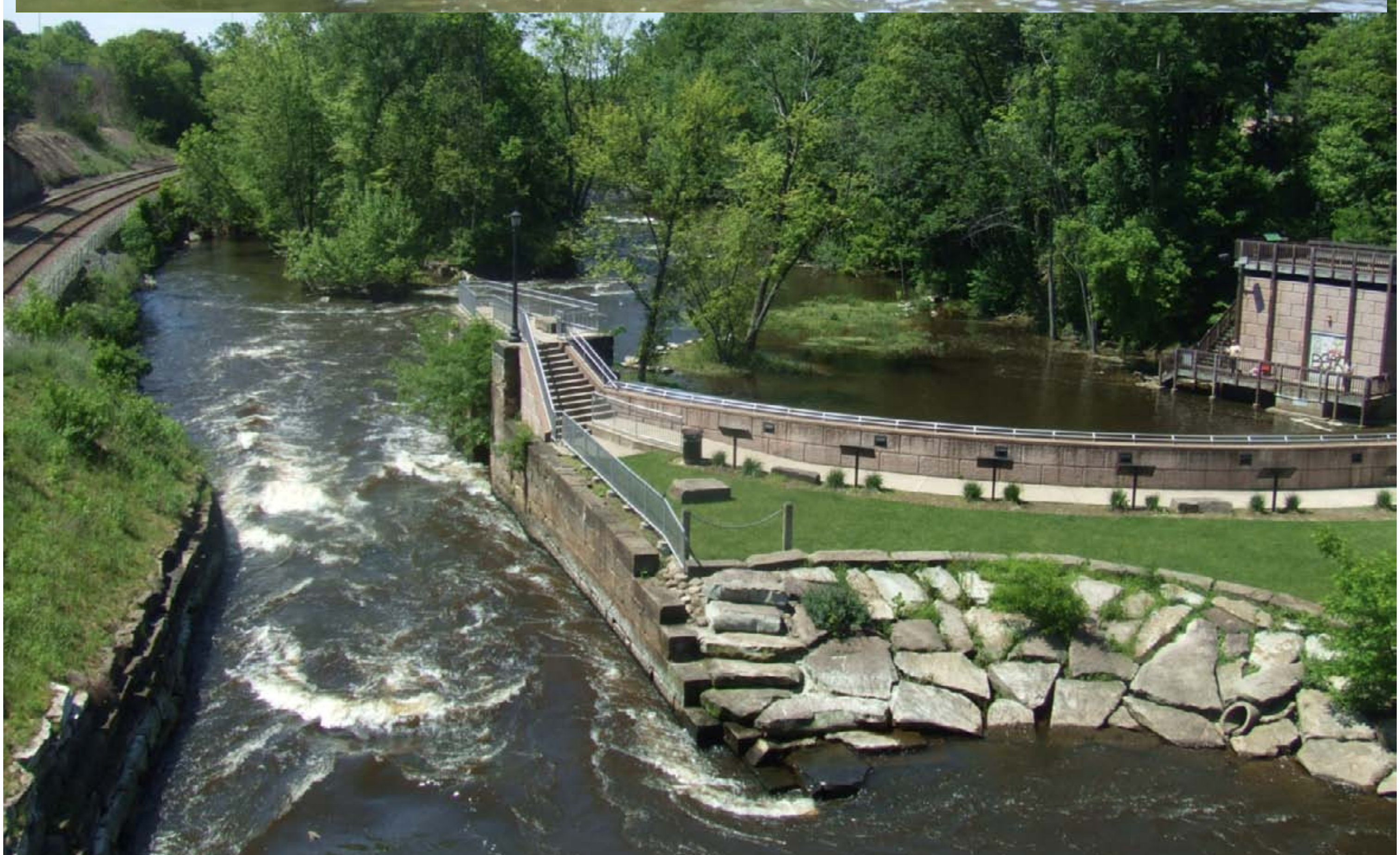
December, 2012



Northeast Ohio Four County Regional Plan and Development Organization

Production of this draft report has been funded by the Ohio Department of Natural Resources through the Watershed Coordinator Program, with additional financial and technical assistance from watershed partners. If you wish further information, please contact the Middle Cuyahoga River Watershed Coordinator, NEFCO, 180 E. South St., Akron, OH 44311, 330-252-0337.





Middle Cuyahoga River Watershed Action Plan

December, 2012

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Middle Cuyahoga River Watershed Action Plan 2012

Partner Community/ Organization	Title	Endorsement	Date
NEFCO			
City of Akron			
City of Cuyahoga Falls			
City of Hudson			
City of Munroe Falls			
Silver Lake Village			
City of Stow			
City of Tallmadge			
Summit County Planning Dept.			
Summit County Dept. of Environmental Services:			
Summit Soil and Water Conservation District			
Village of Hartville			
Lake Township			
Marlboro Township			
Stark County Regional Planning Commission:			
Stark County Health Dept.			

Middle Cuyahoga River Watershed Action Plan 2012

Partner Community/ Organization	Title	Endorsement	Date
Brady Lake Village			
Brimfield Township			
Franklin Township			
City of Kent			
Randolph Township			
Ravenna Township			
Rootstown Township			
City of Streetsboro			
Suffield Township			
Village of Sugar Bush Knolls			
Portage County Regional Planning Commission:			
Portage Soil and Water Conservation District:			
Portage County Health Dept.:			
Portage County Engineer:			
Portage Parks:			

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Middle Cuyahog River Watershed Action Plan
Acronyms and commonly used abbreviations

Acronym	Term
ACOE	Army Corps of Engineers
ALU	Aquatic Life Use (Ohio water quality category)
AMATS	Akron Metropolitan Area Transportation Study
AOC	Area of Concern (designation applied to impaired areas of Lake Erie/tributaries)
AWS	Agricultural water supply (Ohio EPA water quality designation)
BMP	Best Management Practice
BOD	Biological oxygen demand
CCAP	Coastal Change Analysis Program
CF	Cuyahoga Falls
cfs	cubic feet per second
COD	Carbonaceous oxygen demand
CSO	Combined sewer overflow
DERR	Division of Environmental and Remedial Response
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DRP/SP	Dissolved Reactive Phosphorous/soluble phosphorous
DST	downstream
EOLP	Erie Ontario Lake Plain (ecoregion)
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HIT2	High Impact Target sediment loading model
HSTS	Home sewage treatment systems
HUC	Hydrologic Unit Code
IBI	Index of Biologic Integrity
ICI	Invertebrate Community Index
IWS	Industrial water supply (Ohio EPA water quality designation)
LRW	Limited Resource Water (Ohio Water Quality Designation)
LTCP	Long Term Control Plan (for controlling combined sewer overflows)
MF	Munroe Falls
mg/l	milligrams per liter
mgd	million gallons per day
MIWb	Modified Index of Well Being (Ohio EPA water quality indicator)
mpn	most probable number (relates to monitoring for colonies of *E. coli* bacteria*)*
MS4	Municipal Separate Storm Sewer System
MWH-C	Modified Warmwater Habitat (Ohio Water Quality Designation)
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
ORAM	Ohio Rapid Assessment Method (wetland assessment)
ORC	Ohio Revised Code
PAH	Poly-aromatic hyrdocarbons
PCR	Primary contact recreation (Ohio water quality designation)
PWS	Public water supply (Ohio EPA water quality designation)
QHEI	Qualitative Habitat Evaluation Index (Ohio EPA water quality indicator focused on habitat)
RAP	Remedial Action Program (federal program to bring impaired portions of L. Erie into attainment)
RM	River Mile
RUSLE	Revised Uniform Soil Loss Equation

Acronyms and commonly used abbreviations

Acronym	Term
STEPL	spreadsheet tool for estimating pollutant loading
TMDL	Total Maximum Daily Load
TP	Total Phosphorous
TSD	Technical support document (Ohio EPA documents)
TSS	Total suspended solids
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UST	upstream
WC	Watershed coordinator
WRLC	Western Reserve Land Conservancy
WTP	water treatment plant
WWH	Warm Water Habitat (Ohio Water Quality Designation)
WWTP	Waste water treatment plant

1. Purpose

The purpose of this watershed plan is to build a framework for the long-term protection and improvement of the Middle Cuyahoga River, its tributaries, and watershed. A major focus of Watershed Action Plans is to achieve the goal of the Clean Water Act, i.e., to

> "Restore and protect the chemical, physical, and biological integrity of the nation's waters."

In evaluating, protecting, and improving the health of the Middle Cuyahoga River and its watershed, it is necessary to understand how the physical, chemical, and biological components are related, and how impacts to one aspect may affect another. This document addresses water quality as a function of the interrelated elements of a stream system.

This document :

- Presents a watershed inventory, describing physical, social/land use, historic, biological, and hydrologic conditions;
- Identifies problem areas within the stream network, such as water quality impairments, nuisance algae, degraded stream morphology, or areas where flooding or erosion problems may be occurring due to stresses in the stream system;
- Identifies key landscape features protecting the water quality and related stream system;
- Identifies potential risks to water quality and the health of the system;
- Identifies and prioritizes opportunities for protection or restoration;
- Provides a prioritized list of tasks or efforts for watershed partners to implement to improve and protect the waters of the Middle Cuyahoga.

Part of the guide plan is the establishment of a long-term collaboration to implement the measures recommended in this plan. This document describes the framework that the partners are adopting to ensure the plan is implemented.

This document is being submitted for endorsement by the Ohio Department of Natural Resources and Ohio Environmental Protection Agency.

2. Introduction

2a Middle Cuyahoga River Watershed

The Middle Cuyahoga River watershed is in northeast Ohio, in the Lake Erie basin, immediately east of Akron and approximately 25 miles south of Cleveland. (See Figure 2a-1). The middle portion of the Cuyahoga River extends from the Lake Rockwell dam in Kent west to the Ohio Edison dam in Cuyahoga Falls. The watershed extends west to Ravenna and south to Hartville. (See Figure 2a-2.) The watershed includes portions of Summit, Portage, and Stark Counties and covers 137 square miles. Breakneck Creek is the largest tributary.

The United States Geological Survey designates watersheds by Hydrologic Unit Code (HUC). The most inclusive, largest drainage areas have the fewest digits; sub-watersheds have additional digits indicating that they are part of larger systems. The designations for the Middle Cuyahoga River are shown in Table 2a-1.

Table 2a-1 Middle Cuyahoga River Sub-watershed HUC Designations

Level of HUC Designation	HUC Designation	Description
2-digit	04	Great Lakes Basin
4-digit	0411	Southern Lake Erie (northeast Ohio)
8-digit – rivers and creeks	04110002	Cuyahoga River
10-digit – river between major tributaries	04110002 02 04110002 03	Cuyahoga River between Black Brook and Breakneck Creek Cuyahoga River between Breakneck Creek and Little Cuyahoga River
12-digit –subwatersheds tributaries and mainstem between tributaries	04110002 02 03 04110002 02 02 04110002 02 01 04110002 03 01 04110002 03 05 04110002 03 05	Lake Rockwell dam to Breakneck Cr. Feeder Canal/Potter Cr. Breakneck Creek/Potter Cr. Plum Creek Fish Creek Main Stem to Little Cuyahoga

It should be noted that the area adopted as the Middle Cuyahoga River watershed differs slightly from designated HUC 10 or HUC 12 watersheds, as follows:

- The watershed working group chose the Ohio Edison dam as the lower extent of the Middle Cuyahoga, because the Cuyahoga River Area of Concern extends upstream from Lake Erie to the Ohio Edison dam. It should be noted that removal of the Ohio Edison dam has been contemplated during recent years. To address the possibility that this artificial boundary may be removed in the future, the mapping at the lower end of the watershed has been extended to the confluence with the Little Cuyahoga, but mapped as a separate sub-watershed.

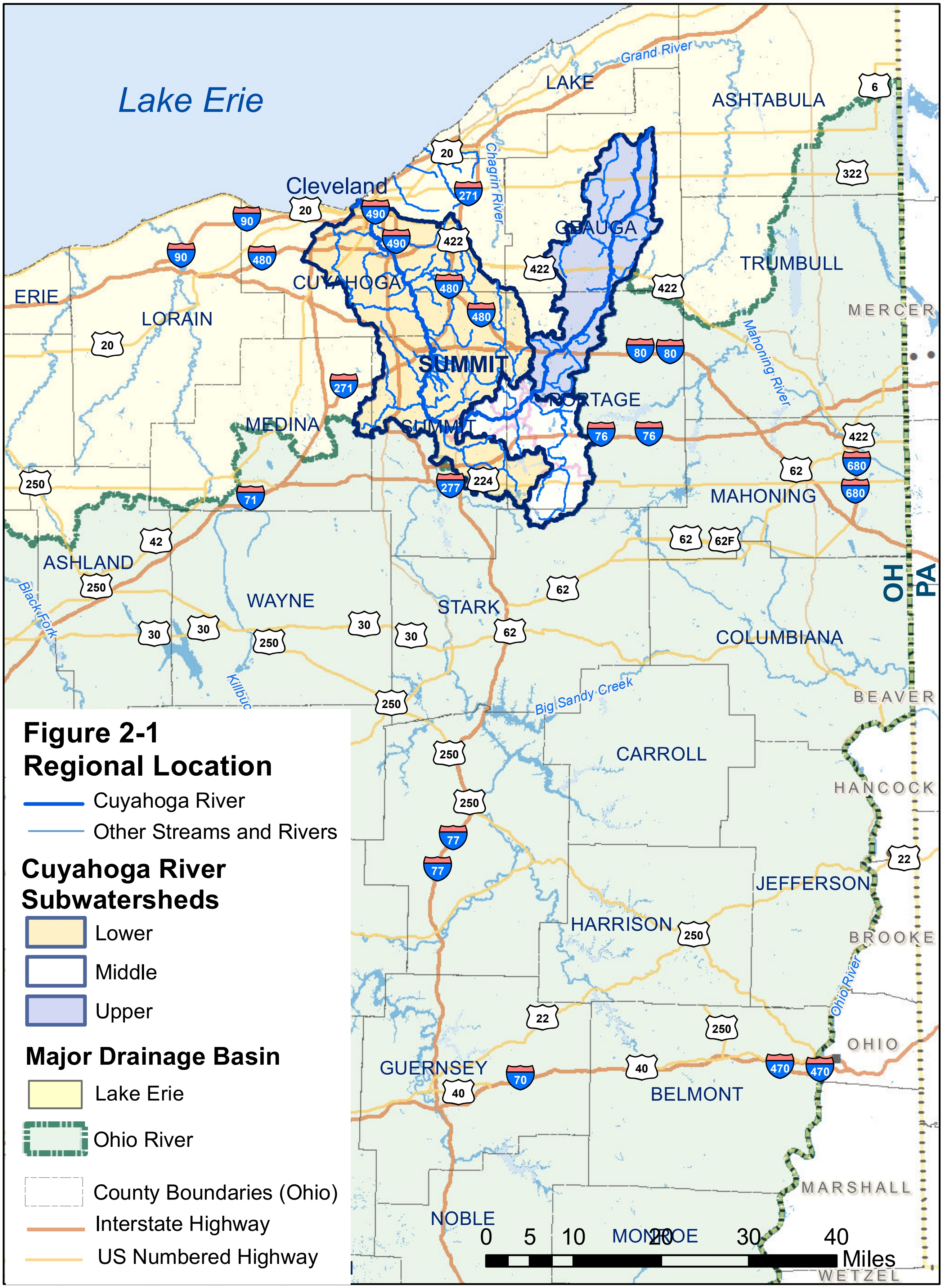


Figure 2-1
Regional Location

Sources: Ohio DNR GIS Mapping 2012, NEFCO 2012

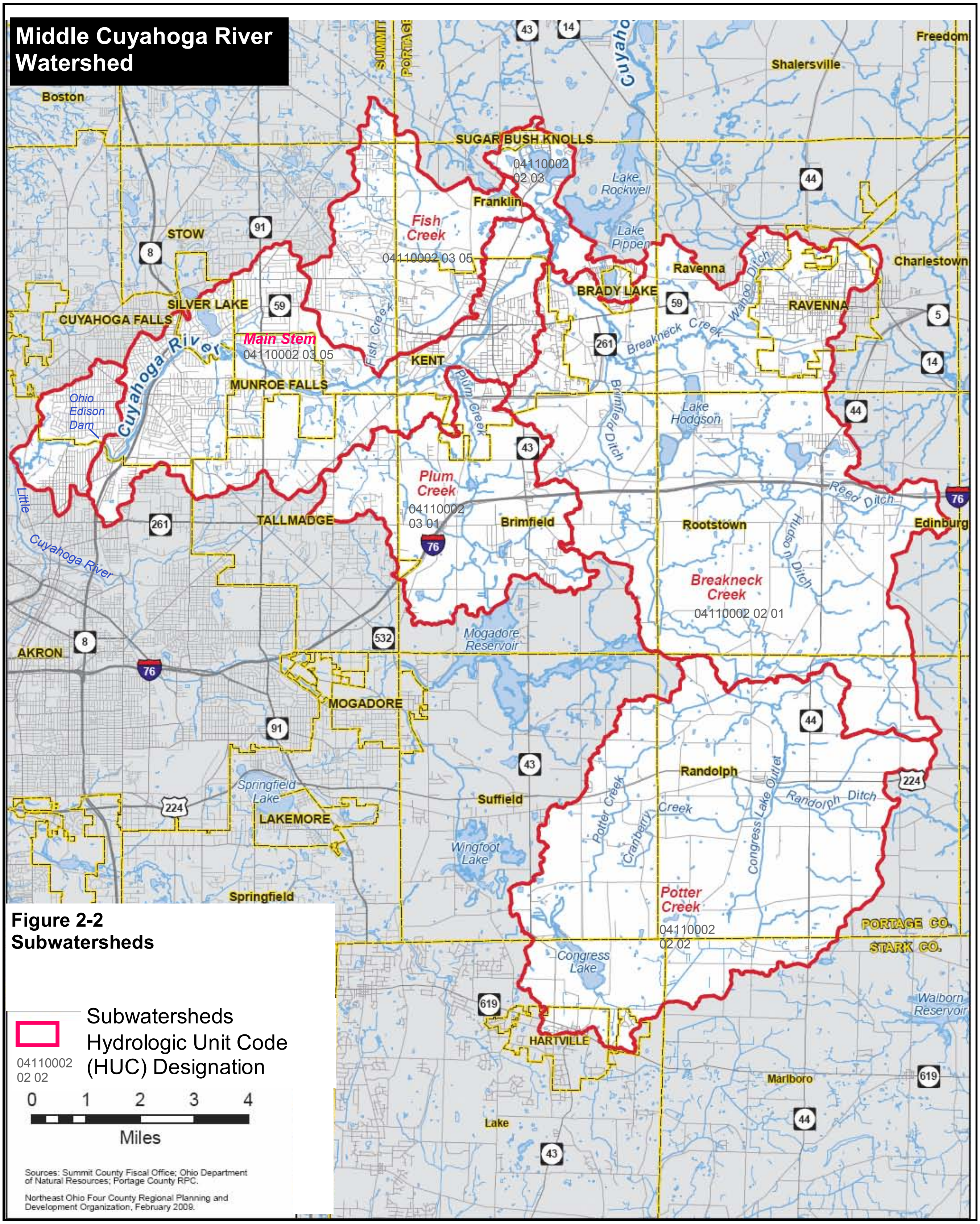


Figure 2-2
Subwatersheds

The Upper Cuyahoga is generally accepted as the watershed upstream of the Lake Rockwell dam and had been the subject of coordination by the Upper Cuyahoga River Task Force. The HUC-10 and HUC 12 designations include the portion of the river between the Lake Rockwell dam and Breakneck Creek as Upper Cuyahoga. However, since this portion of the watershed is within the city of Kent and downstream of an obvious boundary (the Lake Rockwell dam), the watershed group has included this small portion of the Upper Cuyahoga HUC 10 watershed as part of the management unit.

- Fish Creek, once designated as its own subwatershed, has been incorporated into the newly revised HUC 12 boundaries as part of the main stem subwatershed. Because Fish Creek has a distinctive character and identity, this report continues to include mapping for the Fish Creek watershed as a separate unit.

The Middle Cuyahoga River watershed includes portions of Stark and Summit Counties, but is predominantly in Portage County. The following entities are within the watershed.

Table 2A-2 Entities in the Middle Cuyahoga River Watershed

Summit County	*Portage County*
City of Akron*	City of Kent
City of Cuyahoga Falls	Brady Lake Village
Village of Silver Lake	Franklin Township
City of Munroe Falls	City of Streetsboro*
City of Hudson*	Village of Sugar Bush Knolls
City of Stow	City of Ravenna
City of Tallmadge	Ravenna Township
Summit Soil and Water Conserv. Dist.	Brimfield Township
Summit County Health District	Rootstown Township
MetroParks, Serving Summit County	Suffield Township
	Randolph Township
Stark County	Portage Soil and Water Conservation Dist.
Village of Hartville	Portage County Health District
Lake Township	Portage Park District
Marlboro Township	
Stark Soil and Water Conservation Dist.	
Stark Health District	
Stark Parks District	

*Very small portions of these communities are within the watershed.

All cities in urbanized areas and certain counties are required to obtain permits under the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program to operate their Municipal Separate Storm Sewer System (MS4). All communities in the watershed except Randolph and Marlboro townships require NPDES permits. Portage County has created a county-wide stormwater district to manage stormwater throughout the county.

Special designations affecting the Cuyahoga River include:

- Wild and Scenic River – Upper Cuyahoga River
- American Heritage River, National Heritage Corridor– entire Cuyahoga River
- Great Lakes Area of Concern – Lower Cuyahoga River to upstream of the Ohio Edison Dam.

2b. Population, Demographic, and Economic Characteristics

Water quality in a watershed is affected by land use, which is reflected in and related to population, housing, and economic data. Factors such as population, age, family status, location and type of employment, and income affect housing demand, retail development, and other land uses. Furthermore understanding these characteristics of a watershed can help develop an understanding of its use, functioning, trends, and potential concerns and opportunities.

The demographic and economic profile of the Middle Cuyahoga River watershed reflects the varied nature of its communities:

- The older urban centers of Akron, Cuyahoga Falls, Kent, and Ravenna;
- Surrounding older suburban areas that developed during the last 10-50 years;
- Recently developed or currently developing areas; and
- Rural communities in the outlying areas in Portage and Stark Counties, with villages and largely agricultural communities.

Population and household totals reflect 2000 and 2010 Census data. Economic data, which also include residence of employees, were available from the U.S. Census for 2002-2011. These were compared with known areas of growth and recent land use mapping/aerial photography, discussed further in Chapter 4.

Watershed Population Density, and Housing: 2010 Census

Table 2b-1 indicates that the overall population of watershed communities is almost the same as it was in 2000. However, there has been an increase in households by nearly 4,000, mostly in the communities of Stow, Tallmadge, Twinsburg, Streetsboro, Brimfield, Kent, Rootstown, and Lake Township. Akron experienced a substantial population loss, and in Hudson, Munroe Falls, Silver Lake, Brady Lake, Randolph, Ravenna City and Township, Sugar Bush Knolls, and Suffield Township population declined by approximately 47 to 500 people in the various communities. Some of the population declines in townships may be attributed to annexation. It is likely that the population change did not occur as a consistent trend over the decade. Communities outside the older urban centers grew rapidly until 2007, when a major multi-year recession began, with stalled housing development, excess housing stock, and possibly population loss.

Figures 2-3a and 2-3b present the 2010 and 2000 Census population density of the watershed by census block groups.[*] These often allow population patterns to be determined on a finer resolution than community-level mapping. Mapped census data from 2000 and 1990 were compared visually to determine areas of population change during the 1990s.

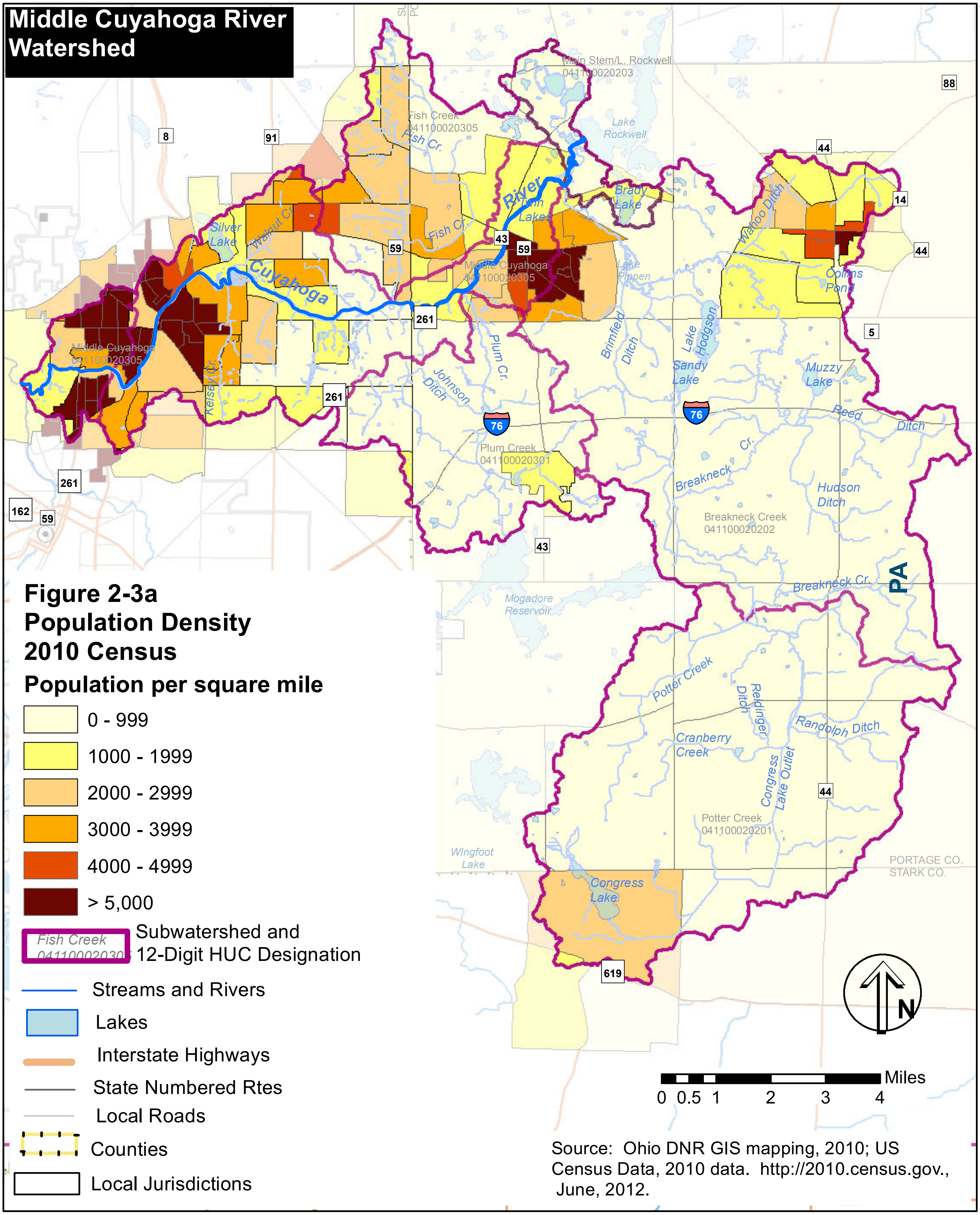
---

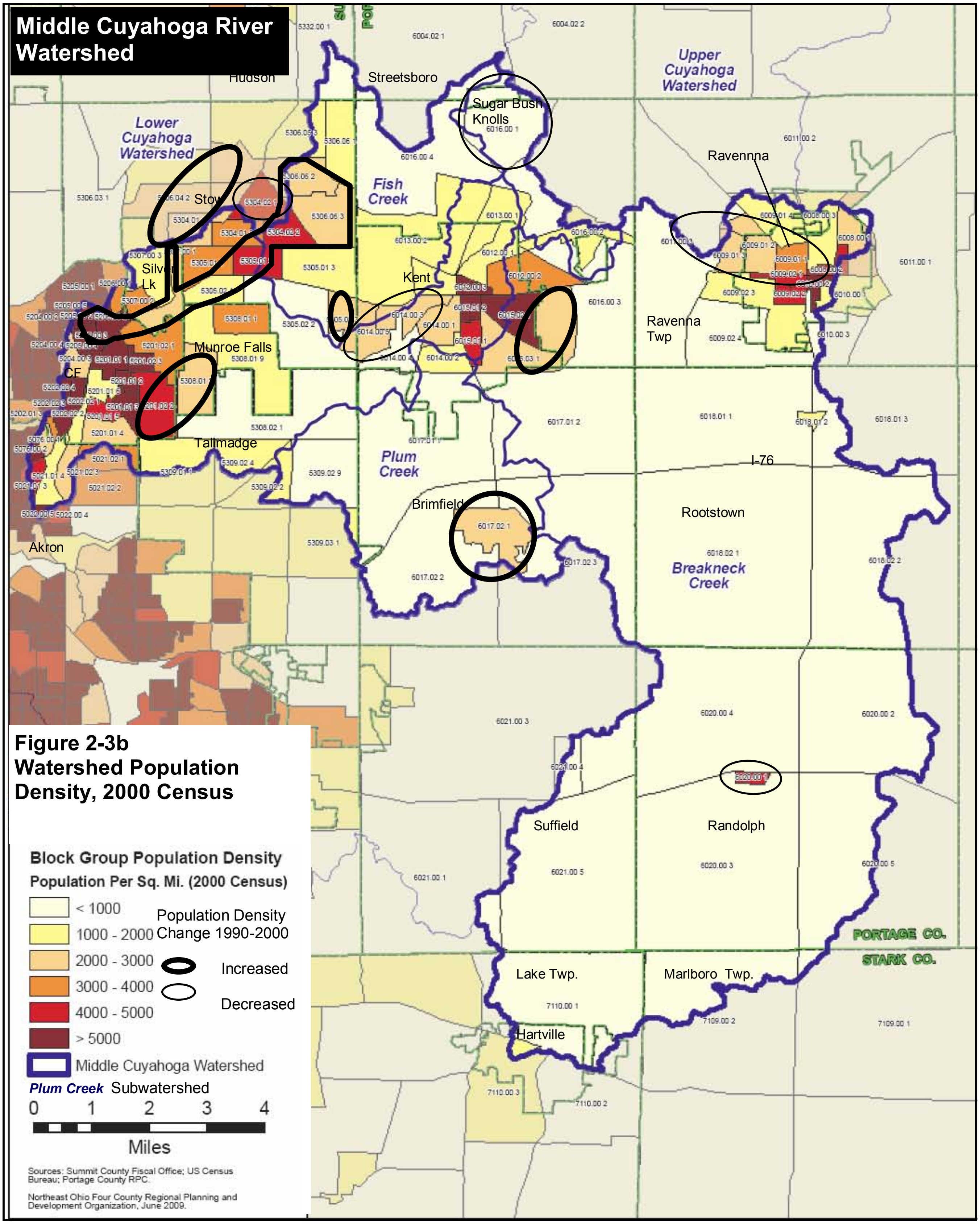
[*] Census blocks are the smallest area for which census counts are reported. Their boundaries may be streets in urban areas. Their population can range from zero to several hundred. Census block groups are grouped census blocks, the smallest unit for which census sampling results are reported. Census blocks may change with shifts in population.

Table 2b-1 Population and Household Change 2000-2010

Community	*Total Population* 2010	2000	*2000-2010 Population Change* Change	Percent	*Households* 2010	2000	*2000-2010 Change Household Total* change	% change	*Persons per Household* 2010	2000
Akron city, Summit County, Ohio	199,110	217,074	-17,964	-8%	83,712	90,116	-6,404	-7%	2.38	2.41
Cuyahoga Falls city, Summit County, Ohio	49,652	49,374	278	1%	22,250	21,655	595	3%	2.23	2.28
Hudson city, Summit County, Ohio	22,262	22,439	-177	-1%	7,620	7,357	263	4%	2.92	3.05
Munroe Falls city, Summit County, Ohio	5,012	5,314	-302	-6%	2,086	1,955	131	7%	2.40	2.72
Silver Lake village, Summit County, Ohio	2,519	3,019	-500	-17%	1,004	1,235	-231	-19%	2.51	2.44
Stow city, Summit County, Ohio	34,837	32,139	2,698	8%	14,226	12,317	1,909	15%	2.45	2.61
Tallmadge city, Summit County, Ohio	17,257	16,180	1,077	7%	6,939	6,210	729	12%	2.49	2.61
Brady Lake village, Portage County, Ohio	464	513	-49	-10%	201	202	-1	0%	2.31	2.54
Brimfield township, Portage County, Ohio	10,376	7,963	2,413	30%	3,996	2,959	1,037	35%	2.60	2.69
Franklin township, Portage County, Ohio	5,527	5,276	251	5%	2,447	2,174	273	13%	2.26	2.43
Kent city, Portage County, Ohio	28,904	27,906	998	4%	10,288	9,772	516	5%	2.81	2.86
Randolph township, Portage County, Ohio	5,298	5,504	-206	-4%	2,007	1,958	49	3%	2.64	2.81
Ravenna city, Portage County, Ohio	11,724	11,771	-47	0%	5,055	4,980	75	2%	2.32	2.36
Ravenna township, Portage County, Ohio	9,209	9,270	-61	-1%	3,817	3,739	78	2%	2.41	2.48
Rootstown township, Portage County, Ohio	8,225	7,212	1,013	14%	3,128	2,624	504	19%	2.63	2.75
Streetsboro city, Portage County, Ohio	16,028	12,311	3,717	30%	6,562	4,908	1,654	34%	2.44	2.51
Suffield township, Portage County, Ohio	6,311	6,383	-72	-1%	2,481	2,411	70	3%	2.54	2.65
Sugar Bush Knolls village, Portage County, C	177	227	-50	-22%	69	79	-10	-13%	2.57	2.87
Tallmadge city, Portage County, Ohio	280	210	70	33%	87	63	24	38%	3.22	3.33
Hartville Village, Stark County	2,944	2,174	770	35%	1,154	900	254	28%	2.52	2.42
Lake Twp, Stark County	29,961	25,892	4,069	16%	10,809	9,166	1,643	18%	2.77	2.82
Marlboro Twp., Stark County	4,356	2,287	2,069	90%	1,585	1,452	133	9%	2.75	1.58
total	470,433	470,438	-5	2.046088	191,523	188,232	3,291	2%	2.46	2.50

Source: American Fact Finder, 2010 Census, 2000 Census.


Middle Cuyahoga River Watershed
Main Stem/L. Rockwell 041100020203
Fish Creek 041100020305
Fish Cr.
Lake Rockwell
Brady Lake
Twin Lakes
River
Silver Lake
Walnut Cr.
Cuyahoga
Middle Cuyahoga 041100020305
Lake Pippen
Wahoo Ditch
Collins Pond
Kelsey Cr.
Johnson Ditch
Plum Cr.
Brimfield Ditch
Lake Hodgson
Sandy Lake
Muzzy Lake
Reed Ditch
Plum Creek 041100020301
Breakneck Cr.
Hudson Ditch
Breakneck Creek 041100020202
Breakneck Cr.
PA
Mogadore Reservoir
Potter Creek
Reddinger Ditch
Randolph Ditch
Cranberry Creek
Congress Lake Outlet
Potter Creek 041100020201
Wingfoot Lake
PORTAGE CO.
STARK CO.
Congress Lake
8
91
59
43
261
76
44
14
5
88
162
619
Figure 2-3a
Population Density
2010 Census
Population per square mile
0 - 999
1000 - 1999
2000 - 2999
3000 - 3999
4000 - 4999
> 5,000
Fish Creek 041100020305
Subwatershed and 12-Digit HUC Designation
Streams and Rivers
Lakes
Interstate Highways
State Numbered Rtes
Local Roads
Counties
Local Jurisdictions
N
0 0.5 1 2 3 4 Miles
Source: Ohio DNR GIS mapping, 2010; US Census Data, 2010 data. http://2010.census.gov., June, 2012.



Middle Cuyahoga River Watershed
Hudson
Streetsboro
Upper Cuyahoga Watershed
Lower Cuyahoga Watershed
Sugar Bush Knolls
Ravennna
Fish Creek
Stow
Silver Lk
Kent
Ravenna Twp
Munroe Falls
CF
Tallmadge
Plum Creek
I-76
Brimfield
Rootstown
Akron
Breakneck Creek
Suffield
Randolph
PORTAGE CO.
STARK CO.
Lake Twp.
Marlboro Twp.
Hartville
Figure 2-3b
Watershed Population Density, 2000 Census
Block Group Population Density
Population Per Sq. Mi. (2000 Census)
< 1000
1000 - 2000
2000 - 3000
3000 - 4000
4000 - 5000
> 5000
Population Density Change 1990-2000
Increased
Decreased
Middle Cuyahoga Watershed
Plum Creek Subwatershed
0 1 2 3 4
Miles
Sources: Summit County Fiscal Office; US Census Bureau; Portage County RPC.
Northeast Ohio Four County Regional Planning and Development Organization, June 2009.

In 2000, the population of the watershed census block groups was pproximately156,000, and in 2010, the population of the watershed census block groups was approximately 165,000. One likely reason that the census block group estimate shows more growth than the community figures is that only a small portion of Akron is in the watershed, and most of the population loss from Akron occurred outside the watershed. Figures 2-3a and b show the highest population density in the watershed area in the urban areas of Cuyahoga Falls, Akron, Kent, and Ravenna, and the lowest population density in Portage and Stark Counties.

Between 1990 and 2000, the watershed population had increased by nearly 13,000 with the most prominent growth occurring in portions of Cuyahoga Falls, Munroe Falls, Stow, Kent, and Brimfield. Portions of Kent, Ravenna City, Randolph Township, and Sugar Bush Knolls decreased in population density, possibly due to smaller household sizes in built-out communities or migration.

Between 2000 and 2010, growth continued in the areas between Stow and Munroe Falls, and Kent, Ravenna, Brimfield, Ravenna Township, and Rootstown. Brimfield has not visibly increased in density, but the population data indicate an increase in total, which, because it is distributed across a large area, does not appear to increase in density.

Housing demand is related to household size. As household sizes decrease, more housing is needed to accommodate the same level of population. In recent decades, household sizes nationwide have tended to decrease, due to factors such as the increasing age of the population, number of children or other relatives in the same household, number of single-parent households or individuals living alone. As shown on Table 2b-1, in 2010 the household sizes in watershed communities averaged 2.46, lower than the average household size in 2000 of 2.57. In almost every community, the average household size has declined, contributing to the demand for additional housing to accommodate the population.

The 2000 census provides more information than the 2010 census, as the “long form” data sampling was eliminated during the most recent census. The 2000 Census data indicate that most of the housing units in the watershed (ranging from 77 to 97 percent in 2000) were built before 1990. (See Table 2b-2.) With the exception of Kent, the percent who reported living in the same house in 2000 as in 1995 ranged from 55 to 78 percent within the watershed communities, indicating that 22 to 45 percent of the population in these areas had moved within five years. Since most structures were built before 1990, most of the population who moved did so into existing houses. The recent ACS data suggest that in the survey communities, approximately 50 percent of residents moved to their current home since 2000.

The population and housing data discussed in this section refer to entire communities, many of which are only partially in the watershed. For instance, most of Akron, Streets-boro, and Hudson are outside the watershed, as are substantial portions of Tallmadge, Stow, Cuyahoga Falls, and Lake Twp. In understanding the watershed, it is helpful to understand where growth seems to be occurring within each community.

Table 2b-2 Length of Residence versus Age of Housing

Community	% in Same Housing 1995	% of Housing Built before 1990
Ohio	57	87
Summit County	58	88
Akron*	55	94
Cuyahoga Falls	57	88
Silver Lake	71	97
Hudson*	57	84
Munroe Falls	66	90
Stow	55	77
Tallmadge	65	82
Portage County*	56	82
Kent	35	92
Franklin Twp	61	89
Streetsboro*	49	60
Brady Lake Village	62	92
Sugar Bush Knolls	74	79
Ravenna City	52	93
Ravenna Twp	59	78
Brimfield Twp*	63	92
Rootstown Twp	68	79
Suffield Twp	78	87
Randolph Twp	69	83
Stark County	62	90
Lake Twp	61	81
Hartville	51	84
Marlboro Twp	72	84

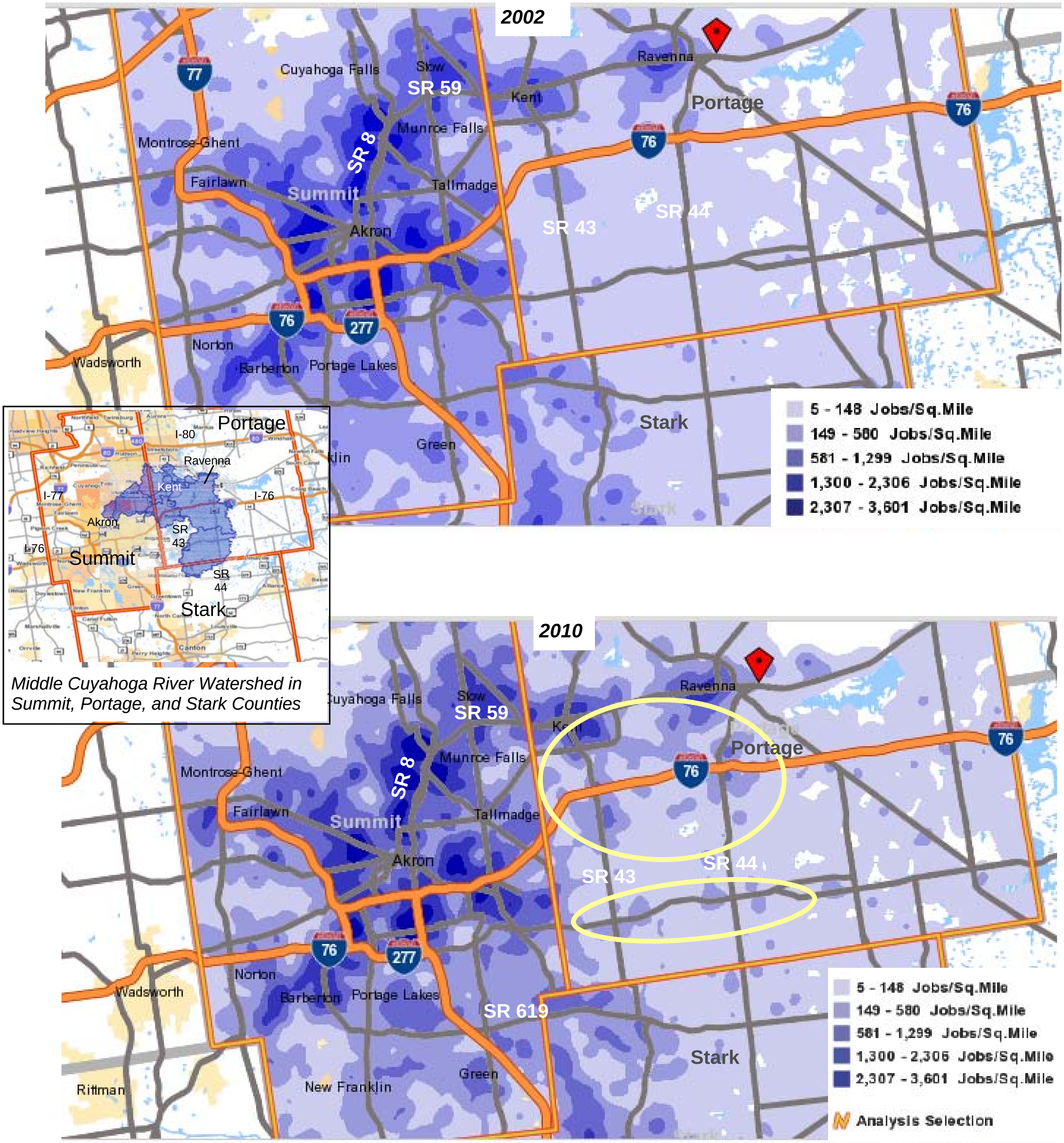
**Only a small portion of these communities is in the watershed. Source: 2010 Census American Fast Facts.*

Figure 2-4 presents changes in housing patterns based on reported numbers of employees in each county by residence for 2002 and 20010. Because these data are aggregated at the census block level, the mapping shows housing distribution within communities and clearly reflects the growth patterns described in this section, with growth occurring in areas of Portage County that previously were sparsely developed.

Potential Future Growth Areas

In the recent economic downturn, which began in late 2007-2008, little housing development has occurred. However, the past trends suggest which areas are likely to experience growth in population and housing once the market is more favorable for development. While there is still undeveloped land in some of the watershed communities in Summit County, future growth in these communities is likely to taper off over time as the vacant land in these communities dwindles. The Cities of Kent and Ravenna are surrounded by unincorporated areas. While these cities are quite built up, they could still expand through annexation. Since 2000, Brimfield Township entered into Joint Economic Development District agreements with the neighboring cities of Tallmadge and Kent. Brimfield is located along Interstate 76 with short travel time to the Akron area and has ready access to sewer and water providers. Brimfield experienced rapid growth in residential, commercial, and industrial development and is likely to continue doing so once development starts occurring in the region again. Recent development in other outlying areas, especially with highway access, such as Rootstown, suggest that these areas will experience future development pressure as well.

Figure 2-4 Employed Residents, Summit, Portage, and Northern Stark Counties, 2002 and 2010



Notes:
OnTheMap put a red marker at approximately the NE edge of the watershed.
Yellow ovals indicate growth areas (increase in number of residents with jobs) from 2002-2010.

Source: U.S. Census Bureau, OnTheMap Application and LEHD Origin-Destination Employment Statistics (Beginning of Quarter Employment, 2nd Quarter of 2002-2010). US Census OnTheMap http://onthemap.ces.census.gov/

Economic Characteristics

Watershed residents' occupation and income may affect their ability or willingness to undertake certain improvements or projects, the tax base of communities supporting the projects, and eligibility for certain grants. Watershed residents' occupation relates directly to their use of and relationship to the land.

The employment characteristics and trends in a watershed and its region affect land use patterns, growth pressures, regionally important employment centers, and the potential for out-migration and vacancies. Land use pressure is often greatest near good access to employment centers. Substantial changes in certain employment sectors can affect migration patterns, development pressure, and vacancies in an area. The type of employment in a region is related to income, housing price people are willing to pay, education level of residents, how far employees are willing to travel from their homes to work, and conversely, how far from the employment centers they are willing to live.

Data from the 2011 U.S. Census American Community Survey indicates that the median income of communities in the watershed varies widely (See Table 2b-3.) Ravenna, Kent and Akron are older urban centers, with older and more densely developed residential areas. Akron and Kent also contain resident student populations who attend the universities in each city, which may skew income data. A comparison of median household income data for communities versus the state for 2007 and 2011 indicates that, during that period, the median income in the cities decreased relative to the state, while median income in the outlying communities increased relative to the state.

Employment data of residents from the 2007-2011 American Community Survey, and Census employment data for counties and county subdivisions from 2002-2010 were reviewed. A useful tool was the Census OnTheMap interactive mapping program, which maps data from selected years, aggregated to the census block level.

As shown on Figure 2-5, the employment centers in the watershed counties focus on the population centers and corridors between Canton, Akron, Twinsburg (and north), and Kent. This distribution has been constant since 2002, the first date included in OnTheMap.

As shown on Table 2b-4 the industries employing the most residents included manufacturing, wholesale/retail, and education/health care/social assistance. Portage County had higher proportions of residents employed in manufacturing and education/ health care fields, and Summit County had higher proportions of people employed in information and professional industries. The construction employment may be low compared to other time periods, due to the economic downturn that began in 2007. Between 2002 and 2010, health and education industries expanded, while many others declined, especially manufacturing. This trend may reflect in part the economic downturn but may also reflect longer term trends in employment.

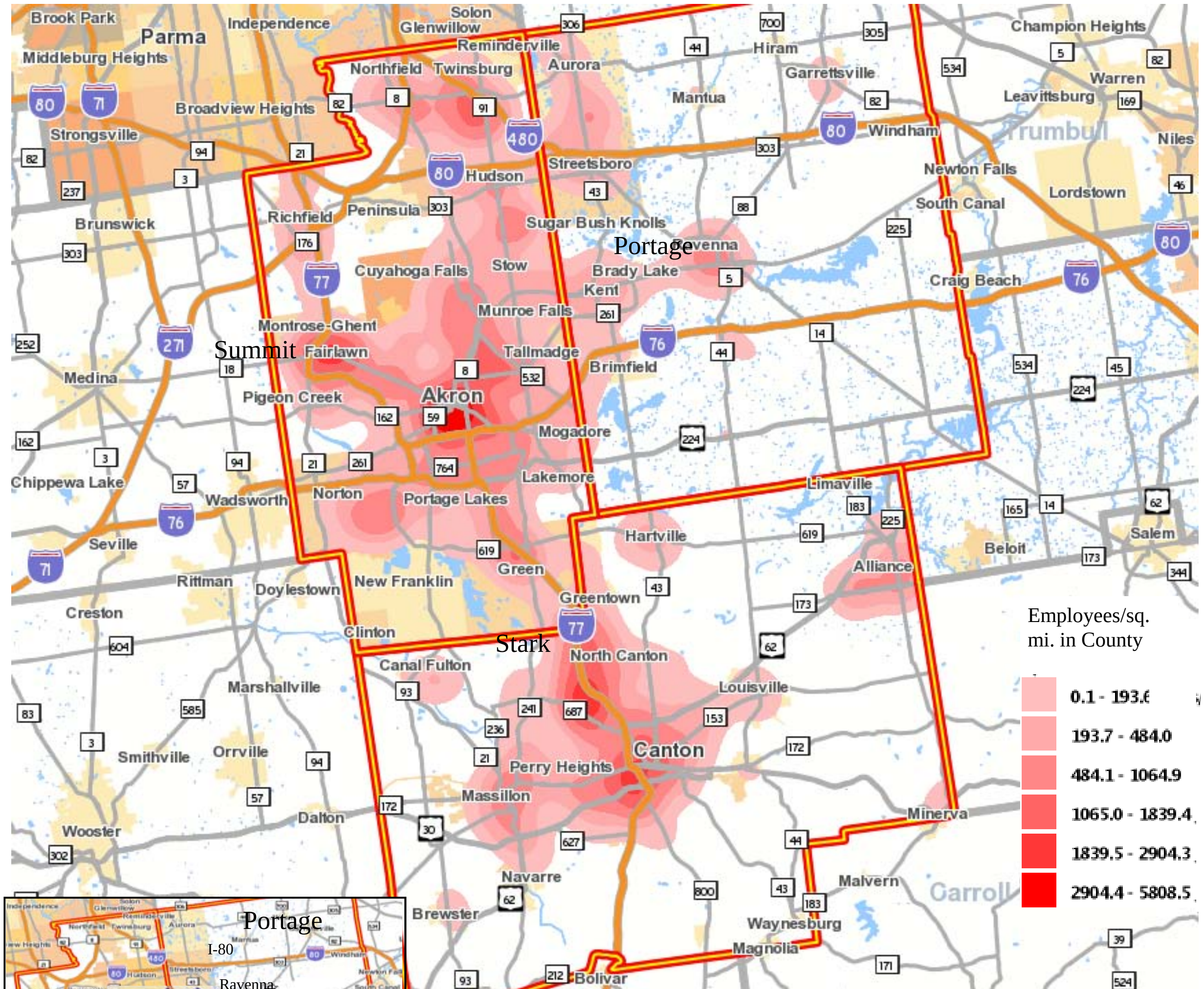
Table 2b-5 indicates that the number of residents employed in manufacturing and construction declined from 2002 to 2010, and those employed in health care and professional fields increased. Some of the construction decline may be related to the economic downturn, which affected the real estate market heavily, but the other trends reflect longer-term patterns.

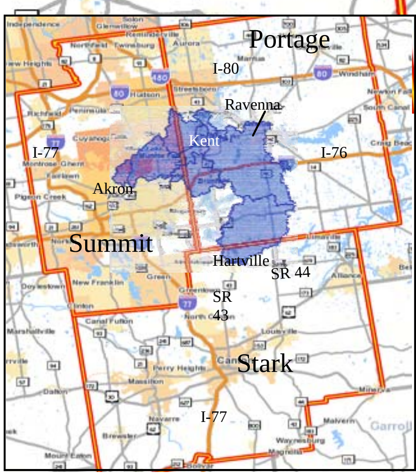
Table 2b-3 Income and Poverty Levels

	Median Household Income		Percent Difference from State		Percent below Poverty 2011	
	2000	2011	2000	2011	People	Families
Ohio	**40,956**	**45,749**	**0.0**	**0.0**	**14.8**	**10.8**
Summit County, Ohio	***42,304***	***48,790***	***3.3***	***6.6***	***10.4***	***14.5***
Akron	31,835	34,190	-22.3	-25.3	19.9	19.9
Cuyahoga Falls	42,263	46,450	3.2	1.5	8.2	8.2
Hudson	70,875	144,523	73.1	215.9	3.1	2.1
Munroe Falls	61,169	65,970	49.4	44.2	3.6	3.6
Silver Lake Village	70,875	96,250	73.1	110.4	1.3	4.3
Stow	57,525	64,577	40.5	41.2	4.6	1.6
Tallmadge	49,381	58,391	20.6	27.6	8.5	8.5
Portage County, Ohio	***44,347***	***51,441***	***8.3***	***12.4***	***8.9***	***14.3***
Brady Lake Village	36,406	47,188	-11.1	3.1	27.4	23.8
Brimfield Twp	46,973	55,976	14.7	22.4	12.9	7.9
Franklin Twp	47,750	53,176	16.6	16.2	19.1	8.0
Kent	29,582	26,923	-27.8	-41.2	35.3	18.5
Randolph Twp	49,665	64,100	21.3	40.1	7.6	7.1
Ravenna	35,650	34,825	-13.0	-23.9	21.8	16.9
Ravenna Twp	38,325	47,842	-6.4	4.6	11.2	6.7
Rootstown Twp	48,931	60,382	19.5	32.0	7.1	6.7
Suffield Twp	51,495	55,625	25.7	21.6	5.0	5.4
Streetsboro	48,661	62,183	18.8	35.9	4.7	7.2
Sugar Bush Knolls	129,555	79,107	216.3	72.9	4.2	4.7
Stark County, Ohio	***39,824***	***45,347***	***-2.8***	***-0.9***	***10.0***	***13.6***
Lake Twp	57,347	69,081	40.0	51.0	2.3	2.3
Hartville	41,012	30,707	0.1	-32.9	7.8	5.7
Marlboro Twp	53,351	65,744	30.3	43.7	2.9	2.9

*Poverty Threshold, reported here, is statistical tool used by US Census, reflecting previous year's income compared to nationwide levels determined by the US Census. Eligibility for federal programs is determined by the Poverty *Guidelines* developed by the Dept. of Health and Human Services.

Sources:
2011 data - US Census 2007-2011 American Community Survey Table DP03, Economic Characteristics, American FactFinder web page, 2012. factfinder2.census.gov
2000 data - US Census Bureau Profile of General Demographic Characteristics, 2000.





Source: *U.S. Census Longitudinal Employer Household Dynamics, OnTheMap http://lehd.did.census.gov/led/*

Middle Cuyahoga River Watershed in Summit, Portage, and Stark Counties

Figure 2-5
Employment Centers, Summit, Portage, and Stark Counties, 2007

Table 2b-4 Employment of Residents, 2011

	Civilian employed population 16+	Ag, forestry, fishing, hunting, mining		Construction		Manufact.		Wholesale/ Retail		Transport., Warehouse, Utilities		Information, Finance, Insurance, Real Estate		Professional, Scientific, Mgmt, Admin, Waste mgmt		Educ., Health Care, Social Assistance		Arts, Recreation, Entertainmt, Accomm, Food svc		Other service except public admin		Public Admin	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Summit County, Ohio	***258,042***	***601***	***0.2***	***13,615***	***5***	***42,173***	***16***	***37,809***	***15***	***11,440***	***4***	***22,367***	***9***	***25,719***	***10***	***61,276***	***24***	***22,361***	***9***	***12,299***	***5***	***8,382***	***3***
Akron*	87,966	138	0.2	4,478	5	12,840	15	12,947	15	3,907	4	6,242	7	7,807	9	22,474	26	9,148	10	4,735	5	3,250	4
Cuyahoga Falls	25,024	84	0.3	1,443	6	3,988	16	4,092	16	1,077	4	2,192	9	2,605	10	5,549	22	2,061	8	949	4	984	4
Hudson*	10,486	88	0.8	240	2	1,721	16	1,592	15	284	3	1,348	13	1,360	13	2,601	25	759	7	339	3	154	2
Munroe Falls	2,768	0	0	166	6	520	19	310	11	133	5	392	14	183	7	740	27	118	4	85	3	121	4
Silver Lake Village	1,153	5	0.4	70	6	197	17	127	11	57	5	121	11	188	16	245	21	39	3	75	7	29	3
Stow	17,962	40	0.2	927	5	2,755	15	2,619	15	641	4	1,639	9	2,189	12	4,493	25	1,525	9	750	4	384	2
Tallmadge	7,978	2	0	320	4	1,481	19	1,033	13	404	5	719	9	698	9	2,219	28	670	8	266	3	166	2
Portage County, Ohio	***80,821***	***504***	***0.6***	***4,887***	***6***	***15,661***	***19***	***12,612***	***16***	***3,213***	***4***	***5,136***	***6***	***6,301***	***8***	***18,475***	***23***	***8,045***	***10***	***3,433***	***4***	***2,554***	***3***
Brady Lake Village	246	7	2.8	36	15	41	17	21	9	3	1	6	2	31	13	65	26	7	3	19	8	10	4
Brimfield Twp	5,205	64	1.2	272	5	1,095	21	838	16	285	6	464	9	419	8	774	15	534	10	178	3	282	5
Franklin Twp	2,954	0	0	165	6	449	15	401	14	65	2	178	6	367	12	950	32	210	7	116	4	53	2
Kent	14,904	38	0.3	549	4	1,114	8	2,217	15	368	3	972	7	1,054	7	4,977	33	2,854	19	484	3	277	2
Randolph Twp	2,578	0	0	105	4	630	24	392	15	73	3	119	5	146	6	682	27	140	5	20	1	271	11
Ravenna	5,288	20	0.4	191	4	1,126	21	880	17	123	2	376	7	397	8	1,106	21	691	13	243	5	135	3
Ravenna Twp	4,761	41	0.9	346	7	1,409	30	740	16	130	3	244	5	296	6	802	17	307	6	263	6	183	4
Streetsboro*	8,739	71	0.8	425	5	1,828	21	1,419	16	340	4	762	9	774	9	1,719	20	704	8	476	5	221	3
Rootstown Twp	4,220	29	0.7	235	6	647	15	843	20	318	8	269	6	240	6	826	20	310	7	232	6	271	6
Suffield Twp	3,185	44	1.4	290	9	627	20	580	18	255	8	157	5	264	8	592	19	187	6	105	3	84	3
Stark County, Ohio	***172,484***	***1,148***	***0.7***	***9,378***	***5***	***31,621***	***18***	***25,271***	***15***	***7,901***	***5***	***11,669***	***7***	***14,794***	***9***	***42,307***	***25***	***15,640***	***9***	***8,374***	***5***	***4,381***	***3***
Lake Twp	14,323	125	0.9	856	6	2,136	15	2,346	16	894	6	1,022	7	1,422	10	3,419	24	966	7	657	5	480	3
Hartville Village*	1,603	27	1.7	99	6	277	17	278	17	123	8	126	8	172	11	296	19	159	8	79	5	12	1
Marlboro Twp	2,173	104	4.8	313	14	374	17	329	15	120	6	116	5	132	6	490	23	78	4	85	4	32	2

*Only small portions of these communities are in the watershed.
Source: US Census 2007-2011 American Community Survey Table DP03, Economic Characteristics, as reported on American FactFinder web page, 2012. factfinder2.census.gov

Table 2b-5 Employment trends Watershed Counties, 2002 to 2010

Jobs by NAICS Industry Sector* in Summit, Portage, and Stark Counties

	2010		2002	
	Count	**Share**	**Count**	**Share**
Agriculture, Forestry, Fishing and Hunting	626	0.1%	740	0.2%
Mining, Quarrying, and Oil and Gas Extraction	870	0.2%	770	0.2%
Utilities	2,459	0.6%	2,775	0.6%
Construction	14,855	3.5%	20,428	4.4%
Manufacturing	61,959	14.5%	83,508	18.1%
Wholesale Trade	22,498	5.3%	25,346	5.5%
Retail Trade	48,565	11.4%	54,661	11.9%
Transportation and Warehousing	12,498	2.9%	12,571	2.7%
Information	7,813	1.8%	9,824	2.1%
Finance and Insurance	15,550	3.6%	18,623	4.0%
Real Estate and Rental and Leasing	4,771	1.1%	5,788	1.3%
Professional, Scientific, and Technical Services	21,416	5.0%	19,375	4.2%
Management of Companies and Enterprises	14,641	3.4%	13,368	2.9%
Administration & Support, Waste Management and Remediation	23,151	5.4%	23,231	5.0%
Educational Services	39,796	9.3%	41,329	9.0%
Health Care and Social Assistance	70,666	16.6%	59,513	12.9%
Arts, Entertainment, and Recreation	5,276	1.2%	5,694	1.2%
Accommodation and Food Services	33,333	7.8%	34,620	7.5%
Other Services (excluding Public Administration)	13,224	3.1%	14,698	3.2%
Public Administration	12,574	2.9%	13,747	3.0%
Total	426,541		460,609	

*U.S. Census North American Industry Classification System
Source: CensusOnTheMap

The increase in people who are willing to travel to work from their homes in outlying areas in Portage County is likely to increase the demand in Portage County for housing, a trend that has been observed during the recent decade. Interstate 76 passes through two rapidly growing watershed communities, providing good access for Portage County residents to the employment centers in Akron and elsewhere.

During the past two years, 2010-2012, the potential for oil and gas extraction from the Utica shale has generated numerous permits for wells that use hydrofracturing ("fracking"). There is the potential that installation of wells and manufacturing of parts will affect employment in the watershed counties.

Demographic Conditions, Summary

Canton, Akron, Kent, and Ravenna are the older urban centers in the watershed, where jobs and residences are concentrated. Older suburbs include Tallmadge, Munroe Falls, and Cuyahoga Falls. More recently, rapid development has occurred in Stow and portions of Portage County. Housing and economic data suggest that development is expanding out from the core into previously undeveloped areas of Portage County. The region will bear watching as the current economic downturn is resolved, to determine whether the patterns that became apparent over recent decades continue, resulting in further development pressure in areas like Brimfield, or whether the economy is shifting in such a major way that previous patterns of economic activity, population, and housing are changed substantially.

2c. Watershed management background

Communities and organizations within the Middle Cuyahoga watershed have been involved in watershed planning efforts to some degree for over 30 years. Planning efforts in the watershed that preceded development of this plan included:

- NEFCO, as the Areawide Planning Agency for Summit, Portage, Stark, and Wayne Counties, has compiled the region's Section 208 water quality improvement plans since the inception of the program.
- Breakneck Creek watershed management study – inventory – NEFCO partnered with Breakneck Creek Coalition
- Middle Cuyahoga River Comprehensive Watershed Management Plan –Inventory
- In the 1990s NEFCO convened a Middle Cuyahoga River task force to develop a watershed plan. The collaborative effort resulted in an inventory with goals and objectives, but it was interrupted by lawsuits involving the City of Akron and communities downstream of the Lake Rockwell dam concerning releases of water from the Akron public water supply at Lake Rockwell.
- Portage County has developed a watershed plan with input from a variety of stakeholders and experts.
- The three counties, park districts, soil and water conservation districts, and numerous communities are actively seeking to restore and protect watershed features. Many watershed communities have or are considering riparian setbacks, are installing rain gardens, bioinfiltration, and permeable pavement, and many have been involved in restoring stream morphology. The Cities of Kent and Cuyahoga Falls have removed two low-head dams from tributaries in their cities (Plum and Kelsey Creeks), and Cuyahoga Falls will be removing two low head dams along the Cuyahoga River within a year.
- Kent and Munroe Falls have sponsored annual River Day festivals to celebrate the Cuyahoga River during May. Portage Parks holds Breakneck Creek Day on the same day. The City of Cuyahoga Falls holds clean-ups from Earth Day to River Day annually and has recently been coordinating autumn clean-ups with the Kent State University Outdoor Adventure Center.
- Portage County has adopted a countywide stormwater utility, and Summit County is evaluating the feasibility of a countywide approach to stormwater management.

<u>Middle Cuyahoga River TMDL and Dam Alteration/Removal</u>

The Ohio EPA published the state's first Total Maximum Daily Load study for the Middle Cuyahoga River in 2000 to address non-attainment of water quality standards in this portion of the river. The TMDL found that the major causes of impairment were low oxygen, poor habitat, and flow alteration in dam pools along the Middle Cuyahoga River due to dams along the river at Kent, Munroe Falls, and Cuyahoga Falls. The TMDL recommended removing the dams at Kent and Munroe Falls, or, alternatively, placing extremely stringent limits on permits for wastewater treatment plant effluent.

The Kent and Munroe Falls dams were altered or removed in 2004-2005. Riverbank restoration upstream of the Munroe Falls dam was a collaborative effort between the County of Summit, NEFCO, MetroParks, Serving Summit County, Summit County Soil and Water Conservation District, and the cities of Kent, Stow, and Munroe Falls.

Water quality monitoring following removal/alteration of the two dams indicated that the biological communities between Munroe Falls and Lake Rockwell were either in attainment of water quality standards or were approaching attainment, expected to recover fully within the near future. The impairments identified by the TMDL along the mainstem of the Middle Cuyahoga have been largely addressed. However, some of the tributaries remain impaired, and land use practices contributing to impairment continue.

NEFCO approached the partners from previous collaborative efforts with a proposal to obtain a watershed coordinator grant for the watershed, in order to safeguard the progress that had been made and continue to make improvements in the watershed. The partners indicated that they had been attempting watershed management in the past but were unable to devote staff time consistently and had difficulties working across county and municipal boundaries. The partners expressed immediate and enthusiastic support for a watershed coordinator and for developing a state-endorsed watershed action plan.

3. Watershed Plan Development

3a. Watershed Group

At the beginning of this planning process, in January, 2009, invitations were sent to the communities, park, health, and soil and water conservation districts within the watershed to participate in development of a Watershed Action Plan. The e-mail contact list grew to over 100 people representing communities, land trusts, individuals, university faculty, county and local government, and special districts. The watershed coordinator met with individuals from communities and Kent State University, spoke at various other groups to raise awareness and solicit comments and suggestions, including Kent Environmental Council, Summit and Portage NPDES Phase II Stormwater Information and Public Education groups; Akron-Summit Homebuilders Association; Rotary Club of Portage County. Outreach efforts will continue following endorsement of the plan.

During four years of preparation, perhaps 60 different people came to meetings that were held approximately monthly, but the partners who frequently attended represented the following interests:

- City of Kent
- Portage County Regional Planning Commission
- Portage Park District
- City of Ravenna
- Akron Water Supply and wastewater management
- Summit County Environmental Services
- City of Cuyahoga Falls
- Summit and Portage Soil and Water Conservation Districts
- Local environmental consulting firm
- Citizens from the watershed (Kent, Akron, Cuyahoga Falls), who are involved in environmental advocacy and promotion of recreational paddling

In addition to participating in meetings, Kent State University Recreational Services and the City of Cuyahoga Falls have coordinated autumn river clean-ups, with assistance from Summit County Department of Environmental Services.

In addition, as the need for comments or information arose, the watershed coordinator contacted other partners, or others from the mailing list or those with related interests. Agency officials from Ohio EPA and DNR attended meetings occasionally.

During river clean-ups, which has already become an annual event, a slightly different group of partners would come together to accomplish those events. This approach seems to define the group for the time being: As partners' interests coincide, they work together on shared efforts.

The partners are a relatively new group of collaborators, although many had worked together on other efforts in the region. They joined in this effort because they shared interests in protecting and promoting water quality in the watershed, and they recognized the benefits of collaboration and developing a common framework. In the two and a half years of working as a partnership, they have demonstrated and further developed a strong ability to collaborate.

The group was initially conceived as a loose partnership to develop the Watershed Action Plan, and so far, has been able to accomplish a great deal collaboratively through consensus. Having reached the milestone of an endorsed plan, the partners wish to continue as a loose collaboration for the short-term future. The need for a separate organization with officers and rules of operation will be assessed as time and implementation work progresses.

NEFCO has agreed to provide initial funding to continue the watershed coordinator position, as funds allow for the short term, to allow the coordinator to work with partners on starting projects and obtaining funding. The first year will be used to establish momentum and funding to carry the partnership forward for several years. The partners perceive this as an interim period until the group has successfully carried out some activities and has had a chance to develop an understanding of how they would like to proceed in the longer term. This informal approach should be successful for the near-term, because the partners, who have invested substantial amounts of time and match funds, wish to start accomplishing some of the efforts they have identified. The action tables in Section 7 were developed based on the interests of the partners who were participating in the plan development. A variety of tasks have been identified, which would allow some collaboration where appropriate, but would also allow individual partners to, alone or together, work with the Watershed Coordinator to accomplish certain efforts.

During the last few months of the planning grant, the partners did not meet as frequently as initially, as much of the work was focused on document production. Once the plan is endorsed, the watershed coordinator will be working with individual partners on raising awareness of the plan, writing grant proposals, and starting implementation projects. The coordinator will hold less frequent but regular meetings with the partners to provide some continuity, most likely two to four times per year, depending on the need expressed by the partners.

Mission statement

The partners agreed that the following represents the mission of this group:

Protect, restore, and improve Middle Cuyahoga River, its tributaries, and watershed by protecting the elements that are achieving a high quality, improving, enhancing, or restoring degraded systems, and reducing the effects of the altered watershed.

3b. Plan Outline

This plan largely follows the Appendix 8 outline for Watershed Action Plans. The Problem Statements, Goals, Objectives, and Actions, which are in four separate separate sections in the Appendix 8 outline, have been combined into a single section, 7, in a separate volume. The remainder of the document is organized as follows:

<u>**Section**</u>	<u>**Descripton**</u>
4	Watershed Inventory
4a	Description of the watershed (geology, biological features, water resources
4b	Cultural Resources
4c	Previous and complimentary efforts
4d	Physical Aspects of Streams
4e	Designated use/attainment, threats
5	Impairments, Concerns, Problem Statements
5a	Impairments
5b	Habitat and hydrologic concerns
6	Implementation Considerations
Volume II	
7	Problem Statements, Goals, Objectives, Actions
8	Monitoring/Evaluation
9	Plan Revision

A separate photographic section, 4P, is included with appendices.

3c. Endorsement

The Watershed Coordinator has met with representatives of various communities during development of this plan. Endorsement will be sought individually from the partners that participated in plan development.

3d. Information component

In addition to the elements noted above, implementing the watershed action plan relies on outreach, education, and stewardship that involves a wide range of people. Several of the actions listed in Section 7 focus on outreach and information, including developing a website to serve as a center of watershed-related information; producing flyers; continuing to organize clean-ups of the Cuyahoga River, increasing stewardship activities to lakes or tributaries, conducting workshops for local officials, and developing demonstration projects.

Following plan endorsement, the watershed coordinator will be meeting with stakeholders who did not regularly attend meetings. It is anticipated that the watershed coordinator, along with select partners, will present at forums of interested officials and the public. Because meetings focused on watershed planning tend not to attract large audiences, the watershed coordinator has been having discussions with groups at their own meeting venues, in order to increase awareness, and will likely continue doing so.

4. Watershed Inventory

4a Description of the Watershed
-i Geology

The landscape affects the nature and health of water resources. Topography affects stream energy and morphology; soils affect drainage; and land use affects stream integrity, runoff, groundwater recharge, and habitat. Wetlands and floodplain access are important components of healthy hydrologic systems, and stream morphology affects stream stability over time and response to storm events and flooding. The presence or absence of vegetated riparian (streamside) corridors plays a crucial role in water quality, habitat, flooding and erosion.

In order to provide a framework for identification of problem areas and opportunities, Sections 4 presents an inventory of watershed conditions, literally from the ground up. Sections 4a-c first describe the physical and biological characteristics of the watershed, then hydrology, land use and historical resources, and previous related efforts. Section 4d examines many of the physical conditions of the stream corridors. The last section of the inventory, 4e, examines alterations to the watershed and how these changes affect the quality of the resources. The intent is to use the inventory of conditions to help identify areas to protect or improve, and existing or potential causes of water quality impairment or related concerns within the watershed system.

Geology (Bedrock and Surficial), Topography, Soils, and Ecoregion

The bedrock and surficial materials of an area provide the foundation for the landscape – its topography, soils, drainage patterns, and surface and ground-water hydrology. The bedrock and surficial materials in the watershed have a substantial affect on the landscape of the watershed and the functioning of the waters.

Bedrock Geology

The Middle Cuyahoga River watershed is in the glaciated Allegheny Plateau. This region is characterized by broad bedrock uplands of sedimentary rock separated and incised by deep river channels, all of which have been subsequently modified by glaciers. In Northeast Ohio, the Allegheny Plateau generally ranges from 1,050 to 1,200 feet in elevation and is dissected by valleys as much as 500 feet deep, which have since been filled by as much as 200 feet of glacial deposits.

The bedrock at the surface in the watershed is primarily the Pottsville group of early Pennsylvanian age (about 300 million years ago). This nearly level assemblage of sandstones, shales (mudstones), and coals formed out of the sediments eroding off uplands in Pennsylvania and Canada. The most prominent member of the Pottsville group is the lowest, oldest member, the Sharon sandstone, a rather uniform sandstone with layers containing noticeable round white (quartz) pebbles. The Sharon is resistant to weathering and tends to erode into ledges, creating some of the most distinctive landscape features in the region: sandstone cliffs, ledges, and waterfalls. Early settlers harnessed waterfalls along the Cuyahoga River to provide water power for mills and factories, creating the nuclei for communities such as Kent, Munroe Falls, and Cuyahoga Falls. Associated with the sandstone units are shale and coa, which formed in quiet environments, such as swamps, lakes, or embayments. Where shaley layers like the Meadville shale underlie the ledge-forming sandstones, the less resistant, less permeable shale weathers out from under the ledges, forming overhangs and caves. The Sharon Sandstone is also one of the major bedrock aquifers of the region, because of its high transmissivity (ability of water to flow between pore spaces).

Prior to the most recent glaciation, which began approximately 2 million years ago, the broad uplands of the Allegheny plateau had been eroded, dissected into deep valleys by rivers over millions of years. The previous drainage system in northeast Ohio, known as the Erigan, drained north toward the present St. Lawrence valley. White, 1982; J. Evans, 2003.

Surficial Geology

Glacial History-Background

Background: Glacial History

The most recent glaciation that covered northeast Ohio from 2 million years ago to 14,000 years ago modified the pre-existing topography. Steep-sided valleys were partially smoothed over and filled in with sediment. The moving ice scraped off portions of bedrock and left deposits on the uplands. Streams and lakes that developed from melting ice left behind deposits that range from flat to hilly, clay to gravel. These modifications created the topography, parent material, and conditions for our current soils and landscape, and left behind deposits through which groundwater flows.

To develop an understanding of the surficial materials, several sources were reviewed. This chapter includes digital mapping that was readily available from the Ohio GIS Internet Management System (GIMS). The background from several previous reports is generally consistent with the available mapping. The various sources combined provide an adequate understanding of how the landscape and surficial materials developed and how they will affect the soils, landscape, surface and ground water hydrology in the watershed.

Glacial Materials and Landforms

As glaciers advance and retreat, they leave behind several types of material and forms. These are generally grouped by whether they were formed in water (outwash) or were left behind by the ice as it retreated (till). The process that formed these landscape features affects the nature of the deposits left behind.

Outwash - sediment left behind by melting water from the ice. Outwash is often stratified (layered) by the flowing water and tends to be well-sorted, with grains relatively uniform in size. (See Figure 4a-1.) Outwash material that is sand or gravel tends to store a great deal of water between pore spaces and allows water to flow through it easily. Outwash material that formed in lakes tends to be very fine-grained and does not allow water to flow through easily. Outwash landforms include:

- Kames - circular or elongate knolls, mounds, ridges, or terraces of outwash material (often sand or gravel) that were deposited by streams in holes or cracks in the ice or along the margins of ice blocks and valleys. The material in kames is variable, ranging from sand to cobbles or boulders. The layering is often tilted.

Typical till in northeast Ohio has a high proportion of clay, with silt, gravel, cobbles, and boulders mixed in.
Source: J Szabo, University of Akron.

Glacial outwash is often sandy or gravelly. It typically exhibits horizontal or dipping layers, and the sediment is well-sorted by size, with deposits of finer or coarser grains reflecting different flow conditions. *Photo source: J. Peck, University of Akron Geology Dept.*

Figure 4a-1
Glacial Deposits: Till and Outwash

- Kame terraces are stratified deposits along valley sides, which formed where water flowed along the margin of ice that remained in deep bedrock valleys. Where the current was swift, coarser material was deposited. Occasionally, ponds would form along the ice margins, resulting in deposits of fine-grained material.
- Kettles formed where ice blocks from the stagnant or retreating ice margin broke off and were covered by outwash sediment. After the remnant ice blocks melted, deep, steep sided, isolated valleys were left behind, which often formed bogs or lakes. The surficial material at the bottom of kettles is often peat or clay.
- Along outwash valleys, glacial rivers carried and deposited sediment. These were unlike present streams in the region. Glacial streams tend to be high energy with high loads of sediment, leaving extensive deposits of well-sorted sand and gravel. As gravel bars accreted (grew vertically with sediment), streams would shift, flowing along a different path. The tundra climate would allow minimal vegetation to grow, and the severe winds of the tundra would remove most silts from exposed sediment, depositing the silts as loess, uniform deposits of silt. Loess deposits, while present in the middle Cuyahoga watershed, are generally so thin they are not mapped separately.
- At the ice margins, pro-glacial lakes might form. The lake bottoms would be covered with clay and other fine-grained material.

Till – left behind as the ice moves, consists of ground up bedrock and incorporated surface materials, ranging from clay size to boulders. As shown on Figure 4a-1, this material is generally unlayered and poorly sorted. With a range of particle sizes, any pore space between larger particles is often filled with smaller material, resulting in generally poor drainage, low water storage. Water often does not move freely through the limited pore space. Such material is said to transmit water poorly or have low transmissivity.

- As the ice melted back across the landscape, the ground-up sediment melted out, remaining on the landscape as moraines:
- Ground moraine - a relatively thin coating of till deposited across bedrock highs.
- End moraine or recessional moraine - At the extent of the ice sheet or where the glacier paused while melting back, the till was deposited in long, relatively narrow, linear, continuous bands of hummocky topography (i.e., characterized by numerous rounded hills or knolls). Ridges at the furthest extent of the ice margins are end moraines, and ridges formed as the ice paused are recessional moraines.

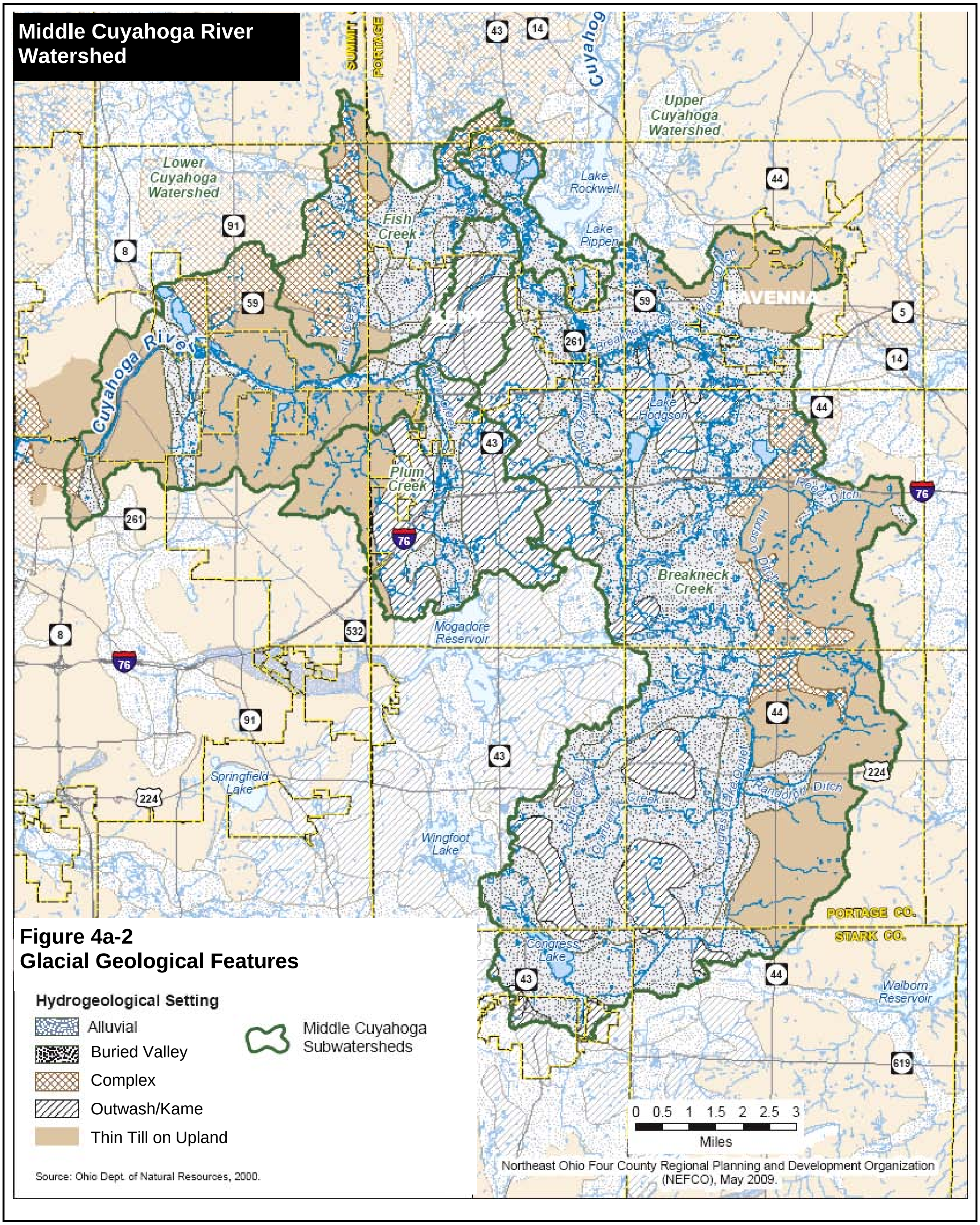
Buried valleys are ancient, often deep, incised river valleys that are now partially filled with glacial materials. The valleys can be filled with outwash from glacial streams, till, lake deposits, or a combination of materials in various layers and lenses.

Findings: Glacial/Surficial Materials of the Middle Cuyahoga River Watershed

Glacial Landscape of the Middle Cuyahoga River Watershed

The incised bedrock of the Middle Cuyahoga River watershed area trapped retreating glacial ice, resulting in deposits that vary widely in composition and topography within a short distance. White (1982) notes that northeast Ohio experienced several glacial advances and retreats, each modifying the previous landscapes. In other areas like central Ohio, where the ice margins fluctuated over a wide area, the glaciers left several distinct linear, narrow end moraines across a north-south distance of about 100 miles. However, in the area of the middle Cuhayhoga watershed, the pre-existing valleys trapped portions of the glacial ice, compressing several moraine ridges into a very narrow band. The glaciers melted more quickly from the neighboring bedrock uplands. The ice within the valleys neither advanced nor retreated, but stagnated. Melting ice and the meltwater deposited kames and kame terraces along the margins of the ice and valleys. Later advances of ice draped these deposits with new till. Kettles formed where ice blocks broke off and melted. The resulting landscape, a kame moraine, is a confused mix of hummocky topography contained by till-covered bedrock uplands, with a mixture of outwash features (such as kames and kettles) and end-moraine or recessional moraine till, all sometimes overlain with till by subsequent glacial advances and retreats.

Figure 4a-2 presents the Ohio DNR mapping of unconsolidated aquifer geology in the Middle Cuyahoga River watershed. The eastern portion of the watershed roughly east of Route 44 is largely composed of thin till on upland. White (1982) described this as Lavery Till ground moraine, a thin silty till deposited as gently rolling topography over bedrock uplands. The central portion of the watershed is mapped as buried valley, outwash, and kames. This corresponds to the Kent Kame Moraine described by White, the narrow, irregular band of hummocky topography with till and outwash features jumbled together over a width of approximately 15 miles in a buried valley. The western portion of the watershed is mapped as thin till overlying bedrock highlands, described as Hayesville Till (in Stow and Munroe Falls) in the northwestern portion of the watershed. Plum Creek and Kelsey Creek flow through buried valleys. The Cuyahoga River flows through till-covered upland and a buried valley, identified in other mapping as outwash valley trains. In many areas, the river has eroded down and into the bedrock. The sandy and gravelly deposits in the Plum Creek buried valley and along the Cuyahoga River near Kelsey Creek have high transmissivity (allow groundwater to flow through easily). The Portage County and Cuyahoga Falls wellfields are located in these deposits. (George W. White, 1982.)


Middle Cuyahoga River Watershed
Upper Cuyahoga Watershed
Lower Cuyahoga Watershed
Lake Rockwell
Lake Pippen
Fish Creek
Cuyahoga River
RAVENNA
Breakneck Creek
Lake Hodgson
Plum Creek
Mogadore Reservoir
Springfield Lake
Wingfoot Lake
Congress Lake
Walborn Reservoir
PORTAGE CO.
STARK CO.
SUMMIT
PORTAGE
Figure 4a-2
Glacial Geological Features
Hydrogeological Setting
Alluvial
Buried Valley
Complex
Outwash/Kame
Thin Till on Upland
Middle Cuyahoga Subwatersheds
Source: Ohio Dept. of Natural Resources, 2000.
0 0.5 1 1.5 2 2.5 3
Miles
Northeast Ohio Four County Regional Planning and Development Organization (NEFCO), May 2009.

Topography

The most visible evidence of the glacial and pre-glacial history is the topography of the landscape. It is also one of the key factors controlling such hydrologic characteristics as gradient, stream power (the energy to move material), and morphology of stream channels, and the presence and extent of wetlands and floodplains.

Figure 4a-3 shows the elevation patterns of the Middle Cuyahoga River watershed, and Figures 4a-4.1 through 4a-4.5 show the topography of the subwatersheds. The watershed ranges in elevation from 900 feet at the Ohio Edison dam (840 feet immediately downstream of the dam) to approximately 1,269 feet on knolls in the Breakneck Creek watershed. Most of the watershed ranges between 1,100 and 1,200 feet.

The landscape of Middle Cuyahoga River watershed reflects the underlying geologic features. The eastern portion of the watershed has thin till on broad, gently undulating uplands. (See Figure 4a-5 for typical landscapes.) The central portion of the watershed, the Kent Kame Moraine, exhibits much more uneven, hummocky topography, with the higher glacially deposited uplands separated by valleys. The areas noted on Figure 4a-2 as buried valleys tend to be low in elevation and relief. The western portion exhibits broad uplands, steep-sided stream and river valleys, and the low-relief buried valleys. The till-covered uplands (pale-colored on the map) are apparent in eastern Summit County and portions of western Portage County. As the Cuyahoga River flows through Cuyahoga Falls, the river enters a steep-walled gorge.

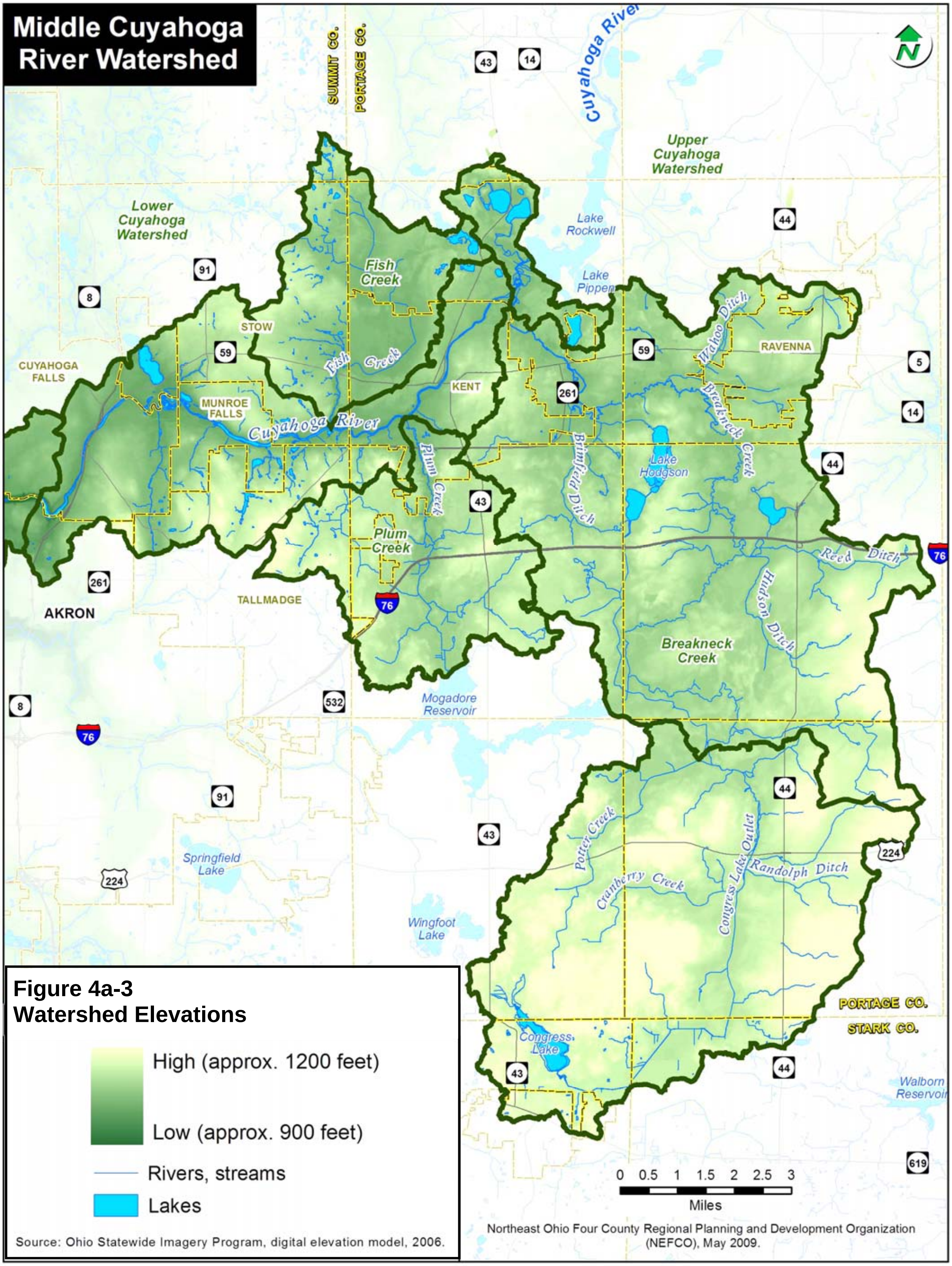
Soils

Developing a general understanding of the soils of the watershed important, as the soils are key factors in the hydrology and drainage of an area. Through weathering, biological activity, and the addition of organic matter, soils in the watershed have evolved from the parent glacial material left in area and more recent deposits left by streams and lakes. The characteristics of the soils reflect their parent material.

General Soils Associations

The Natural Resources Conservation Service (NRCS) has developed large-scale maps of soil units maps based on field mapping. These have been generalized to show repeatable patterns of soil associations, which provide a broad overview of the types of soils most prevalent in an area. It is important to note the generalized areas contain many different soil units, each with its own characteristics. For instance, outwash derived soils can range from clay soils formed in lakes to coarse gravels formed in kame deposits, including everything in-between. Even individually mapped units contain components of other soil types. Mapping at either the unit or regional scale serves as a guide – conditions at specific sites must be field verified.

Figure 4a-6 and Table 4a-1 illustrate how the soils reflect the parent glacial material. Two rather mixed soil assemblages in the southeastern part of the watershed in Portage County reflect a landscape with outwash (Chili soils) and till combined. This combination may reflect the varied deposits of the buried valley, with kames interspersed among till.


Middle Cuyahoga River Watershed
SUMMIT CO.
PORTAGE CO.
Cuyahoga River
Upper Cuyahoga Watershed
Lower Cuyahoga Watershed
Lake Rockwell
Lake Pippen
Fish Creek
STOW
CUYAHOGA FALLS
MUNROE FALLS
KENT
RAVENNA
Wahoo Ditch
Breakneck Creek
Brimfield Ditch
Lake Hodgson
Plum Creek
Reed Ditch
Hudson Ditch
TALLMADGE
AKRON
Breakneck Creek
Mogadore Reservoir
Springfield Lake
Wingfoot Lake
Potter Creek
Cranberry Creek
Congress Lake Outlet
Randolph Ditch
Congress Lake
PORTAGE CO.
STARK CO.
Walborn Reservoir
Figure 4a-3
Watershed Elevations
High (approx. 1200 feet)
Low (approx. 900 feet)
Rivers, streams
Lakes
Source: Ohio Statewide Imagery Program, digital elevation model, 2006.
0 0.5 1 1.5 2 2.5 3
Miles
Northeast Ohio Four County Regional Planning and Development Organization (NEFCO), May 2009.

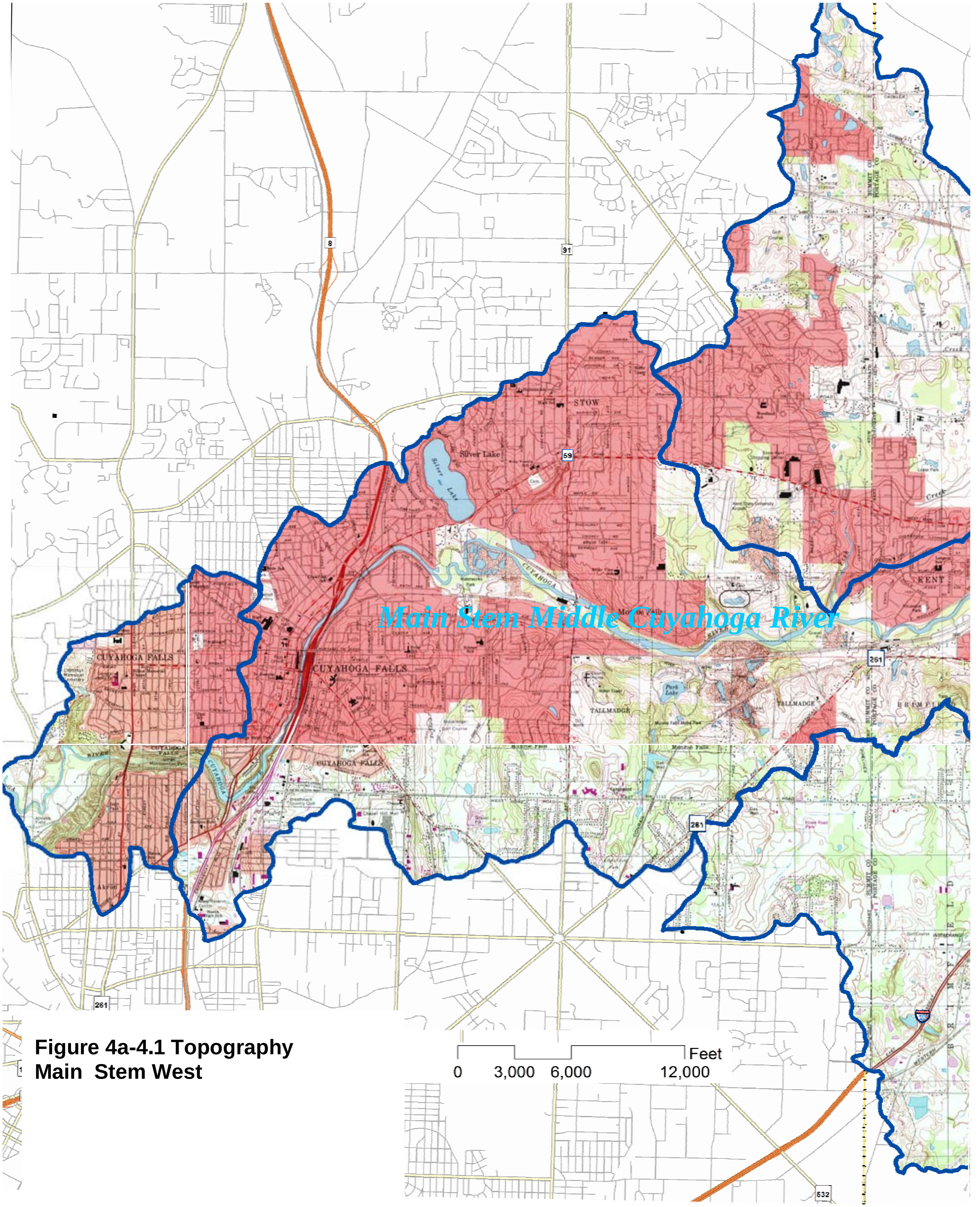


Figure 4a-4.1 Topography
Main Stem West

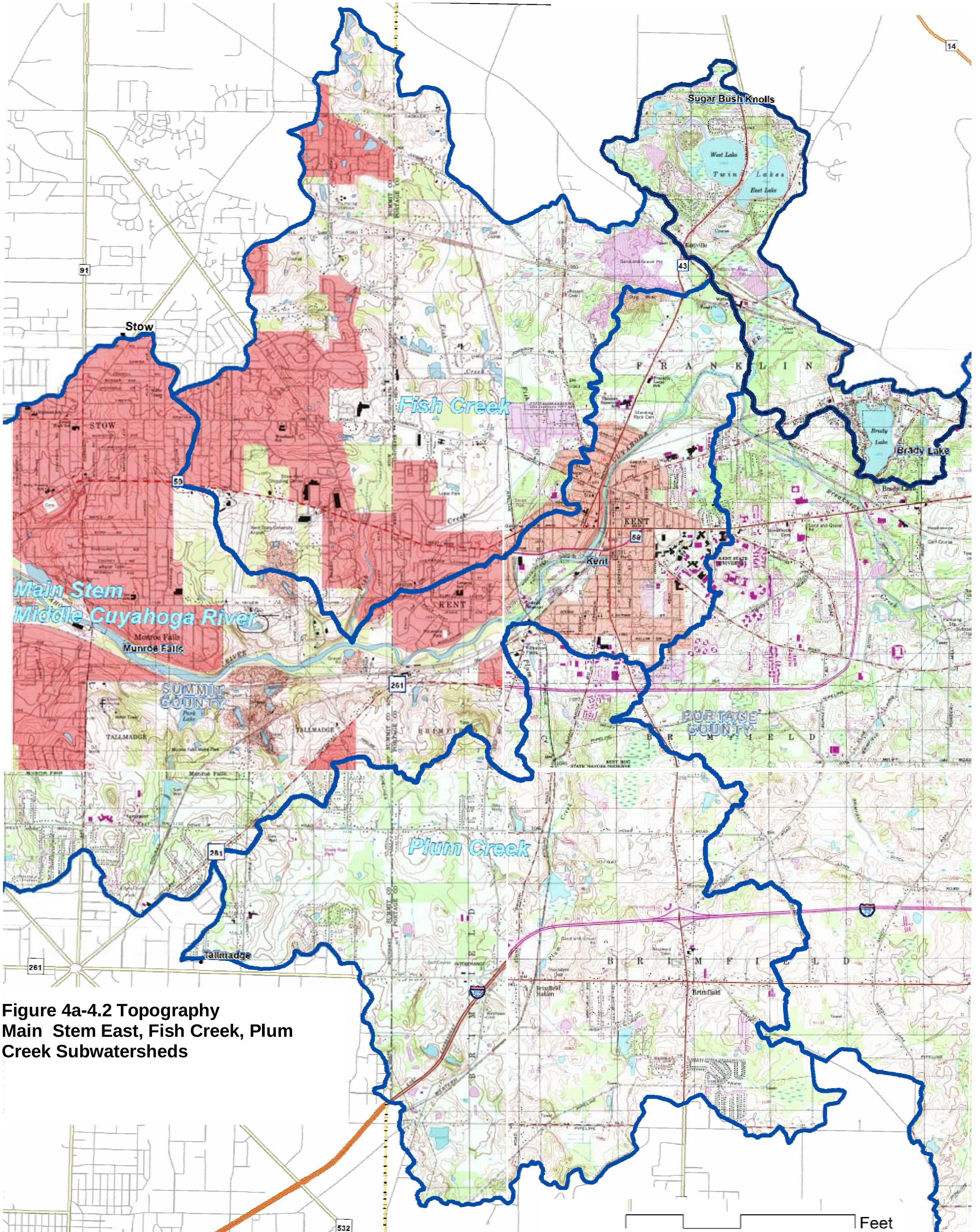


Figure 4a-4.2 Topography
Main Stem East, Fish Creek, Plum Creek Subwatersheds

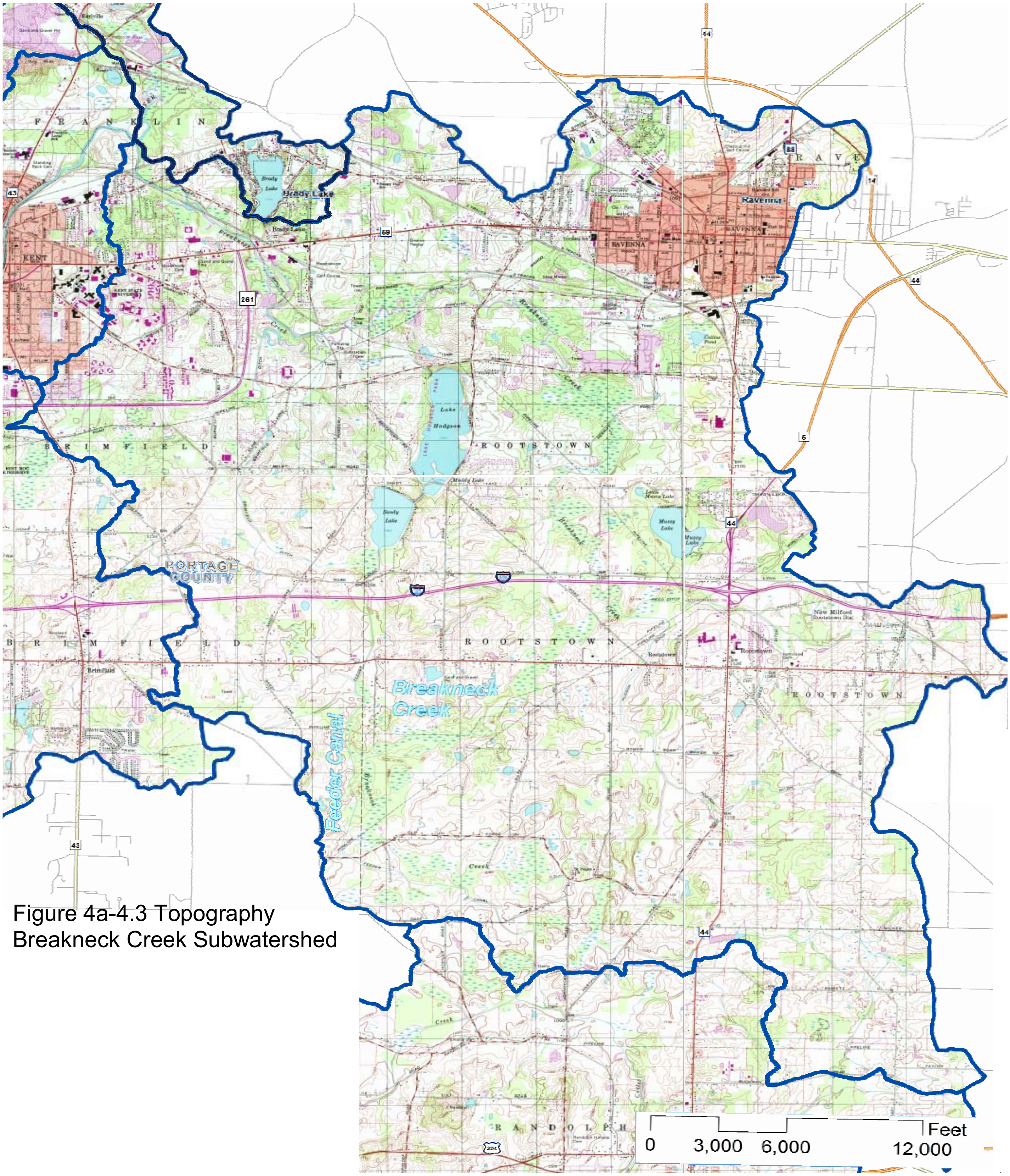


Figure 4a-4.3 Topography
Breakneck Creek Subwatershed

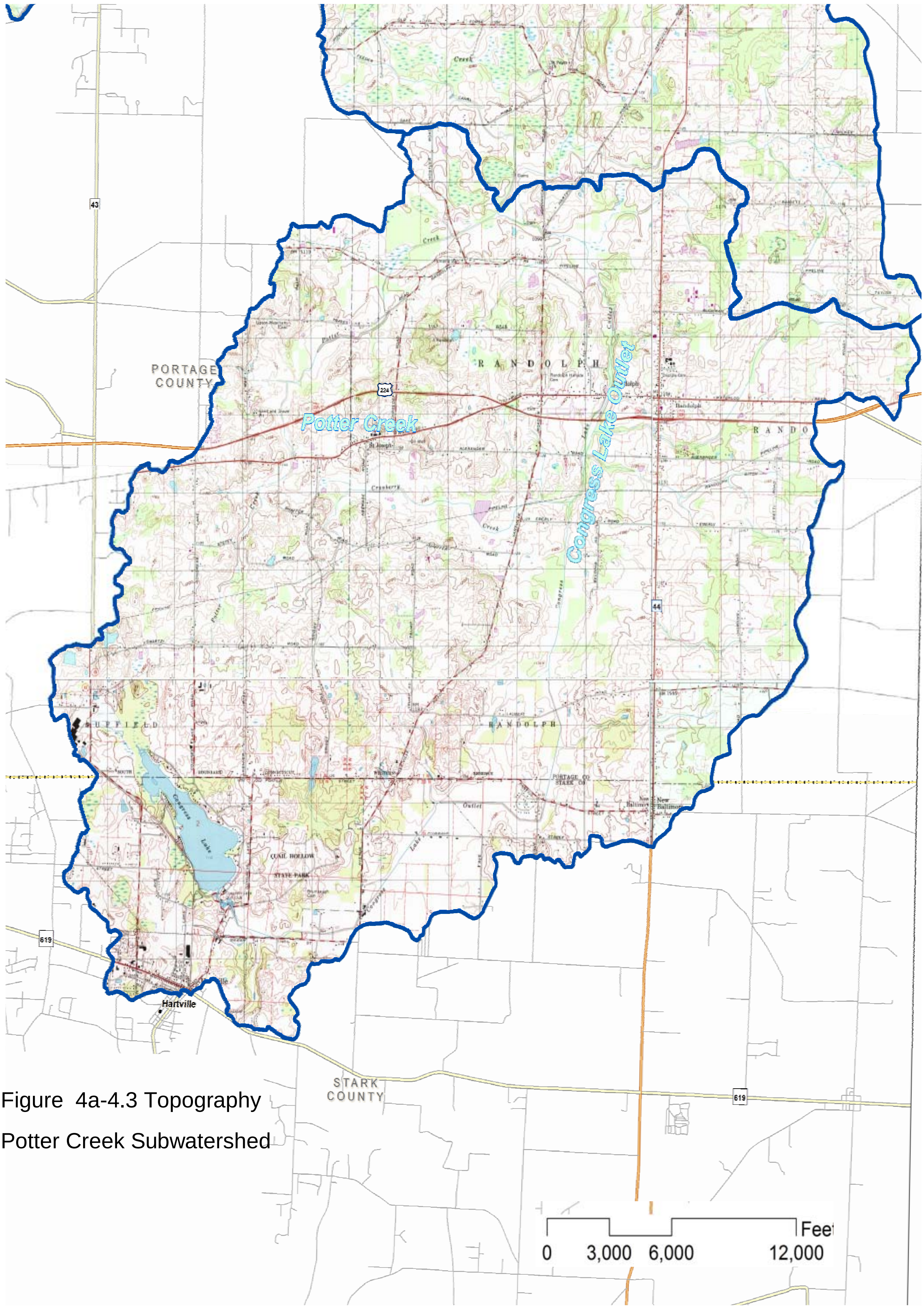


Figure 4a-4.3 Topography

Potter Creek Subwatershed

Broad till-covered uplands, eastern watershed.

Hummocky Topography Kame-Moraine

Breakneck Creek wanders through a landscape of glacial uplands and extensive wetlands.

Walnut Creek tributary cuts through steeply sloping till-covered bedrock to incised bedrock valley, main stem subwatershed.

Steep till-covered bedrock slopes confine much of the Middle Cuyahoga River

Cuyahoga River Gorge, Front St., Cuyahoga

Figure 4a-5
Typical Topography in the Middle Cuyahoga River Watershed

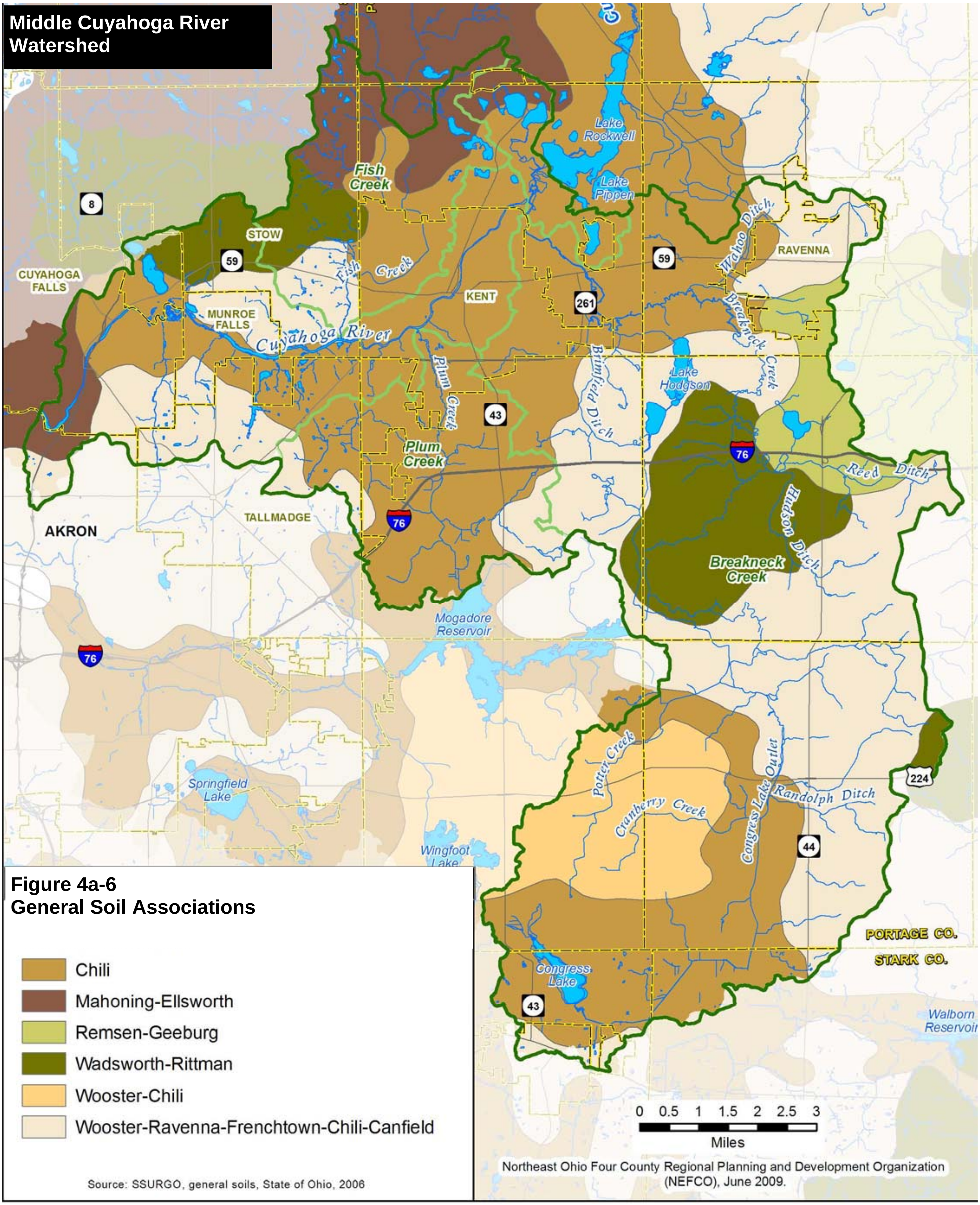


Figure 4a-6
General Soil Associations

In the central portion of the watershed, where the kames and kame terraces dominate the glacial deposits, much of the soils associations are Chili associations, well-drained, nearly level to steep. In the western portion of the watershed are found till-based soils, such as Canfield associations, which are somewhat poorly drained to moderately well drained, nearly level to sloping loam/silt-loam. Scattered throughout the watershed are soils that form in depressions, lakes, bogs, marshes, floodplains, and stream channels, which formed either in glacial lakes and kettles or more recent streams and ponds. These tend to be nearly level and poorly drained.

Table 4A-1 Soil Association Characteristics

Name	Characteristics	Slope	Formed in
Chili	Well drained	Nearly level to steep	Sand and gravelly glacial outwash, possibly covered by loamy material.
Mahoning-Ellsworth	Somewhat poorly drained and moderately well drained	Nearly level to sloping	Fine textured glacial till
Remsen-Geeburg	Moderately well-drained to somewhat poorly drained	Nearly level to gently sloping	Fine textured glacial till
Wadsworth-Rittman	Somewhat poorly drained and moderately well drained	Nearly level to sloping	Medium- and Moderately fine-textured glacial till
Wooster-Chili	Well drained soils	Sloping to very steep	Sandy or loamy material overlying sand or gravel or both. Wooster formed in till, Chili in outwash.
Wooster-Ravenna-Frenchtown-Chili-Canfield	Somewhat poorly drained and well-drained.	Sloping to steep	Canfield-Ravenna-Wooster is described in county Soil Surveys as a medium textured glacial till. Frenchtown formed in low elevations. Chili formed in outwash.

Soil Mapping Units – Select Characteristics

As shown in Table 4a-2, over 70 percent of the watershed is represented by seven soil series. The predominant soil series in the watershed are the outwash-derived Chili soils, followed by Canfield and Wooster. Two of the most prevalent groups are considered “hydric,” or soils saturated long enough to develop distinct characteristics reflecting saturation. These tend to develop in depressions, bogs and marshes, drainageways, glacial lakes, floodplains, and areas that flood. Hydric soils tend to be used as key indicators of the presence of wetlands and are mapped in the hydrology section.

Soils may be grouped according to a variety of characteristics, slope, potential for runoff or erosion, limitations to use such as septic systems or development, and potential for crop production. This section summarizes the general nature of the soils in the watershed in terms of: slope, runoff potential, prime farmland soils, and erosion potential. The purpose of this discussion is to present an overview of the general characteristics within the watershed. Soil characteristics that reflect hydrology (e.g., hydric soils and flood-prone soils) will be further addressed in the Hydrology section. Characteristics that can affect water quality, such as erodibilty and steep slopes, will be addressed more specifically in Section 4E, which addresses potential causes of impairment.

<u>Slope</u>

As shown in Table 4A-3, soils of a moderate slope (2-6%) are the most prominent in the watershed, making up 42 percent. Soils mapped with no slope designation, many of which are hydric or urbanized soils, make up 25 percent. Soils with slopes greater than six percent (C, D, and E) are considered steep slopes for the purposes of assessing erosion potential. Steep slopes make up approximately 22 percent of the watershed.

Table 4A-2 Middle Cuyahoga River Watershed Predominant Soils

Soil groups	Soil names and symbols*	Percent	Area (acres)	Hydrologic Soil Group	K Factor (erodibility)	Prime Farmland	Characteristics
Chili		*25.2%*	*21,263*				*Deep, well-drained, nearly level to very steep loamy soils that formed in loamy outwash material underlain by sand and gravel. May have silt mantle 8-24 inches thick. These soils are on outwash terraces and kames.*
	Chili loam (Cn A, CnB, CnC);	7.9%	6,649	B	0.37	Cn A & B prime CnC local importance	
	Chili Gravelly loam (CoC,CoC2, CoD2, CoE2)	2.3 %	1,912	B	0.43	CoC2 local imp.	
	Chili silt loam (CpA, CpB, CpC, CpC2)	6.2%	5,189	B	0.37	CpA & B prime CpC local	
	Chili-Oshtemo complex (CtD, CtE, CtF)	2.4%	2,062	Chili (55% of unit) B Oshtemo (45%) A	0.37 0.24	CtD local imp.	
	Chili-Urban land complex (CuB, CuC, CuF)	4.2%	3,501	Chili (40% of map unit) B	0.37		
	Chili-Conotton gravelly loams (CvF2)	.003%	3	Chili (55% of unit) B Oshtemo A	0.37 0.24		
	Chili-Wooster complex (CwC2, CwD2, CwE, CwE2)	2.3%	1,948	Chili (50% of unit) B Wooster (30%) C	0.37 0.43	CwC2 local imp.	
Canfield		*14.3%*	*12,058*				*Deep moderately well drained nearly level to sloping soils, formed in loam and fine sandy loam glacial till. On uplands in southern Summit County, SE and north central Portage County. These contain fragipan (loamy brittle subsurface horizon low in organic matter and clay, rich in silt, very hard. Ruptures rather than deforms when moist).*

[1]

[1] *Because soils maps were developed for each county, the names or symbols may differ across county boundaries. The capital letters and numbers at the end of each soil type reflect slope: A = 0-2%, B = 2-6%, C = 6-12%, D = 12-18%, E = 18-25%, and F = 25-75%. Numbers indicate eroded soils: 2 indicates the soil is moderately eroded.

Table 4A-2 Middle Cuyahoga River Watershed Predominant Soils (cont'd)

Soil groups	Soil names and symbols*	Percent	Area (acres)	Hydrologic Soil Group	K Factor (erodibility)	Prime Farmland	Characteristics
	Canfield silt loam (CdA, CdB, CdC, CdD2)	11.3%	9,496	C in Portage D in Summit	0.43	CdA & B prime CdC &C2 local	
	Canfield silt loam (CfB, CfC) urban land complex.	3.0%	2,495	C in Portage D in Summit	0.43		
Wooster		*5.9%*	*4,997*				*Deep, well-drained gently sloping to very steep soils that fomed in loam glacial till. These soils are on uplands mainly in southern Summit County, southwestern and north-central parts of Portage County. Fragipan. Formed in outwash.*
	Wooster silt loam (WuB, WuC, WuC2, WuD, WuD2, WuE2)	5.8%	4,921	C	0.43	WuB prime WuC & C2 local imp.	
	Wooster silt loam, sandstone substratum (WvC2, WvD2)	0.08%	68	C	0.43		
	Wooster urban land complex, hilly (Wu)	.009%	8	C	0.43		
Ravenna		*5.5%*	*4,630*				*Medium textured (loam or silt loam) glacial till on uplands, somewhat poorly drained. Inclusions in ReA formed in depressions and drainageways are hydric. Fragipan.*
	Ravenna silt loam (ReA, ReB)	5.3%	4,304	D	0.43	ReA & B if drained	
	Ravenna urban land complex (Rn)	0.2%	126				
Carlisle		*4.9%*	*4,150*				*Very poorly drained organic soils formed in muck and peat deposits more than 51 inches thick. These are in depressions, broad low bogs, marshes, or kettles mostly in western Portage County. Hydric soils.*
	Carlisle Muck (Cg, Ch)	4.9%	4,150	*A/D**	--		

Table 4A-2 Middle Cuyahoga River Watershed Predominant Soils (cont'd)

Soil groups	Soil names and symbols*	Percent	Area (Acres)	Hydrologic Soil Group	K Factor (erodibility)	Prime Farmland	Characteristics
Sebring		*4.6%*	*3,914*				*Deep, poorly drained, nearly level soils that formed in silty sediments. These soils are on stream terraces throughout Portage County. Formed on terraces, depressions, glacial lakes. Hydric soils.*
	Sebring silt loam (Sb, Sv)	4.6%	3,866	C/D	Sb 0.37 Sv 0.32	Sb prime if drained	
	Sebring silt loam, till substratum (Se)	0.6%	48	C/D	0.37		
Rittman		*4.2%*	*3,502*				*Deep, moderately well drained, gently sloping to steep soils, formed in clay loam and silty clay loam glacial till. Drainageway units (RsB and RsC2) have hydric inclusions. Fragipan*
	Rittman silt loam (RsB, RsC, RsC2, RsD, RsD2, RsE2)	3.8%	3,205 ac	D	0.43	RsB prime RsC/C2 local imp.	
	Rittman silt loam, sandstone substratum (RtB)	0.04%	33 ac.	D	0.43	RtB	
	Rittman urban land complex (RuB, RuC)	0.3%	264 ac.				
Other Soils in Associations							
Mahoning	Mahoning silt loam (MgA, MgB, MdB, MnB)			C/D	0.43	Prime if drained	*Formed on till plains, somewhat poorly drained. MgA and MnB have 10% inclusions of hydric Trumbull in depressions.*
Ellsworth	Ellsworth silt loam (ElB, ElB2, ElC, ElC2, ElD2, ElE2 EsB, EuB Urban)			C	0.43	ElB, ElB2, EsB Prime	*Gently sloping to sloping deep, moderately well drained soil developed on till plains. EsB has a sandstone substratum.*
Remsen	Remsen silt loam (RmA, RmB)			D	0.43	Local imp.	*Somewhat poorly drained. Formed on till plains.*
Geeberg	Geeburg silt loam (GbB, GbB2, GbC2, GbD2, GcB, GcB urban, GeF)			D	0.43	GbB, GbB2, GbC2 Local imp.	*Moderately well drained. Formed on till plains and moraines.*
Wadsworth	Wadsworth Silt Loam (WaA, WaB, WbB)			D	0.43	Prime if drained	*Formed on till plains, somewhat poorly drained. WaA/B have 5-10% inclusions of hydric Frenchtown in drainageways.*
Frenchtown	Frenchtown silt loam			D	0.37	Prime if drained	*Hydric. Poorly drained. Formed on till flats..*

Table 4A-3 Middle Cuyahoga River Watershed Soil Slope Characteristics

Slope Designation	Percent in Watershed	Acres in Watershed
No designation	25.1	21,186
A (0-2%)	9.7	8,160
B (2-6%)	42.4	35,744
B2 (2-6% moderately eroded)	.02	15
C (6-12%)	10.0	8,407
C2 (6-12% moderately eroded)	6.5	5,479
D (12-18%)	2.2	1,842
D2 (12-18% moderately eroded)	2.7	2,276
E (18-25%)	0.7	629
E2 (18-25%) moderately eroded	0.3	238
F (25-75%)	0.4	297
F2 (25-75% moderately eroded	0.003	3

Hydrologic Soil Group

Figure 4a-7 depicts how soils characteristics generally relate to underlying geology. One measure of drainage characteristics in soils is the hydrologic soil group, which reflects the potential for storm water to run off the land or infiltrate into the ground, i.e., how well water moves (transmits) through the soils when they are wet. It is related to other drainage characteristics and illustrates how well water moves through the soils.

The hydrologic groups are generally determined based on the layer with the lowest transmissivity (how freely water moves through the soil, lowest means water does not move through easily). The hydrologic groups range from A to D as follows:

- A - Soils with low runoff potential, water is transmitted freely through soil even when thoroughly wetted. These consist chiefly of deep, well drained to excessively well-drained sands or gravels.
- B - Soils having moderately low runoff potential, transmission of water through soils is unimpeded, even when thoroughly wetted. These consist chiefly of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse textures.
- C - Soils having moderately high runoff potential, transmission of water through the soils is somewhat restricted, even when thoroughly wetted. These consist chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures.
- D - Soils with high runoff potential. Water transmission is restricted or severely restricted when wetted. These consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a dense clay layer at or near the surface, and shallow soils over material that allows only minimal water movement through it. Many D soils are considered wetland (hydric) soils or contain inclusions of hydric soils.
- Some soils were mapped as C In Portage County and D in Summit County.

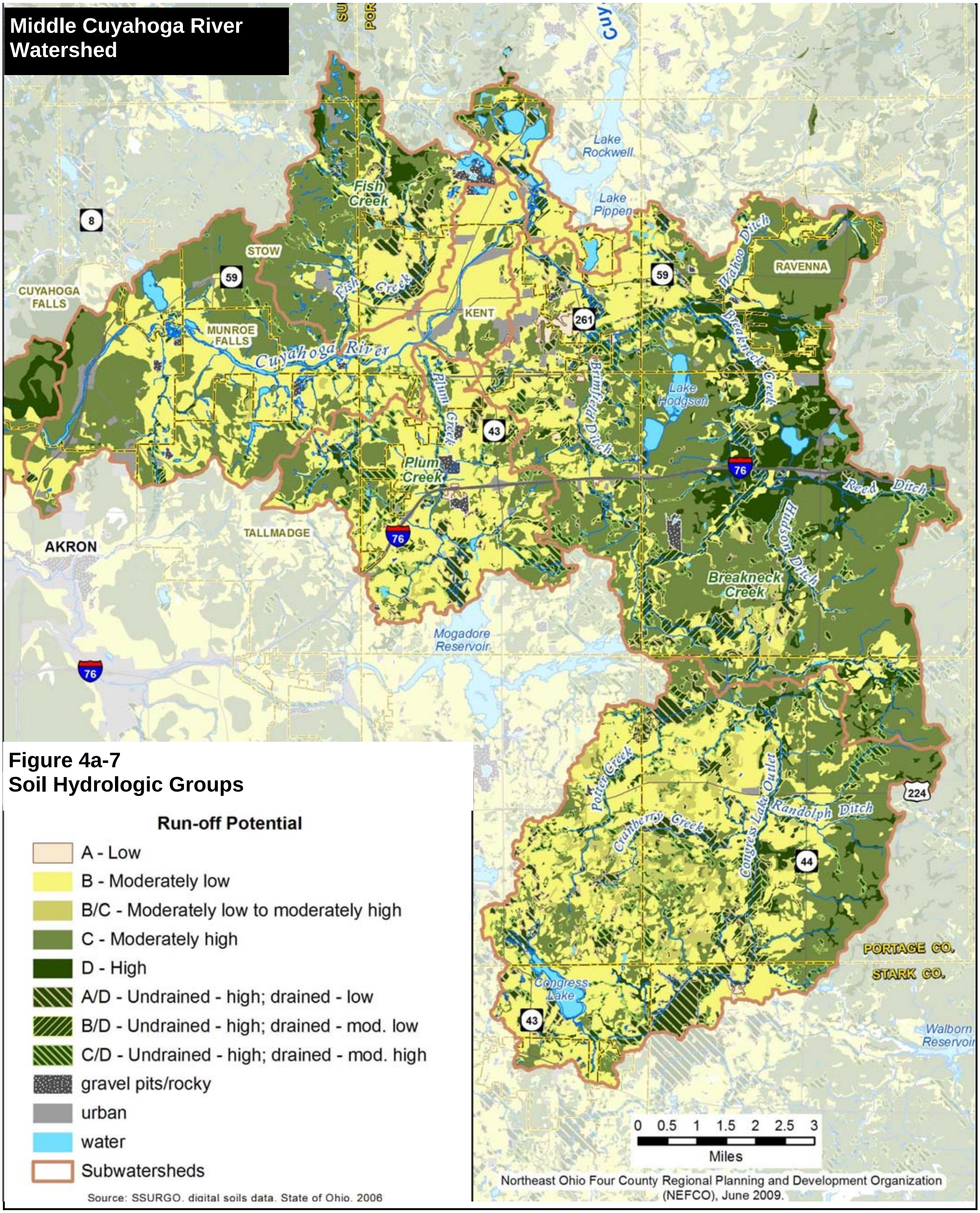


Figure 4a-7
Soil Hydrologic Groups

- A/D, B/D, C/D– Certain soils are placed in the D category because the water table is within 24 inches of the surface. If these soils can be adequately drained (increasing the depth of the water table below 24 inches), they exhibit runoff characteristics of the hydrologic group identified by the first letter in the designation.

As shown in Figure 4a-7, the group C soils, which somewhat restrict water flow, coincide in many areas with the till-covered uplands. The group B soils, allowing more rapid water movement, occur along the central band of outwash. In the southern portion of the watershed, the soils reflect the varied nature of the hummocky kame-kettle and kame-moraine landscape. This area is predominantly group B soils, but there are many small areas of group C and D soils, which are likely to occur in lake bottoms and bogs. The path of certain streams and rivers are also quite apparent in the patterns of the floodplain/drainageway-derived soils (linear group D soils). The broad patterns of soil drainage characteristics generally reflect the underlying parent material; however, at a more local scale, the characteristics vary widely.

As shown in Table 4a-4, the predominant hydrologic group in the watershed is C, and another third is the higher transmissivity group B soils. Nearly one-fifth of the watershed is classified as hydric soils, and over one-fourth of the watershed contains inclusions of hydric soils. It should be noted that the large amount of mapped hydric soils may not accurately reflect the existing soil conditions. While these areas are generally unsuitable for development due to their saturated condition, sites with hydric soils have been altered and developed. Certain hydric soils can be highly productive agricultural soils when drained. Hydric soils are discussed further in the hydrology section, as they are often indicators of wetlands.

Table 4A-4 Middle Cuyahoga River Watershed Soil Hydrologic Groups

Hydrologic Group	Percent in Watershed	Acres in Watershed
A	0.3	287
B	33.8	28,475
C	35.8	30,193
D	5.7	4,778
A/D	5.7	4,800
B/C	2.3	1,948
B/D	4.9	4,857
C/D	5.5	4,611
85-100% Hydric	18.4	15,527
Contains 5-10% hydric inclusions	30.7	25,847

While general patterns in elevation and soil characteristics coincide with the broad distinctions of till versus outwash, at a local level, the soil conditions vary widely. Such variability is characteristic of this portion of northeast Ohio, reflecting the different types and episodes of glacial modification within a relatively small area. Conditions can range from well-drained to poorly drained, nearly level to steeply sloping within a small area.

Because of this great degree of variability, soil conditions must be carefully evaluated at a site level when considering problems, sources, and implementation projects.

Erodibility

Soil erodibility is characterized by a “k” factor, which designates the susceptibility of each soil to erosion by shallow, broad sheet flow of water or rills, the small channels that form on the landscape as water just becomes channelized as it flows across the land. The “k” factor, which is based on particle size and soil-water characteristics, is used in the uniform soil loss equation (or revised uniform soil loss equation) as a multiplier in calculating soil erosion. The higher the “k” factor, the greater the potential for erosion of unprotected soils. Highly erodible soils, another category of soil erodibility, are mapped later in Section 4e as a potential risk to water quality. The overview presented in this chapter indicates that much of the soils of the watershed have a “k” value of 0.37 to 0.43 out of a possible range of 0.02 to 0.69. Muck soils are not assigned erodibility factors.

Important Farmland Soils

This document focuses on the watershed characteristics related to water quality. However, much of the land use in Portage and Stark Counties is agricultural. The U.S. Department of Agriculture defines prime farmland soils as those with the best combination of physical and chemical properties for use in producing food, feed, forage, fiber, or oilseed crops. Some soils become prime farmland soils if drained. “Farmland of local importance” is designated by local agencies as important for the same purposes as prime farmland.

As shown in Table 4a-2, over half of the watershed soils are of prime or local importance for farmland. Some of the hydric soils and silt loams are prime farmland soils if drained. This presents a potential conflict between wetland preservation (important for watershed health) and the desire to drain certain hydric soils (wetlands) for economic use as farmland.

Ecoregion

One of the ecological classification systems that embodies the interrelationships between landscape, hydrology, and biota, is that of ecoregions. Ecoregions denote areas of general similarity in ecosystems and environmental resources. They are designated to provide an overall, integrated framework for understanding and managing the natural resources of a region. Ecoregions are used in developing biological criteria and water quality standards as well as the establishment of management goals for nonpoint-source pollution.

The classification is a hierarchical system, designated by Roman numerals. The U.S. includes 15 Level I regions, 52 Level II regions, and 99 Level III regions, based on geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. Ohio has been divided into 4 Level III ecoregions, which have been further subdivided into Level IV sub-regions.

The Middle Cuyahoga River Watershed is within the Level III Ecoregion 61, Erie and Ontario Lake Plain Level, which is characterized by low-lime glacial and lake deposits over rolling to level topography. The ecosystem description notes that lakes, wetlands, and swampy streams occur in flat, clayey areas and where drainage patterns are not well defined. Soils tend to be lower in carbonate and less fertile than other glaciated areas. The Cuyahoga River occupies the Level IV ecoregion, No. 61e, the Summit Interlobate Area, representing the area between two lobes of the most recent glacier, with the landscape deriving from outwash and till features. The ecoregion description notes that this area is distinctive for its numerous lakes and wetlands, kame and kettle topography, sphagnum bogs, and sluggish streams. The landscape of this ecoregion is a mosaic of urban/suburban development, agricultural land, peatland, gravel quarries, and forest.

Source: Woods, et al. ftp://ftp.epa.gov/wed/ecoregions/oh_in/ohin_front.pdf

4a-ii Biological Resources
- ii.1 Rare, Threatened and Endangered Species, Important Habitats

The Ohio DNR maintains a database of sightings of rare, threatened, and endangered species. Some of these records are decades old, and recent development may have affected the resources. In addition, the Western Reserve Land Conservancy held workshops in the summer, 2010, where resource management professionals identified important habitat areas based on field experience and knowledge of the area.

Figure 4a-8 shows the rare, threatened, and endangered species and important habitats in the Middle Cuyahoga River watershed. The habitats are shown as "polygons" (filled-in shapes), lines, and points (used in geographic information system – GIS – mapping) on a map of wetlands and developed areas. (The numbers on the map refer to Table 4a-5 by polygon, line, or point.) Species of concern are often clustered in wetlands, especially the kettle bogs of Portage County, and also in the cliffs of the Gorge in Cuyahoga Falls. In some locations, such as along the river in Kent, areas with older sightings have since become developed. Areas with species of concern or important habitats include:

- Portions of the Plum Creek corridor encompassing Kent bog;
- Bogs along the Cuyahoga River in Kent
- The large wetland complex along Potter Creek
- The Breakneck Creek floodplain/wetland corridor
- Wetlands along Fish Creek
- Potential and Existing Wetland Restoration areas

Table 4a-5
Areas identified in Western Reserve Land Conservancy Workshops as Important Habitats for Conservation

	Resource	Why Important
Polygons 1	Lion's Park wetlands	Wetland
2	Created wetlands	restoration
3	Wetland Restoration Potential	farmed/impacted/restoration potential wetland restoration
4	Muck soils	
5	Headwater	threatened - beaver wetlands
6	Plum Creek/Kent Bog	Habitat
7	Carter Lumber/Gray Birch Bog	Plant species; Bog Adjacent
8	Bird Bog	Bog
9	Macomber Bog	Bog
10	Sand banks	sand/bog
11	Bavan Bog	rare species/habitat
12	Kline Road Bogs	rare species/habitat
13	Muck Sites	Muck wetlands
14	Fish Creek Riparian	muck/wetlands
15	Bog adjacent to golf course	bog
Lines L1	trib to Congress Lake Outlet	threatened quality habitat -vernal pool
L2	Breakneck Creek	Extreme Development Pressure, cat 3 wetland
L3	Breakneck Cr. Franklin Twp.	Development, cat 3 wetland
Points P1	Sandy Lake	rare species
P2	Rookery - Kent Water Plant	Threatened habitat

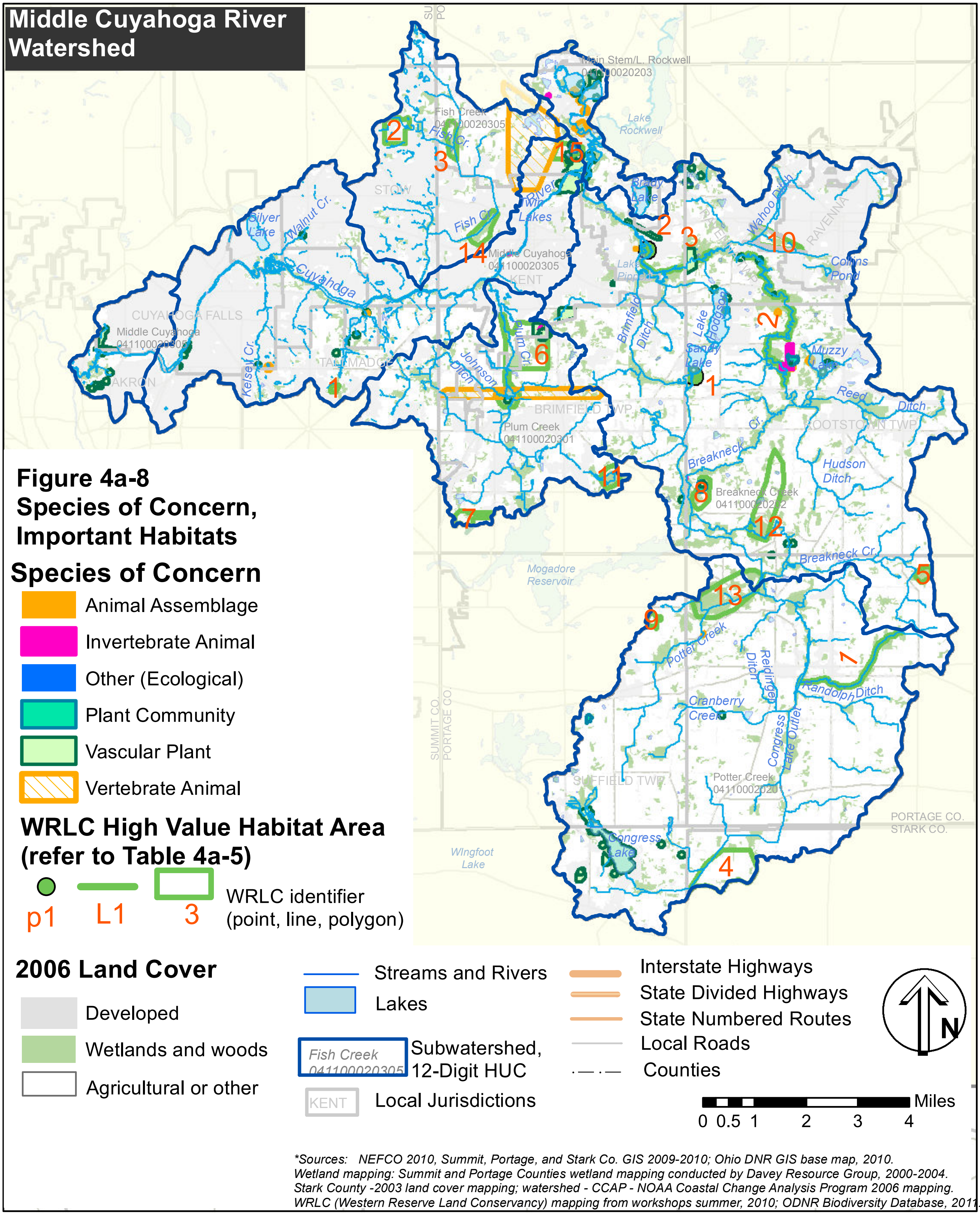


Figure 4a-8 Species of Concern, Important Habitats

Table 4a-6 lists the habitat areas identified by Ohio DNR as likely sites of species of concern, and the general type of resource. Table 4a-7 lists the sightings of species of concern included in the Ohio Biodiversity Database.

Table 4a-6 Managed and Resource Areas with Species of Concern

Managed Area	Resource Area	Category, No. of occurrences
ADELL DURBIN PARK		Vascular Plant
BATTAGLIA BOG		Plant Community 2
BATTAGLIA BOG		Vascular Plant 12
CASCADE VALLEY METRO PARK		Vascular Plant 12
GORGE METRO PARK		Other (Ecological) 3
GORGE METRO PARK		Vascular Plant 7
KENT BOG STATE NATURE PRESERVE		Invertebrate Animal 2
KENT BOG STATE NATURE PRESERVE		Plant Community
KENT BOG STATE NATURE PRESERVE		Vascular Plant 7
LAKE HODGSON PARK		Vascular Plant 4
MUNROE FALLS METRO PARK		Vascular Plant 5
QUAIL HOLLOW STATE PARK		Vascular Plant 2
TOWNERS WOODS		Plant Community 3
TRIANGLE LAKE BOG STATE NATURE PRESERVE		Invertebrate Animal 4
TRIANGLE LAKE BOG STATE NATURE PRESERVE		Plant Community
TRIANGLE LAKE BOG STATE NATURE PRESERVE		Vascular Plant 7
TRIANGLE LAKE BOG STATE NATURE PRESERVE		Vertebrate Animal
	BARNACLE BOG WETLANDS	Animal Assemblage
	BARNACLE BOG WETLANDS	Vascular Plant 3
	BIRD BOG	Invertebrate Animal
	BIRD BOG	Plant Community
	BIRD BOG	Vascular Plant 8
	CATHERINE ROAD SWAMP	Plant Community
	DOLLAR SWAMP	Plant Community
	DOLLAR SWAMP	Vascular Plant 10
	HARTVILLE BOG	Plant Community
	HARTVILLE BOG	Vascular Plant 6
	SHOWALTER BOG/STRATON POND	Plant Community 2
	SHOWALTER BOG/STRATON POND	Vascular Plant 10

Table 4a-7
Species of Concern Sightings, Ohio Biodiversity Database

Scientific Name, No. of sightings	Common Name	Category	Last Observed	STATE STAT
Breeding Amphibian Site		Animal Assemblage	2000-06-23	
Great Blue Heron Rookery 2		Animal Assemblage	1993	
Catocala gracilis 2	Graceful Underwing	Invertebrate Animal	1991-08	E
Cordulia shurtleffii	American Emerald	Invertebrate Animal	2003-06-08	E
Dorocordulia libera	Racket-tailed Emerald	Invertebrate Animal	2006-07-05	E
Epiglaea apiata 2	Pointed Sallow	Invertebrate Animal	1991-10	E
Lasmigona compressa	Creek Heelsplitter	Invertebrate Animal	1996-08-19	SC
Leucorrhinia frigida	Frosted Whiteface	Invertebrate Animal	2000-06-09	E
Ligumia nasuta	Eastern Pondmussel	Invertebrate Animal	1996-08-21	E
Cave or cavern 4		Other (Ecological)	2008-07-09	
Little bluestem prairie		Plant Community	1995-09-22	
Maple-ash-oak swamp		Plant Community	1995-09-05	
Mixed shrub swamp		Plant Community	1996-07-27	
Sphagnum peat bog 8		Plant Community	8/80-6/96	
Aconitum noveboracense	Northern Monkshood	Vascular Plant		E
Adlumia fungosa	Mountain-fringe	Vascular Plant	1997-07-29	T
Arabis hirsuta var. adpressipilis 2	Southern Hairy Rock Cress	Vascular Plant	1998-05-18	P
Calla palustris 1994-2003	Wild Calla	Vascular Plant	1994-2003	P
Carex alata 3	Broad-winged Sedge	Vascular Plant	1988-1996	P
Carex atlantica ssp. Capillacea 4	Howe's Sedge	Vascular Plant	1982-1996	P
Carex cephaloidea	Thin-leaved Sedge	Vascular Plant	1998-05-18	P
Carex diandra	Lesser Panicled Sedge	Vascular Plant	1989-06	T
Carex disperma	Two-seeded Sedge	Vascular Plant	1989-06	E
Carex echinata	Little Prickly Sedge	Vascular Plant	1983-06	E
Carex limosa	Mud Sedge	Vascular Plant	1996-06-15	E
Carex oligosperma 6	Few-seeded Sedge	Vascular Plant	1993-2003	T
Carex straminea 2	Straw Sedge	Vascular Plant	2001, 2009	P
Castanea dentata 2	American Chestnut	Vascular Plant	1980, 1995	P
Chamaedaphne calyculata 11	Leather-leaf	Vascular Plant	1981-2009	P
Cinna latifolia	Northern Wood-reed	Vascular Plant	2004-07-15	E
Clintonia umbellulata	Speckled Wood-lily	Vascular Plant	2004	T
Corallorhiza maculata	Spotted Coral-root	Vascular Plant	1995-08-14	P
Cornus rugosa	Round-leaved Dogwood	Vascular Plant	2004-09-21	P
Cyperus diandrus 3	Low Umbrella-sedge	Vascular Plant	1988-1997	P
Deschampsia flexuosa 15	Crinkled Hair Grass	Vascular Plant	1958-2004	P
Eleocharis tenuis	Slender Spike-rush	Vascular Plant	2007-09-06	T
Epilobium strictum	Simple Willow-herb	Vascular Plant	1960-08	T
Equisetum sylvaticum	Woodland Horsetail	Vascular Plant	1997-08-25	P
Equisetum variegatum	Variegated Scouring-rush	Vascular Plant	1993-04	E
Eriophorum virginicum 3	Tawny Cotton-grass	Vascular Plant	1980-1994	P
Gentianopsis procera	Small Fringed Gentian	Vascular Plant	1958-09	P
Glyceria acutiflora 3	Sharp-glumed Manna Grass	Vascular Plant	1997-2000	T
Helianthemum canadense	Canada Frostweed	Vascular Plant	1997-07-08	T
Hydrocotyle umbellata 5	Navelwort	Vascular Plant	1988-2004	E
Hypericum boreale	Northern St. John's-wort	Vascular Plant	1996-09-06	T
Larix laricina 7	Tamarack	Vascular Plant	1998-2009	P
Lechea intermedia 5	Round-fruited Pinweed	Vascular Plant	1979-1997	P
Lechea villosa	Hairy Pinweed	Vascular Plant	1997-09-08	P
Ledum groenlandicum	Labrador-tea	Vascular Plant	1995-08-15	E
Liatris squarrosa	Scaly Blazing-star	Vascular Plant	2004-07-15	P

Table 4a-7 *(cont'd)*
Species of Concern Sightings, Ohio Biodiversity Database

Scientific Name, No. of sightings	Common Name	Category	Last Observed	STATE STAT
Lilium philadelphicum	Wood Lily	Vascular Plant	1955-06	E
Lupinus perennis	Wild Lupine	Vascular Plant	1997-07-08	P
Luzula bulbosa 2	Southern Woodrush	Vascular Plant	1960, 1997	T
Luzula bulbosa	Southern Woodrush	Vascular Plant	1960-07-14	T
Myriophyllum sibiricum 2	American Water-milfoil	Vascular Plant	1971, 1980	T
Najas gracillima	Thread-like Naiad	Vascular Plant	1996-07-27	E
Oenothera parviflora	Small-flowered Evening-primro	Vascular Plant	2004-07-15	P
Panicum boreale	Northern Panic Grass	Vascular Plant	1960-07-14	P
Persicaria setacea 2	Bristly Smartweed	Vascular Plant	1991-07-23	E
Phegopteris connectilis 3	Long Beech Fern	Vascular Plant	1997-1998	P
Platanthera flava	Tubercled Rein Orchid	Vascular Plant	1960-07-14	P
Potamogeton friesii	Fries' Pondweed	Vascular Plant	1988-08	X
Potamogeton zosteriformis 6	Flat-stemmed Pondweed	Vascular Plant	1981-1997	T
Potentilla palustris 3	Marsh Five-finger	Vascular Plant	1960, 1995, 1996	P
Rhododendron prinophyllum 2	Northern Rose Azalea	Vascular Plant	1979, 1997	P
Rhynchospora alba	White Beak-rush	Vascular Plant	1996-08-27	P
Sarracenia purpurea 2	Pitcher-plant	Vascular Plant	1997, 2003	P
Silene caroliniana ssp. pensylvanica	Carolina Catchfly	Vascular Plant	1998-04-28	T
Sorbus decora	Western Mountain-ash	Vascular Plant	1997-06-12	E
Sparganium emersum 5	Small Bur-reed	Vascular Plant	1996, 1997	E
Sphenopholis pensylvanica 2	Swamp-oats	Vascular Plant	1997, 1998	P
Utricularia geminiscapa 2	Two-scaped Bladderwort	Vascular Plant	1997, 2010	E
Utricularia intermedia 2	Flat-leaved Bladderwort	Vascular Plant	1960, 2004	T
Vaccinium oxycoccos 2	Small Cranberry	Vascular Plant	1996, 2007	T
Viburnum opulus var. americanum	Highbush-cranberry	Vascular Plant	1995-09-06	E
Viola primulifolia	Primrose-leaved Violet	Vascular Plant	1996-06-01	E
Wolffiella gladiata 2	Wolffiella	Vascular Plant	1988, 2008	P
Xyris difformis	Variable Yellow-eyed-grass	Vascular Plant	1996-08-27	E
Botaurus lentiginosus	American Bittern	Vertebrate Animal	1984-06	E
Erimyzon sucetta	Lake Chubsucker	Vertebrate Animal	1985-05	T
Etheostoma exile 2	Iowa Darter	Vertebrate Animal	2000, 2008	SC
Gallinago delicata	Wilson's Snipe	Vertebrate Animal	1985-06	SI
Haliaeetus leucocephalus	Bald Eagle	Vertebrate Animal	2010	T
Opheodrys vernalis	Smooth Greensnake	Vertebrate Animal	1982-05-15	SC
Porzana carolina 2	Sora Rail	Vertebrate Animal	1983, 1984	SC
Rallus limicola 3	Virginia Rail	Vertebrate Animal	1984, 1987	SC
Terrapene carolina	Eastern Box Turtle	Vertebrate Animal	2004	SC

4a-ii Biological Resources
ii.1 Invasive Non-Native species

Invasive species pose a threat to native habitats, because they often spread rapidly, displacing native species, out-competing for resources, and replacing important elements of habitats with less beneficial species. Often invasive species are non-native and lack natural controls on their population. Some invasive species were brought from elsewhere for landscaping or agriculture. Some aggressively colonize disturbed areas. Some plant species were planted recently as groundcover or for erosion control because of their rapid growth but later were found to threaten native species. Aquatic species may travel in ballast water to the major waterways and on the hulls of smaller craft between smaller water bodies. The Ohio DNR is one of the agencies that maintains lists of non-native, invasive plant species found in Ohio.

Of the 700 non-native plant species, about 60 threaten Ohio's natural preserve areas. These should be controlled and removed as possible and should not be used in new plantings. They are grouped into the following categories:

- Targeted – found throughout the state, they reproduce rapidly. These are the most difficult to control.
- Well-established invasives – found regionally or throughout the state, pose moderate to serious threats to native areas.
- Watch list – these are very invasive in neighboring states but are a potential threat to Ohio natural areas. Their distribution in Ohio is limited but should be monitored.

The Ohio DNR list of invasive plants dates from 2000 is shown on Table 4a-8, which follows.

Aquatic invasive species are frequently carried into lakes and streams in ballastwater, bilgewater or attached to the hulls of boats. Introduction of invasive species from Europe or Asia commonly occurs when freighters empty the ballastwater they take on overseas. Like terrestrial invasives, aquatic invasives they can severely disrupt affected ecosystems and spread rampantly, often due to a lack of natural controls. The Great Lakes Commission notes that since the 1800s, over 160 invasive species have entered the Great Lakes. The Great Lakes Commission notes that aquatic invasive species in Lake Erie and the other Great Lakes, include the zebra mussel, goby, sea lamprey, Eurasian Ruffe, purple loosestrife, eurasian watermilfoil, and spiny and fishhook waterfleas. Asian carp like the bighead carp, black carp, and silver carp have not yet become established in the Great lakes, but they are under surveillance due to their potential to move easily into and through the Great Lakes ecosystems and cause devastating damage to fisheries. The zebra mussel has reproduced so quickly that it is clogging intake mechanisms for water supplies and actually changing the trophic characteristics of Lake Erie by consuming huge volumes of plankton. Potentially even a greater threat, the quagga mussel can utilize soft substrate as well as hard surfaces, placing a much greater proportion of the lakes at risk. (Source: Great Lakes Commission, Aquatic Nuisance Species. http://www.glc.org/ans/)

A USGS list of aquatic invasive species is included in Table 4a-9. The NOAA Great Lakes Aquatic Nonindigenous Species Information System is available at http://nas.er.usgs.gov/queries/greatlakes/SpeciesList.aspx?Group=&HUCNumber=DGreatLakes&Genus=&Species=&ComName=&status=0&pathway=0&Sortby=1&SpeciesCategory=1.

Table 4a-8
Invasive, Non-Native Species

TARGETED SPECIES

Common Name	Scientific Name
Autumn-olive	*Elaeagnus umbellata*
Buckthorn, glossy	*Rhamnus frangula*
Buckthorn, European or common	*Rhamnus cathartica*
Common reed grass ❋	*Phragmites australis*
Garlic mustard	*Alliaria petiolata*
Honeysuckle, amur	*Lonicera maackii*
Honeysuckle, Japanese	*Lonicera japonica*
Honeysuckle, Morrow	*Lonicera morrowii*
Honeysuckle, Tatarian	*Lonicera tatarica*
Japanese knotweed	*Polygonum cuspidatum*
Multiflora rose	*Rosa multiflora*
Purple loosestrife	*Lythrum salicaria*
Reed canary grass ❋	*Phalaris arundinacea*

❋these species may have native and non-native strains

WELL-ESTABLISHED INVASIVES

Common Name	Scientific Name
Air-potato	*Dioscorea batatas*
Asian bittersweet	*Celastrus orbiculatus*
Bouncing bet	*Saponaria officinalis*
Canada thistle	*Cirsium arvense*
Cattail, hybrid	*Typha Xglauca*
Cattail, narrow-leaved	*Typha angustifolia*
Celandine, lesser	*Ranunculus ficaria*
Crown-vetch	*Coronilla varia*
Curly pondweed	*Potamogeton crispus*
Dame's rocket	*Hesperis matronalis*
Day-lily	*Hemerocallis fulva*
European cranberry-bush	*Viburnum opulus* var. *opulus*

Table 4a-8 *(cont'd)* **Invasive, Non-Native Species**

WELL-ESTABLISHED INVASIVES CONT.

Common Name	Scientific Name
Eurasian water-milfoil	*Myriophyllum spicatum*
Field bindweed	*Convolvulus arvensis*
Flowering-rush	*Butomus umbellatus*
Japanese barberry	*Berberis thunbergii*
Johnson grass	*Sorghum halepense*
Meadow fescue	*Festuca pratensis*
Moneywort	*Lysimachia nummularia*
Lesser naiad	*Najas minor*
Periwinkle or myrtle	*Vinca minor*
Poison hemlock	*Conium maculatum*
Privet, common	*Ligustrum vulgare*
Quack grass	*Agropyron repens*
Queen Anne's lace	*Daucus carota*
Russian-olive	*Elaeagnus angustifolia*
Smooth brome	*Bromus inermis*
Sweet-clover, white	*Melilotus alba*
Sweet-clover, yellow	*Melilotus officinalis*
Teasel, common	*Dipsacus fullonum (sylvestris)*
Teasel, cut-leaved	*Dipsacus laciniatus*
Tree-of-heaven	*Ailanthus altissima*
Water-cress	*Rorippa nasturtium-aquaticum*
Willow-herb, hairy	*Epilobium hirsutum*
Willow herb, small-flowered hairy	*Epilobium parviflorum*
Winged euonymus	*Euonymus alatus*
Wintercreeper	*Euonymus fortunei*
Yellow flag	*Iris pseudacorus*

WATCH LIST

Common Name	Scientific Name
Black swallow-wort	*Vincetoxicum nigrum*
Chinese silvergrass	*Miscanthus sinensis*
Dog rose	*Rosa canina*
Giant knotwood	*Polygonum sachalinense*
Honeysuckle, showy pink	*Lonicera Xbella*
Kudzu	*Pueraria lobata*
Leafy spurge	*Euphorbia esula*
Mile-a-minute vine	*Polygonum perfoliatum*
Nepalgrass	*Microstegium vimineum*
Nodding thistle	*Carduus nutans*
Porcelain-berry	*Ampleopsis brevipedunculata*
Privet, border	*Ligustrum obtusifolium*
Spotted knapweed	*Centaurea maculosa*
Star-of-Bethlehem	*Onithigalum umbellatum*

Source: Ohio DNR Invasive Plants of Ohio, http://ohiodnr.com/tabid/2005/Default.aspx
The USGS maintains a database of aquatic invasive species, which lists 36 species for the Cuyahoga River watershed, listed in Table 4a-9.

Table 4a-9
Non-indigenous Aquatic Species of the Cuyahoga River Watershed

Group	Common name	Group	Common name
Algae	Diatom	Plants	Oak-leaved goosefoot
Coelenterates	Freshwater jellyfish	Plants	Birds-foot trefoil
Fish	American eel	Plants	Eurasian water milfoil
Fish	Freshwater sunfish	Plants	Water mint
Fish	Unidentified pacu	Plants	Spearmint
Fish	American shad	Plants	Purple loosestrife
Fish	Common carp	Plants	Brittle naiad
Fish	tench	Plants	Great hairy willow herb
Fish	Round goby	Plants	Small flowered hairy willow herb
Fish	White perch	Plants	Lady's thumb, smartweed, spotted knotweed
Bivalve	Zebra mussel	Plants	Bitter dock
Plants	Smooth field sow thistle	Plants	Curly pondweed
Plants	Oriental lady's thumb	Plants	Money wort
Plants	Field sow thistle	Plants	White willow
Plants	True forget-me-not	Plants	Crack willow
Plants	Water-cress	Plants	Bittersweet nightshade
Plants	California fanwort	Plants	Narrow leaved cattail
		Reptiles	American alligator

Source: USGS Website Non-Indigenous Aquatic Species http://nas.er.usgs.gov/ March, 2011

Listed by the Great Lakes Commission as Current invaders are:

- **Crustaceans:** Rusty Crayfish | Spiny Water Flea
- **Fish:** Goby (Round) | Goby (Tubenose) | Rudd | Ruffe | Sea Lamprey | White Perch
- **Mollusks:** Quagga Mussel | Zebra Mussel
- **Plants:** Curly-leaf Pondweed | Eurasian Watermilfoil | Phragmites (non-native) | Purple Loosestrife
- **Viruses:** Viral Hemorrhagic Septicemia Virus (VHSv)

Potential invaders:

- **Fish:** Asian Carp

4a-iii. Water Resources

4a-iiia Climate and Precipitation

The climate of the middle Cuyahoga River watershed is continental, with a wide range of temperatures over the seasons. The watershed is affected by air masses moving east across the continent, warm, moist maritime air coming up the Mississippi/Tennessee/Ohio River valleys, drier cooler air from Canada, and to a slight degree, moisture and moderating effects from Lake Erie. Summers tend to be humid and warm with frequent convective thunderstorms; winters tend to be cold with colder, lower-snowfall storms coming in from Canada (Alberta Clippers) and large winter storms bringing greater amounts of moisture in from the south. The watershed is considered part of the secondary Lake Effect snow area. Following winter storms, the area often receives Lake Effect snow but to a lesser degree than communities closer to Lake Erie, often an inch or two of snow compared with six to 12 inches nearer the lake. Occasionally the Lake Effect snows bring much greater amounts of snow.

Annual precipitation is approximately 36-40 inches per year for Akron and Ravenna, respectively. Precipitation amounts are distributed relatively evenly throughout the year. The driest months are January, February, and October, averaging between 2.2 and 2.7 inches. The greatest amount of precipitation falls during May, June, July, and August, averaging from 3.7 to 4.1 inches. Nearly one-half of the days per year have 0.01-0.1 inches of precipitation. The Portage County stations tend to report higher amounts of precipitation than Akron or Stark County. The greatest probability of flooding tends to occur when spring storms combine with snowmelt, or locally during intense thunderstorms. Evaporation potential tends to be greater in the summer than the amount of precipitation, so there is often a moisture deficit in the summer.

Average temperatures range from January temperatures of 17 (low) and 34 (high) to 59 (low) and 84 (high) in July. Akron tends to have higher temperatures than the rest of the watershed stations by approximately 2-4 degrees. The median growing season with temperatures above 32 degrees F in Portage County is 173 days, going from late April to mid-October. At Akron, the growing season is about 20 days longer, extending from mid-April until late October.

Within the pattern described above, there can be great variability in temperature, growing season, and precipitation.

Sources: National Climate Data Center, 2011
http://www.geography.osu.edu/faculty/rogers/OOC.pdf

http://starkcountyweather.com/climate-averages.php

4a-iii Water Resources
-iiib. Surface Water

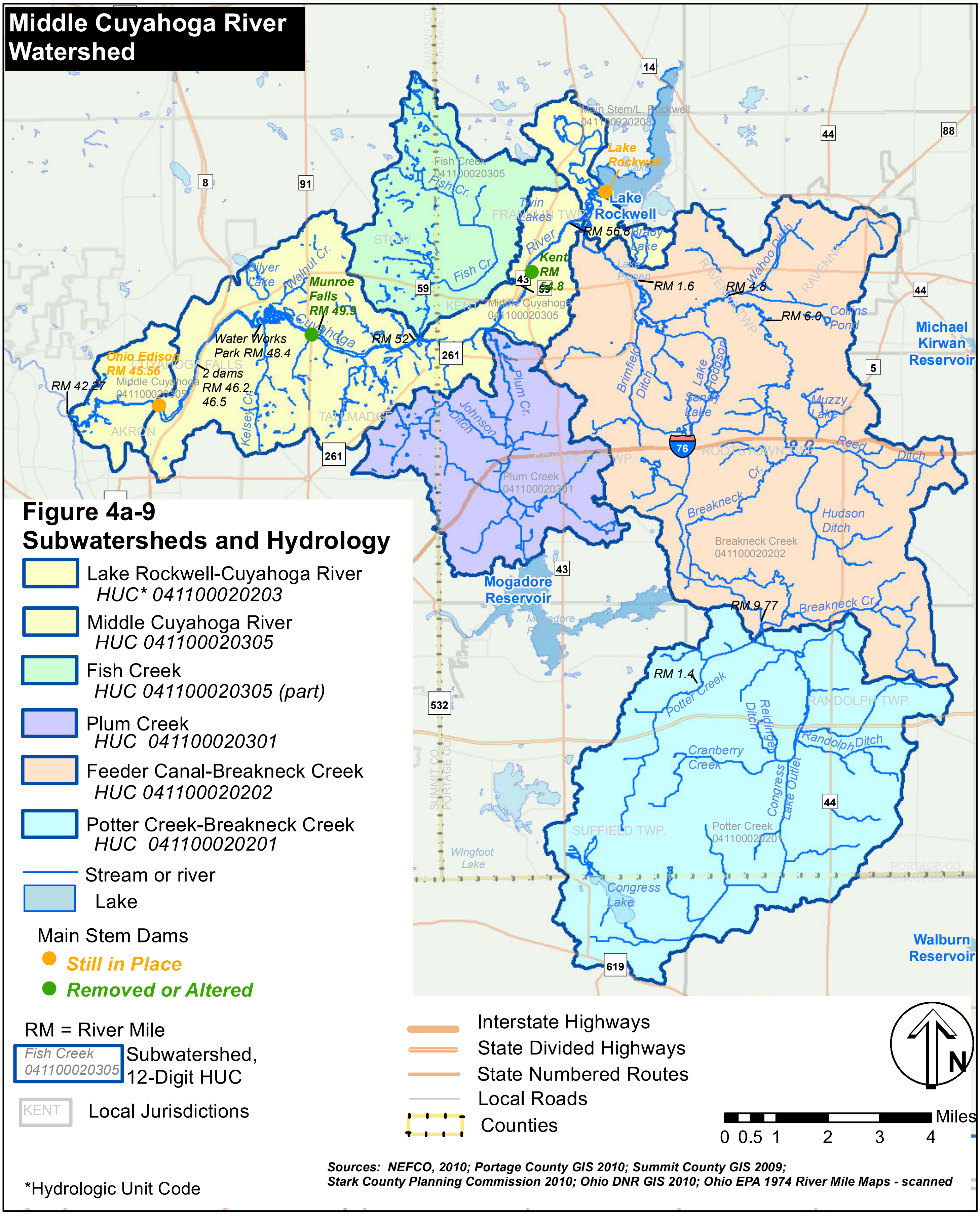
Middle Cuyahoga River Sub-Watersheds and Tributaries

The remainder of Section 4a-iii presents an inventory of surface and groundwater resources. (Water quality and watershed characteristics affecting water quality are discussed in further detail in Sections 4d and 4e.) Table 4a-10 lists the named tributaries in the watershed, and Figure 4a-9 depicts the sub-watersheds, streams, and Cuyahoga River. More detailed maps and discussions are included with each section. Attachment 4P contains photographs of streams from road crossings and various access points, illustrate overall watershed characteristics and examples of features discussed. Each photograph is referenced by number and page on index map and accompanying table, Figure 4P-1 and Table 4P-1. Sections and figures in Sections 4 and 5 refer to these photographs. Figure 4a-10 shows the locations of photographs and certain watershed landmarks.

Table 4a-10
Middle Cuyahoga River Sub-Watersheds and Tributaries

			Watershed Downstream End Coord.*	
Stream/River	**12-Digit HUC Identifier**	**Ohio EPA Identifier**	**Latitude – Decimal Degrees N (deg. minutes seconds)**	**Longitude – Dec. Degrees W (Deg. minutes sec.)**
Main Stem Middle Cuyahoga River	04100020305 04100020203 (Lake Rockwell - Breakneck Cr.)	19-001-000	L. Rockwell dam 41.1819 (41 10 55) Downstream end 41.1195 (41 07 10)	L. Rockwell dam 81.3324 (81 19 57) Downstream End 81.5289 (81 31 44)
• Walnut Creek			41.1488 (41 08 55)	81.4572 (81 27 09)
• Kelsey Creek			41.1453 (41 08 42)	81.4570 (81 27 25)
Fish Creek	04100020305	19-026-000	41.1403 (41 08 25)	81.3989 (81 23 53)
Plum Creek	04100020301	19-027-000	41.1403 (41 22 26)	81.3989 (81 08 32)
• Johnson Ditch			41.1105 (41 06 37)	81.3671 (81 22 01)
Breakneck Creek	04100020202	19-028-000	41.1702 (41 10 13)	81.3381 (81 20 17)
• Wahoo Ditch**		19-028-002	41.1436 (41 08 36)	81.3181 (81 19 05)
• Hommon Rd. Ditch**		19-028-003	41.1436 (41 08 36)	81.3181 (81 19 05)
• Brimfield Ditch			41.1436 (41 08 36)	81.3181 (81 19 05)
• Hudson Ditch**			41.1059 (41 06 21)	81.2569 (81 15 25)
• Reed Ditch**			41.1059 (41 06 21)	81.2569 (81 15 25)
• Feeder Canal			41.1153 (41 06 55)	81.2985 (81 17 55)
Potter Creek	041100020201	19-028-005	41.0538 (41 03 14)	81.2777 (81 16 40)
• Congress Lake Outlet		19-028-004	41.0530 (41 03 11)	81.2722 (81 16 20)
• Cranberry Cr.			41.0204 (41 01 14)	81.2650 (81 15 54)
• Reidinger Ditch			41.0211 (41 01 16)	81.2690 (81 16 09)
• Randolph Ditch			41.0261 (41 01 34)	81.2610 (81 15 14)

* Generally at confluence with next major stream; North American Datum (NAD) 1983
** Coordinates at confluence Wahoo/Hommon; Hudson/Reed; near confluence with Breakneck.


Middle Cuyahoga River Watershed
Lake Rockwell
Lake Rockwell
RM 56.8
Kent RM 54.8
Munroe Falls RM 49.9
Water Works Park RM 48.4
2 dams RM 46.2, 46.5
Ohio Edison RM 45.56
RM 42.27
RM 52
RM 1.6
RM 4.8
RM 6.0
RM 9.77
RM 1.4
Fish Creek 041100020305
Main Stem/L. Rockwell 041100020203
Middle Cuyahoga 041100020305
Plum Creek 041100020301
Breakneck Creek 041100020202
Potter Creek 041100020201
Fish Cr.
Twin Lakes
Silver Lake
Walnut Cr.
Plum Cr.
Johnson Ditch
Brimfield Ditch
Wahoo Ditch
Collins Pond
Lake Hodgson
Sandy Lake
Muzzy Lake
Reed Ditch
Breakneck Cr.
Hudson Ditch
Potter Creek
Cranberry Creek
Reidinger Ditch
Randolph Ditch
Congress Lake Outlet
Congress Lake
Wingfoot Lake
Michael Kirwan Reservoir
Mogadore Reservoir
Walburn Reservoir
STOW
KENT
TALLMADGE
AKRON
SUFFIELD TWP.
RANDOLPH TWP.
ROOTSTOWN TWP.
FRANKLIN TWP.
Figure 4a-9
Subwatersheds and Hydrology
Lake Rockwell-Cuyahoga River HUC* 041100020203
Middle Cuyahoga River HUC 041100020305
Fish Creek HUC 041100020305 (part)
Plum Creek HUC 041100020301
Feeder Canal-Breakneck Creek HUC 041100020202
Potter Creek-Breakneck Creek HUC 041100020201
Stream or river
Lake
Main Stem Dams
Still in Place
Removed or Altered
RM = River Mile
Fish Creek 041100020305
Subwatershed, 12-Digit HUC
KENT
Local Jurisdictions
Interstate Highways
State Divided Highways
State Numbered Routes
Local Roads
Counties
Miles
0 0.5 1 2 3 4
N
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; Ohio EPA 1974 River Mile Maps - scanned
*Hydrologic Unit Code

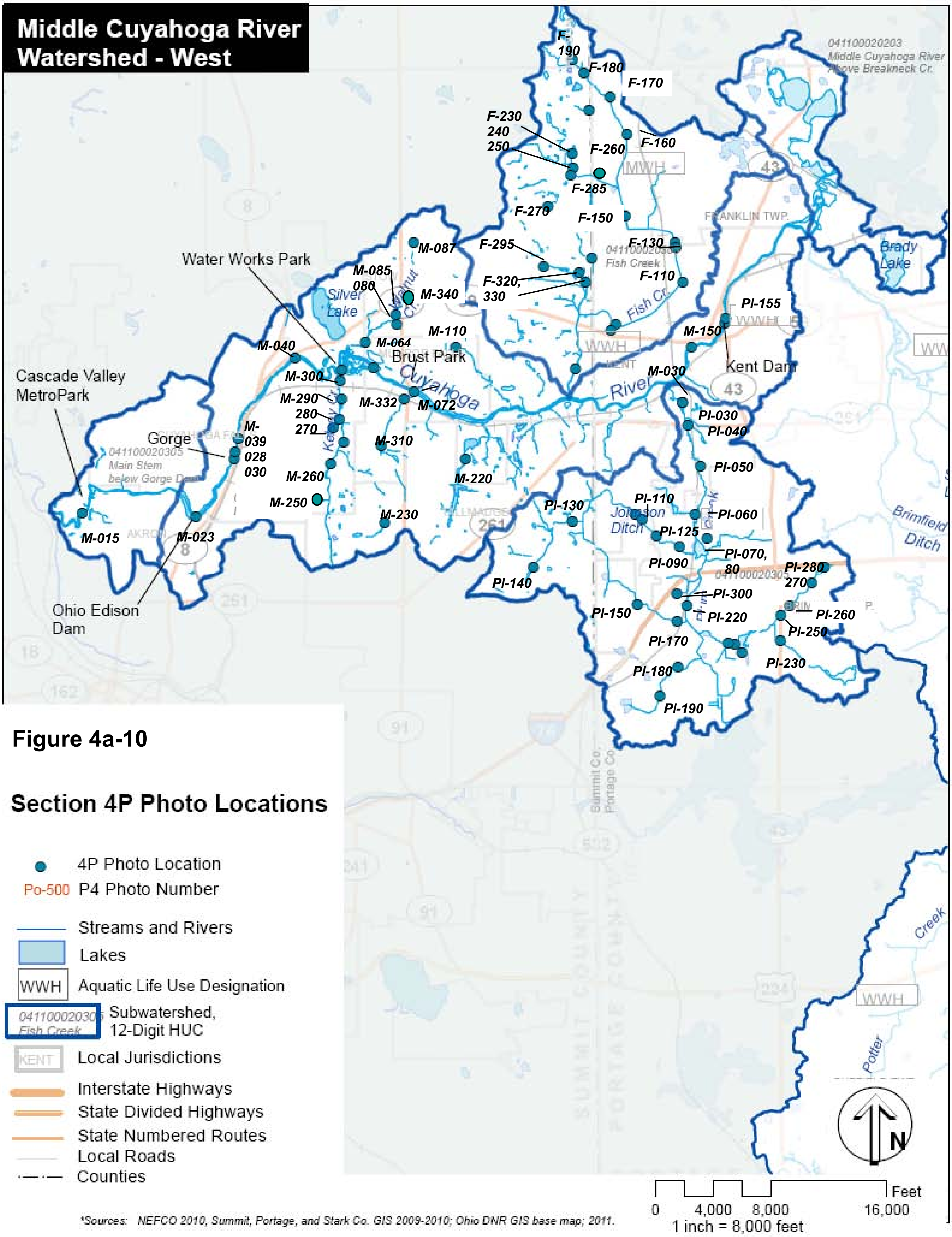


Figure 4a-10

Section 4P Photo Locations

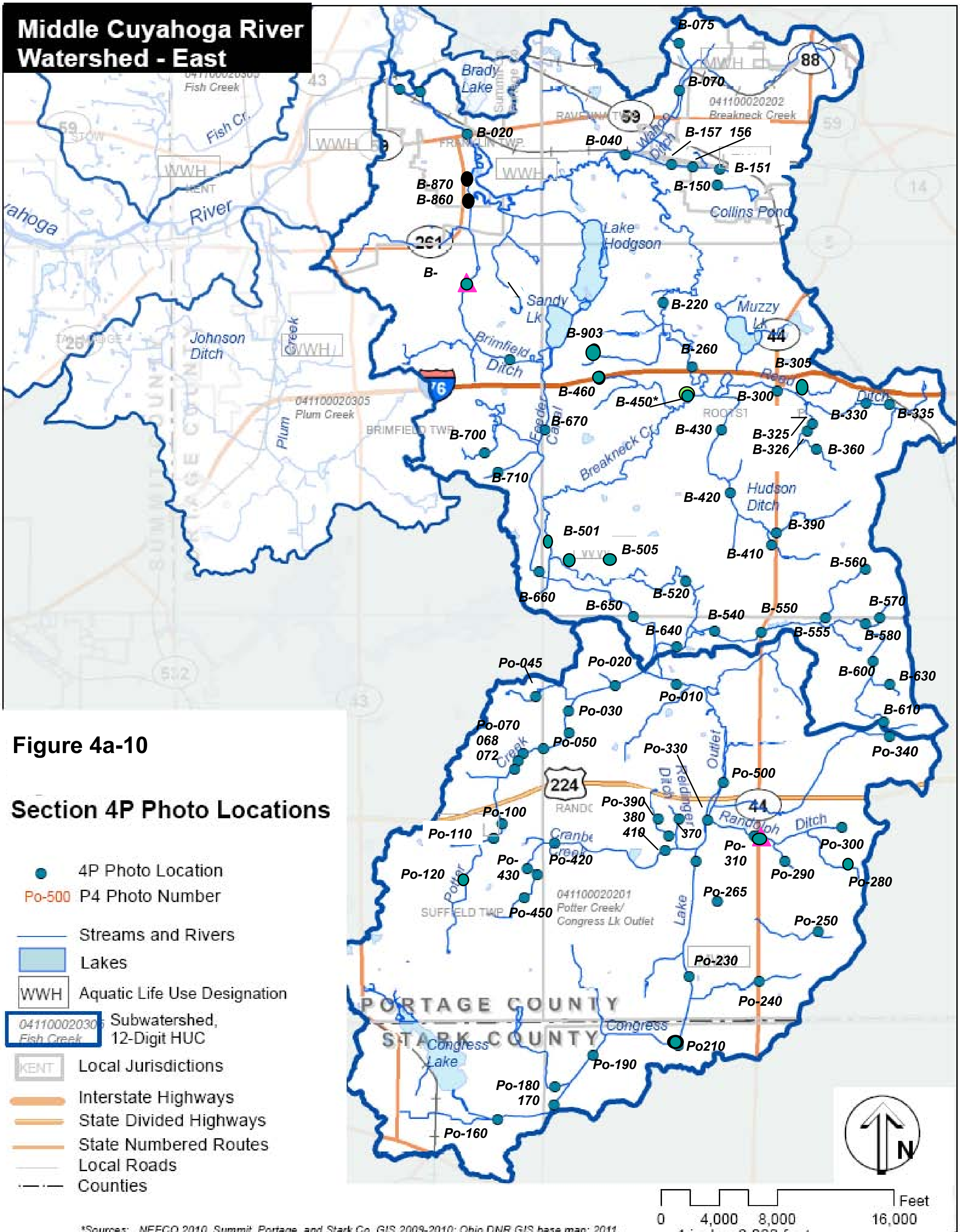


Figure 4a-10

Section 4P Photo Locations

Notes concerning identification of subwatersheds include:

- The Middle Cuyahoga River watershed was identified in a previous study by NEFCO (NEFCO, 2001) as beginning downstream of the area being addressed by the Upper Cuyahoga River Task Force, i.e., the Lake Rockwell dam. The Middle Cuyahoga River watershed thus includes a portion of HUC 04100020203. The earlier Middle Cuyahoga River study incorporated down to the Ohio Edison dam, but since it is likely that the Ohio Edison dam will be removed, the current planning effort has extended the subwatershed to the confluence with the Little Cuyahoga River.

- The Fish Creek subwatershed is considered part of the same 12-digit HUC subwatershed as the Main Stem. However, previously-used 14-digit HUC subwatersheds called out a separate subwatershed for Fish Creek. This document retains that distinction.

- The Breakneck Creek and Potter Creek subwatersheds are identified in the Ohio DNR GIS database as Feeder Canal-Breakneck Creek and Congress Lake Outlet-Potter Creek subwatersheds, respectively. A dug canal (Congress Lake Outlet-Feeder Canal) connects Congress Lake with Lake Hodgson, the public water supply for the City of Ravenna. There is a control structure at the lower end of the Potter Creek subwatershed that currently is used only during dry periods to divert flow away from Breakneck Creek from the Congress Lake Outlet and into the Feeder Canal and Lake Hodgson. During the remainder of the year, Congress Lake Outlet flows directly into Breakneck Creek, and the Feeder Canal is fed only by groundwater and a minimal watershed.

4a-iiib. Surface Waters (cont'd)

-i. Wetlands

Wetlands: Background

Wetlands: Background

What are Wetlands, Functions of Wetlands, Types of Wetlands

Wetlands are features in the landscape where water is at or near the land surface for a substantial part of the year. Wetlands are areas where:

- Water naturally collects,
- Soils have developed that hold water or drain slowly
- The characteristics of the soils reflect long-term saturation; and
- The vegetation is adapted to wet conditions.

Wetlands provide many important functions within watersheds:

- Storage of stormwater – not only in the depressions of the landscape but contained within the soils
- Slowing floodwaters, allowing sediment deposition
- Filtering, adsorbing (binding with) pollutants, uptake of nutrients
- Groundwater recharge and then discharge during dry periods
- Habitat
- Food supply

Wetlands are not simply bowls containing water. Many of the valuable functions they provide arise from the extended residence time of water in the soil and in contact with the roots of vegetation. Because water moves slowly and is stored in the soils, wetlands are especially valuable for flood storage and groundwater recharge/discharge. The extended time of contact between water, soil, and roots allows sediment and pollutants to be filtered, absorbed, and adsorbed.

Wetlands in northeast Ohio include:

- Forested or scrub-shrub swamps, with standing water during a portion of the year, often with a high water table (groundwater level) and trees or shrubs adapted to wet conditions

- Emergent marshes, with standing water all year and vegetation such as cattails, rushes, sedges.

- Fens and bogs. These are unusual habitats with little surface water flowing in, deep pools of standing water, producing peat. They often support rare species. Bogs develop in deep kettle holes left over in glacial outwash. They are often enclosed and support stands of tamarack, sphagnum moss. Bogs are acidic. In contrast, fens, which develop in calcium rich soils, are alkaline.

Wetland Regulation, Mapping

The Ohio EPA, U.S. EPA, and US Army Corps of Engineers regulate filling wetlands and altering water quality. The U.S. Army Corps of Engineers uses a combination of soils, vegetation, and hydrology to identify regulated wetlands:

- Hydric soils - soils that show evidence of saturation or inundation for a long enough time during the growing season to develop anaerobic conditions (lacking oxygen) in the upper part. (USDA NRCS Hydric Soils Introduction, On-line source 2011)

- A predominance of plants that are adapted to saturated conditions during the growing season, i.e., where soil inundation/saturation exerts a controlling influence on the plant community (US ACOE Wetland Delineation Manual, on-line source 2011)

- Hydrology – water regime indicating the soils are saturated or inundated for enough of the growing season to exert a controlling influence on vegetation and soils.

In altered landscapes, it is possible that only one or two of these characteristics is present, and the feature may not be regulated as a wetland. For instance, hydric soils may be left over after the water table is lowered though ditching. The land would have neither wetland vegetation nor hydrology (water at or near the surface), and may not be considered a wetland. Conversely, ditches and storm retention ponds that develop these characteristics often become regulated as wetlands or waters of the state.

Data Sources

Several sources of GIS data were used to map wetland characteristics.

- Hydric soils – soils of Ohio were mapped during the 1970s and have since been incorporated into geographic information systems mapping. The presence of hydric soils generally indicates that wetland conditions are or were present. The soils data indicate that hydric soils in the Middle Cuyahoga River watershed fall into two general categories: soils that are 85-100 percent hydric and those with inclusions of hydric soils that make up approximately 5-15 percent of the mapped unit. The mapping on Figure 4a-11 only shows the soils that are 85-100 percent hydric. A substantial amount of the soils in undeveloped or recently developed areas have 5-15 percent inclusions, these were omitted for clarity of mapping.

- Summit and Portage County wetlands mapping, conducted in 2002 and 2004 using interpretation of aerial photography from 2000 and limited field reconnaissance.

- Coastal Change Analysis Program (CCAP) – the National Oceanographic and Atmospheric Administration (NOAA) has developed mapping of coastal land cover to monitor changes over time. The data are derived from satellite imagery from 1996, 2001, and 2006, with pixels of 30 m per side. Each type of land cover reflects visible, infrared, and ultraviolet light differently. The satellite mapping is based on the reflective characteristics of each land cover type.

- Ohio EPA GIS wetland coverage for Stark County.

- Stark County land cover GIS coverage, 2010.

Findings:
Wetlands of the Middle Cuyahoga River Watershed

Findings: Wetlands of the Middle Cuyahoga River Watershed

The areas shown on Figure 4a-11 and summarized in Table 4a-11 represent likely wetland areas. Mapping wetlands with remote sensing, such as interpretation of aerial photographs or satellite imagery, does not necessarily identify all wetlands, or identify them accurately:

- In aerial photographs and satellite imagery, visual signatures of wetlands may be indistinct. For instance, wooded or scrub-shrub swamps may be misinterpreted as upland habitats, and determining which plant communities are present or predominant from aerial photographs may be difficult.

- The resolution of the imagery may prevent smaller wetlands from being identified.

- Identification of regulated wetlands requires field visits to examine soil characteristics, vegetation, and hydrology. Often, even the field delineation involves interpretation of ambiguous data. For instance, the soils and plant communities may change gradually across an area or have inclusions of varying characteristics, and the high water table or surface water may only be present for a portion of the year.

Table 4a-11
Hydric Soils and Wetlands Mapped by Subwatershed

	Main Stem	Fish Creek	Plum Creek	Breakneck Creek	Potter Creek	Total
Hydric Soils						
▪ 85-100% hydric	1,118	1,401	1,896	5,714	5,127	15,256
% of subwatershed	6.3	20.6	22.9	19.8	23.5	18.3
▪ 5-15% hydric	2,727	1,706	1,288	9,235	4,287	19,243
% of subwatershed	15.3	25.1	15.5	32.1	19.6	23.0
CCAP* mapped wetlands						
▪ Forested	1,203	422	839	3,569	1,599	7,628
▪ Scrub-shrub	69	0	0	108	109	217
▪ Emergent	0	16	0	36	13	134
Total	*1,272*	*438*	*839*	*3,713*	*1,717*	*7,979*
County/State Mapped Wetlands						
▪ Forested	281	85	322	1,988	828	3,504
▪ Scrub-shrub	104	168	314	671	575	1,822
▪ Emergent	133	152	264	112	523	1,194
Total	*518*	*405*	*900*	*2,771*	*1,926*	*6,520*
Total Mapped Wetlands**	1,510	745	1,388	4,598	2,728	10,969
% of subwatershed	8.5	11.0	12.0	16.0	12.5	13.3

*CCAP = National Oceanographic and Atmospheric Administration Coastal Change Analysis Program, using 2006 mapping
** Total does not equal the sum of CCAP and County/State mapped wetlands, due to overlapping data between map sets.

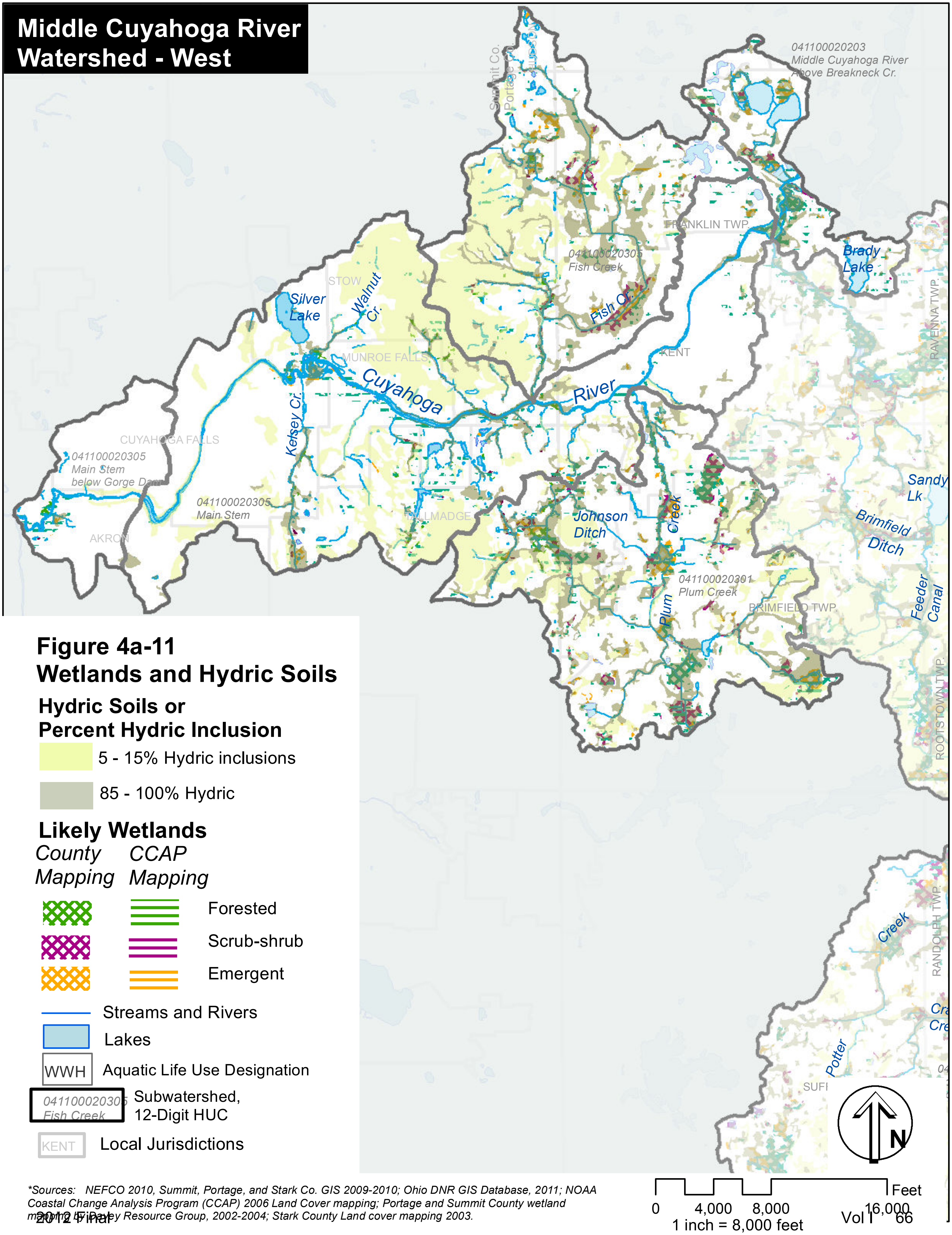


Figure 4a-11
Wetlands and Hydric Soils

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS Database, 2011; NOAA Coastal Change Analysis Program (CCAP) 2006 Land Cover mapping; Portage and Summit County wetland mapping by Davey Resource Group, 2002-2004; Stark County Land cover mapping 2003.

Middle Cuyahoga River Watershed - East

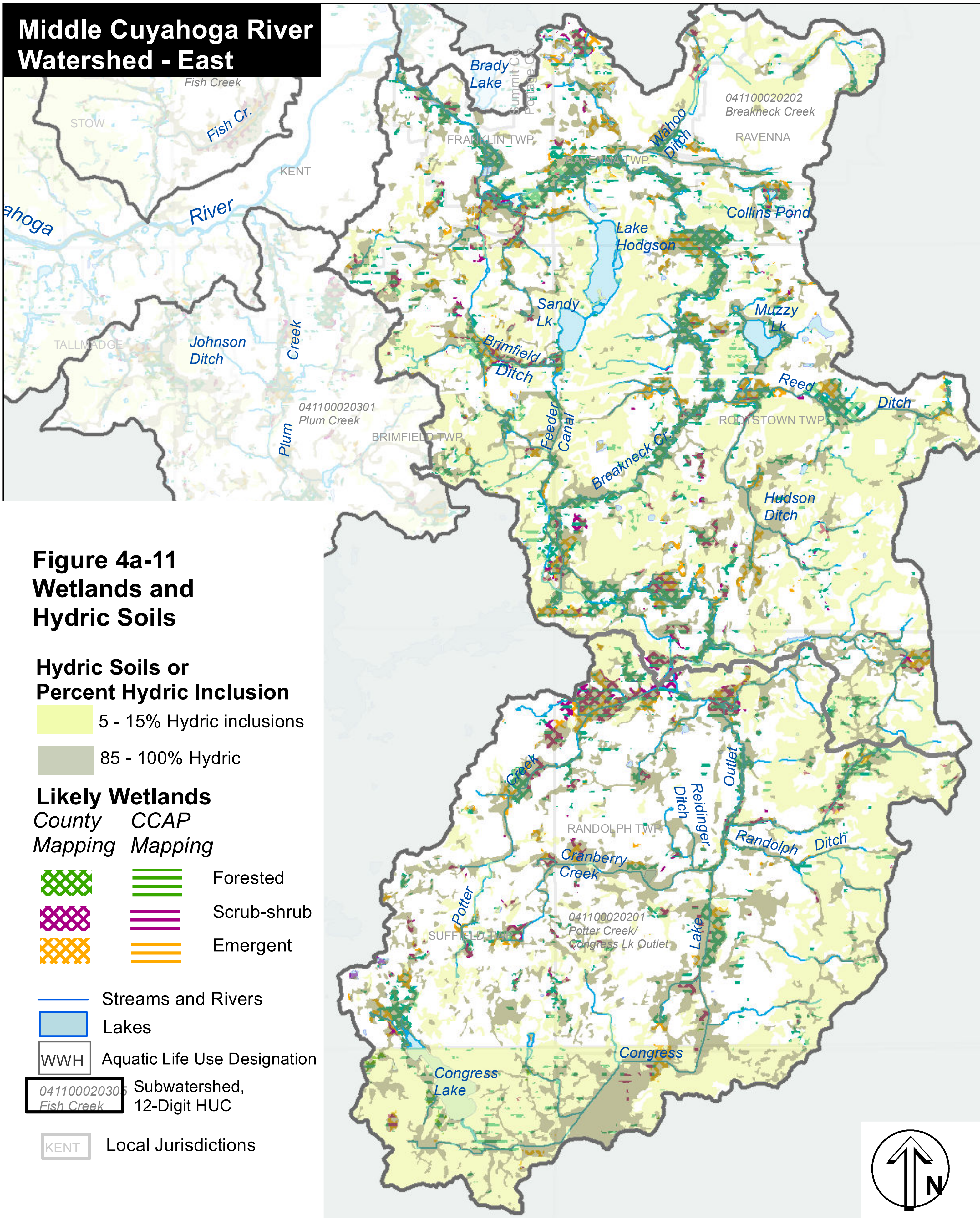


Figure 4a-11 Wetlands and Hydric Soils

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS Database, 2011; NOAA Coastal Change Analysis Program (CCAP) 2006 Land Cover mapping; Portage and Summit County wetland mapping by Davey Resource Group, 2002-2004; Stark County Land cover mapping 2003.

Figure 4a-11 and Table 4a-11 indicate that:

- The Breakneck Creek subwatershed has the greatest amount of wetlands. A nearly continuous band of forested wetlands along Breakneck Creek contributes to the quality of its habitat and provide protection from pollutant loadings and stormwater.

- Forested wetlands are the predominant type overall, but in more urbanized subwatersheds (Main Stem, Plum Creek, and Fish Creek), the County/Ohio EPA mapping suggests that the amount of emergent marshes or scrub-shrub wetlands approach or exceed the amount of forested wetlands.

- In the largest, most diverse wetland areas shown on Figure 4a-10, it is difficult to distinguish the different wetland types, due, in part, to varying interpretations of the data shown in the mapping. However, it is apparent from the mapping that these are large, diverse, and likely high value. Examples include the northwestern portion of Potter Creek and portions of Breakneck Creek.

- In the Potter Creek and Breakneck Creek watersheds, small isolated wetlands and patches of hydric soil may reflect the kame-kettle landscape, which supports wetlands in between kames and at the bottom of kettle ponds.

- The relatively low amount and proportion of hydric/potentially hydric soils in the main stem subwatershed is likely due in part to the steep topography and thin till-covered uplands, but also to development and alteration prior to soil mapping.

The amount and proportion of mapped wetlands is considerably lower than that of hydric soils. This may be due in part to the inability to distinguish wetland from upland habitats (e.g., forest). However, it is likely that some of this represents wetlands that have been altered.

4a-iiib Surface Waters (cont'd)
-ii.1 Streams: Stream characteristics

Cuyahoga River Hydrographs

Cuyahoga River Hydrographs: Background

Background

Three USGS stream gages along the Cuyahoga River near the Middle Cuyahoga River watershed have been in operation since the 1920s. The stream gage upstream at Hiram Rapids, approximate RM 75 (watershed 152 square miles) is in a relatively rural landscape upstream of Lake Rockwell. The Old Portage stream gage, RM 40.18 (watershed 404 sq. mi.), is in a relatively urbanized portion of the Cuyahoga River watershed. The most downstream of the three stream gages is at Independence, RM 13.05 (watershed 707 sq. mi.), further into the urbanized portion of the Cuyahoga River watershed.

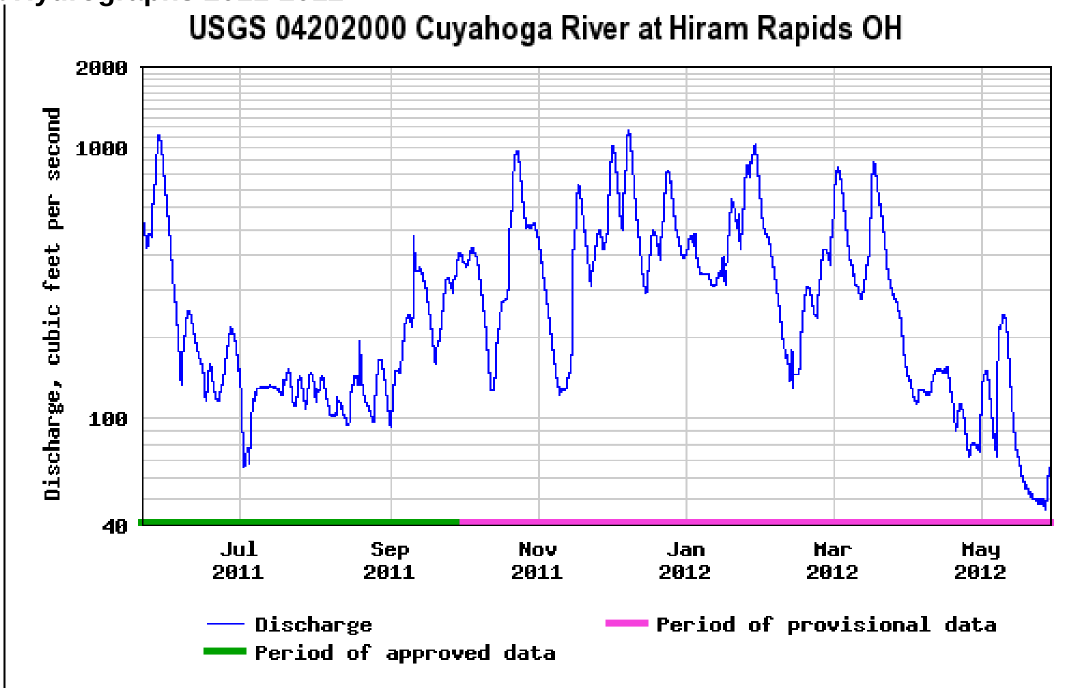
In typical temperate climates similar to northeast Ohio, stream flow fluctuates on a large scale over the year, with lowest flow generally occurring during the summer and early autumn months, with flows increasing through the fall, winter, and early spring, and decreasing in late spring to summer. Stream flow in urbanized landscapes tends to be "flashy," rising and falling rapidly and with extreme peaks during and after storm events, due to the large amounts of runoff coming from impervious surfaces and the limited amount of infiltration and groundwater input. In more undisturbed landscapes, stream flow after storm events rises and falls more gradually and in less extreme amounts.

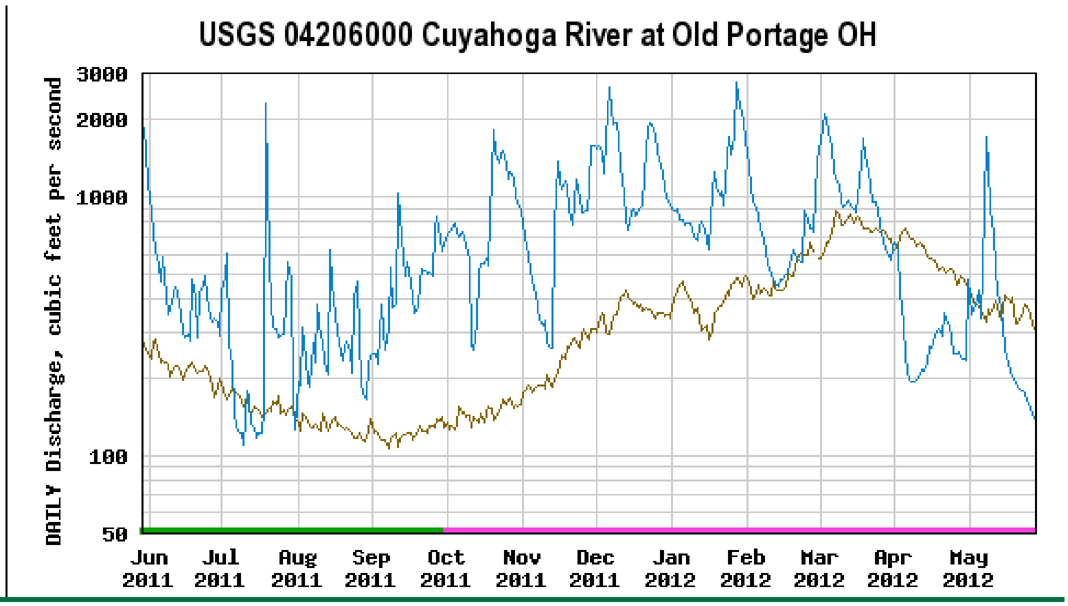
Findings:
Cuyahoga River Stream Gages

Findings: Cuyahoga River Stream Gages

Figure 4a-12a shows the hydrographs over a 1-year period of the three stream gages near the Middle Cuyahoga River. Figure 4a-12b shows the hydrographs from 1985-2012. The stream hydrographs reflect the progression downstream from smaller flows in the upper watershed (ranging from 20 cfs to peaks of 2,000 cfs) to progressively larger and more urbanized watersheds at Old Portage and Independence, with summer low flow of 100 cfs at Old Portage and 200 cfs at Independence, and extreme high flows at Old Portage of 4,000-5,000 cfs and at Independence of 10,000 cfs. The hydrographs show the general increase in flow during fall, winter, and spring months, and the general decrease in summer months. The three stream gages respond to storm events in generally similar ways, but the stream gages in the more urbanized portions of the river downstream show increasingly flashy responses proceeding downstream and further into the urbanized area. The presence of the dam at Lake Rockwell does not appear to alter the general response at the Hiram stream gage versus the other two. This document uses the Portage Path hydrograph for reference, as the Old Portage stream gage includes flow from the Middle Cuyahoga River, and the dams along the Middle Cuyahoga River downstream of the Lake Rockwell dam are not being used to control flow.

Figure 4a-12a Hydrographs 2011-2012





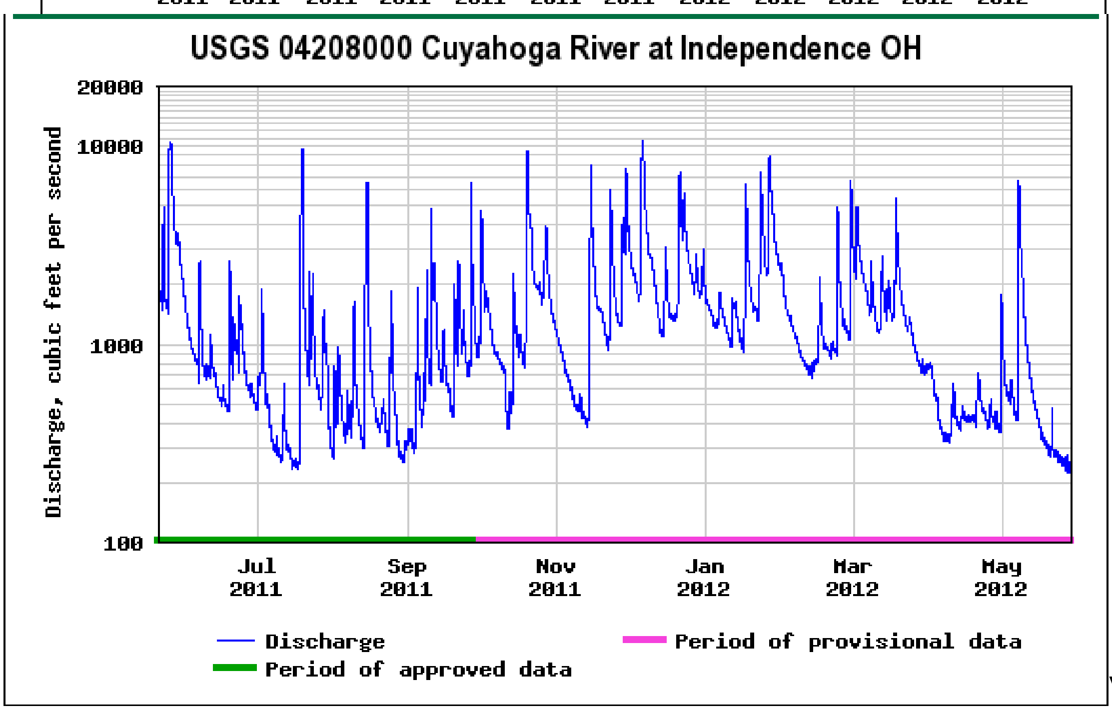
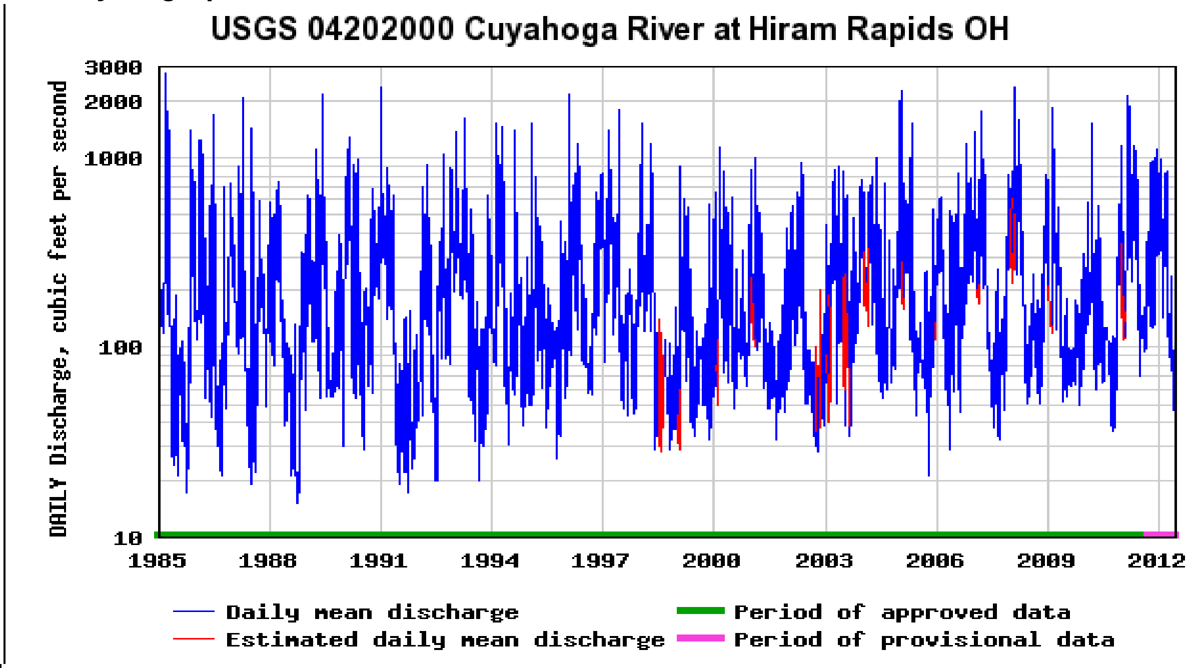
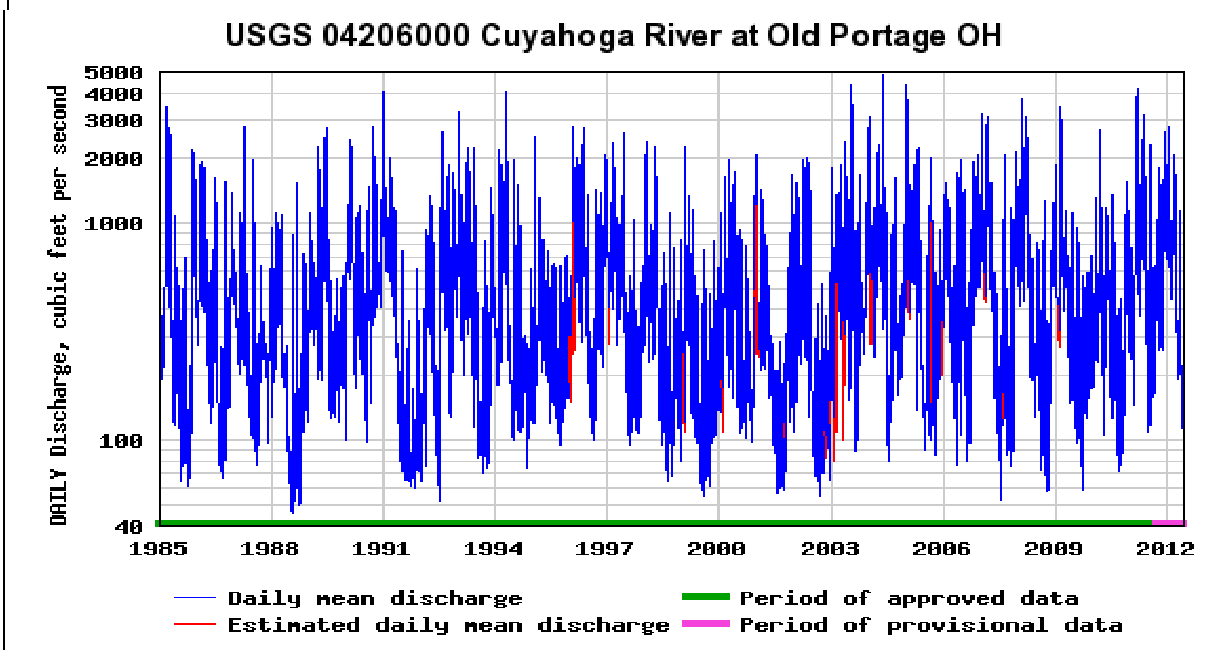


Figure 4a-12b Hydrographs 1985-2012





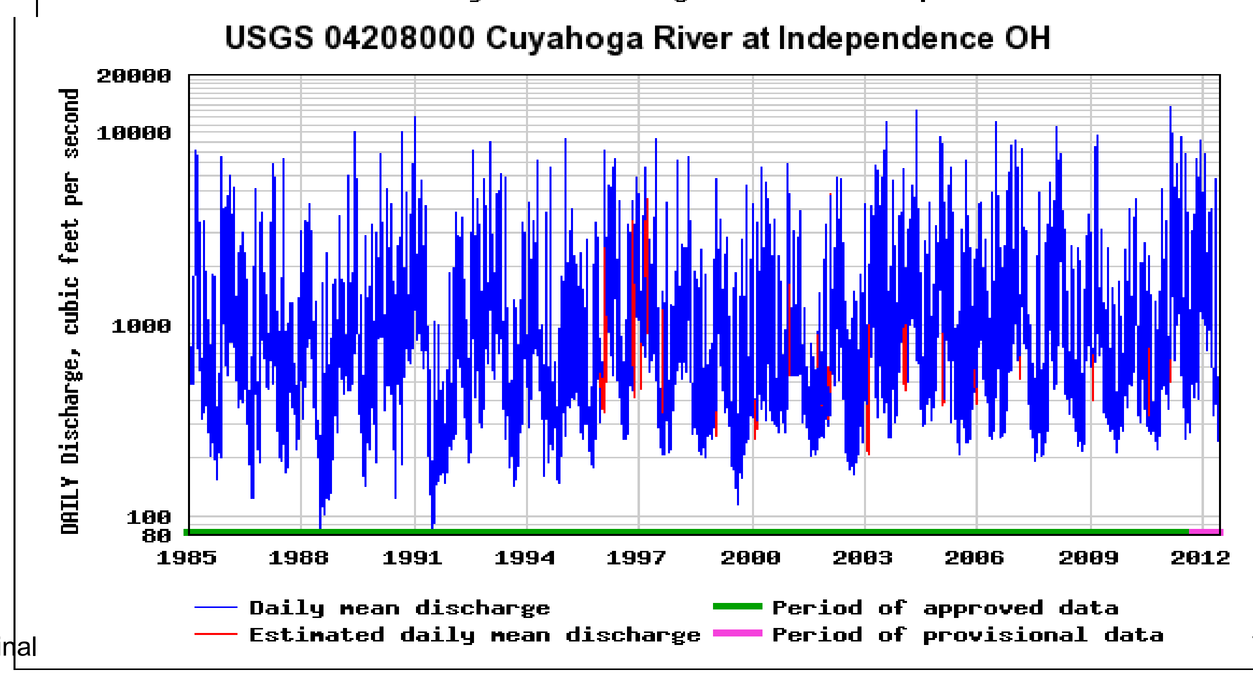


Table 4a-12
Stream Characteristics and Flow

Subwatershed/ stream	Stream Order	Water-shed Size (sq. mi.)	Lth (mi)	Slope ft/mi	Slope Pct	Annual Precip. (in.)	% of Watershed in Forest/ Wetland	Mean Sept. flow (cfs)	Mean Ann. flow (cfs)	2 year (cfs)	10 year (cfs)	100 year (cfs)
Main Stem***	5th	339		2.83		39.8	38.2; 12.6	101	433	4,640	7,260	10,400
Kelsey Cr.	2nd	3.3		37.8	0.72	37.5	18; 2.2	0.67	3.56	235	510	835
Walnut Cr.	2nd	1.92		66.6	1.26	38.7	14.3;2.2	0.41	2.19	165	373	660
MF City Hall	1st	0.82		72	1.36	37.6	15.9; 3.8	0.15	0.86	100	243	449
Fish Creek	3rd	11.5	5.4*	8.3* 10.1	0.19	38.7	26.9; 9.1	2.75	13.5	419	762	1,180
Plum Cr.	2nd above J. Ditch, 3rd below	13.1	5.0*	20.2* 19.3	0.37	36.4	29.8; 11.3	2.61	13.2	484	982	1,420
Johnson Ditch	2nd	4.18		7.07	0.13	36.6	23.2; 11.3	0.79	4.24	178	320	488
Breakneck Creek	3rd to Reed/Hud. 4th below	78.8	26.4*	4.4* 5.15	0.10	35.5	26.8; 11.6	15.1	76	1,640	2,740	4,050
Wahoo	2nd	3.27		14	0.27	36.8	24.2; 4.2	0.65	3.36	186	368	597
Hommon	1st	1.89		22.6	0.43	36.4	25.7; 7.45	0.36	1.88	118	235	382
Brimfield Ditch	2nd	4.52		24.3	0.46	36.5	32.7; 9.3	0.89	4.54	226	439	707
Hudson Ditch	2nd	4.28		23.8	0.45	35.5	28.9;7.5	0.74	4.01	224	441	717
Reed Ditch	3rd	4.7		23.2	0.44	35.6	30.1;16.2	0.83	4.45	219	394	621
Feeder Canal + CLO^	3rd below Cr. Creek	44.2		4.2	0.08	35.4	23.5; 9.6	8.13	41.9	1,050	1,770	2,630
Potter Creek	2nd	5.52	5.2*	13.1* 15.6	0.30	35.5	23.1, 4.3	0.93	5.17	246	463	729
Randolph Ditch	2nd	1.61		37.8	.72	35.4	22.3; 3.8	.25	1.48	124	264	451
Congress Lake Outlet	3rd below Rand. D.	28.2		5.49	0.10	35.5	20.7; 8.2	4.94	26.8	789	1,370	2,080
Cranberry Cr.	2nd	4.17		17.9	0.34	35.5	17.9; 3.6	0.68	3.89	247	479	789
Reidinger Ditch	2nd	0.68		33.3	0.62	35.4	16.5; 3.5	0.1	0.62	63.1	136	232

Sources: Unstarred - USGS StreamStats http://water.usgs.gov/osw/streamstats/ohio.html Ohio DNR, Division of Water, 2001.; with "*" Ohio Gazetteer of Streams, 2001; Water Inventory Report 29. http://dnr.state.oh.us/Portals/7/pubs/pdfs/GAZETTEER_OF_OHIO_STREAMS.pdf;

*** Streamstats model run for upper plus middle Cuyahoga.
^ Streamstats watershed differs slightly from what topography would indicate due to errors in modeling the landscape.
^^ Streamstats could not generate valid watershed, and excluded the northern headwater tributary.

Slope

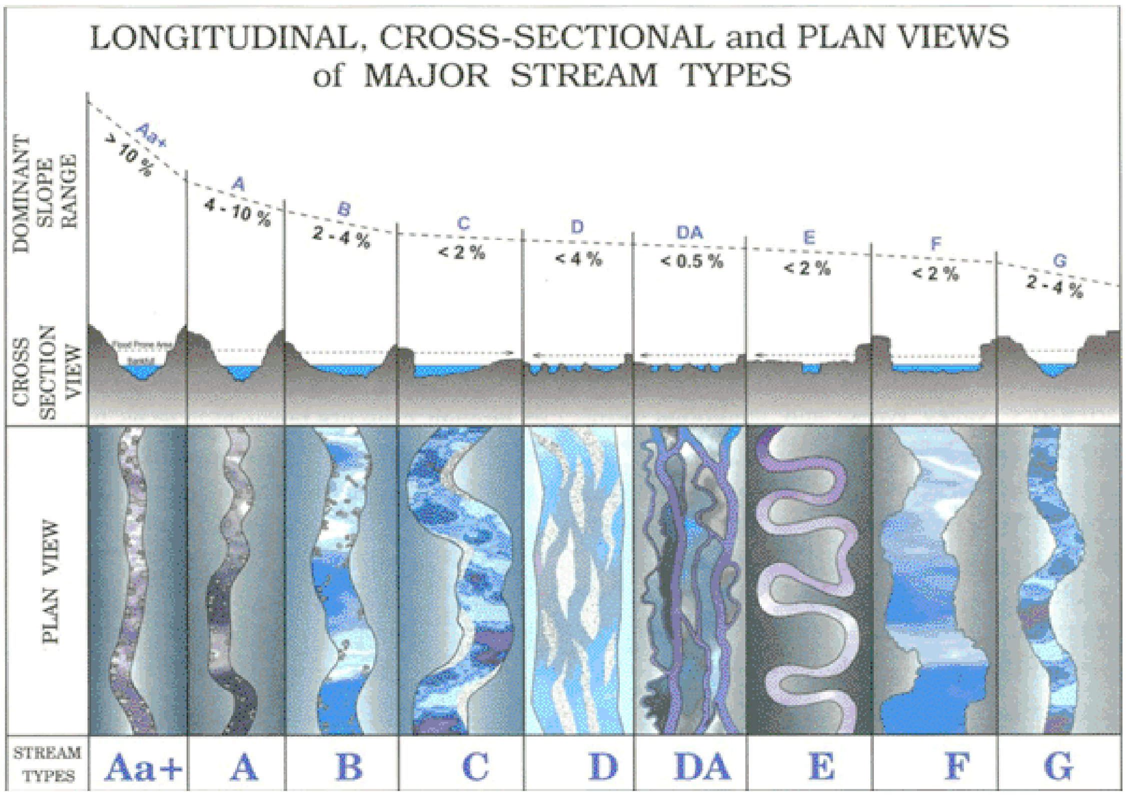
Slope: Background

Background – Stream Slopes Introduction

The slope of a stream affects the amount of energy a stream has, the size of sediment it can transport, and the form. Undisturbed low-gradient streams tend to meander, have broad floodplains, and finer-grained substrate. Higher-gradient streams tend to be narrower, with water traveling in a series of vertical steps, and coarser-grained substrate.

David Rosgen has developed a classification of streams that relates slope to the form that stream systems are likely to take if undisturbed or disturbed. The classification has several tiers of analysis. The Level II analysis looks at stream form, sinuosity, and slope apparent at a mapping scale (e.g., USGS 1:25,000). More detailed levels of analysis require field work to verify width to depth ratios and substrate.

Figure 4a-13 Rosgen Stream Classification



Rosgen, David L. "A classification of natural rivers." Catena 22 (1994): 179. www.wildlandhydrology.com

- Streams with slopes greater than two percent are more likely to be narrower and more entrenched. An Ohio State University fact sheet on stream classification (Ward, D'ambrosio, and Mecklenberg, 2008) notes that streams with slopes of 2-4 percent in Ohio tend to be classified as "B" streams and may be considered "babbling brooks," with channels consisting of a series of rapids and cascades.

Findings:
River and Stream Gradients, Middle Cuyahoga River Watershed

Findings: River and Stream Gradients

Figure 4a-14 and Table 4a-13 present slope information for the Cuyahoga River and watershed streams. The information is presented by county as well as sub-watershed, because a major topographic break and change in underlying geology roughly coincides with the Summit-Portage boundary. Section 4P shows photographs of the Cuyahoga River and streams in the watershed with varying slopes.

- While the overall slopes of the river and tributaries are generally less than 1 percent, portions of streams are much steeper.
- The higher-gradient streams tend to occur along the steep bedrock-controlled Cuyahoga River valley, in the till-covered bedrock uplands of the western portion of the watershed, and in the headwater streams coming off the knolls in the eastern portion of the watershed. In the Main Stem subwatershed, nearly two-thirds of the tributaries are in the steepest categories, whereas in the other subwatersheds, the lowest gradient streams represent most the streams. All the streams with greater than 10 percent slopes are in Summit County, where more than one quarter of the streams have a gradient greater than 2 percent. In contrast, Portage County has a greater proportion of extremely low-gradient streams. More than half the streams in Portage County have gradients of less than 0.3 percent, and in Stark County, none of the streams in the watershed has a gradient greater than 0.6 percent.
- Potter Creek, Congress Lake Outlet, Plum Creek, Breakneck Creek, and Fish Creek are extremely low-gradient, with overall slopes of 0.6 percent or less and many headwater tributaries of less than 1 percent. However, some of the headwater tributaries have slopes of 1, 2, 4, or more percent as they come off the knolls.
- In the Potter Creek subwatershed, most tributaries would be in the slope range for upland drainage categories. The slopes in the Breakneck Creek subwatershed range more widely, between the extremely low slope of Breakneck Creek and the higher gradients of many of the headwater tributaries.
- The slopes of Fish Creek change almost at the county border, reflecting a distinct topographic break between till-covered uplands in Summit County and nearly level buried valley sediments in this portion of Portage County.
- The main stem of the Cuyahoga River has an overall gradient of approximately 0.3 percent, but there are several sections with much steeper slopes (up to 4 percent) and rapids. While the gradient downstream of Water Works Park is approximately 1-2 percent overall, there are areas of steeper gradient - much of the topography of the river channel is masked by the remaining dam pools in Cuyahoga Falls, and low-gradient dam pools are interspersed with steeply plunging falls. In several areas, the resolution of the mapping and stream segment lengths do not allow individual areas of rapids to be identified.

- Streams with slopes greater than 4 percent are likely to develop as cascades or sequences of steps and pools. In the Rosgen classification system, they tend to be considered “A” or “B” streams. The Ohio stream classification paper notes that the higher gradient streams in Ohio are often headwaters coming off hilly uplands.

- Streams with slopes below 2 percent are considered in the Rosgen classification as low gradient streams, likely to meander and have wider floodplains and fringing riparian/wetland systems. Streams below 0.5 percent slope may be braided streams or wetland streams.

The Ohio EPA further distinguishes between lower-gradient streams:

- 0.5 percent and habitat value – Because of the slow velocities, these extremely low-gradient systems are less likely than steeper sloped streams to provide the gravelly substrate that represents the highest quality habitat for invertebrates and fish. In the habitat assessment for typical “warm water” species, a stream with a gradient less than 0.5 percent receives a lower score than one greater than 0.5 percent.

- 0.3-0.6 percent – The proposed beneficial use designations in Ohio’s water quality standards (12/2010) would designate previously channelized water ways with slopes from 0.3-0.6 percent and less than 3.1 square miles of drainage as upland drainage, and these would not be subject to physical, chemical, or biological standards. Alteration permits would receive abbreviated review.

Mapping

Stream slopes were determined comparing the lengths of stream segments in the combined GIS database stream coverage with elevations determined from GIS coverage of digitized USGS 1:24,000 topographic maps. Because of the scale of the mapping, length of stream segments, and, in some cases, discontinuous segments (interrupted by impoundments or even roads), this mapping may not accurately reflect field conditions, but it presents the overall characteristics. Field verification would be required to accurately determine slopes at any site.

Table 4a-13
Summary of River and Tributary Slopes by Subwatershed and County

	Cuyahoga River		Main Stem Tribs.		Fish Creek		Plum Creek	
Slope (Percent)	Length (mi)	Percent	Length (mi)	Percent	Length (mi)	Percent	Length (mi)	Percent
0-0.1	3.1	37%	0.5	2%	3.8	21%	2.4	11%
0.1-0.3	1.2	14%	1.5	7%	2.5	14%	7.8	35%
0.3-0.6	0.3	4%	2	10%	5.2	29%	7.2	32%
0.6-1.0	2.1	25%	4	19%	1.9	11%	1.7	8%
1-2	1.3	16%	5.2	25%	2	11%	2	9%
2-4	0.3	4%	4.2	20%	2	11%	0.9	4%
4-10		0%	2.9	14%	0.4	2%	0.1	0%
>10		0%	0.5	2%		0%	0.3	1%
	8.3		20.8		17.8		22.4	

	Breakneck Creek		Potter Creek		Total Tributaries	
Slope (Percent)	Length (mi)	Percent	Length (mi)	Percent	Length (mi)	Percent
0-0.1	31.0	39%	9.8	23%	47.5	25%
0.1-0.3	18.9	24%	15.3	36%	46	24%
0.3-0.6	8.6	11%	10.1	24%	33.1	18%
0.6-1.0	12.4	15%	5.6	13%	25.6	14%
1-2	8.1	10%	1.7	4%	19	10%
2-4	1.1	1%	0.4	1%	8.6	5%
4-10		0%		0%	3.4	2%
>10		0%		0%	0.8	0%
	80.1		42.9		188	

	Summit County Tributaries		Portage County Tributaries		Stark County Tributaries	
Slope (Percent)	Length (mi)	Percent	Length (mi)	Percent	Length (mi)	Percent
0-0.1	1.9	5%	43.9	31%	1.5	19%
0.1-0.3	5.8	17%	36.8	26%	4.3	56%
0.3-0.6	5.4	16%	26.5	19%	1.9	25%
0.6-1.0	4.9	14%	19.8	14%		
1-2	6.8	20%	12.2	9%		
2-4	6.0	17%	2.3	2%		
4-10	3.5	10%	0.5	0%		
>10	0.5	1%				
	34.8		142.0		7.7	

Middle Cuyahoga River Watershed

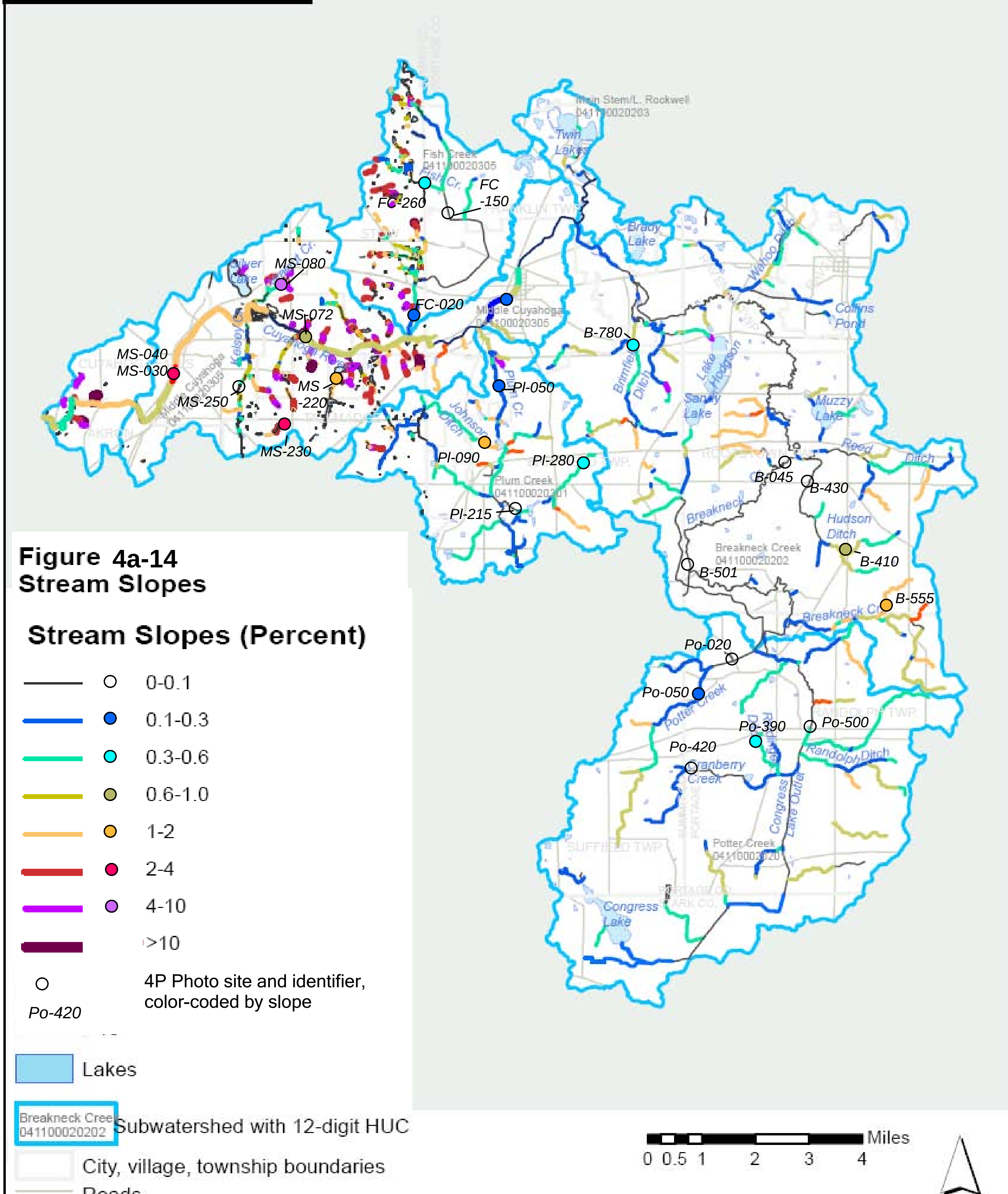


Figure 4a-14
Stream Slopes

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010

Stream Sinuosity

Stream form is related to stream slope and outside factors such as the water-sediment load entering the stream. One of the key indicators in the Rosgen classification is sinuosity, determined by dividing channel length by valley length. Many typically low-gradient streams have sinuosities of 1.2 or greater, and a sinuosity of 1.5 is considered highly sinuous, typical of the lowest-gradient streams (D streams). The steeper streams (A or B streams) tend to have lower sinuosities, as they are often more confined inside their stream channels, and plunge or cascade vertically rather than meandering from side to side.

Mapping

The lengths of stream segments of the combined GIS database were mapped compared with stream valley length determined from a GIS coverage of digitized USGS 1:24,000 topographic maps. It should be noted that the field conditions may differ from these desktop measurements. Many of the line segments used in the mapping were relatively short, which would mask sinuosity. At the scale of mapping used, meanders may not be apparent, or streams may be recovering. Field investigation will be needed to determine characteristics at each site.

Findings:

River and Stream Sinuosities, Middle Cuyahoga River Watershed

Findings: Middle Cuyahoga River Watershed Stream Sinuosity

The predominance of low-gradient streams in the watershed would suggest that many of the streams would have high sinuosities and fringing wetlands and floodplains. However, as the Ohio State University stream classification fact sheet notes, in Ohio, low-gradient channels are common but have often been altered for drainage and meander less than the low slopes would suggest. With a few exceptions, the streams of the Middle Cuyahoga River watershed appear to be following that pattern (See Figure 4a-15):

- Breakneck Creek is highly sinuous with a sinuosity of nearly 1.5. The description of the Cuyahoga River Ecoregions notes it is an extremely low-gradient swamp creek.
- Sinuosity in portions of the main stem, Plum Creek, and Johnson Ditch exceed 1.2, the sinuosity factor that Rosgen associates with typically developing low-gradient streams, which are often in equilibrium with their slope, flow, and sediment load. Some segments of smaller tributaries exceed 1.5.
- Generally, in spite of relatively low gradients in many of the watershed streams, many of them have very low sinuosities, below the 1.2 that Rosgen associates with typically developing lower-gradient streams. Many have sinuosities approaching 1, indicating very little meandering is apparent at the mapping scale. It appears that many streams in the watershed have been channelized, altered.
- A review of aerial photographs suggests that some of the headwater tributaries in the Plum, Breakneck, and Potter Creek subwatersheds may retain much of their sinuosity, but it may not be apparent at the scale of mapping used.

Middle Cuyahoga River Watershed

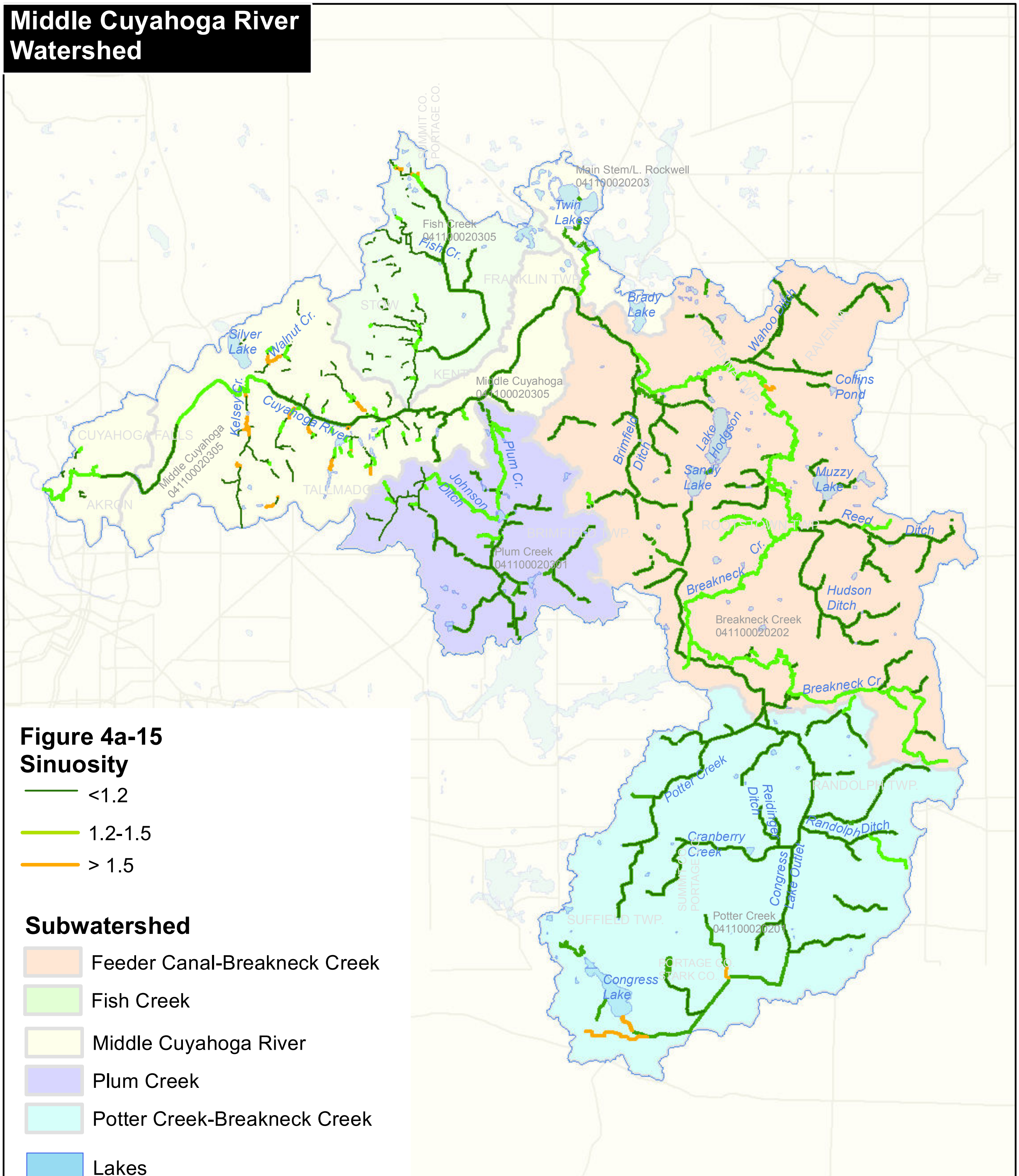


Figure 4a-15
Sinuosity

- <1.2
- 1.2-1.5
- > 1.5

Subwatershed

- Feeder Canal-Breakneck Creek
- Fish Creek
- Middle Cuyahoga River
- Plum Creek
- Potter Creek-Breakneck Creek
- Lakes
- 041100020202 12-digit HUC Number
- City, village, township boundaries
- Roads

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010

Floodplain Areas

Floodplains are an important part of a stream system, providing habitat, water quality, hydrological, and safety benefits. Floodplains are the low-lying areas where streams spill out, during high flow, dissipating energy, storing floodwater, depositing sediment, helping to maintain equilibrium stream form, and supporting fringing wetlands, riparian zones, and habitat. They also represent high-risk areas to structures. Activities that encroach on floodplain storage volume or floodplain access increase flood volume, energy, and erosivity downstream.

The Federal Emergency Management Agency maintains maps indicating:
Floodway – areas likely to have damaging velocities of water during certain events and Floodplains - areas with a certain chance of flooding each year. Areas with 1 percent or 0.2 percent chance of flooding are known as the 100-year or 500-year floodplain and represent severe, rare events. Activity within these zones is regulated by local floodplain managers, often zoning officials, to ensure that structures are not built in the floodway (the area likely to have floodwaters moving at damaging velocities) and that construction within the mapped floodplain is built to local standards, often placing the structure above the base flood elevation.

Flooding occurs much more frequently and is an important part of the river water and sediment budget. In undisturbed streams, “bank-full” events, those where the water is just at the top of the channel and would soon spill out, generally occur with a recurrence interval of once or twice per year. These events are much smaller than the FEMA-mapped events but are probably more significant in the overall processes shaping the channel. One way to determine likely areas of these smaller floods at a watershed scale is by mapping flood-prone soils. Soil mapping occurred largely during the 1970s, so areas mapped as floodprone soils may no longer be associated with flooding streams in the same fashion, if the landscape has changed.

Findings:
Floodplains and Flood-prone soils

Figure 4a-16 presents FEMA-mapped floodplains. In reviewing mapping of floodprone soils, all cases, the floodprone soils occupy a narrow band within the FEMA-mapped floodplains, are not distinctly visible at this scale of mapping, and are not shown.

There are extensive floodplains mapped along many of the tributaries. (See, for example, 4P B-220, B-2; 4P Po-020, Po-1; 4P Pl-040, Pl-1). The main stem for the most part is confined within a relatively narrow bedrock valley, and generally has a much more limited floodplain. (e.g., 4P MS-148, p. 4P MS3). Certain channelized stream sections have very narrow mapped floodplains.

It is important to note that mapping of floodplain does not necessarily mean that the streams have access to the floodplains at that location. Streams may be so incised or so deeply channelized that they can no longer reach the floodplain, addressed later in Section 4d-ii. These would be important areas to restore.

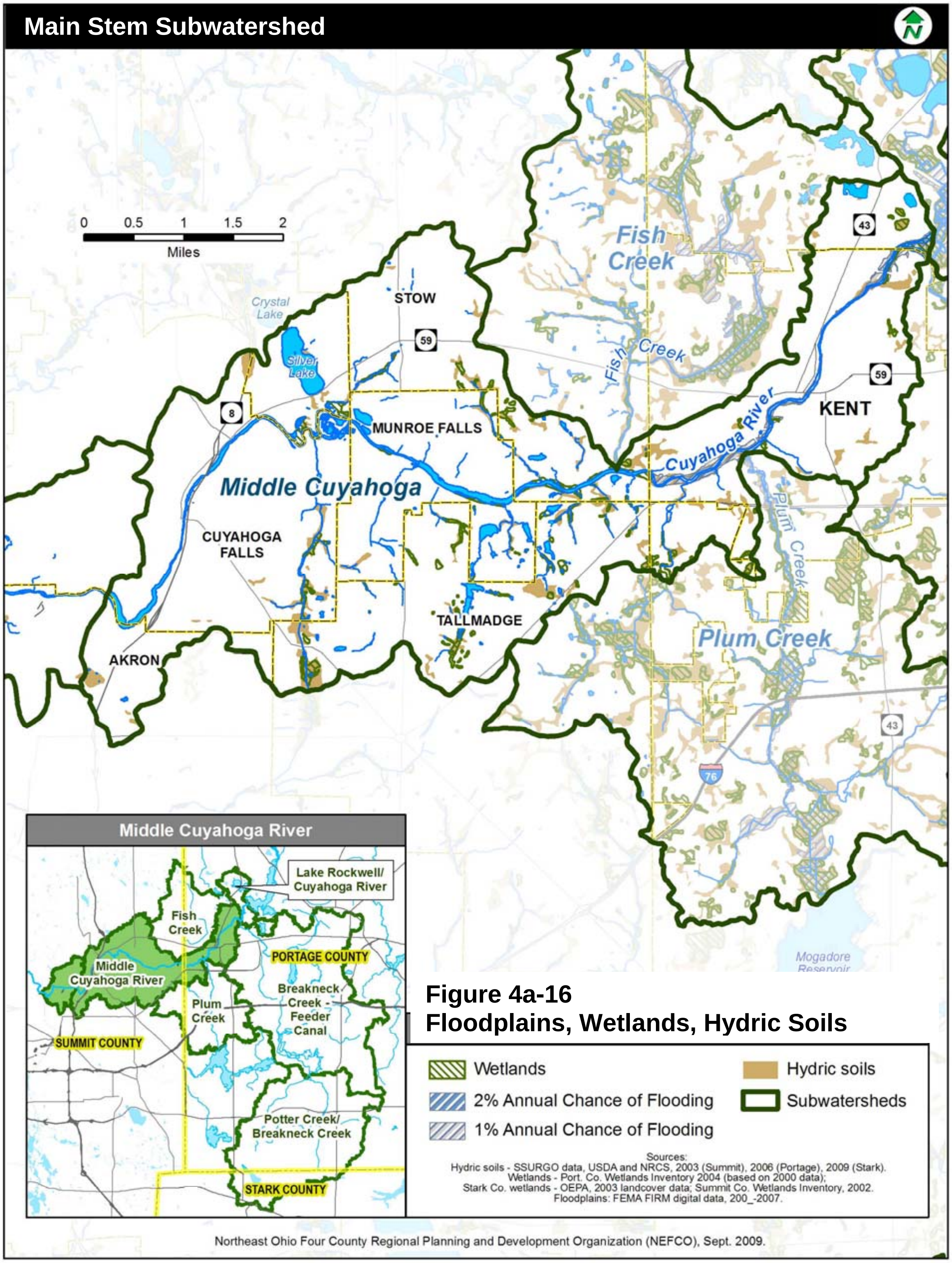
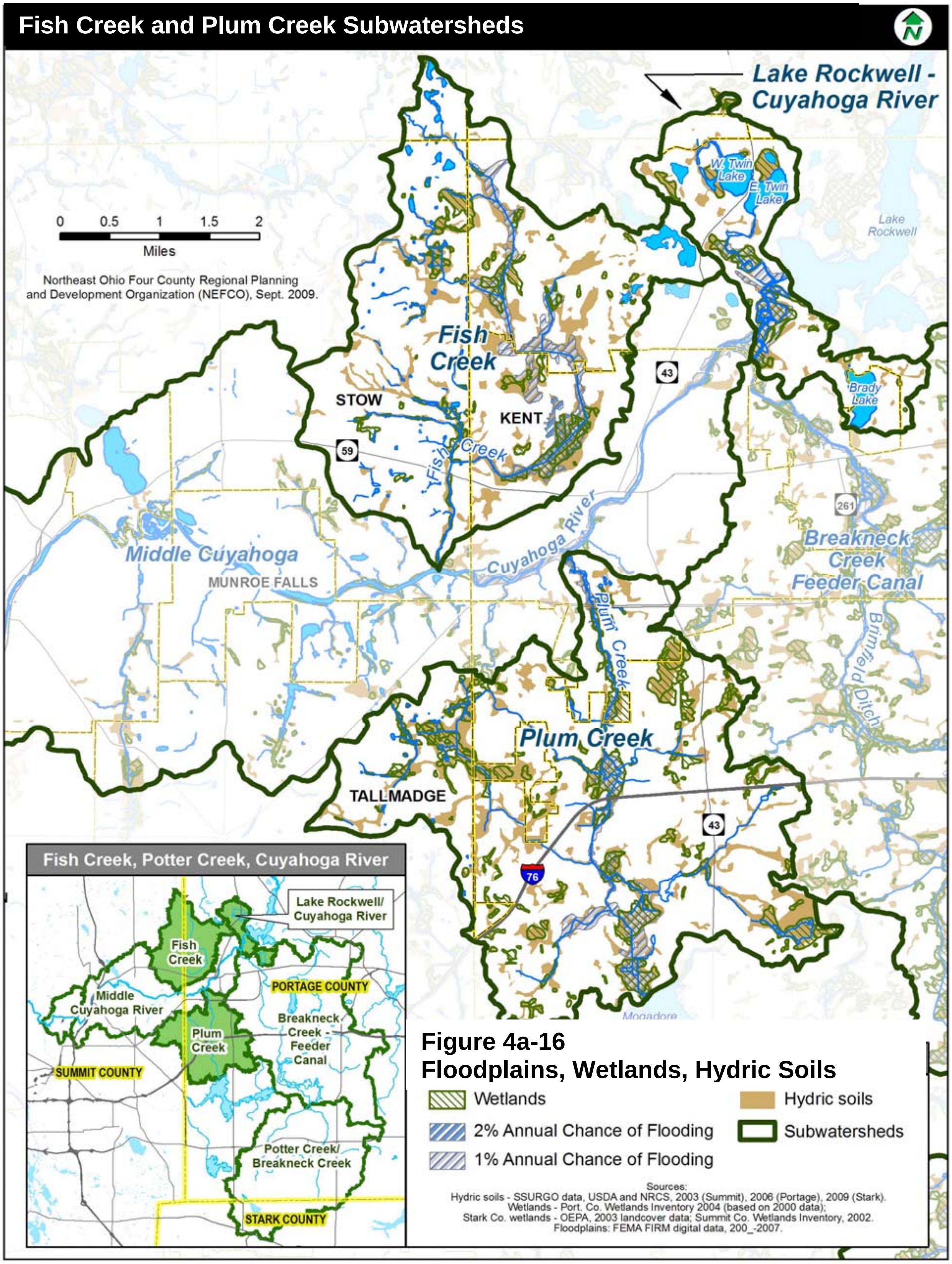


Figure 4a-16
Floodplains, Wetlands, Hydric Soils


Fish Creek and Plum Creek Subwatersheds
Lake Rockwell - Cuyahoga River
W. Twin Lake
E. Twin Lake
Lake Rockwell
0 0.5 1 1.5 2
Miles
Northeast Ohio Four County Regional Planning and Development Organization (NEFCO), Sept. 2009.
Fish Creek
STOW
KENT
Brady Lake
Fish Creek
Cuyahoga River
Middle Cuyahoga
MUNROE FALLS
Breakneck Creek Feeder Canal
Plum Creek
Brimfield Ditch
Plum Creek
TALLMADGE
Fish Creek, Potter Creek, Cuyahoga River
Lake Rockwell/ Cuyahoga River
Fish Creek
Middle Cuyahoga River
PORTAGE COUNTY
Breakneck Creek - Feeder Canal
Plum Creek
SUMMIT COUNTY
Potter Creek/ Breakneck Creek
STARK COUNTY
Mogadore
Figure 4a-16
Floodplains, Wetlands, Hydric Soils
Wetlands
Hydric soils
2% Annual Chance of Flooding
Subwatersheds
1% Annual Chance of Flooding
Sources:
Hydric soils - SSURGO data, USDA and NRCS, 2003 (Summit), 2006 (Portage), 2009 (Stark).
Wetlands - Port. Co. Wetlands Inventory 2004 (based on 2000 data);
Stark Co. wetlands - OEPA, 2003 landcover data; Summit Co. Wetlands Inventory, 2002.
Floodplains: FEMA FIRM digital data, 200_-2007.

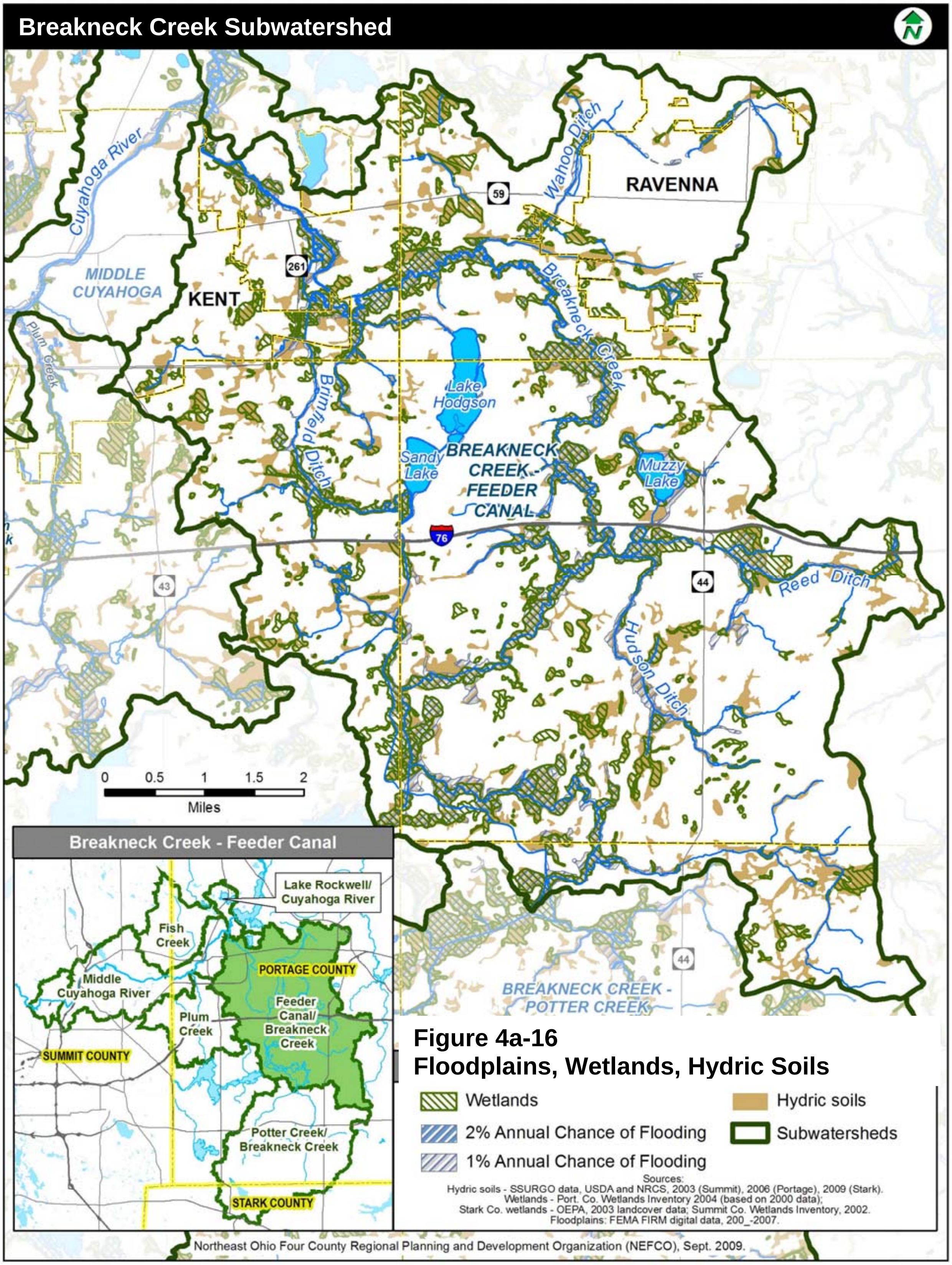
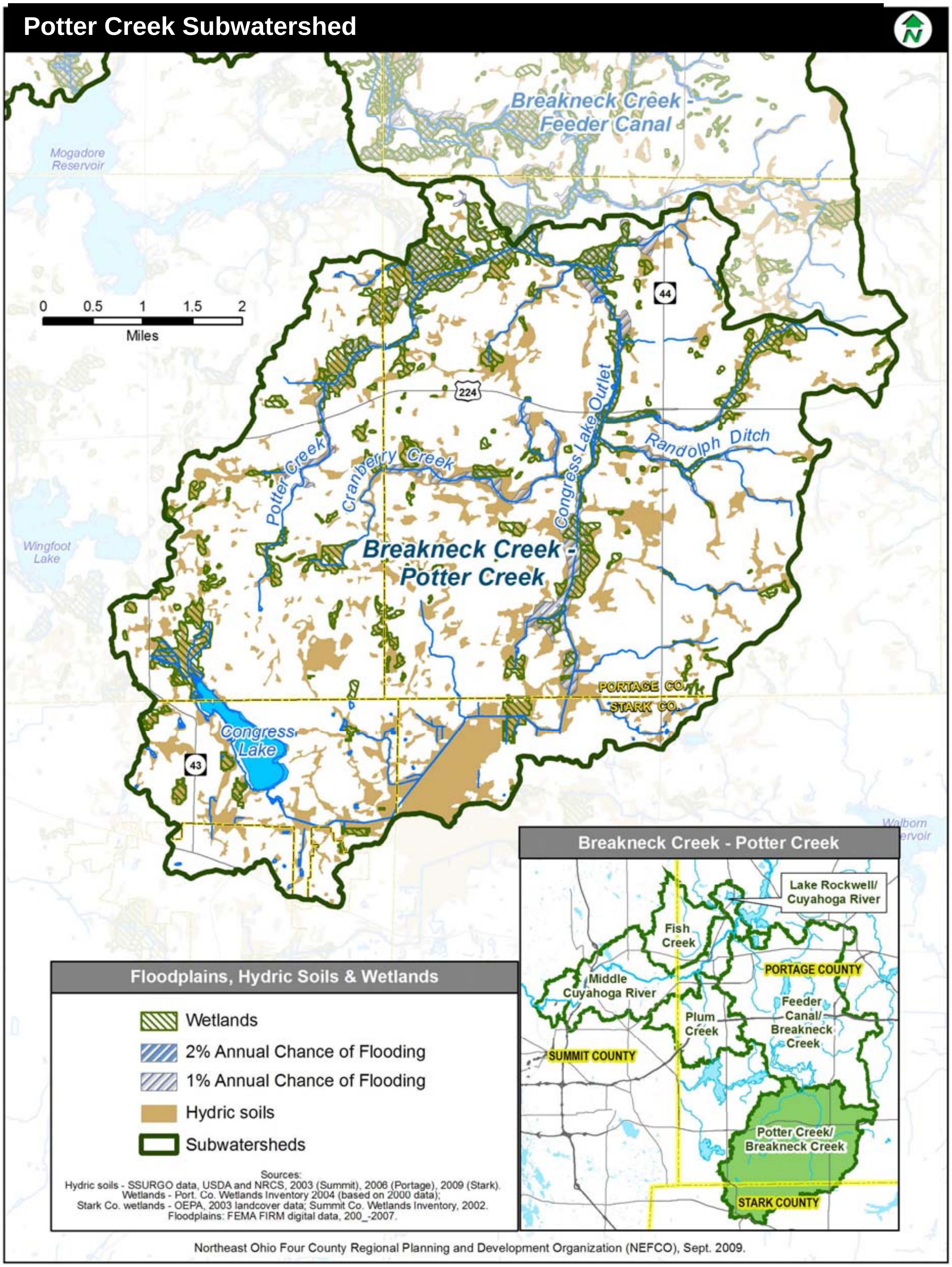


Figure 4a-16
Floodplains, Wetlands, Hydric Soils


Potter Creek Subwatershed
Breakneck Creek - Feeder Canal
Mogadore Reservoir
0 0.5 1 1.5 2
Miles
Potter Creek
Cranberry Creek
Congress Lake Outlet
Randolph Ditch
Wingfoot Lake
Breakneck Creek - Potter Creek
PORTAGE CO.
STARK CO.
Congress Lake
Walborn Reservoir
Breakneck Creek - Potter Creek
Lake Rockwell/ Cuyahoga River
Fish Creek
PORTAGE COUNTY
Middle Cuyahoga River
Plum Creek
Feeder Canal/ Breakneck Creek
SUMMIT COUNTY
Potter Creek/ Breakneck Creek
STARK COUNTY
Floodplains, Hydric Soils & Wetlands
Wetlands
2% Annual Chance of Flooding
1% Annual Chance of Flooding
Hydric soils
Subwatersheds
Sources:
Hydric soils - SSURGO data, USDA and NRCS, 2003 (Summit), 2006 (Portage), 2009 (Stark).
Wetlands - Port. Co. Wetlands Inventory 2004 (based on 2000 data);
Stark Co. wetlands - OEPA, 2003 landcover data; Summit Co. Wetlands Inventory, 2002.
Floodplains: FEMA FIRM digital data, 200_-2007.
Northeast Ohio Four County Regional Planning and Development Organization (NEFCO), Sept. 2009.

4.a-iii.b. Surface Water (cont'd)
-ii.2 Streams: Use Designations and Recreational Uses

Background: Use Designations

Background: Use Designations

Ohio's water quality standards are based on beneficial use that water bodies should be able to support. For each beneficial use there are a number of physical, chemical, and biological standards that are monitored to determine attainment.

Aquatic Life Use

Aquatic Life Use is the primary standard monitored by the Ohio EPA. Biological communities change in response to changing conditions. Unlike chemical parameters, biological response is not a measurement of conditions at a single time but, instead, reflect long-term conditions. The three warmwater categories include use of numerical indices reflecting biological community composition and diversity. The categories include:

- Cold Water Habitat (CWH) - these support stream-based trout stocking or coldwater fish and associated vertebrate, invertebrate, and plant species. These systems are rare in the state, and are extremely susceptible to changes in temperature and chemistry.

- Exceptional Warmwater Habitat (EWH) – These support unusual communities (above the 75^{th} percentile of sampled sites)

- Warm Water Habitat (WWH) – this is the most common Aquatic Life Use designation in Ohio, recognizing typical communities of the generally low-gradient streams in Ohio.

- Modified Warmwater Habitat (MWH) – These water courses have been altered to the extent that they are unlikely to support the full breadth of warmwater species again. The numerical biological criteria are lower for this category than for the other warmwater habitats. Modifications can include channel modification, impoundment, or mine-affected.

- Limited Resource Water (LRW) - used strictly to provide drainage. While there are no biological criteria for this water, it must still be free from nuisance chemicals, toxins, or odors.

- *Proposed Aquatic Life Use designation* - Base aquatic life use – this proposed category applies to waters that are conducive to the survival and propagation of aquatic species. It would apply to all undesignated waters

- *Proposed Aquatic Life Use designation* - Primary Headwater Habitat – all waters with drainage areas of less than 1.0 square mile. There are three categories depending on the biological communities they support and the degree of alteration, with Class III being the highest (and subject to similar chemical standards as Cold Water Habitat) and Class I being so altered that most of the functions these provide could be replicated by adequate stormwater best management practices. Classes II and III can be designated as "modified" if they have been channelized or impounded.

- *Proposed designation* - Lake – dugout lake, impoundment, natural lake, and upground reservoir (used for storing drinking water)

Water Supply

Water supply designations include the following:

- Public Water Supplies (PWS) – designated public water supplies, publicly owned lakes and reservoirs, privately owned lakes used for public water supplies; surface waters within 500 yards of public water supply intakes; and emergency water supplies.

- Industrial Water Supplies (IWS) and Agricultural Water Supplies (AWS) have less stringent standards. All waters are designated IWS and AWS unless specifically removed.

Recreation

Standards for Recreation water focus on *e. coli* and certain toxins. Specific effluent treatment standards apply primarily during the recreation period, May 1 through October 31, unless the season is extended due to exceptionally high use during other times of the year. The categories include:

- General water based recreation – those that support or potentially support at least one form of water based recreation. The standards related to this designation apply year-round.

- Bathing waters – primarily used for swimming during the recreation season.

- Primary contact recreation waters are suitable for one or more full body contact recreational use during the recreation season, including water skiing, paddling, wading, swimming. This designation entails the highest standards, in order to allow frequent contact with immersion in the water in a safe manner. Recent changes in water quality standards have created further categories:
    - Class A recreation waters are those supporting frequent primary contact activities, including lakes with public or privately improved access points and waters designated in the Ohio Revised Code (ORC).
    - Class B and C recreation waters support (or could support) occasional or infrequent primary contact activities. Class C waters have watersheds of less than 3.1 square miles.
    - Secondary contact recreation – minimal risk of exposure to pathogens due to factors such as infrequency of use or remote locations.

Other Proposed Designations: Drainage Use

There are no chemical, bacterial, or biological criteria for streams designated drainage uses.

- Upland Drainage – historically channelized, with watersheds of less than 3.1 square miles and slopes of 0.3-0.6 percent, depending on watershed size.

- Water conveyance – constructed or modified channels made to carry drainage during wet periods. These drain 3.1 square miles or more, are historically channelized, and are otherwise designated WWH, MWH, or LRW.

Findings:
Use Designations, Middle Cuyahoga River Watershed

Findings: Middle Cuyahoga River Watershed Designated Uses

As shown on Table 4a-14 and Figure 4a-17, the Cuyahoga River and seven of the tributaries have been designated for aquatic life use. The Cuyahoga River has been designated Category A, Primary Recreation, supporting an increasing amount of recreational paddling. In addition, Lake Hodgson supports public recreational use.

Stream	Water Quality Designation	Comments/Other
Cuyahoga River	WWH, Category A Primary Recreation	Canoe livery has been established at Tannery Park in Kent
Fish Cr.	WWH/ MWH-C	Channelized to provide drainage upstream of RM 1.4
Plum Cr.	WWH	
Breakneck Cr.	WWH	Includes Congress Lake Outlet
Potter Cr.	WWH	
Congress Lake Outlet	MWH-C	Dug canal connecting Congress Lake with Lake Hodgson
Feeder Canal	MWH-C	Dug canal connecting Congress Lake with Lake Hodgson, flow restricted by control structure, receives flow only occasionally in summer
Lake Hodgson	Public water supply	Recreational use, allows boating and fishing, boat rental
Wahoo Ditch	LRW	Drainage purposes only

Lake Hodgson is the public water supply for the City of Ravenna. Ohio EPA has identified source water management areas for public water supplies. The area identified as source water protection areas include the emergency management zone, an area within 1,000 feet of the intake, and the corridor management zone, a zone 1,000 feet wide along the lake and Feeder Canal, and 500 feet wide along major tributaries. The Potter Creek subwatershed and a small portion of Breakneck Creek subwatershed along the Feeder Canal are in the Corridor Management Zone, most of which is not owned by the City of Ravenna. Because Lake Hodgson is a surface water supply, it is susceptible to surface contamination sources, including: agricultural and residential runoff; failing septic systems; spills; oil and gas wells/pipes; transportation facilities; and the Lake Hodgson marina (which allows no gas-powered motors), and the Randolph Waste Water Treatment Plant. Recommended management measures included lake monitoring; spill response and containment; careful monitoring of conditions during which withdrawals were made from the Congress Lake Outlet; careful management of recreational activities on the lake; protection from nutrients, suspended solids, pesticides; education and outreach; coordination with other agencies; and zoning ordinances to address land use and chemical storage. The City of Ravenna monitors water quality parameters in the lake.

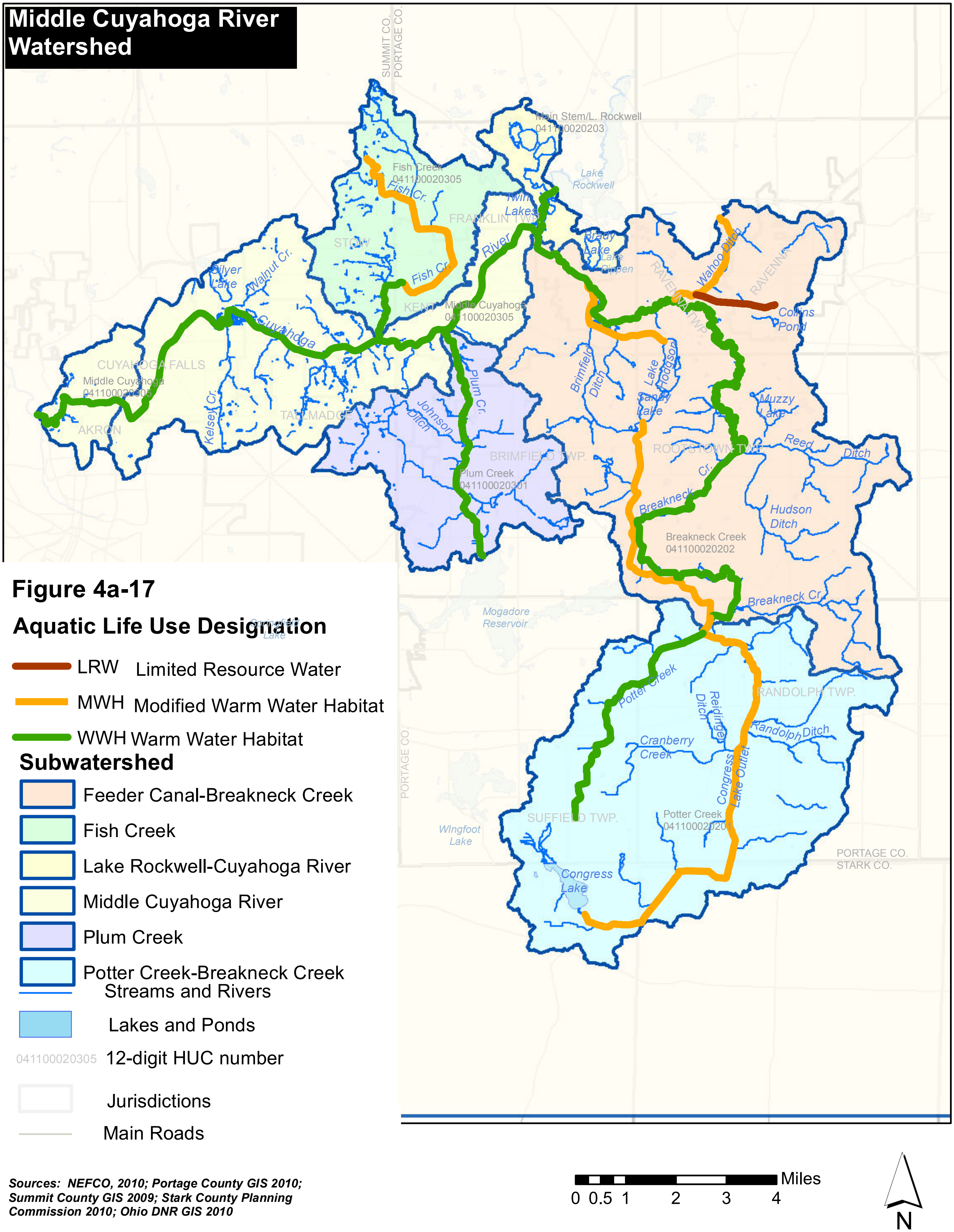


Figure 4a-17

Aquatic Life Use Designation

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010

Recreational Uses

Recreational use has been important along the water bodies and waterways of the watershed and is becoming increasingly so.

- The main stem of the Middle Cuyahoga River is becoming increasingly important for paddling. Near the lower end of the watershed, the rapids at the Sheraton dam provide challenges to expert-level paddlers. A canoe livery was established in the summer of 2010 by the City of Kent and Kent State University in Tannery Park downstream of the Kent dam. The liver offers trips to Brust Park or Water Works Park, where there are canoe pull-outs or boat launches. The venture was so successful in its first year that it is doubling its fleet, as of summer, 2011. The City of Kent has been exploring the possibility of an additional put-in for expert paddlers above the rapids of the Brady's Leap area.

- Municipal or MetroParks bike-hike or hiking trails parallel the main stem from Kent through Cuyahoga Falls, offering passive recreation (hiking) opportunities and fishing access. Some of the paths pass alongside gorges, cliffs, and rapids, offering access to dramatic scenery.

- Portage Park District has begun acquiring parcels along Breakneck Creek, which are currently being used for conservation and occasional passive recreation.

- Cuyahoga Falls, Kent, and Munroe Falls regularly have festivals at parks along the river. These are becoming increasingly important community gathering places.

- Various municipal parks are located along tributaries, including Plum Creek Park, several parks in Cuyahoga Falls, Adell Durbin Park in Stow, and parks in Kent along Fish Creek. Many of these offer access to the tributaries.

- The City of Ravenna allows boating on Lake Hodgson with non-gasoline powered boats, and rents boats.

As of the writing of this plan, a number of communities and organizations have begun the effort to establish a Cuyahoga River water trail, which will establish regularly maintained put-in and pull-out locations and will include a brochure highlighting routes, pull-outs, and important features. Much of the Middle Cuyahoga would occupy the section designated as the "Heritage" section, highlighting the historic dams, communities, and features along its banks. The lower section of the main stem in the watershed would be classified the "expert" section, taking advantage of the Class IV and V rapids in the Gorge section. A short stretch of expert rapids is already exposed, and should the dams in Cuyahoga Falls be removed, it is anticipated that more expert level rapids will be exposed. There are a number of challenges to meet in developing a water trail, but stakeholders see this as an important opportunity to highlight the resource and provide a regional economic development opportunity.

4a-iiic Groundwater Resources
-i Aquifers; i.1 Flow; Flow Regime; 1.3 Pollution potential

Groundwater Resources: Background

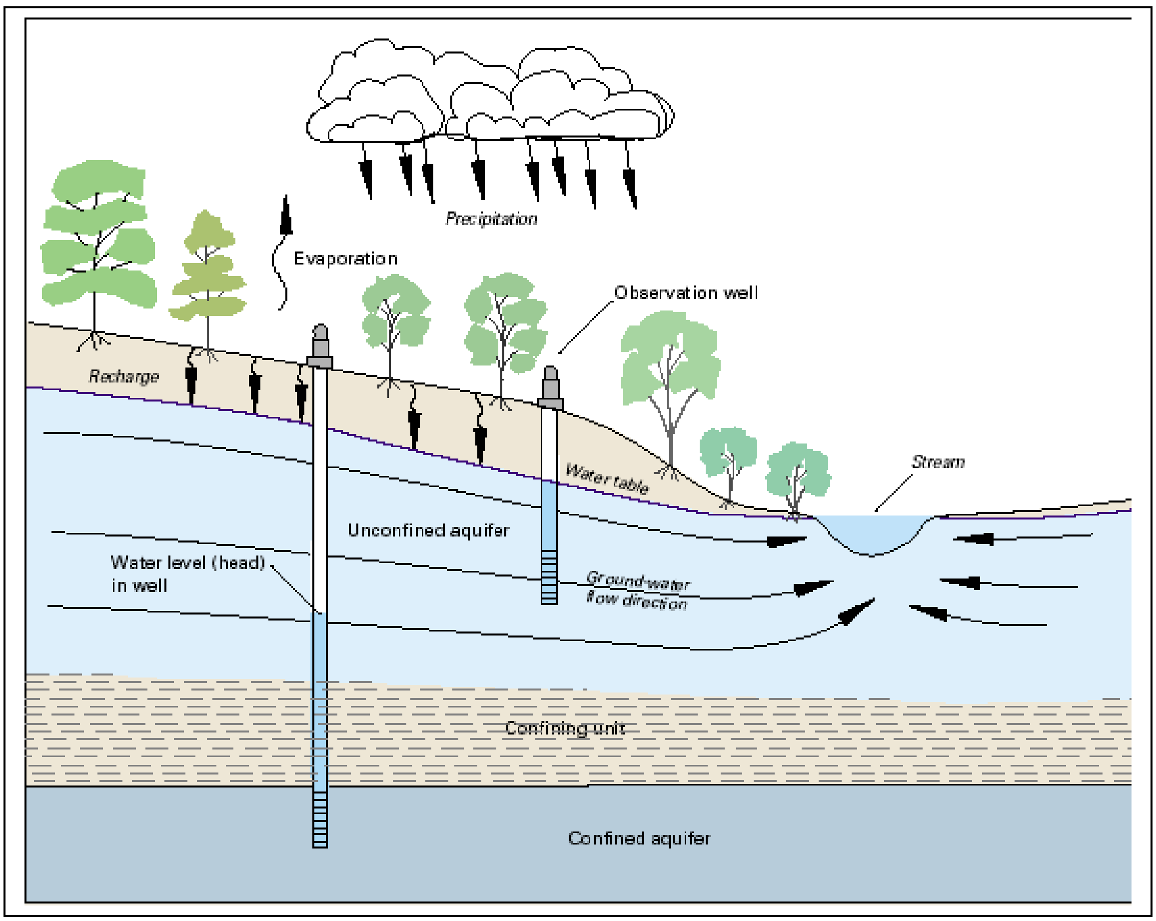
Background - Groundwater

Introduction

The water resources and hydrology of an area extend below the ground surface, where water flows through connected spaces between or rocks, as shown on the following illustration.

Note: This section considers the flow of groundwater, sources of groundwater, public water supplies, and susceptibility to pollution together (in a different order of the Appendix 8 outline), because they all address flow of groundwater. Section 4a-iiic-i.2, Source Water Assessment Plans, is presented after this discussion related to groundwater flow.

Figure 4a-18
Groundwater Hydrology Diagram



Source: Hydraulic Head and Factors Causing Changes in Ground Water Levels U.S. Geological Survey Circular 1217 by Charles J. Taylor and William M. Alley 1217 Box A http://pubs.usgs.gov/circ/circ1217/html/boxa.html

Groundwater…

- Is recharged through infiltration.

- Flows through connected spaces between sediment or rocks, flowing most easily where relatively large pore spaces are connected, such as in sand and gravel or sandstone, (high transmissivity). Groundwater flow through till is limited, as the finer silt particles fill the spaces between the sand and gravel.

- May flow through surface sediment or rocks (unconfined) or in permeable layers, such as sandstone, that are between impermeable ones such as shale (confined);

- Flows from areas of high potential to low potential within areas of similar transmissivity, which in surface sediments often reflects the topography. This is mapped as the potentiometric surface, the level to which water would rise in an open well.

- Groundwater often emerges at the surface in wetlands and streams, providing a base level of flow during dry weather. Where permeable layers emerge below impermeable layers in cliffs, the groundwater emerges as seeps.

- Areas of high groundwater tables are often wetlands and may be poorly suited for septic systems and structures.

Groundwater provides an important source of drinking water in public and private wells. Areas that are best suited for wells are usually in sediment or bedrock with high transmissivity, which makes them especially susceptible to contamination from materials carried in the groundwater. Contamination can occur from spills on the surface that enter the groundwater or from travel of contaminants below the surface.

Mapping and Data

Ohio DNR has mapped a number of groundwater characteristics for use in developing wells, monitoring and understanding flow patterns, and managing contaminated groundwater:

- Potentiometric surface, allowing determination of flow direction (generally perpendicular to potentiometric contours and to the lower elevations);
- Groundwater aquifers, units storing enough water to potentially support wells;
- Transmissivity and hydraulic conductivity (how easily water moves through the subsurface);
- Pollution susceptibility, reflecting transmissivity and other hydraulic factors, as well as whether the aquifer is near the surface and thus, more susceptible to surface influences (this data is known as DRASTIC maps, with the acronym standing for a number of factors influencing susceptibility to pollution); and
- Well locations and withdrawal amounts.

Three USGS groundwater monitoring wells are located within the Middle Cuyahoga River Watershed: Kent near Route 59, Cuyahoga Falls at the Cuyahoga Falls water supply, and Quail Hollow State Park in Stark County. Monitoring data from these were compared to each other and stream hydrographs to determine how the groundwater in each area changes seasonally and with precipitation.

Ohio EPA has determined zones likely to contribute groundwater to public wells within one and five years, to allow public water suppliers to protect the sources of their well water. Water suppliers may adopt source water protection programs, which identify potential sources of contaminants and disruptions to public water supplies and incorporate measures to reduce risks to the water supplies.

Findings:
Groundwater Resources, Middle Cuyahoga River Watershed

Figure 4a-19 shows the general direction of the groundwater flow, which is generally toward the river and tributaries. This figure also shows the location of the monitoring wells.

Figures 4a-20.1 through 4a-20.4 compare groundwater levels at three locations in the watershed and in relation to flow in the Cuyahoga River. Groundwater levels typically fluctuate during the year, with the highest levels in late fall to spring and the lowest levels in summer. The Quail Hollow State Park monitoring well, which is influenced by wetlands rather than streams, clearly exhibits this seasonal fluctuation. The other two monitoring wells show more rapid fluctuations in the groundwater elevations, which correspond to changes in flow in the Cuyahoga River, especially during wet periods, and indicate that these two wells are influenced by precipitation. The changes at the Cuyahoga Falls monitoring well, which is adjacent to and recharged by the river, more closely reflect the changes in the river flow during wet periods than Kent, where fluctuations appear to be modified, perhaps by the extensive wetlands nearby.

Figure 4a-21 presents the major aquifers, public water supplies, and areas of highest pollution potential. There are three major groundwater public water supplies: Cuyahoga Falls, Kent, and Portage County. They are all within the sand and gravel aquifer of the buried river valleys. Numerous smaller wells are also found in the sand and gravel aquifer. Lake Hodgson is a surface water public water supply, but Lake Hodgson and the Feeder Canal likely receive water from groundwater flow. The Kent and Portage County public water supplies are in areas of higher or moderate pollution potential – where groundwater moves easily through sediment, there is a greater likelihood that pollutants will also move easily, and these aquifers do not have isolating lenses of low-permeability material above them to provide protection from surface pollutants.

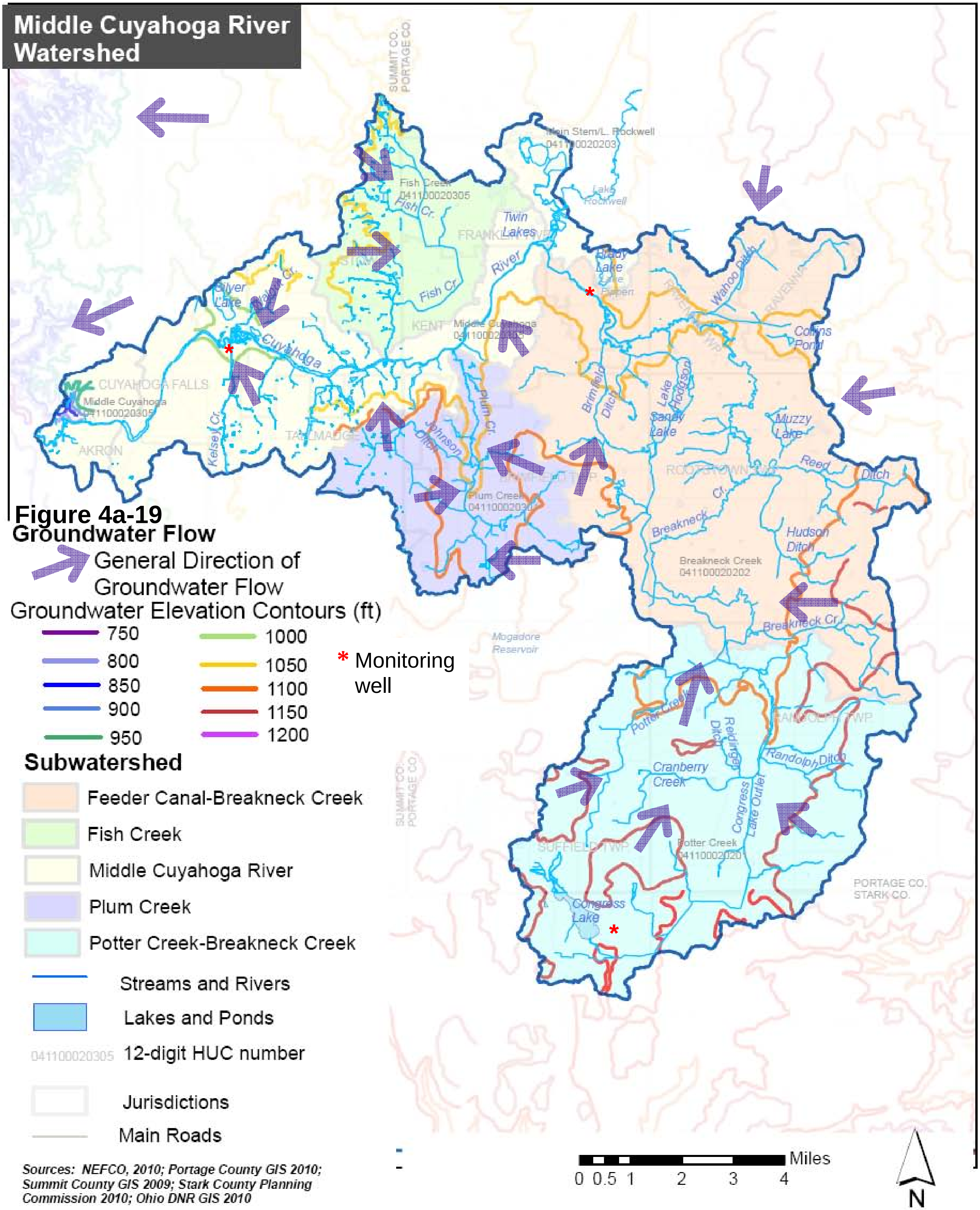
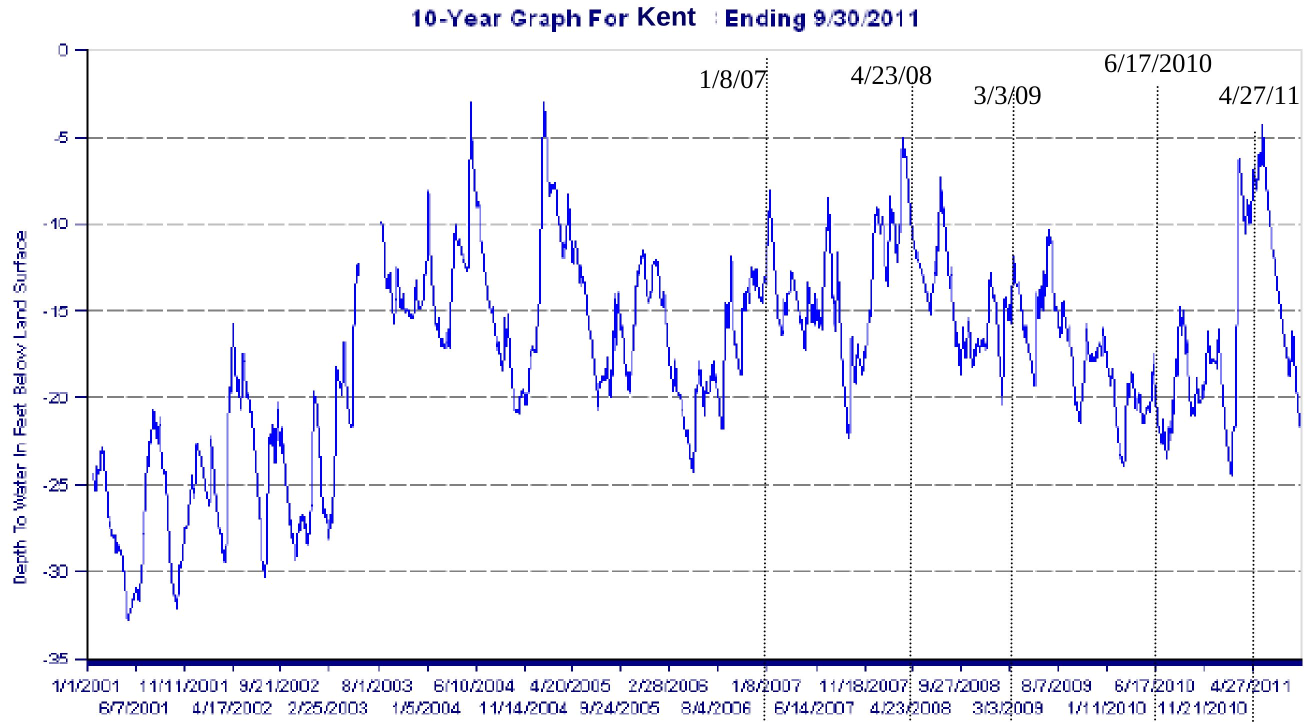
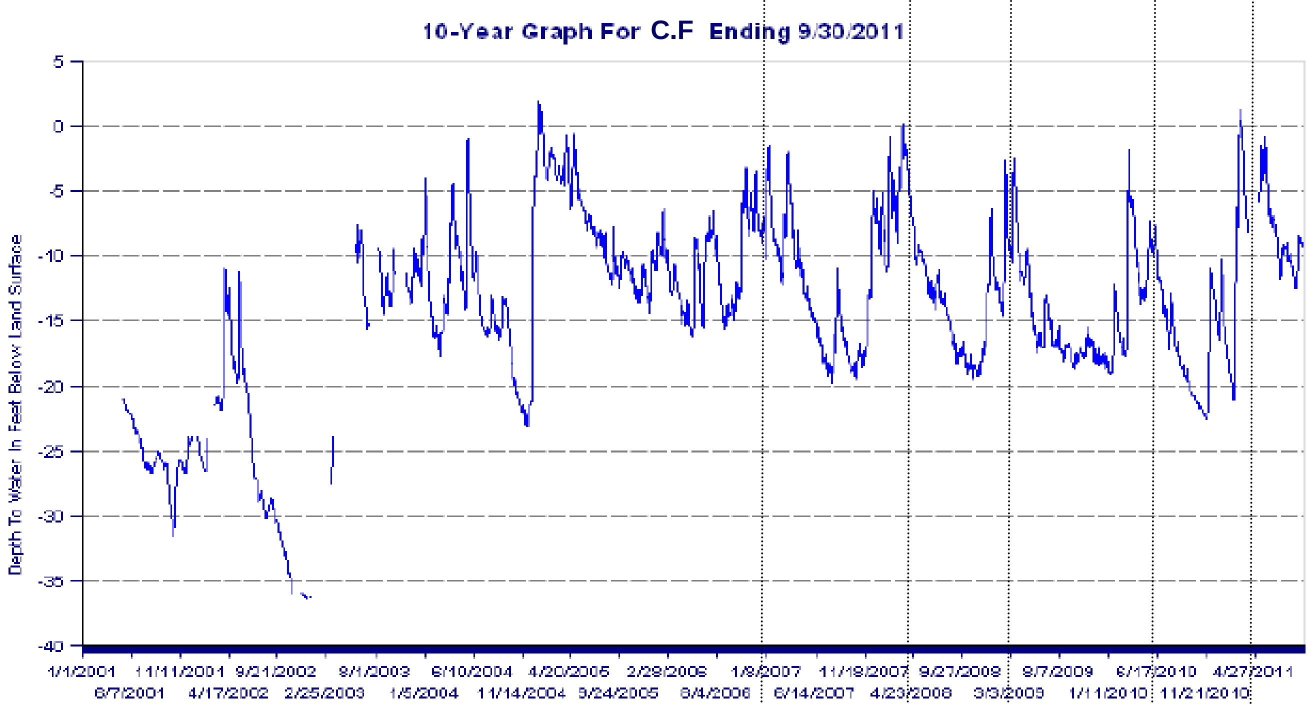


Figure 4a-19 Groundwater Flow

Review Draft 6/30/12





Quail Hollow State Park, Stark Co.

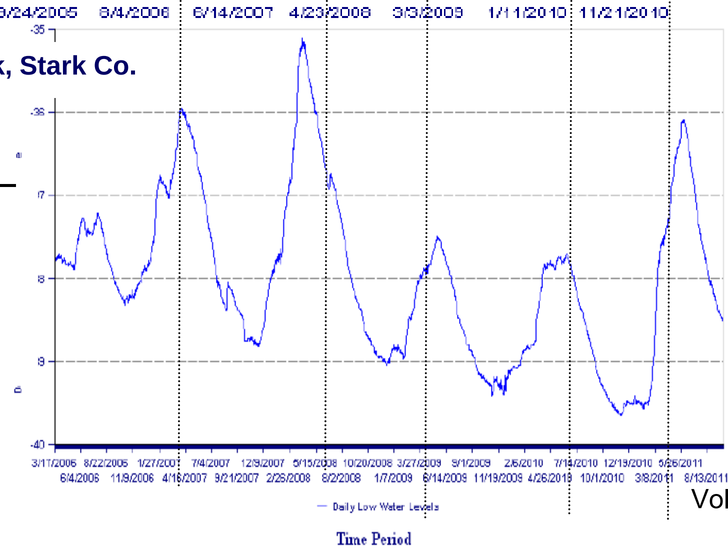


Figure 4a-20.1 Groundwater Flow Regime—Long-term Monitoring Well Hydrographs
Kent, Cuyahoga Falls, Quail Hollow State Pk

Source: Ohio Department of Natural Resources Ohio Monitoring Well Network. http://www.dnr.state.oh.us/water/waterobs/obs_well_map.asp, 2012.

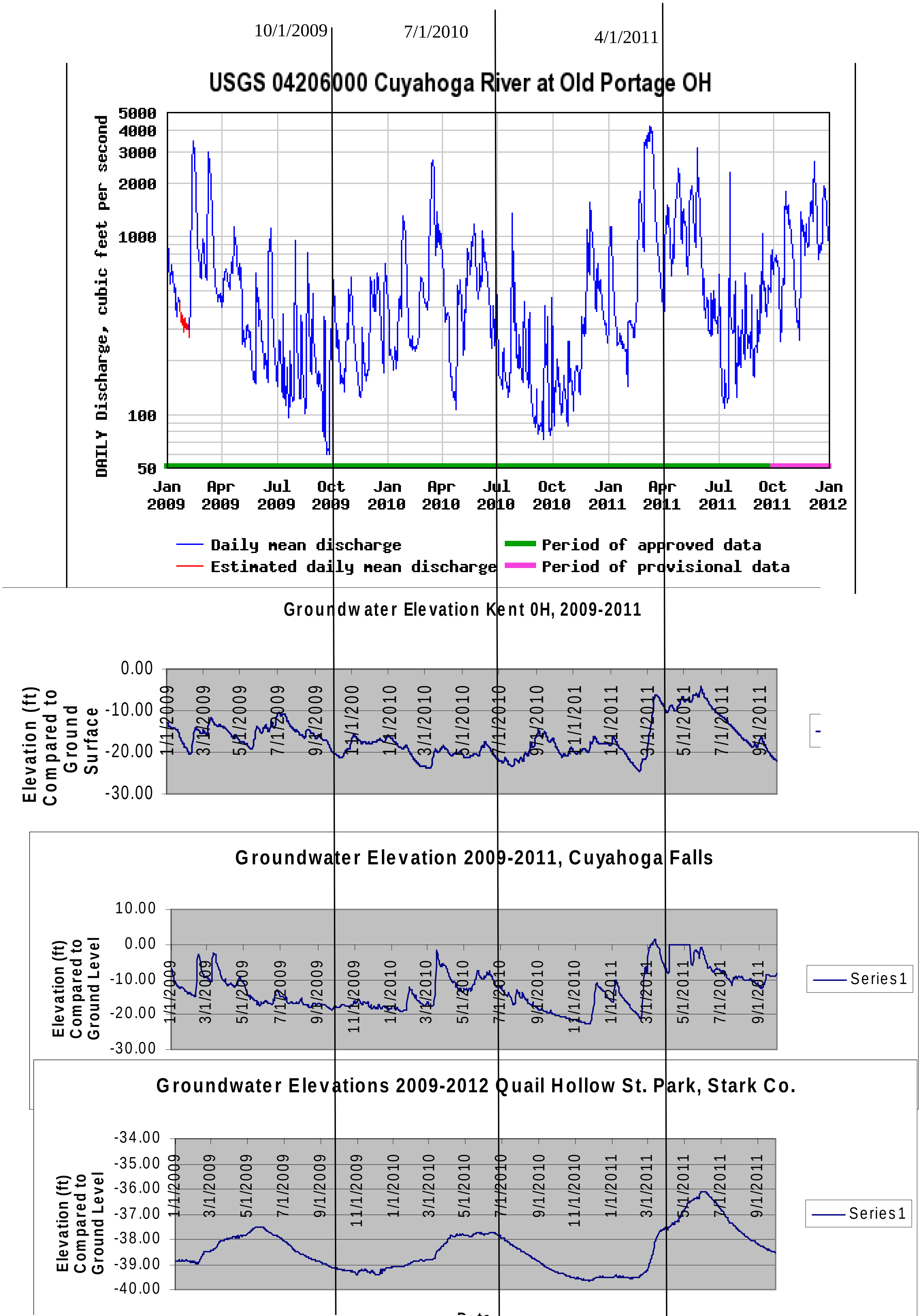


Figure 4a-20.2 Groundwater Elevations Compared to Cuyahoga River Flows

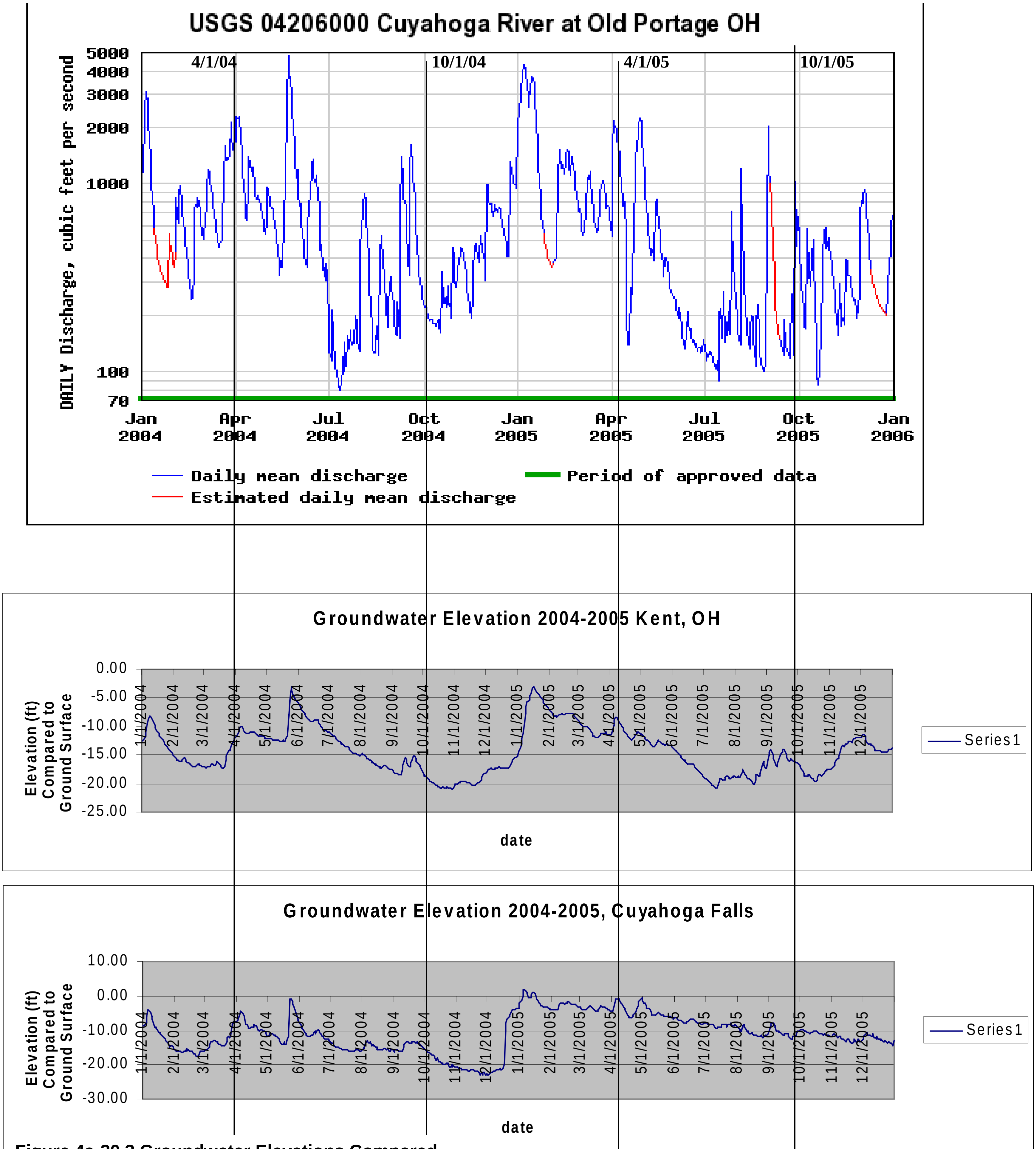


Figure 4a-20.3 Groundwater Elevations Compared to Cuyahoga River Flows, Wet period

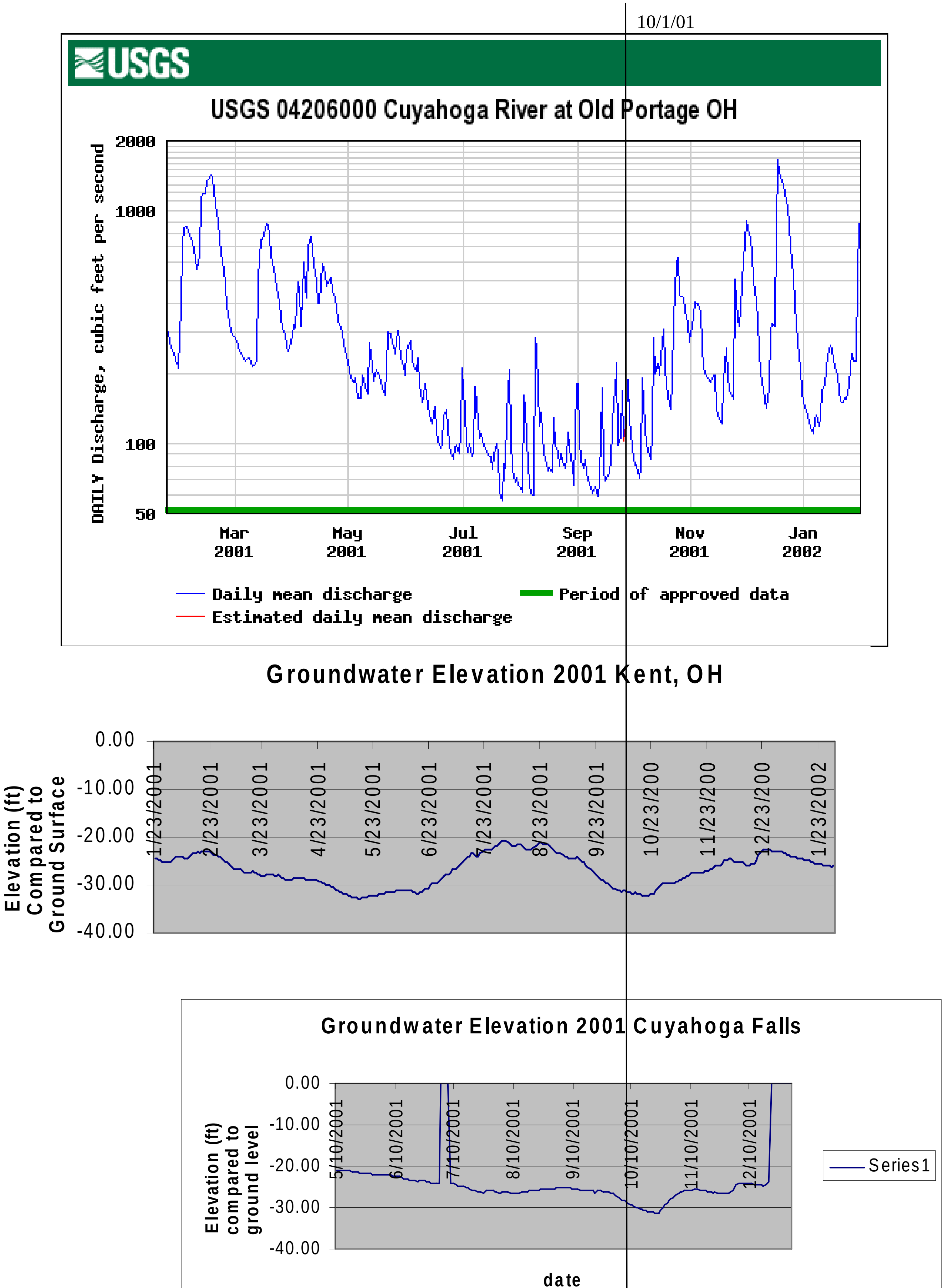


Figure 4a-20.4 Groundwater Elevations Compared to Cuyahoga River Flows, Dry period

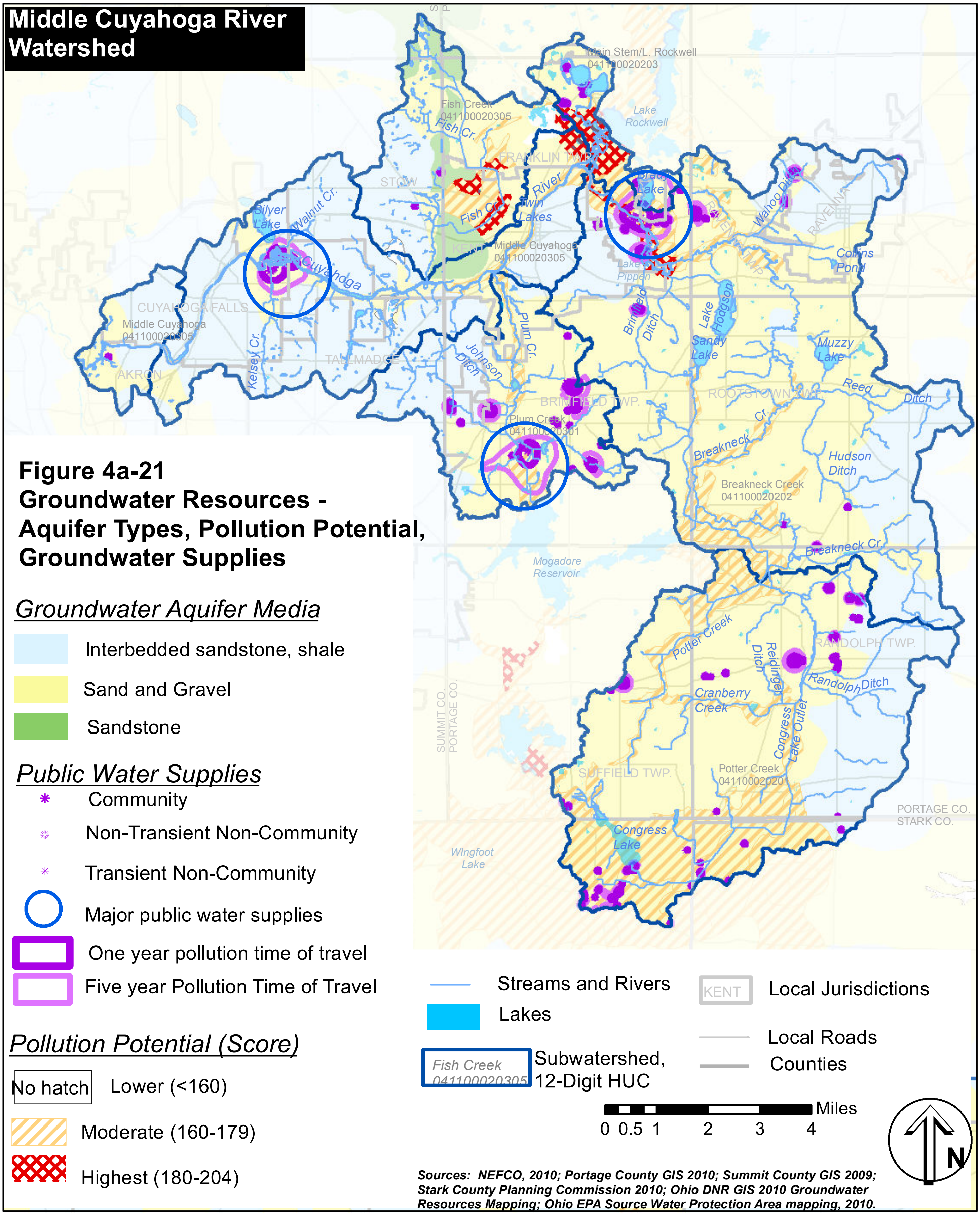


Figure 4a-21
Groundwater Resources - Aquifer Types, Pollution Potential, Groundwater Supplies

4a-3c Groundwater Resources (cont'd)
-i.2 Source Water Assessment Plans

The Ohio EPA has developed Source Water Assessments for all public water supplies, which describe the water supply characteristics, and identify susceptibility to contamination, zones likely to influence the water supply, potential sources of contamination within one- and five-year time of travel zones. Public water suppliers may develop Source Water Protection Plans, which list potential water quality threats, measures to minimize threats, alternate water supplies in case of emergency, and outreach goals.

Table 4a-15 presents the key findings for the three major groundwater public water supplies in the watershed, i.e., Cuyahoga Falls, City of Kent, and Portage County.

- The City of Kent and Portage County do not own (i.e., have control over) the 1- and 5-year time of travel zones associated with their groundwater supplies.

- Potential sources of contamination to the three water supplies include: Transportation; oil and gas wells; surface water contamination at Cuyahoga Falls and Kent; industrial/commercial/automobile-related facilities; agricultural uses (Ravenna); golf course (Portage County); and toxins from old landfills (Kent).

- Recommendations generally include: encouraging land uses that do not pose risks; acquisition of land near the water supply; outreach to educate landowners about risks of spills; notifying emergency services of potential for spills; spill containment; and in the case of Ravenna's water supply, agricultural best practices. With a golf course in Portage County's water supply protection area, it may be appropriate to provide specific outreach efforts to the golf course to encourage reduced use of chemicals and other best practices.

- The City of Kent's Source Water Protection Plan identified as potential concerns several uncapped or active landfills and emphasized the need for outreach and land use controls.

- The City of Cuyahoga Falls is in the process of finalizing their source water protection plan. Unlike Portage County and Kent, Cuyahoga Falls owns a substantial portion of their source water protection area, which is largely contained within Water Works Park.

- In addition to these major public water supplies, there are numerous smaller supplies providing water to individual developments. Reviews of the source water assessments indicate that in several cases, potential contamination sources have been identified, but not necessarily verified. The Ohio American Water Co., serving the Beechcrest allotment at Route 43 in Brimfield, produces approximately 108,000 gallons per day and has shown evidence of human impact, with toluene appearing in the samples.

Table 4a-15 Summary of Source Water Plans/Reports for Major Public Water Supplies (Surface and Groundwater)

Water Supply	Year of Assessment/ Plan	Type of water supply	Gallons/ people served	Soil	Potential contaminant sources	Groundwater Quality
Portage Co. Brimfield	2002	3 wells - 2 in buried valley sediment; - 1 in bedrock	632,000 510	Muck to silty loams, low permeability	Asphalt plants; above-ground storage tanks; natural gas lines; oil/gas wells; golf course; transportation;	No evidence of chemical contamination
Kent	1993	3 wells 1 (Breakneck Creek wellfield) recharged by Breakneck Creek and surface reservoir Buried valley sediment (Sand, gravel, till) flanked by sandstone	3.3-3.7 mgd		Oil & gas wells Underground storage tanks Commercial/industrial Automobile garage Breakneck Creek contamination, Ravenna WWTP Abandoned landfill ("Old Kent Dump" – on opposite side of groundwater divide), salvage yard Powder Mill site: landfill	The Kent Wellfield Susceptibility Assessment indicated no evidence in finished water of contamination.
Ravenna	2002	Surface water – kettle lake in buried valley complex	1.75 mgd 15,000	Poorly-drained Canfield to well-drained Chili	Oil and gas wells; Transportation Underground storage tanks Marina, no gas boats Gas station/automobile dealership Cemeteries; golf course Residential developments Agricultural uses; Randolph WWTP Randolph salt storage Note: Lake Hodgson rarely draws water from as far away as Congress Lake	No violations of finished water Some pesticides detected at low levels
Cuyahoga Falls	2002	Floodplain, sand/gravel	6-9.7 mgd 49,000	Silty loams	Underground storage tanks Injection well; transportation; pond Dumps/landfills; emergency response site; park (chemicals); sewer line, water treatment plant	No evidence of chemical contamination in finished water

4a-iv.1 - Land Cover, Urban Areas, and Impervious Surfaces

Land Cover: Background

Background

One of the most important elements of the watershed plan is balancing resource protection and management with the need of the residents, businesses, and communities in the watershed to use the land. Wetlands, woods, and other areas of native vegetation contribute to the health of water resources and watersheds. Development and agriculture are a necessary part of human settlement, but they alter hydrology and contribute non-point source pollution. Land cover information is used in:

- Assessing intactness of or impacts to stream channels, riparian areas (streamside habitats) and wetlands,
- Assessing impervious cover in a watershed (watersheds with greater than 10 percent impervious surface tend to show impacts, unless there are well-functioning riparian areas to mitigate impacts); and
- Modeling the amount and composition of runoff from disturbed land and impervious surfaces (surfaces such as pavement or roofs that do not allow rain water to be absorbed into the ground).

In identifying how land is being used, resource managers use land cover and land use mapping, alone or in combination. Each data set has advantages and disadvantages.

- Land cover mapping generally uses aerial photographs or satellite imagery to identify physical features on the landscape. Such mapping often cannot distinguish between uses that appear similar from the air or space. For instance, it can be difficult to distinguish between small commercial buildings or houses, offices or apartment buildings. In some cases, neighborhoods with mature trees may be mapped as woods, based on the visual characteristics of the tree cover. Land cover interpretation maps the physical footprint of structures, pavement, and types of vegetation on the ground.
- Land use mapping indicates how the land is being used. Uses that are grouped by function may have different land cover and effects on the watershed. For instance, with land use data, undeveloped land is often described as “vacant,” which does not allow distinctions to be made between wetlands, woods, or old fields. Land use mapping can represent the physical footprint, as viewed from aerial photographs or satellite imagery, or the parcel use designation.

Several sources of land cover or land use mapping are available, including Ohio EPA, National Oceanographic and Atmospheric Administration Coastal Change Analysis Program (CCAP), Akron Metropolitan Area Transportation Study (AMATS), and County parcel land use data, all from the period of 2005-2006. A review of the available mapping indicated that even with pixels of 30 m (approximately 100 feet) on each side, the CCAP satellite-based mapping provided a high degree of accuracy in mapping neighborhoods, useful analysis of impervious surfaces (the surfaces that prevent rainwater from filtering into the ground), and a wide enough variety of land cover types to allow further analyses.

The CCAP mapping identifies developed land in terms of percent imperviousness:

- High intensity is 80-100% impervious, corresponding to areas with large areas of parking lot or roof, e.g., densely developed urban centers, large commercial, industrial, multi-family, or institutional uses.

- Medium intensity is 50-80% impervious. This often corresponds to some larger roads, many smaller commercial uses, and many residential uses.

- Low intensity is 20-50% impervious, generally low-density residential uses, smaller roads

- Developed open space is 0-20 percent impervious, often large expanses of turf.

For ease of analysis, average values of impervious cover were applied to determine the percent of impervious cover in each subwatershed (i.e., high intensity – 90%, medium intensity – 65%, low intensity – 35%, and open space – 10%).

Findings:
Land Cover, Middle Cuyahoga River Watershed

Findings: Middle Cuyahoga River Watershed Land Cover Mapping

Figure 4a-22 and Table 4a-16 summarize the 2006 CCAP land cover mapping, allowing the following observations:

- Across the watershed, the most prevalent land cover types are low intensity developed areas, pasture/hay, and deciduous forest. Approximately one-third of the watershed is in developed uses. Most of the developed land occurring in the northern portion of the watershed. This area includes older neighborhoods and downtown areas in Cuyahoga Falls, Munroe Falls, Stow, Kent, and Ravenna. As noted previously, the Fish Creek and Plum Creek subwatersheds have undergone considerable development recently.

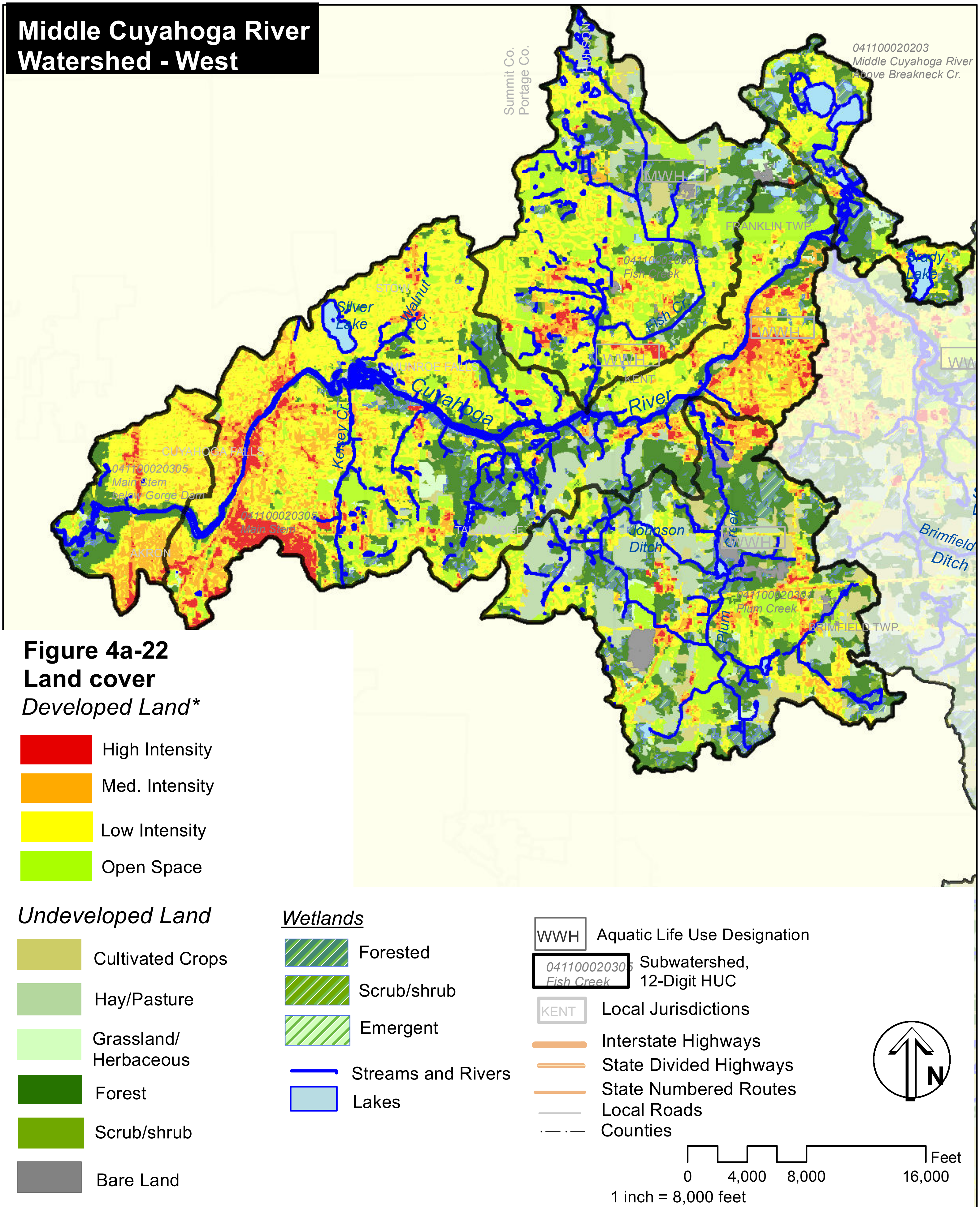
- The watershed as a whole is approximately 13 percent impervious. Imperviousness ranges from just under 3 percent in the rural, agricultural Potter Creek subwatershed to 25 percent in the developed subwatershed along the mainstem. The urbanized areas within the subwatersheds would have a much higher degree of imperviousness.

- The Main Stem and Fish Creek subwatersheds are predominantly low intensity developed uses with associated developed open space, and deciduous forest. These two subwatersheds have the highest percent imperviousness, 28 and 20 percent, respectively.

- Reflecting its developing nature, the Plum Creek subwatershed has a similar amounts of agricultural, low intensity, and developed open space uses, but considerably less woods.

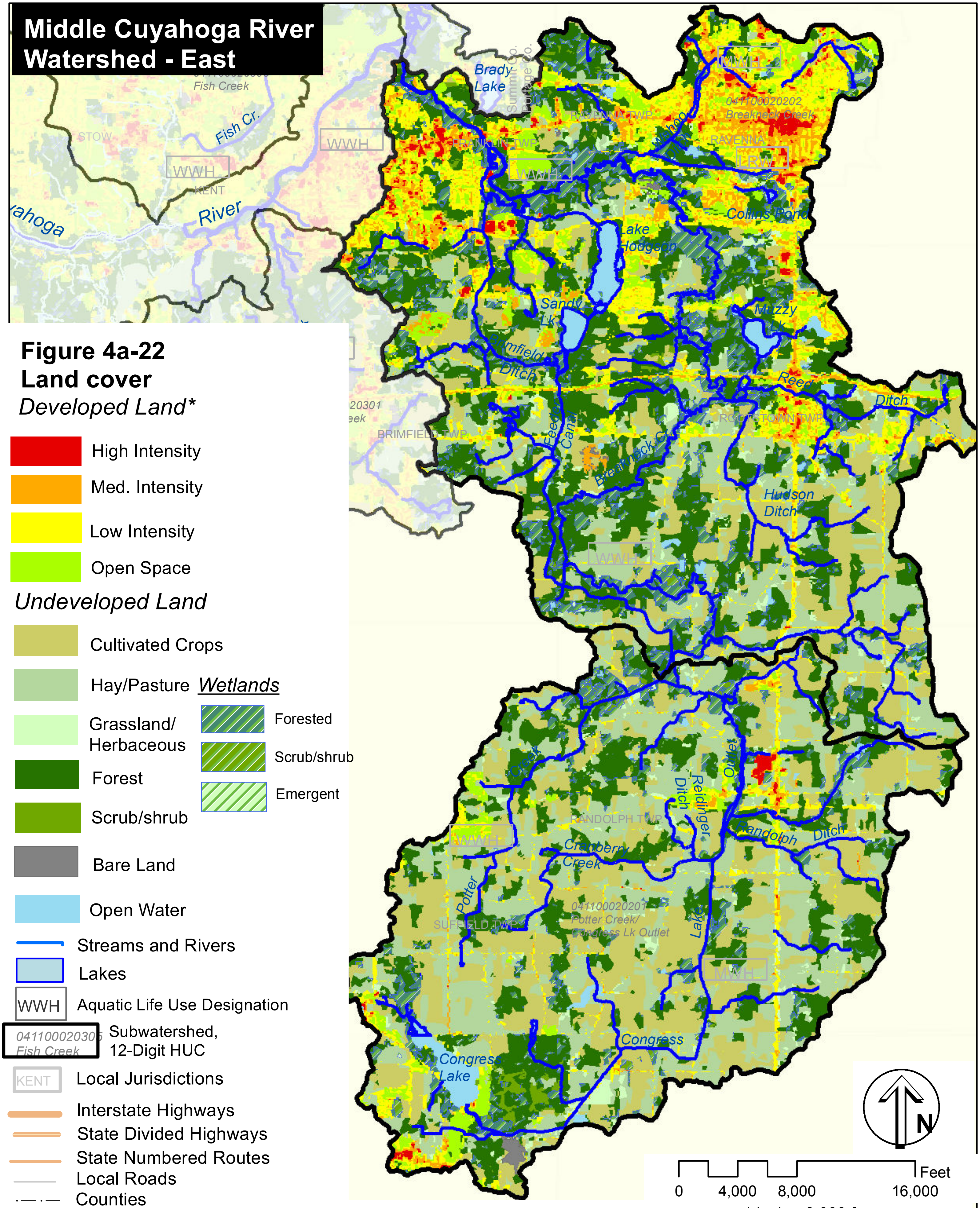
- Breakneck Creek is a mix of agricultural land and woods, with a smaller proportion of developed land. The watershed as a whole is approximately 10 percent impervious, but the northern portion in intensely urbanized, with much higher imperviousness, and the southern portion is much less developed.

- Potter Creek is primarily agricultural, with nearly 25 percent in woods or wetlands.



*Developed land intensity based on imperviousness (e.g. buildings, parking lots, roofs): High - 80-100% (e.g., commercial/industrial, large parking lots); Medium - 51-79% ; Low - 21-50% Open Space - <20% impervious.

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS mapping 2009-2010; NOAA Coastal Change Analysis Program Land Cover Mapping 2006.



*Developed land intensity based on imperviousness (e.g. buildings, parking lots, roofs): High - 80-100% (e.g., commercial/industrial, large parking lots); Medium - 51-79% ; Low - 21-50% Open Space - <20% impervious.

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS mapping 2009-2010; NOAA Coastal Change Analysis Program Land Cover Mapping 2006.

Table 4a-16

Land Cover and Imperviousness by Subwatershed

Land Cover	Main Stem Middle Cuyahoga		Fish Creek		Plum Creek		Breakneck Creek		Potter Creek		Total Watershed	
Developed by imperviousness	Acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
High intensity (90% impervious)	873	4.2%	113	1.2%	121	1.3%	406	1.3%	82	0.4%	1,595	1.9%
Medium intensity (65% imperv.)	2,396	12.0%	366	4.0%	479	5.4%	1,760	5.7%	204	0.9%	5,206	6.2%
Low intensity (35% impervious)	6,214	36.2%	1,987	42.1%	1,186	15.9%	4,042	13.5%	986	4.4%	14,415	17.2%
Open space (10% impervious)	2,571	14.1%	1,629	22.9%	1,098	11.6%	1,767	5.5%	538	2.4%	7,602	9.1%
Cultivated Land	82	0.6%	244	2.5%	533	6.3%	3,962	14.2%	6,710	30.3%	11,531	13.8%
Pasture/Hay	573	4.5%	480	5.0%	1,410	18.1%	4,354	18.0%	6,729	31.9%	13,546	16.2%
Grassland	216	1.1%	72	0.8%	153	1.7%	494	1.6%	394	1.7%	1,330	1.6%
Deciduous Forest	3,013	17.9%	1,246	13.9%	2,033	24.5%	7,490	25.6%	3,741	17.0%	17,524	21.0%
Evergreen Forest	37	0.2%	7	0.1%	29	0.3%	122	0.4%	235	1.0%	430	0.5%
Mixed Forest	15	0.1%	5	0.0%	3	0.0%	23	0.1%	24	0.1%	69	0.1%
Scrub/Shrub	154	0.8%	108	1.2%	177	1.8%	195	0.7%	169	0.7%	804	1.0%
Forested Wetland	1,016	5.1%	367	4.4%	777	8.6%	3,404	11.0%	1,543	7.0%	7,106	8.5%
Scrub/Shrub Wetland		0.0%		0.0%		0.0%	108	0.3%	109	0.5%	217	0.3%
Emergent Wetland	69	0.3%	16	0.2%		0.0%	36	0.1%	13	0.1%	135	0.2%
Bare Land	2	0.1%	64	0.7%	239	2.4%	31	0.1%	58	0.3%	394	0.5%
Water	581	2.8%	96	1.0%	54	0.6%	608	1.9%	322	1.4%	1,661	2.0%
total area (acres)	17,813		6,801		8,292		28,801		21,857		83,565	
Total area (sq. miles)	28		11		13		45		34		131	
Impervious	4,776	25.7%	1,198	20.7%	945	11.3%	3,101	10.1%	605	2.7%	10,625	12.7%

4a-iv.1 Land Use/Land Cover
-a Urban

The urban areas are apparent on Figure 4a-22 as the concentrations of high, medium, and low-density development. The northern one-third of the watershed is the most heavily developed. This portion of the watershed contains the more densely settled communities of eastern Cuyahoga Falls, Munroe Falls, Stow, portions of Tallmadge, Kent, and the city of Ravenna. Some of these, like Cuyahoga Falls, Munroe Falls, Kent, and Ravenna, are historic centers of development. Others, like portions of Tallmadge, Stow, and parts of Munroe Falls, developed primarily in the latter 1900s. Outside the heavily developed area in the north, Brimfield, Rootstown, Randolph, and Hartville have varying degrees of development at their centers. Whereas Stow experienced substantial development between 1990 and 2010, more intense development began in Brimfield since 2000.

4a-iv.1 Land Use/Land Cover
-a.i Impervious surfaces

In four of the five subwatersheds, imperviousness ranges from 10 to 26 percent for the subwatersheds, with urban areas at much higher levels. Increased imperviousness generates additional runoff and loading to the stream channels, raising the risk of vertical instability, stream degradation, unstable banks, increased flooding problems, and degradation of habitat and water quality. The increased imperviousness also generates additional contaminants that enter the water courses as non-point source pollution in runoff. When watersheds reach an imperviousness level of 10 percent, degradation can be observed in stream systems. When the level of imperviousness reaches 20 percent, degradation is likely, although intact buffer systems can help reduce the impacts.

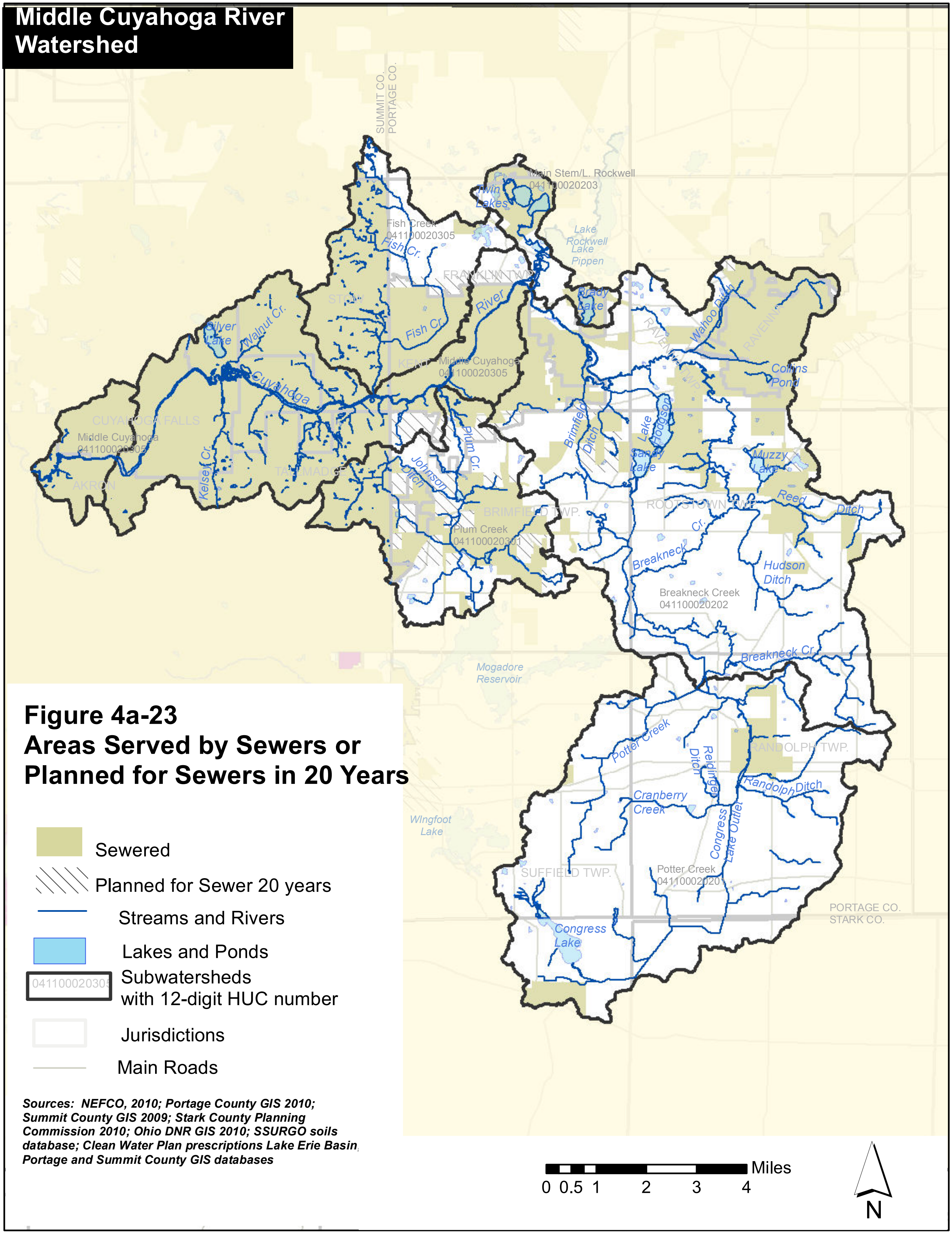
4a-iv.1 Land Use
- a.ii Home Sewage Treatment Systems (HSTS)

The presence of sewer service is of interest in watershed management because

1) Failing, inadequately designed, or discharging home sewage treatment systems are a source of nutrients and pathogens to surface and groundwater; and

2) The availability of sewer service, especially in areas with soil limitations for home sewage treatment systems, tends to attract and focus development.

Figure 4a-23 shows the areas in the watershed that are served by sewers. Most of the Summit County portion of the watershed has sewer service. In Portage County, Kent, Ravenna, Brimfield, and a portion of Randolph Township have or are anticipated to get sewer service. Even though townships do not often provide sewer service, Brimfield has access to systems from adjoining communities through Joint Economic Development Districts. Not all properties within the sewered areas are connected to the sewer system. However, it is expected that over time, as home sewage treatment systems fail, more properties will be connected to sewer service where it is available.



Middle Cuyahoga River Watershed
SUMMIT CO.
PORTAGE CO.
Main Stem/L. Rockwell 041100020203
Twin Lakes
Lake Rockwell
Lake Pippen
Fish Creek 041100020305
Fish Cr.
FRANKLIN TWP.
Brady Lake
STOW
Silver Lake
Walnut Cr.
River
Middle Cuyahoga 041100020305
Cuyahoga
KENT
RAVENNA TWP.
RAVENNA
Wahoo Ditch
Collins Pond
CUYAHOGA FALLS
Middle Cuyahoga 041100020305
AKRON
TALLMADGE
Kelsey Cr.
Plum Cr.
Johnson Ditch
Brimfield Ditch
Lake Hodgson
Sandy Lake
Muzzy Lake
Reed Ditch
BRIMFIELD TWP.
ROOTSTOWN TWP.
Plum Creek 041100020301
Breakneck Cr.
Hudson Ditch
Breakneck Creek 041100020202
Breakneck Cr.
Mogadore Reservoir
Potter Creek
Reidinger Ditch
RANDOLPH TWP.
Randolph Ditch
Cranberry Creek
Wingfoot Lake
Congress Lake Outlet
SUFFIELD TWP.
Potter Creek 041100020201
PORTAGE CO.
STARK CO.
Congress Lake
Figure 4a-23
Areas Served by Sewers or Planned for Sewers in 20 Years
Sewered
Planned for Sewer 20 years
Streams and Rivers
Lakes and Ponds
041100020305
Subwatersheds with 12-digit HUC number
Jurisdictions
Main Roads
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; SSURGO soils database; Clean Water Plan prescriptions Lake Erie Basin, Portage and Summit County GIS databases
Miles
0 0.5 1 2 3 4
N

As shown in Figure 4a-23, the availability of sewer service versus HSTS is as follows in the watershed.

- The main stem subwatershed is largely served by sewer systems.
- About three-fourths of the Fish Creek and Plum Creek subwatersheds is or is anticipated to be served by sewers.
- Sewer service in the Breakneck Creek subwatershed is available near Kent, in Brimfield, in the vicinity of Ravenna, and near Lake Hodgson and Muzzy Lake.
- In the Potter Creek subwatershed, sewer service is provided only at Hartville and the center of Randolph, where failing septic systems necessitated installation of a small wastewater treatment plant.

4a-iv 1 Land Use/Land Cover
-b Forest

As shown in Table 4a-16, forest or forested wetland ranges from 17 percent to 37 percent. Surprisingly, the smallest percentage of forest is not the urbanized Main Stem subwatershed, but the Fish Creek subwatershed. Portions of the Main Stem subwatershed in Summit County remain undeveloped, and MetroParks, Serving Summit County holds a large parcels of wooded land in the Munroe Falls, Gorge, and Cascade Valley MetroParks.

Portage County developed a watershed study for the county in 2004, which included mapping of forested land and wetlands, and analysis of relative importance of protecting various resources. The Portage County Watershed Study identified the wooded wetlands along Breakneck Creek as high importance for watershed functions.

4a-iv Land Use
-1c Agricultural Uses

Agricultural uses and practices greatly influence the water quality of the streams and lakes in the watershed. Agricultural fields are often sources of nutrients and sediment in runoff, and the amount of each that enters streams depends on factors such as the crops grown, tillage practices, cover used, buffers, and whether livestock have direct access to streams.

NRCS staff in Portage County, where most of the watershed agricultural land is, noted that they did not have an inventory of all practices conducted by farmers but were able to provide the following comments and estimates based on observations:

- The primary crop types are a corn-bean-wheat rotation, and use as hayland in rotation with corn. Tillage practices used are approximately 10 percent conventional, 50 percent conservation, and 40 percent no-till. (Conventional tillage involves breaking up and inverting soil prior to planting. Conservation tillage practices leave crop residue on the ground. No-till practices are a form of conservation tillage, planting directly into the residue.)
- Most farm fields in the watershed are 10-25 acres.

- Chemical application includes spring herbicides, fertilization at planting. Some producers apply herbicides in the summer and some side dress with nitrogen for corn.

- Producers in Portage County are not using irrigation practices.

- Farmers are using best management practices, such as grassed buffer strips, to varying degrees.

- Most (90 percent) farmers with livestock allow unrestricted access to streams. Livestock operations are found in all subwatersheds to varying degrees. Even the more urbanized subwatersheds have one or two farms with livestock.

The use of drainage tiles has also been observed in some of the fields.

A comparison of watershed agricultural data with Agricultural Census Data for 2007, (Table 4a-17) indicates that Portage and Stark Counties had larger average/median farm sizes than Summit County, with average sizes of approximately 100 acres and median farm sizes of approximately 35 acres. In all three counties, over half of the farms were under 50 acres. (Note: according to Portage Soil and Water Conservation District staff, it is difficult to assess how many acres are included in farms at any time, because lease arrangements change, and fields may be taken out crops for a period of time.) Stark County is much more heavily agricultural than Portage and Summit. Because the Potter Creek subwatershed includes only a small portion of Stark County, inventoried animals from Stark County were not included in estimates.

One farm in Summit County has been noted while photographing streams. The portion of Stark County in the watershed is dominated by Congress Lake and its associated development, the Quail Hollow State Park, and muck farms being used to grow tomatoes.

4a-iv.2 Protected Lands - Parks, Large Parcels

Protected Lands: Background

<u>Background</u>

Lands that are protected from development can help protect resources by providing a vegetated buffer and intact habitat. Corridors of protected lands (e.g., along streams) are especially valuable, as they provide space for migration along natural wildlife corridors. Corridors can also be used for hike-bike trails.

It should be noted that simply because a parcel is preserved as a park does not necessarily mean that the stream is protected, as the landscape within parks can be (and often is) altered dramatically for ease of maintenance, recreational uses, and to provide the unobstructed views to which park visitors are often accustomed.

However, even where riparian landscapes have been altered, streams in public parks or other conservation lands present very good opportunities for demonstration projects or improvement. They often have substantial visibility, and they allow restoration of large areas, which will not be used for private development. Even large privately owned parcels, or those held by homeowners' associations, may provide good opportunities for restoration or preservation, if the

Table 4a-17 Agriculture in Subwatersheds Compared with Census of Agriculture by County

	Portage County	Summit County	Stark County	Main Stem ag (percent of Summit+ Portage Counties)	Fish Creek ag (percent of Portage + Summit)	Plum Creek ag (Percent of Portage + Summit)	Breakneck Cr. ag (Percent of Portage Co.)	Potter Cr. ag (Percent of Portage Co.)
Acres in farms/ agricultural uses	82,759	15,166	138,061	0.7%	0.7%	2.0%	10.0%	16.2%
Average size farm (ac)	96	45	106					
Median size farm (ac)	38	15	35					
				Estimated Livestock/Poultry based on % of County Ag. Land in Subwatershed				
Cattle and calves	7,971	1,199	26,824	61	68	182	801	1294
Beef	2,215	*	3,707				223	360
Dairy	1,834	*	9,732				184	298
Hogs and Pigs	524	*	5,871	4	4	10	53	85
Sheep and lambs	643	98	1,582	5	5	15	65	104
Chickens								
Layers	2,189	3,262	4,081	36	40	108	220	355
Broilers sold	360	421	22,089,471	5	6	15	36	58

*Inventory not reported due to small number of farms in county and confidentiality requirements.

landowner is willing. Easements held by a third party can help ensure that the restored or protected areas remain undisturbed. Developing and implementing long-term management practices for large parcels in single ownership is easier and probably more effective that many small parcels, as management measures or easements can be consistently developed and applied. Existing parks and conservation lands can serve as the nuclei of larger, connected habitat areas or corridors.

A number of sources were consulted to map parks and large parcels:

- AMATS land use data
- County planning/GIS Departments
- Ohio DNR GIS database
- Land use mapping was queried for public, institutional, and recreation/conservation lands

In addition, some of the watershed communities have instituted riparian setbacks in their development codes, requiring that development or disturbance be set back from streams, wetlands, or floodplains. Setbacks can be an effective tool to protect long stretches of streambank from encroachment.

Findings:
Parks and Conservation

Findings: Middle Cuyahoga River Parks, Conservation, and Large Parcels

As shown on Figure 4a-24, substantial amounts of land along streams are held as parks, conservation lands, or belong to owners of large parcels. These provide:

- A good start to protecting significant stream corridors and providing passive recreational opportunities along streams and rivers through establishment of connected greenways;
- Opportunities to restore portions of stream bank that have been altered;
- Recreational, aesthetic, and transportation (e.g., bike-hike trails) resources for local communities and counties.

Large portions of the margin of the river are protected as parks and bike-hike trails.

- Conservation lands in the watershed include Triangle Bog and Kent Bog nature preserves and the Jesse Smith conservation land in Kent.

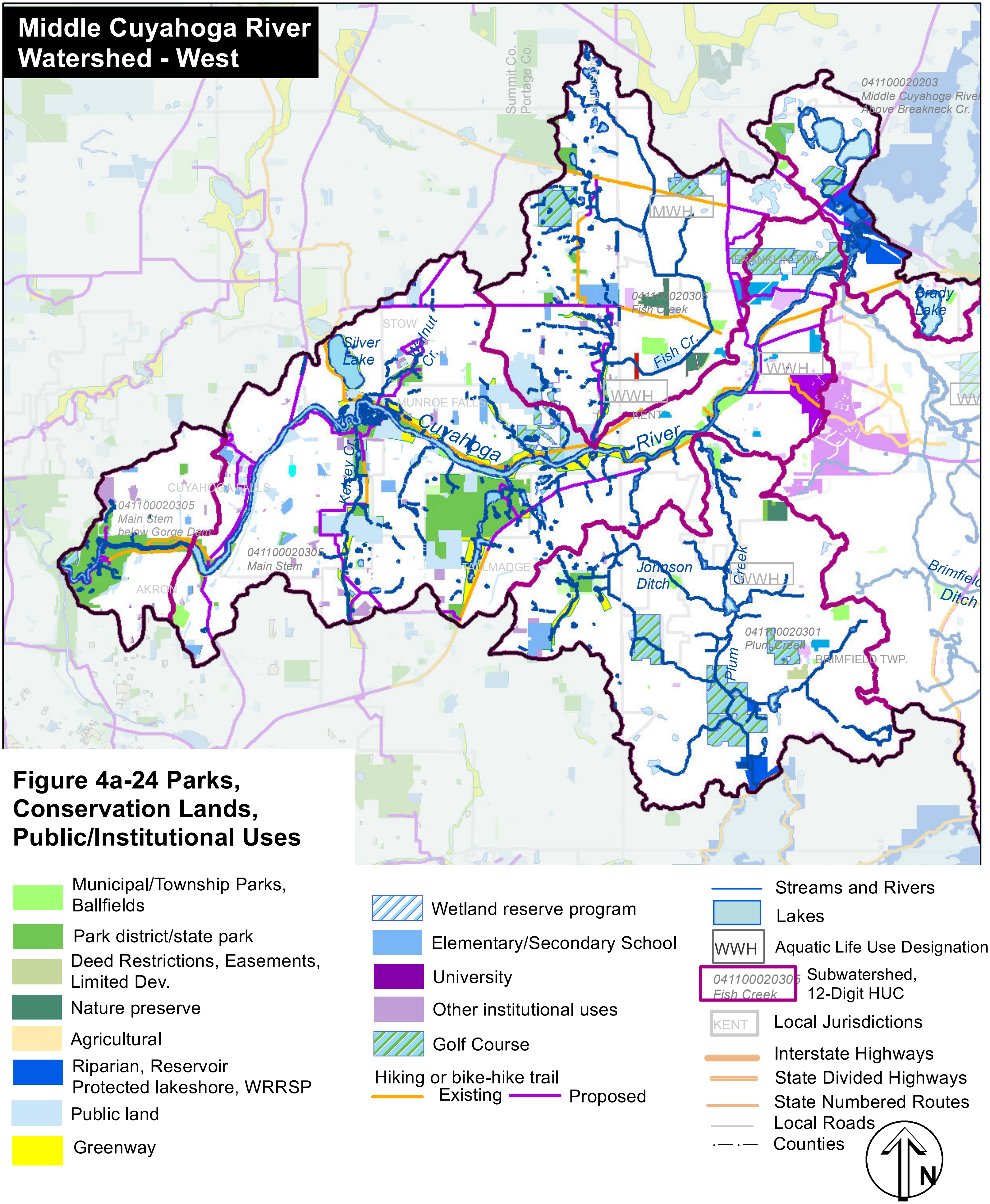


Figure 4a-24 Parks, Conservation Lands, Public/Institutional Uses

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map; 2011.

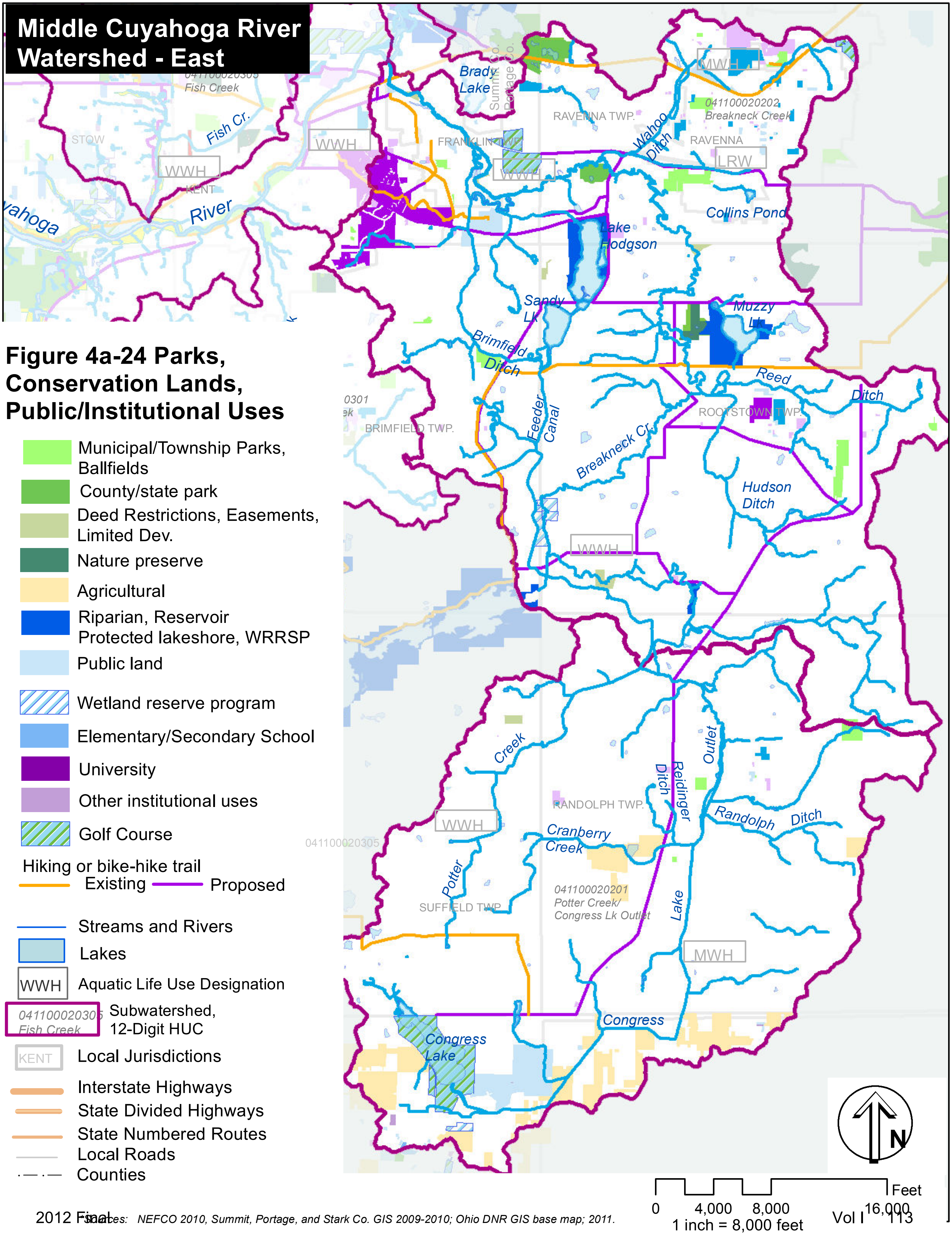


Figure 4a-24 Parks, Conservation Lands, Public/Institutional Uses

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map; 2011.

- MetroParks, Serving Summit County has three parks in the watershed, Munroe Falls Park, Cascade Valley (at the confluence with the Little Cuyahoga River), and the Gorge MetroPark. Quail Hollow State Park protects wetlands in Stark County. Substantial areas of all these parks are left undisturbed.

- Portage Park District owns parcels at Towners Woods and Breakneck Creek Preserve and anticipates encouraging passive recreation only.

- The City of Kent maintains a string of City parks and a lengthy hiking (or bike-hike) trail along the river.

- In Munroe Falls, the immediate vicinity of the river on the north side is unlikely to be developed due to steep slopes, the lack of infrastructure, riparian setbacks, and ownership by Ohio Edison and CSX railroad.

- The City of Cuyahoga Falls has several parks, including Water Works Park, along the river.

- All the major tributaries have at least one park along them and often have more than one.

- In addition, there are numerous parcels owned by homeowners' associations, institutions, and public owners. Many of these have been altered but present opportunities for restoration, enhancement, preservation, and stewardship.

Communities with riparian setbacks include Tallmadge, Munroe Falls, Kent, Ravenna, and Brimfield.

Table 4a-18 summarizes parks and conservation land held in total or as easements. These amounts are approximate and represent data sources from several years. They do not necessarily include publicly owned land that can also be used for conservation. County park districts, conservancies, and several communities are actively acquiring land for conservation.

County and state parks represent large holdings in the three counties, but as noted above, local communities hold a considerable amount of land in parks and conservation/recreation areas. Conservancies like The Nature Conservancy and Western Reserve Land Conservancy have not been as active in this portion of northeast Ohio as some other areas, but they still have several holdings as easements or purchases. Some of the unique habitat areas may be good opportunities for land conservancy involvement in the future.

Table 4a-18
Parks and Conservation Land

	Acres				
Subwatershed	**Local Park**	**County/ State Park**	**Riparian/Wildlife/ Natural Area/ Reservoir**	**Easement**	**Comments**
Main Stem	411	1202	820		Local includes several city-owned parks along Cuyahoga River. County parks include Portage County Camp Spelman, which is partially in the Fish Creek subwatershed, and the MetroParks, Serving Summit County Cascade, Gorge, and Munroe Falls MetroParks metroparks The latter was recently expanded. Conservation includes City of Akron public water supply holdings. Conservancy holdings: TNC 33 acres Crystal Lake nature preserve; Western Reserve Land Conservancy 9 ac. easement, 44 acres north of Kent.
Fish Creek	412	61	99		Camp Spelman and Silver Creek Park (Stow) are partially in the watershed. Kent is acquiring a conservation loop around a portion of Fish Creek.
Plum Creek	195	22	231	24	Includes Cooperrider bog, Plum Creek Park (site of recent stream restoration), Tallmadge Jaycee park/wetland area, and Portage County wellfields
Breakneck Cr	295	350	671	185	Local includes Lake Hodgson access. Conservation includes Kent wellfields, Lake Hodgson, Muzzy Lake, Triangle Bog
Potter Cr.	49	703	267 farm conserv.	38	Quail Hollow State Park. Conservancy holdings 16 ac. Easement.

Sources: 2008 Parks Database, Portage County; 2010 and 2012 Summit, Stark, and Portage County tax databases;
Summit County Parks database

4a-iv.3 Land Use, Status and Trends

Factors controlling the density of future development include zoning, degree of development within communities, access to the highway system, conservation lands, and access to sewer systems. Park and conservation lands have been discussed in Section iva-iv.2.

From 2000-2007, development in the watershed was occurring rapidly near the already developed centers of Stow, Tallmadge, Munroe Falls, and Kent. The areas in the immediate vicinity of these cities are approaching build-out, with limited large parcels available in the cities for new development. Newly developing areas focused near I-76, primarily in Brimfield, especially after establishing a Joint Economic Development District with Tallmadge for utilities, and also in Rootstown. These areas were growing rapidly due in part to accessibility of the interstate highway and sewer service. Figure 4a-25 shows numerous developments in progress in the Plum and Breakneck Creek subwatersheds when the photograph was taken in 2006.

Beginning in 2007-2008, a major economic downturn occurred, that was initially characterized by a slump in the housing market. At the time, many housing developments had received approvals but had not been fully constructed. As of summer, 2011, the housing market has not yet rebounded. There is a substantial backlog of foreclosed properties, as well, suggesting that the housing market may still not recover for some time to come.

However, assuming the housing market eventually recovers, the areas where development was occurring rapidly during the growth period are likely to see development pressures once again. Some of the approved subdivisions may be able to proceed, and the factors that made this area popular for development will remain in place– accessibility of sewer service, interstate highways, and employment centers.

Figure 4a-23, which shows areas served by sewer, helps to indicate the areas that are likely to experience development once development begins again in earnest.

- The Plum Creek watershed and portions of the Breakneck Creek watershed are likely to experience development pressure, because of ready access to sewers and highways.

- The sewers south of Kent and Ravenna go along the state numbered highways, Routes 43 and 44, which are already centers of development and are likely to continue as such.

The zoning tends to support continuation of current land use patterns.

- In Brimfield and Tallmadge, the area around Mogadore Road and Howe Ave. have been developing as industrial uses, and the area is zoned for continued industrial development.

- Portage and Stark county townships are largely zoned for low density residential use.

- Brimfield's comprehensive plan calls for the most intensive development in the vicinity of I-76 and north, which will continue to affect Plum Creek and Breakneck Creek subwatersheds. Likewise, Rootstown's zoning calls for development near Route 44 and I-76, continuing the current land use patterns.

Since large portions of the Plum Creek and Breakneck Creek subwatersheds in the growing areas are undeveloped, there is potential for substantial impacts from development and also the ability to manage the as-yet unrealized growth.

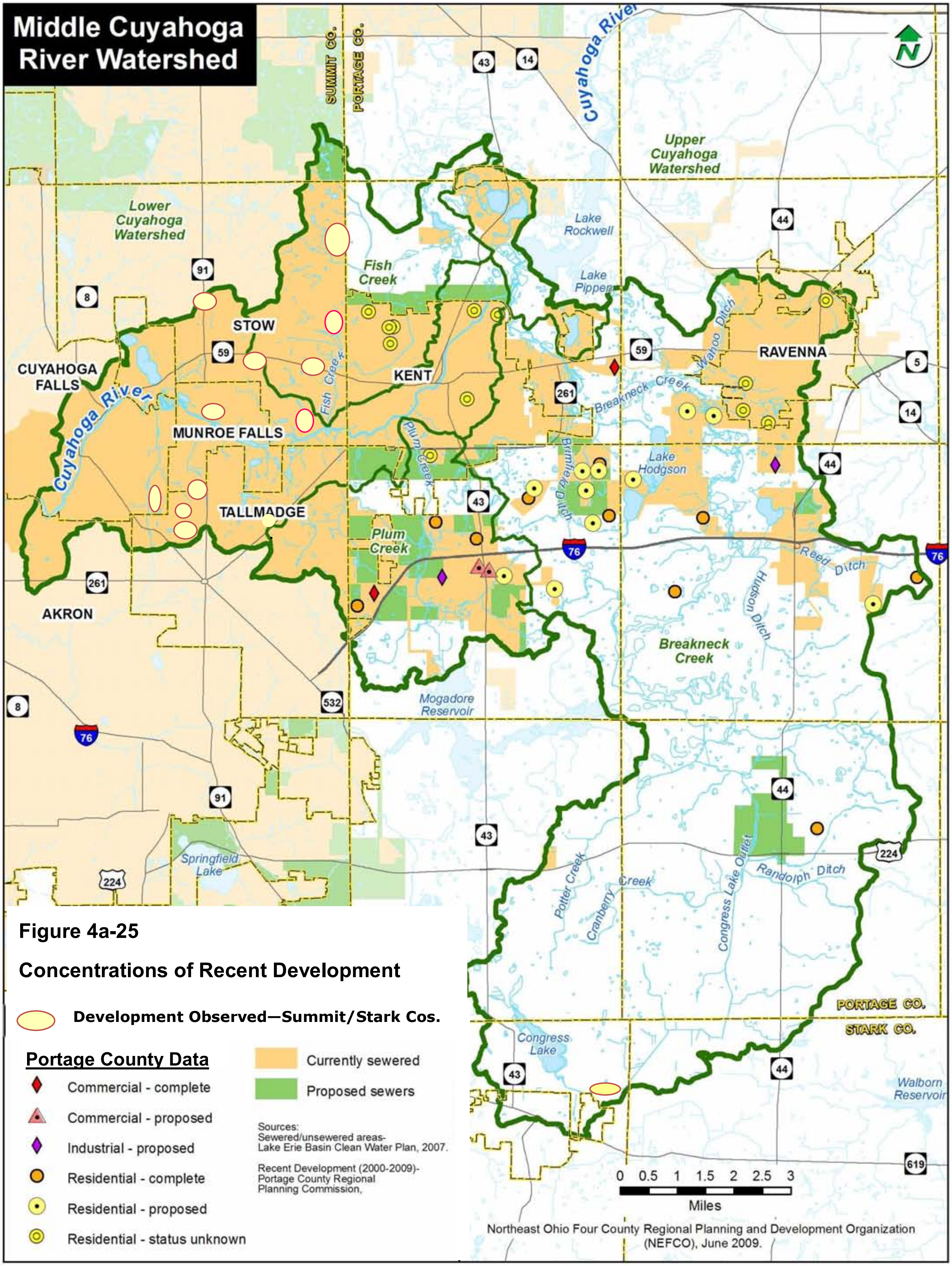


Figure 4a-25

Concentrations of Recent Development

4b. Cultural Resources

The Cuyahoga River and its surrounding landscape played a major role in the development of the region. The general layout of many communities in the region resulted from the benefits provided by the river, and many of these communities have historic centers. Because of the intensive use of the river and its tributaries, the historical uses were also very important in the alteration of the river and stream network. Finally, the location of historic and prehistoric resources is important in considering restoration and preservation opportunities and regional attractions. Riverside parks and hiking corridors can serve multiple purposes – linear transportation (bicycle/hiking) routes; recreation; conservation of important riparian vegetation; and providing access to and opportunities to appreciate the region's history and cultural resources. Historic riverfront cities offer the combined attractions of historic buildings and streetscapes and river access. These often present ideal locations for parks and festival locations, and provide economic opportunities.

This is not intended to be a complete inventory of all known historic and prehistoric sites. The intent of this section is to provide a historical context and highlight certain locally and regionally important features.

Many of the major roads in the watershed have been around for nearly 200 years, and isolated historic structures are still found along them. Many of the cities and villages also began over 150 years ago, and the centers of these communities often contain well-preserved historic buildings of various eras and styles, contributing to a sense of aesthetics and place.

The sandstone ledges over which the river flows created falls that became ideal sites for water-powered mills. These became centers of industrial development in the current cities of Kent, Munroe Falls, Cuyahoga Falls, and Akron. The dam in Kent is one of the remaining arch-weir dams from the early 1800s and was preserved during the restoration of the Cuyahoga River flow in Kent. Several historical mills still standing in Kent and visible from the river were developed because of the water-power available. The remaining dams in Cuyahoga Falls also reflect this history.

The Cuyahoga River was an important transportation route because of its location near the continental divide between the Lake Erie and Ohio River basins. Cleveland and Akron developed at the mouth of the river at Lake Erie, and Akron at the summit of the drainage divide, respectively. Portage and Summit Counties were both named for their locations on the watershed divide. Because the Cuyahoga River passes within 3 miles of the Tuscarawas River watershed, the Native Americans who were in the region before settlement developed a path to portage between the two basins, downstream of the confluence with the Little Cuyahoga River. The Portage is noted in various markers, statues, and road names a short distance downstream of the confluence with the Little Cuyahoga River.

During the 1820s, canals were dug connecting Lake Erie to the Ohio River, with the first segment being Akron to Cleveland. Subsequently, the Pennsylvania and Ohio canal was dug between the Cuyahoga River at Cascade Locks and the Beaver River in Pennsylvania, and the Feeder Canal was dug to provide water from Congress Lake, Sandy Lake, and Lake Hodgson (then Muddy Lake) to the P&O Canal. See Figure 4b-1. Throughout the region, the presence of the reliable, relatively fast transportation routes of the canals connected Ohio to other regions in the country and created a booming economy. Towns often developed at the locks. The developing rail system began out-competing the canals by the 1850s. By 1868, the P&O Canal

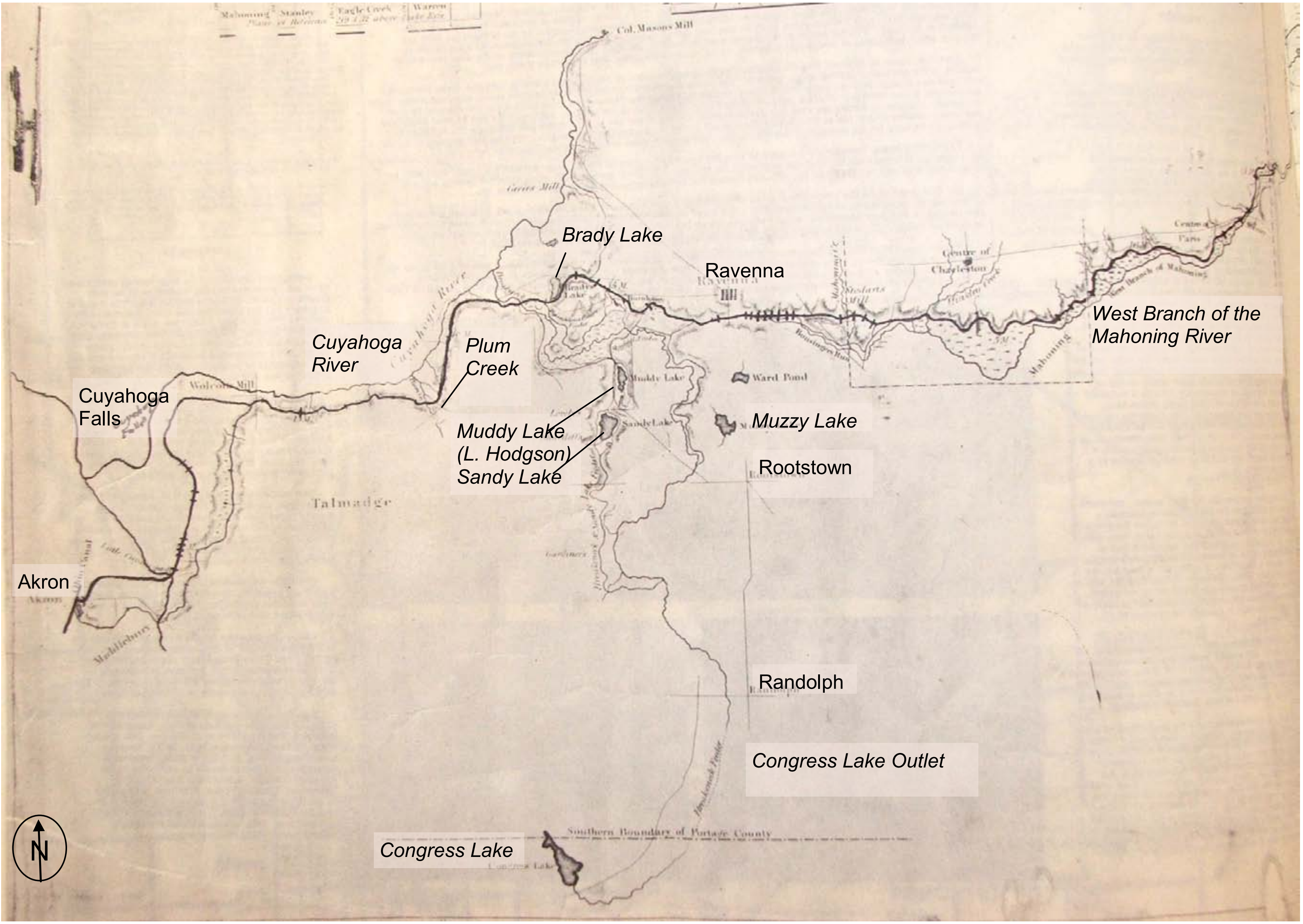


Figure 4b-1 1840s Map of the Pennsylvania and Ohio Canal—Pennsylvania border to Akron

Source: Map and Profiles of the Pennsylvania and Ohio Canal, 1840s (from Portage County Centennial map collection) was no longer in use for freight, but mill owners downstream retained water rights for their mills by taking one round trip up the canals per year. In the 1870s, local residents, tired of the stagnant water along the P&O Canal, breached the canal walls in several locations.

Over the years, additional canals were sold, dynamited after the 1913 flood, or otherwise destroyed. However, remnants of canal channels ("prisms") and locks may be found along the route of the former canals, including:

- Kent - canal remnants are found at the historic dam, upstream at "Brady's Leap," and at the site of an aqueduct over Plum Creek;

- Munroe Falls – canal prism is visible south of the river near Route 91. Brust Park has a historical marker.

- Cuyahoga Falls – even though there is no marker, the canal prism remains at the railroad crossing at Water Works Park. The "Chuckery Race" stone walls, an attempt to bring canal water down the Cuyahoga River Gorge, are still evident in Gorge in Cuyahoga Falls.

- Outside this watershed, portions of the canal, individual locks, and canalside buildings are still intact in Trumbull County, Stark County, Akron and the Cuyahoga Valley National Park.

- Throughout the watershed and beyond it, former canal towpaths are being used for an extensive network of extremely popular bike-hike trails. The Cuyahoga Valley National Park and the Ohio-Erie Canalway are two major efforts in the vicinity of the Middle Cuyahoga River watershed to join recreational opportunities, economic development (tourism), and the canal histories.

The P&O Canal resulted in some important alterations to the hydrology of the subwatershed, some of which still remain.

- The Congress Lake Outlet and Feeder Canal were dug to provide water for the P&O Canal. After the demise of the canals, these were used to supply water to a worsted wool mill in Ravenna, and are currently used to provide an additional source of water to the Lake Hodgson, the City of Ravenna water supply.

- The Feeder Canal entered Breakneck Creek at a slackwater (dam pool) and then re-entered the creek near Hommon Rd., which is currently the ditch providing drainage for the Ravenna Waste Water Treatment Plant.

- Sandy Lake, Lake Hodgson, Muzzy Lake, Brady Lake, and the Twin Lakes were all originally kettle lakes, but dams were added to help provide water for the feeder canal, and these became "surge" sources. These would collect water during spring snow melt and storms, and the water would later be fed into the canals. Many of these lakes still have dams.

Prehistoric Settlements and Artifacts

Prior to the settlers' arrival, various prehistoric peoples inhabited the region, often living along the rivers. By about 2,000 years ago, middle Woodland period peoples began constructing villages and enclosures along high bluffs overlooking the rivers. During about 1000 to 800 years ago, the populations increased, and permanent villages were established on hilltops and bluffs overlooking the major river valleys. These villages, apparently built for defense, housed dozens of families from late spring to early fall, sometimes year-round. The group disappeared from northeast Ohio about 350 years ago, so The abundant and distinctive remains of this latest prehistoric society are known as Whittlesey cultural tradition, named after the archaeologist who identified the culture from artifacts. During the 1700s, refugee tribes located in Ohio, but they were subsequently displaced by policies favoring settlers and relocating native peoples. Prehistoric mounds have been found in the region. One is preserved in the Towner's Woods Park in Portage County. Other sites identified as high probability of having archaeological remains include the high bluffs overlooking tributaries and rivers. As pointed out in the Portage County Watershed Plan, preservation of these areas may coincide with preservation goals for watershed functions.

http://www.cmnh.org/site/ResearchandCollections/Archaeology/Research/GeneralAudienceNontechnicall/HistoryNEOhio.aspx
Portage County Watershed Plan. Ravenna, OH.
http://co.portage.oh.us/watershedmaps102006/2.1%20Existing_Demographic.pdf

Amusement Parks

During the late 1800s and early 1900s, Ohio experienced a boom in amusement parks. Three were formerly located within the watershed:

- High Bridge Glens Park was built in 1882 in downtown Cuyahoga Falls along the Gorge. The amusement park, easily accessible by rail, contained one of the earliest roller coasters, a dining hall and dance hall pavilion, trails down in the Gorge to Mirror Lake, Fern Cave, a suspension bridge over the river, and toy houses for children. Construction of the Northern Ohio Traction and Light Company dam (predecessor to Ohio Edison) in 1912 created a dam pool that backed up into the park, obscuring the scenery for which visitors came, and the park closed. Industrial development during the early 1900s used the site. However, the now-vacant buildings have been removed.

  The City of Cuyahoga Falls has recently opened a boardwalk, reconstructed a bridge over the gorge, and placed a historical marker at the site of the former High Bridge Glens Park. Sources: Ohio Historical Marker; Cuyahoga Falls Historical Society, http://www.cuyahogafallshistory.com/parks_high_bridge_glens.htm

- Silver Lake Amusement Park, Silver Lake. This spring-fed lake, formerly Wetmore Pond, was developed by Ralph Hugh Lodge for an amusement park in 1875. The regional resort had boating, swimming, a dance pavilion, rail access, an aquarium, and an air field. The Lodge family raised black bears, a novelty. The Lodges sold the land was sold for residential development in 1918, as rail travel was limited during World War I, and the residents have sole rights to the lake. *Source: Summit County Historical Society http://summithistory.org/Community/museum_silverlake.htm*

- Brady Lake Electric Park was erected by A.G. Kent in 1891. It was accessible by rail and contained a dance hall pavilion, roller coaster, row boats, a steam boat and pony track. Source: The Art Armory. *http://www.artarmory.com/kent/brady.html*

Other areas in the Middle Cuyahoga River Watershed boast items of local and regional historical interest:

- In the early 1800s, the legendary Indian scout, Captain James Brady, was being held captive by local Indians. He escaped and fled, reportedly leaping a distance of 22 feet across the chasm of the raging Cuyahoga River in Kent. This site is known as Brady's Leap and is part of the river-side series of parks in Kent, marked with a plaque on a granite boulder. The bedrock channel has since widened, but the daring of his leap is still apparent. He then continued his flight and hid under a log a few miles away in what is now known as Brady Lake.

- Mary Campbell Cave in the scenic Gorge MetroPark is the site where a settler's daughter was held after capture by local tribes.

- Accounts of early life in Brimfield included mucking out the extensive swamps and placing a dam on Plum Creek for water power.

- Governor William McKinley provided assistance to form the public Canton Outing Club in 1894, the precursor to the Congress Lake Club, which became privately owned in 1899. source: https://congresslakeclub.memberstatements.com/tour/tours.cfm?tourid=52744

Recreational Resources

- In addition to the parks noted previously in Section 4a-iv.2, several major recreational efforts are underway that and promote the river as a center of recreational activity and major attraction for visitors.

- The Cuyahoga Valley National Park, one of the most heavily visited national parks, is located a short distance downstream of the Cascade Valley MetroPark, the western-most extent of the Middle Cuyahoga River. The National Park shares much of the same historical interest as the watershed, focusing on the Ohio and Erie Canal and the Cuyahoga River. In a program similar to geocaching, the National Park, Ohio and Erie Canalway trail system, and MetroParks, Serving Summit County, have recently begun a "questing" program focused on the Ohio and Erie canalway. Like geocaching, questing involves following clues to reach a set destination. However, questing does not involve the exchange of trinkets and does not require the use of gps systems, but instead, relies on clues focusing on the history or natural history of the quest area. This approach, being used in other regions, offers another activity and attraction focused on the Cuyahoga River.

- Communities and other partners along the entire river are seeking to establish a water trail for paddling. This concerted effort involves developing and publishing a map that identifies resources, paddling conditions, items of local interest, portages, pull-out opportunities and obstacles. Various partners along the river are focusing on developing each segment. The Middle Cuyahoga River would include the Heritage Section from Kent to Cuyahoga Falls, and a portion of the Expert Section in the Gorge and downstream. With the establishment of the canoe livery at Kent and accessible, high quality waters, the water trail partners perceive the Heritage Trail as the furthest along in development as a water trail segment.

- River Day is observed in many communities along the River during May, including Kent, Munroe Falls, and Cuyahoga Falls. Portage Park District sponsors Breakneck Creek Day on the same day as River Day each year.

4c – Previous and Complimentary Efforts

Communities and organizations within the Middle Cuyahoga watershed have been involved in watershed planning and management efforts to some degree for over 30 years. The following are some of the major studies and watershed management efforts within the watershed. Often, various watershed planning studies agree on the need and general techniques for:

- Protecting and restoring riparian corridors and wetlands
- Regional approaches to water resource management
- Restoring natural flow in waterways, especially the Cuyahoga River
- Reducing sediment, nutrients, pathogens, and non-point source pollutants from agricultural land, construction sites, failing or inadequate HSTS,
- Protecting surface and groundwater supplies,
- Controlling combined sewer overflows
- Public outreach and stewardship.

This Watershed Action Plan draws upon information developed for earlier studies and seeks to be consistent and compatible with similar and related efforts. As possible, the partners will collaborate with other organizations to achieve shared goals and promote the goals expressed in this plan.

Reports and Plans

Previous management studies are numerous and include the following:

NEFCO, as the Areawide Planning Agency for Summit, Portage, Stark, and Wayne Counties, has compiled the region's Section 208 Water Quality Management since the inception of the program. The Section 208 plan specifies areas to be served by sewers but also establishes a number of other goals related to watershed management and water quality. Included in the most recent version of the Section 208 plan are measures such as reduction of non-point source pollution, restoration of urban streams, regionally important waters, reduction of non-point source pollution. NEFCO has also conducted numerous watershed-related studies in the area, including:

- 1989-90, Analysis of Nonpoint Source Pollution within the Lake Hodgson Watershed, quantifying sediment erosion in the Lake Hodgson watershed and making recommendations that were later incorporated in the Source Water Protection Plan, including monitoring of water quality in the Feeder Canal and use of aeration devices at depth to reduce recycling of nutrients.

- 2004, Comprehensive Watershed Management Plan, Phase I, Middle Cuyahoga River Watershed. NEFCO convened a Middle Cuyahoga River task force of Middle Cuyahoga River partners to develop a watershed plan. The collaborative effort resulted in an inventory with goals and objectives, but it was interrupted by lawsuits involving the City of Akron and downstream communities concerning releases of water from the Akron public water supply at Lake Rockwell.

- Breakneck Creek Watershed Management Plan Inventory, 2004

Additional water quality management studies pertaining to the watershed include:

- Portage County Regional Planning Commission, in partnership with NEFCO, Portage Park District, Portage Soil and Water Conservation District, and several other organizations, developed the Portage County Watershed Plan, highlighting key resources to protect and establishing the basis for corridor protection.

- Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems, NOACA Septic System Study, 2001. This study identified factors correlated with high rates of septic system failure.

Water Quality Improvement Projects

- The Cuyahoga River has been the subject of three Total Maximum Daily Load analyses, which are described further in Section 5a-1. The Kent and Munroe Falls dams were altered or removed to restore flow in response to the Middle Cuyahoga River TMDL, resulting in water quality improvements.

- The City of Kent removed a small low-head dam from Plum Creek and restored the channel and floodplain. The City of Cuyahoga Falls already removed a small low-head dam on Kelsey Creek and is in the process of restoring floodplain access, channel form, and riparian corridor along the creek in Kennedy Park.

- The City of Cuyahoga Falls will be removing two low-head dams from the Cuyahoga River in 2013.

- The City of Stow recently stabilized a severely eroding portion of Walnut Creek.

- Implementation of NPDES Stormwater Permits. In 2003, new regulations went into effect requiring small Municipal Separate Storm Sewer System providers to develop and implement stormwater best management practices in order to receive General Permits for stormwater discharge. The General Permit entails requirements for six minimum control measures, including illicit discharge elimination, good housekeeping practices, stormwater management programs, and public information and public education programs. Both Summit and Portage Counties have developed collaborative County-wide programs that include public information and public education groups comprised of municipal, township, and county officials.   Portage County has recently begun implementing its stormwater management program.

- Potter Creek Restoration Project - NEFCO obtained an implementation grant to improve an agricultural headwater stream in Portage County. Collaborators included the City of Ravenna, Portage Soil and Water Conservation District, Cuyahoga River RAP, and Portage Parks District. The project was designed but not constructed. Over 20 acres of diverse wetland habitat were protected through easement purchase.

- Wastewater treatment plants at Franklin Mills and Ravenna were upgraded to improve water quality between 2000 and 2007.

- Portage and Summit Counties have adopted programs to reduce septic system failure that focus on design of new systems and maintenance or improvement of pre-existing ones.

- Summit County, Kent, Ravenna, Tallmadge, and Munroe Falls have adopted riparian setback requirements for development.

4c-ii Current Water Quality Efforts

- The City of Akron is currently implementing the early phases of a Long Term Control Plan under agreement with the US EPA to control combined sewer overflows, which affect the lower portion of the Middle Cuyahoga River.

- Summit County is undertaking a regional stormwater management study. The focus of this is on managing water quantity, but it is hoped that a regional approach to controlling water quantity can identify needs and opportunities for water quality improvement.

- Portage County has recently adopted a stormwater utility countywide, to provide a funding source for managing stormwater across the county.

- Portage County Regional Planning Commission has installed a stormwater infiltration trench in its parking lot.

- Several cities in the watershed have installed rain gardens as demonstration projects.

- Summit County is conducting a brownfields inventory and brownfields remediation pilot project. Portage County is seeking funding for a brownfields inventory.

- The Ohio Edison dam is being evaluated for removal.

- Cuyahoga Falls will be removing two low-head dams on the Cuyahoga River in 2013. The City is pursuing funding to reconnect large portions of Kelsey Creek to its floodplain, in the Brookledge Golf Course. The City is working with a school at the edge of Kennedy Park to develop a city arboretum along Kelsey Creek, which will provide hands-on projects for the high school students, increase awareness, and improve the riparian corridor.

- MetroParks, Serving Summit County, will be restoring stream morphology in the newly acquired portion of Munroe Falls MetroPark. Portage MetroParks is conducting a stream restoration and has recently acquired 45 acres of riparian corridor/wetland near Breakneck Creek.

Individually, partners have taken the initiative to conduct restoration and other water quality efforts. In implementing this plan, the partners will build on previous successes and collaborations.

4d – Physical Attributes of Streams and Floodplain Areas

Organization of Sections 4d-4e

Section 4d through 4e discuss physical characteristics of the stream corridors, alterations, threats to water quality, and the resulting water quality indicators. While the previous sections have focused on the characteristics of the watershed, the next three sections focus on what aspects are providing benefit, which should be protected, which should be restored or improved. These will provide much of the basis for determining what the watershed partners wish to accomplish toward protecting and improving the river, tributaries, and watershed.

This background section discusses how the landscape elements of the stream corridor interact to affect water quality, the functioning of streams and rivers, their stability and resilience, and hazards such as flooding problems, excessive erosion, and harmful algae blooms. Altering the landscape can affect water quality and the functioning of the stream system. The goal of the watershed partners is to protect the beneficial stream systems and elements and restore or improve the elements that have been degraded. While restoring full water quality attainment and all the stream functions may be an ideal, in some cases it may be feasible only to restore some of the functions lost in an altered setting, thus improving the system.

The outline contained in Appendix 8 lists factors to consider in assessing stream channel condition, many of which are assigned their own section number in Sections 4d-4e and some of which are repetitive. However this document combines similar topics into fewer groups:

Section 4d

Stream Systems and Water Quality Background

1. Pre-Settlement Conditions
2. Channel and floodplain condition, including livestock access, eroding banks, floodplain connectivity, entrenched channels, intact or altered
3. Forested riparian corridor
4. Permanent protection
5. Altered Stream Network
6. Dams and Petition Ditches
7. Status and trends
8. Expected development
9. Expected road, highway, and bridge construction

Section 4e

1. Designated Use, Attainment, Causes, Sources
    a. Water bodies
    b. Lakes
    c. Wetlands
    d. Groundwater
2. Point Sources
    a. Permitted Discharges, effluent volume
    b. Spills
3. Non-point Sources
    a. Home Sewage Treatment Systems
    b. New Homes
    c. Animal Feeding Operations
    d. Highly Erodible Land, Potential Soil Loss
4. Status and Trends

Stream Systems and Water Quality: Background

Stream Systems and Water Quality: Background

<u>Physical and Chemical Factors Influencing Water Quality and Biological Indicators</u>

The Ohio EPA enforces Ohio's federally mandated water quality standards, which are expressed in terms of beneficial uses. Ohio EPA focuses considerable effort on attainment of aquatic life use standards, because the biological communities reflect and are good indicators of the physical and chemical conditions of stream systems. However, in framing the discussion of stream systems, it is useful to understand the factors that contribute to biological communities and thus, water quality attainment status.

Figures 4d-1 and 4d-2 illustrate that the biological communities are a result of tiered influences related to the physical environment, each level being affected by others. Even though it is not shown in the illustration, it is important to note that chemical parameters are also important at the various levels.

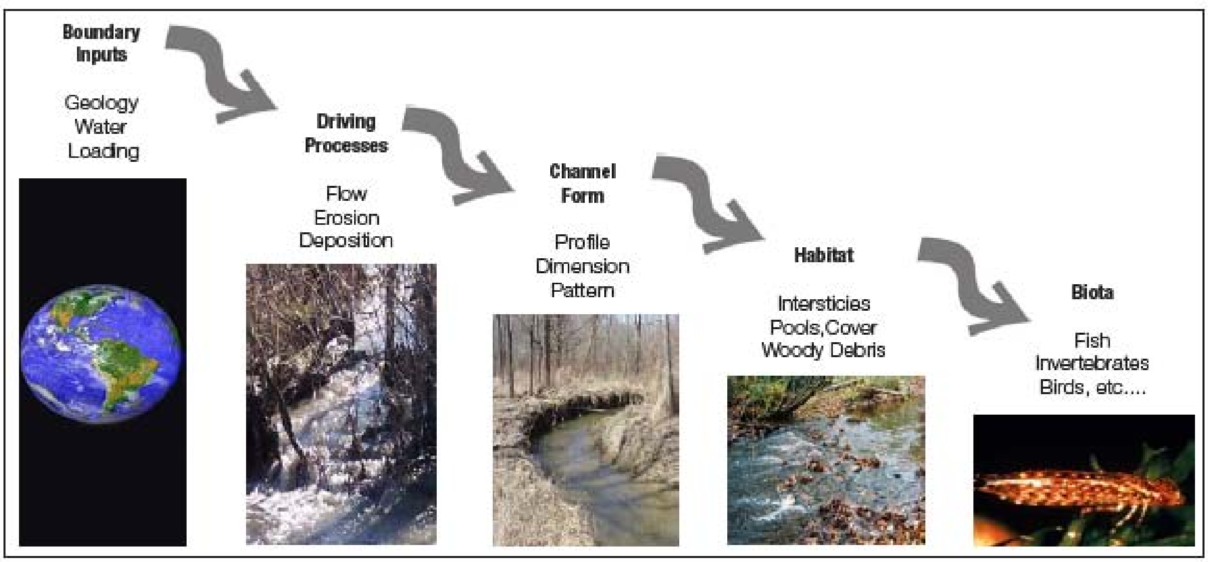


Figure 1 Relationship of the stream variables responsible for stream integrity

Figure 4d-1 Relationship of the stream variables responsible for stream integrity. *Source: Ohio Rainwater and Development Manual, App. 7, Planning for Streams, Fig. 1. Ohio DNR, 2006.*

Biological communities depend on

- o Physical/chemical parameters of the water, including nutrients such as nitrogen and phosphorous, sediment/turbidity, light penetration, temperature, and oxygen;

- o Habitat, including variable flow and depth, substrate with surfaces to adhere to (e.g., gravel versus silt), cover, vegetation, condition of the banks and riparian zone (transition between stream and upland); and

- o The physical, chemical, and habitat characteristics depend largely on stream form, including the accessible floodplains, wetlands, and riparian zone; bank slope, meanders, and bank vegetation. These characteristics are also affected by biological communities, and the amounts of sediment, water, and chemicals entering the system.

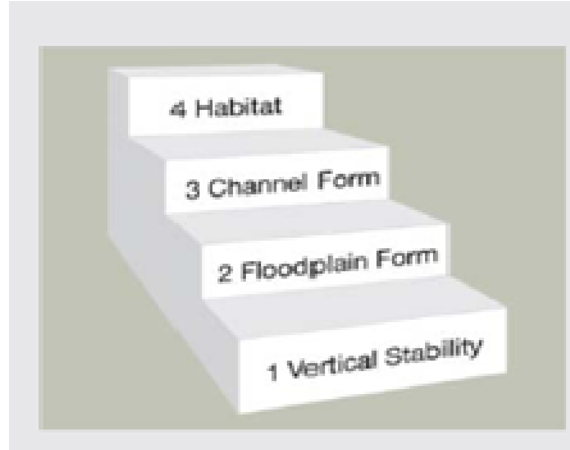


Figure 4d-2 Physical characteristics provide the basis for habitat and biological communities *Source: Ohio Rainwater and Development Manual, App. 7, Planning for Streams, Fig. 1. Ohio DNR, 2006.*

- The stream form depends on the vertical stability of the stream, whether the stream is in balance with the flow, slope, and sediment load or is, instead, eroding vertically downward or silting in. Vertically stable streams meander, eroding outside bends and depositing at inside curves (point bars). Over time, the meanders shift, but the stream can maintain a consistent plan, dimension, and profile. Key to maintaining stream form is floodplain access.

- Vertical stability depends on the amount of water and sediment coming into the system, the stream slope, sinuosity, and floodplain access. When the system is out of balance due to a change in the volume of water in the channel (e.g., through loss of floodplain access or increased runoff), a change in slope (e.g., through channel straightening), or change in sediment input, the stream adjusts by eroding the channel wider and deeper or silting in. Both types of adjustment damage the stream form, impair habitat and water quality attainment, and may increase risks of flooding damage or unstable banks.

- The amount of inputs also affects the levels of contaminants, nutrients, oxygen, and nuisance species. Many of the inputs of water and contaminants can be reduced or treated if the elements of the stream channel and stream form are intact.

In assessing the health and functioning of a stream system, factors such as stream form and inputs are as important as biological and chemical attributes, providing the basis for the conditions within the stream system.

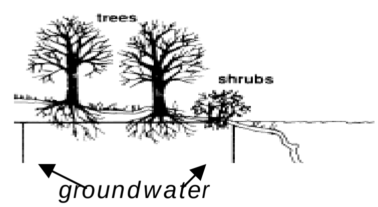
Stream Corridors - Landscape Functions

The physical characteristics of the stream channel and corridor play a major role in the health of the stream system and the way it functions, affecting many of the characteristics noted above. The landscape elements of an intact stream system perform functions that are not only essential for healthy biological communities but also reduce flooding and erosion problems, bank instability, and nuisances such as harmful algal blooms and levels of certain toxins in drinking and recreational waters. An intact stream corridor landscape is one of the most effective tools to provide flood reduction and storage and water treatment, minimizing impacts to the stream system (and downstream properties), and maintaining a healthy stream system.

Important landscape elements of the stream corridor are shown in Figures 4d-3 and 4d-4, and include:

- Vegetated upland buffer – undisturbed, vegetated land above the low-lying stream corridor – absorbs and filters precipitation and runoff and contributes to habitat.

- Accessible floodplain, where water can spill out of the channel. This reduces the load on the stream channel and the erosive force of the water, is crucial to stream channel stability, and allows sediment to settle out.



- The riparian zone is the transition between the stream and upland, where the groundwater is close to the surface and interacts with the stream. Water-loving and water tolerant plants “get their feet wet” with their roots in the groundwater. An intact, vegetated riparian zone provides nutrient uptake, filtering of runoff, and streambank stability.

- Wetlands in the low-lying stream corridor area store floodwater, are importan absorption, storage, and adsorption of contaminants. During dry periods, we base flow to streams.

- Stream form, with meanders or step-pool sequences, variable flow, and often banks. These features are present in intact stream systems, although they m stream slope. They provide habitat (pools and gravel-lined riffles), increase c water, allow sediment to be scoured from the active channel and deposited on bars and floodplains, and are important to maintaining vertical channel stability.

- Riparian vegetation – trees, shrubs, and even tall grasses help absorb precipitation and runoff, take up and absorb nutrients, provide bank stability with their root systems, and help maintain lower water temperatures, important for certain organisms and maintaining dissolved oxygen levels.

Collectively, these elements are important for maintaining vertical stability, stream form, floodplain access, flood storage and attenuation, pollutant uptake, and habitat. The assessments of stream corridor conditions in this Watershed Action Plan consider the presence and quality of these features at the watershed scale, and where the features – or their functions – should be protected, improved, or restored.

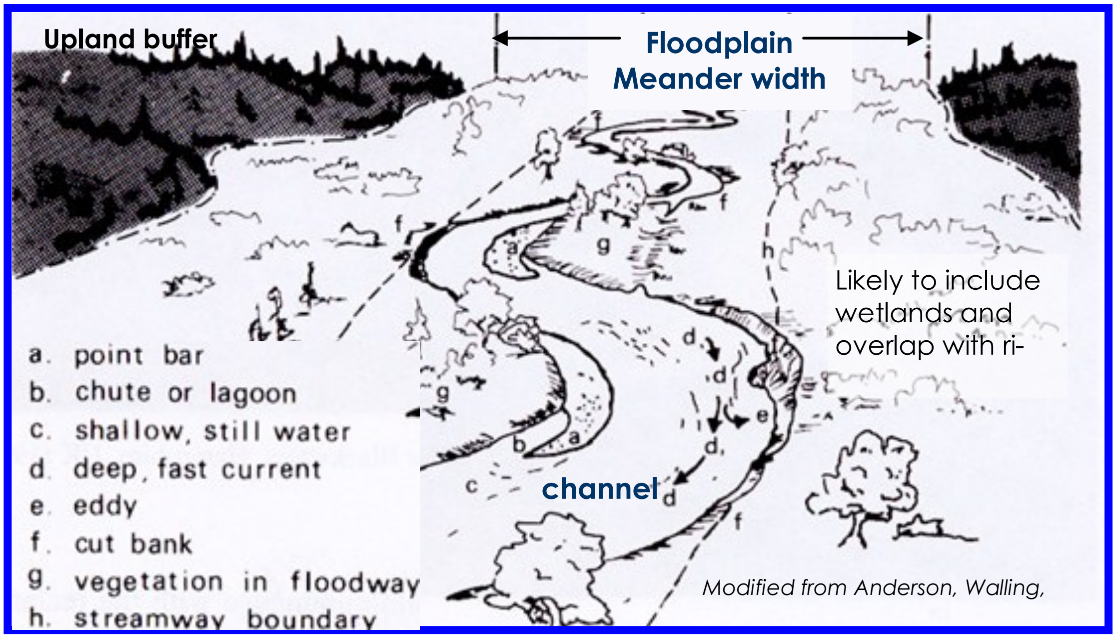


Figure 4d-3. Features of an Intact Riparian Corridor

Riparian zones, wetlands, and floodplains often coincide in the low, wet areas along the streams in the Middle Cuyahoga River watershed.

Upland slope – absorbs water – during a day-long storm, only a minimal amount of water trickled off the slope into the stream below. Wooded buffers are even more effective at absorbing water, preventing erosion, and taking up nutrients.

Floodplain at work storing water

Figure 4d-4. Landscape Elements Provide Watershed Benefits, Middle Cuyahoga River Watershed

Figure 4d-5 Vertical Stability of Streams
Vertically stable streams (left) have accessible floodplains and riparian zones, and will not erode or silt in over time. (Source: R. Keitz Ohio DNR Oster-Zimber Ditch Presentation n.d.) In contrast, the unstable channels at the right have tall vertical banks. The channel at the top right has uniform, slow flow, with no floodplain access. With no way to clear the sediment out from the channel, it is silting in. The channel at the bottom right s overloaded, has no access to a floodplain, lacks stabilizing vegetation, and is eroding vertically.

4d-1 Pre-Settlement Conditions

Findings:
Pre-Settlement Conditions

In 1966, the Ohio State botanist published *Natural Vegetation of Ohio, at the Time of the Earliest Surveys*, using methods developed in the 1920s to map early surveyors' records of trees. Ohio DNR has since digitized the map into the GIS system.

As shown on Figure 4d-6, the Middle Cuyahoga River watershed was a predominantly mixed oak forest, with mixed mesophytic woods occurring in the eastern portion of the watershed. While the watershed lacked the extensive wetlands of the Black Swamp system in northwest Ohio, there were substantial peatlands along Potter Creek, Fish Creek, and the confluence of the current Brimfield Ditch and Breakneck Creek. The lakes in the watershed are generally kettle lakes, which pre-date the canal alterations. Writings from early settlers describe the clear waters of the Cuyahoga, a ford at Munroe Falls, and extensive swamps in Brimfield. http://www.dnr.state.oh.us/website/ocm_gis/mapviewer_app/default.asp

As discussed in the next several sections, since the settlers first came, the residents of the watershed have been altering the hydrology to harness water power, provide transportation, drain wet areas, change flooding patterns, create dry land for farming and building, dispose of waste, and develop water supplies for industry, drinking, and recreation. Alteration continues as the land is used for agriculture, new housing and commercial developments. As the stream network is altered, the stream corridor functions are often reduced, resulting in increased loading of water and pollutants, streambank instability, and damaging floods.

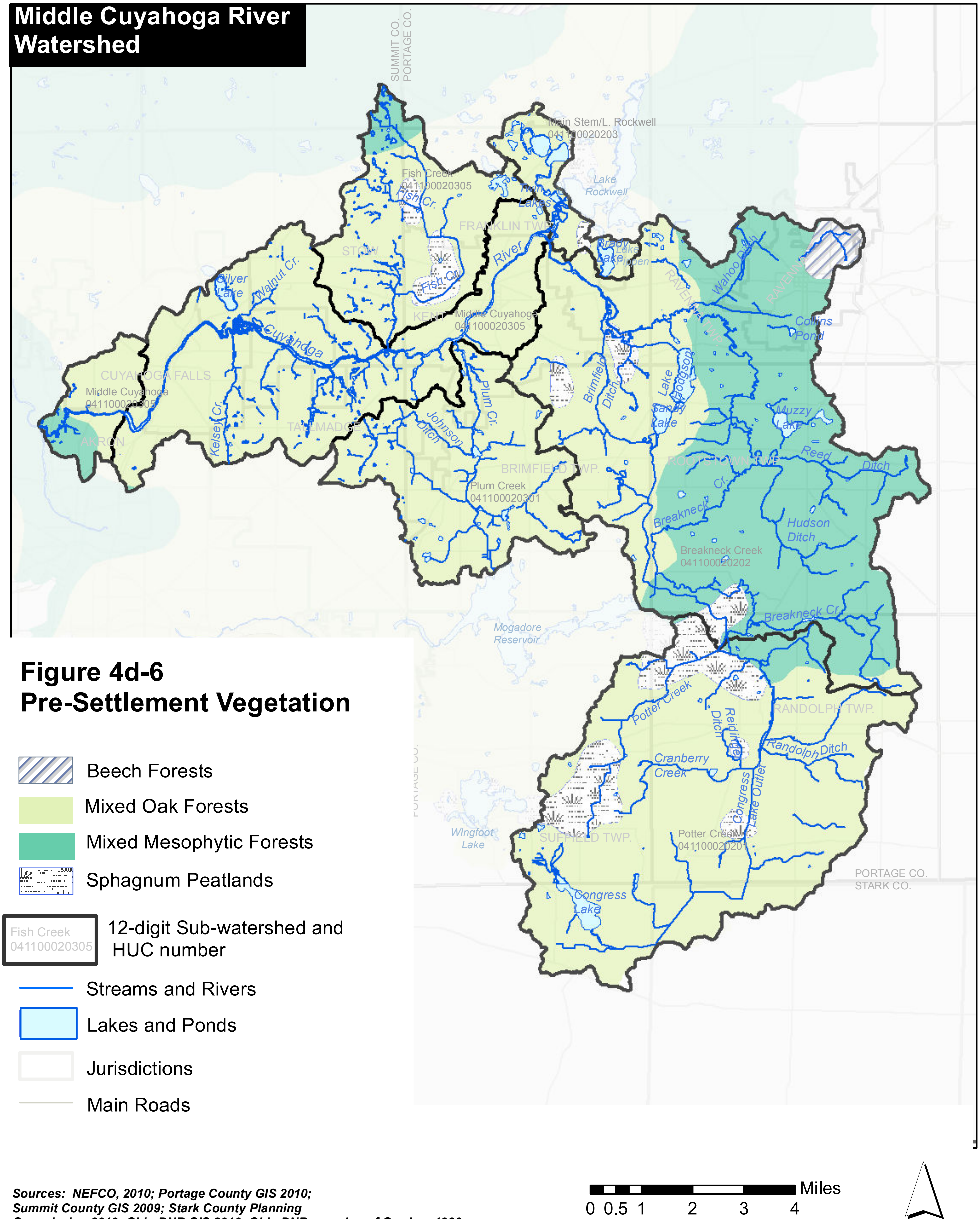


Figure 4d-6
Pre-Settlement Vegetation

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; Ohio DNR mapping of Gordon, 1966

4d-2 Channel and Floodplain Conditions

Mapping

Channel conditions were assessed visually through field visits to stream access points and through interpretation of aerial photographs from 2006. Channels were classified as intact (appearing to have features of an intact riparian corridor), recovering, eroding, eroding with livestock access, channelized, or altered. There is considerable overlap between the categories. Channels mapped as “eroding” may also be incised or incising, or could be expected to become incised soon and also likely has lost floodplain access. The “altered” category as mapped is a broad one and could to conditions ranging from lack of riparian vegetation to completely culverted or hardened. Photographs in Section 4P can be used to further determine characteristics at photograph sites. It should be noted that certain characteristics or features may not be visible from the aerial photographs, and the limited number of field visits did not allow all channels to be observed under ideal viewing conditions. For instance, during summer, dense vegetation makes visibility difficult, and during fall, winter or spring months, high water can mask the shape of the channel or the nature of the vegetation. As with all mapping in this plan, field assessments are necessary to more clearly define conditions at specific sites.

Findings:
Channel Conditions, Middle Cuyahoga River Watershed

Findings: Channel conditions

Figure 4d-7 presents mapped channel conditions, which are summarized in Table 4d-1. Figure 4d-7 also presents photo locations. Photos in Attachment 4P are referenced for example, as 4P xx-###, where xx is the subwatershed designation, and the numbers refer to the photo number in that set.

Outside the impounded dam pools, the Cuyahoga River channel is largely intact (or recovering its forested riparian corridor.) Much of the tributaries and their surrounding landscape have been altered by drainage ditching, agriculture, or development.

In the urbanized portions of the watershed, substantial portions of stream channels and the adjacent landscape have been altered:

- Direct alteration, e.g., through dam construction, by culverting, hardening the channel, or mowing or filling riparian buffer (e.g., 4P MS-340, 345, p. ms5; BC-070, p. b-9, BC-360. p. b-7, F-330, p. f-7) or

- Indirect alteration resulting from impacts of impervious surfaces, such as streambank erosion and channel incision from increased storm water volumes. (e.g., 4P MS-085 p. ms-5, 230, p. ms-4).

In the rural portions of the watershed, many headwater streams and creeks have been channelized. Many are eroding and becoming incised, some due to livestock access, some due to channelization (e.g., 4P BC-780, p. b-8; BC-555, p. b-3). Throughout the watershed, roadway ditches and gutters serve as the new headwater streams. (e.g., 4P BC-670 p. b-12)

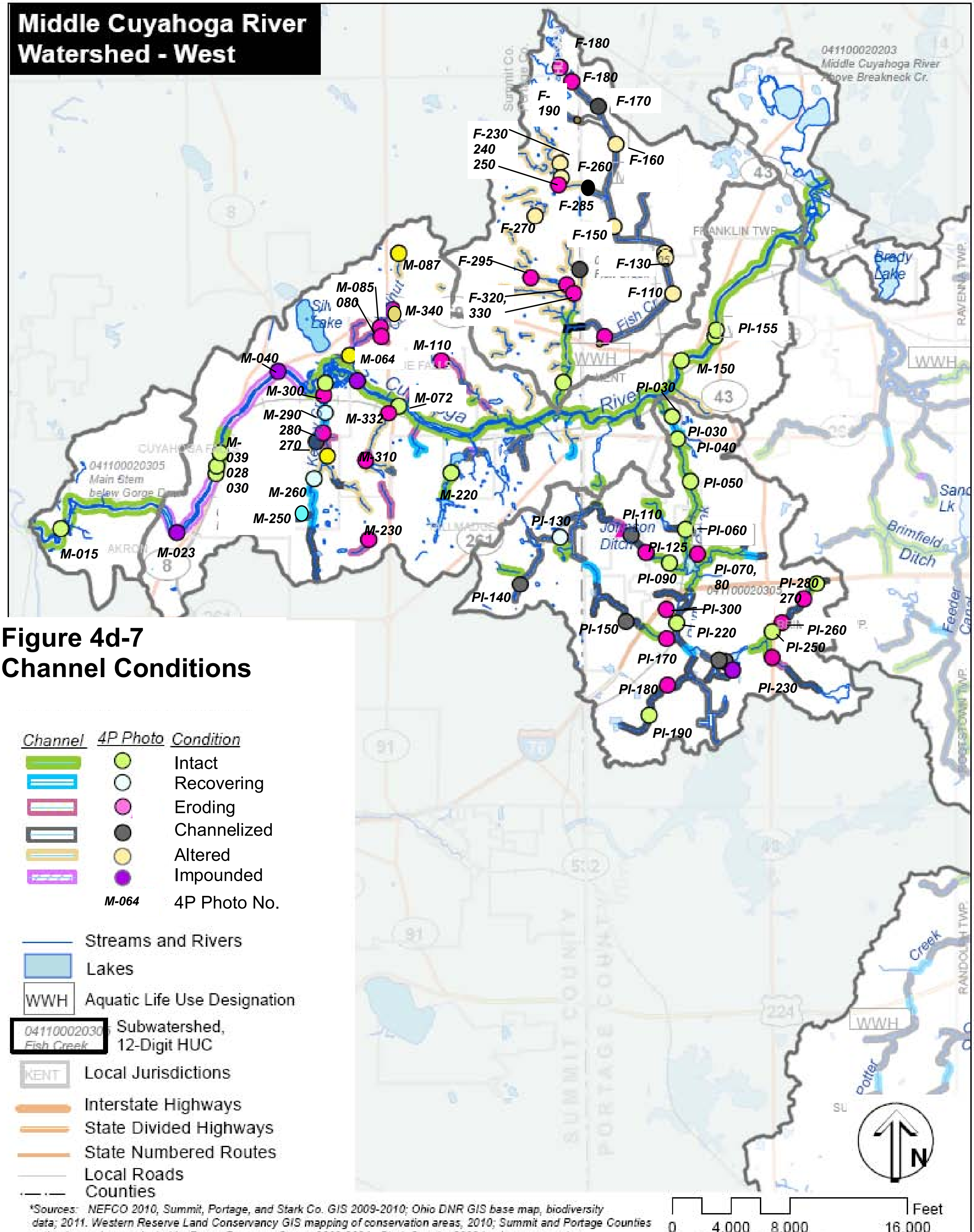


Figure 4d-7
Channel Conditions

Channel	4P Photo	Condition
		Intact
		Recovering
		Eroding
		Channelized
		Altered
		Impounded
	M-064	4P Photo No.

Streams and Rivers
Lakes
WWH Aquatic Life Use Designation
041100020305 Fish Creek — Subwatershed, 12-Digit HUC
KENT — Local Jurisdictions
Interstate Highways
State Divided Highways
State Numbered Routes
Local Roads
Counties

0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet

*Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

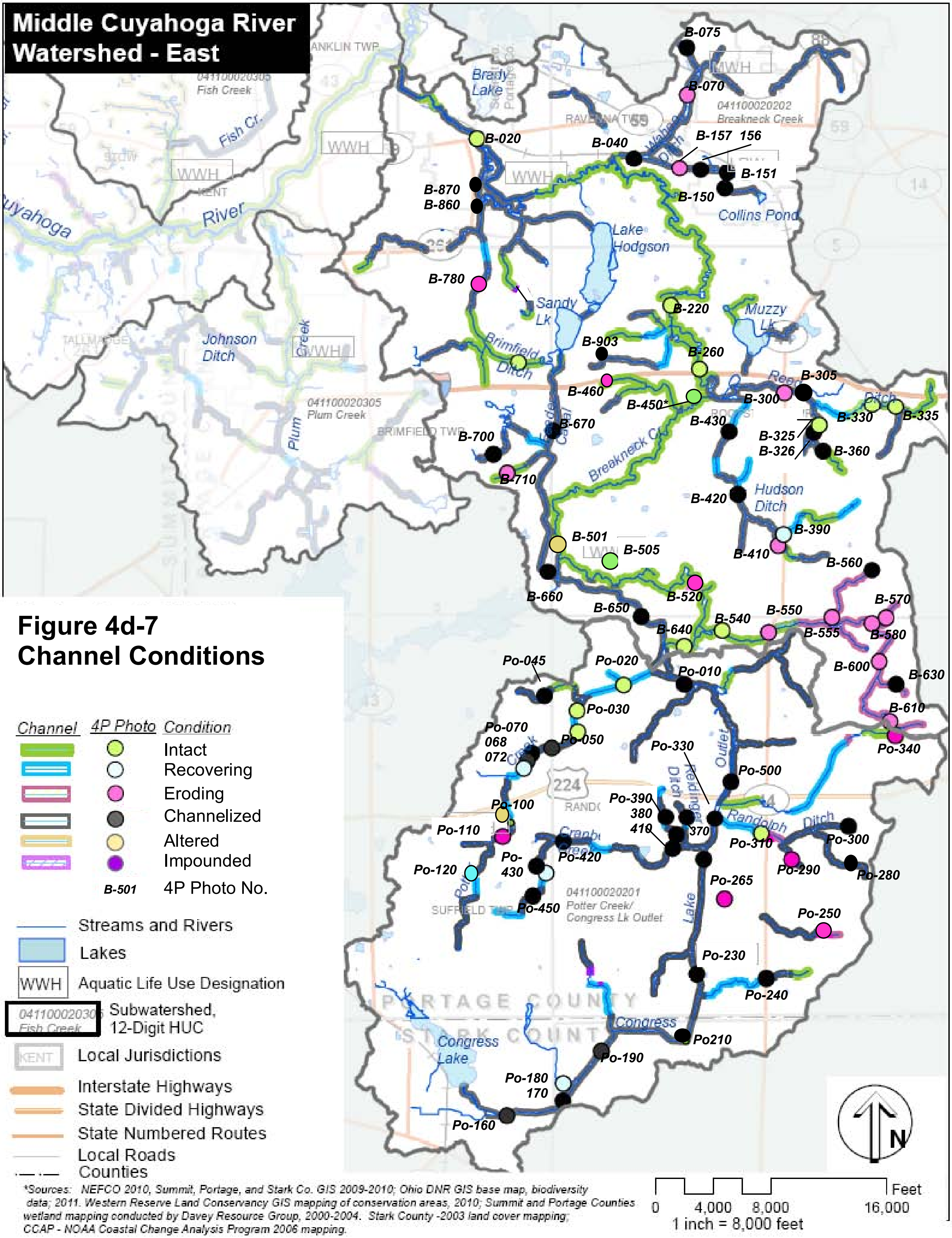


Figure 4d-7
Channel Conditions

Table 4d-1
Channel Conditions*

	Estimated length (in miles) of condition along channel					
	Main Stem					
Subwatershed	*Cuyahoga River*	*Other tributaries*	**Fish Creek**	**Plum Creek****	**Breakneck Creek**	**Potter Cr.**
Intact	12.8	2	1.4	4.7	25.3	2.8
Recovering	0	1.5	0	1	4.7	7.5
Channelized	0	3.8	6.7	11.9	36.8	29.5
Eroding	0	4.9	0.1	0.4	6.6	1.5
Eroding - livestock	0	0	0	0.1	0.2	0.7
Altered riparian area, hydrology, or channel	0	5.6	8.8	0.2	10.6	0
Impounded	3.1	0.3	0	0	0.1	0.1
Undetermined	0	0	0.8	4.1	0	2.8

*Observed from 2006 aerial photographs and limited visits to road crossings; generally do not count impoundments, except for the dam pools along the Cuyahoga River and limited sections of impounded tributaries. In several instances, channels could be categorized as several types, e.g., channelized and eroding, but the channels were only counted in one category. Totals are estimates based on general conditions. Planning for specific actions would require field verification.

** Along Plum and Breakneck Creeks, much of the intact corridor is along the main stem.

However each subwatershed also contains important intact riparian corridors, wetlands, and woods that are providing protection and are likely reducing impacts. Some are extensive riparian corridors, others are more isolated remnants along the stream corridors. These riparian corridors are areas to focus preservation and enhancement efforts. (P4 B-045, p. b1)

Each subwatershed also offers opportunities to restore or improve watershed functions to some degree, such as:

- Restoration of floodplain access, wetlands, stream channel morphology, or riparian vegetation;
- Increasing the use of best management practices in developed, developing, agricultural landscapes, or along roadside ditches, or
- Reducing imperviousness and increasing infiltration.

In each of the subwatersheds, there are areas that have been protected or where best management practices are being used to some extent. Within some parks and less densely developed areas, the more intact buffers offer protection. NRCS staff have been working with farmers to improve use of best management practices. Local communities have begun watershed protection or restoration efforts, removing dams, installing rain gardens, adopting riparian protection ordinances, purchasing land for conservation. The Middle Cuyahoga River Watershed efforts should build on these efforts to protect the intact systems, reduce future impacts, and improve the altered systems.

Main Stem

Approximately three miles of impoundment remain on the main stem. (4P MS-023, p. m-1, 057, p. m-2) Outside the dam pools, the channel of the main stem is largely intact, with its wooded riparian corridor recovering in the former dam pools (e.g., 4P MS-015, p. m-1, MS-148, p. m-3). The river has improved greatly with the removal or alteration of two dams. (4P MS-072, 150, p. m-3). The available floodplain in the predominantly narrow valley appears to be accessible along much of the river. Substantial portions of the main stem are fringed by undeveloped land, which is held in parks or is difficult to develop due to slopes and limited access or infrastructure. The channel should continue to improve as more dams are removed and as vegetation becomes re-established along the river margins outside of the downtown areas of Cuyahoga Falls and Kent. The unprotected riparian buffer along the river should be preserved.

With a high degree of development and imperviousness and steep slopes in this subwatershed, most of the main stem tributaries channels are altered, lack riparian buffers (other than sod), and have become incised. (4P MS-110, p. m-4, MS-332, p. m-6). Flooding problems have been noted at the upper and lower reaches of Walnut Creek, where development occupies former floodplains and wetlands. A few remaining undeveloped parcels could be used to improve hydrology, flood control, stream form, and habitat locally, reducing volume and sediment entering the river. Examples include Kelsey Creek and unnamed tributaries in Munroe Falls.

Tributaries flowing through wooded buffers appear to be relatively intact and offer better habitat. The tributary flowing through the Munroe Falls MetroPark appears to be the highest-quality habitat of this sub-watershed (MS-220, p. 6). Where Kelsey and Walnut Creek flow through wooded parks, their condition appears improved, although both show signs of impact from the high quantities of urban runoff. (4P MS-250, p. m-5, MS-085, p. m-4) The existing parks, Cuyahoga Falls golf course and land held by homeowners' associations offer opportunities for stewardship and improving riparian conditions.

Fish Creek

The lower portion of Fish Creek has an intact wooded corridor and appears to have much of its natural stream channel intact. (4P FC-020, p. f-1) Anecdotal reports from nearby residents note that the water flows more rapidly and clears out more quickly after storms since the Munroe Falls dam was removed, possibly reflecting the lower base level of the mouth and thus steeper slope of this tributary.

The upper portion of Fish Creek has been highly altered. Along most of its length, the channel appears ditchlike and heavily embedded with silt. Extensive wetlands have been altered both in Portage County and Summit County, reducing floodplain access, flood storage capacity, water quality treatment in the wetlands, and degrading habitat. (Photos 4P FC-080, p. f-2, 150, p. f-3; 240, p. f-6) Recent development has altered most of the tributary stream channels, directly by culverting, or indirectly, by altering the riparian corridor. (Photos 4P FC-330, p. f-7, 295, p. f-7)

The City of Kent owns substantial parcels along Fish Creek, which protects existing woods and wetlands and may provide an opportunity to restore altered channel or riparian landscape. In Stow, there are many small parcels held by homeowners' associations along streams where riparian plantings could be improved. In the undeveloped portion of the watershed, there may be opportunity to restore wetlands that were ditched for agriculture (or otherwise altered, as with playgrounds), either where the agricultural use has ceased or along the less-used margins of the properties.

Plum Creek

Plum Creek is a mosaic of intact, altered, and threatened landscapes. The most intact portions are generally within a couple of miles at at the downstream end. The City of Kent has removed the dam below Plum Creek Park, has restored floodplain access, channel morphology, and has planted the riparian buffer (4P Pl-025, p. pl-1) The downstream portions of Plum Creek flow through intact riparian wetland-floodplain complexes (4P Pl-040, p. pl-1). The Howe Ave./Jaycee park protects a substantial and diverse wetland system, but the stream is channelized through the wetland. (4P Pl-130, p. 3) Many other areas have been ditched through agricultural or residential land, offering no floodplain access or water quality treatment along the riparian corridor, and often resulting in erosion (4P PL-105, p. pl-2, 110, p. pl-3, pl-4, 210., p.pl-5) . Through golf courses and industrial parks, the creek often has unprotected riparian buffer (4P Pl-180, p. pl-4). Eroding banks are apparent along Johnson Ditch and in the densely developed commercial and community center of Brimfield. (4P Pl-260, p. pl-6) The lake at the center of the "Pleasant Lakes" development receives water from all the ditched headwater tributaries. (4P Pl-080, p. pl-1)

This subwatershed was the most rapidly developing area prior to the economic downturn of 2007-2008, and is likely to be so again when the economy recovers, due to its access to Route I-76 and sewer and water infrastructure. Preservation of the intact riparian corridor is important in this subwatershed, as well as improving best management and riparian management practices on large parcels, and promoting development and agricultural practices that minimize stormwater and water quality impacts.

Breakneck Creek

The condition of the riparian corridor, wetlands, floodplain access, and stream channel morphology vary throughout this subwatershed. Breakneck Creek itself appears largely intact. (4P B-045, p. b-1; 220, p. b-2.) The extensive riparian wetland-floodplain systems along the creek have buffered the effects of the altered landscapes upstream. The Feeder Canal is channelized.

The tributary ditches tend to be channelized with no floodplain access, reducing flood storage capacity. Erosion is occurring along Hudson Ditch and at the downstream end of Reed Ditch, in Brimfield Ditch, along the channelized headwater tributaries upstream of Congress Lake Outlet, and along portions of Wahoo Ditch (4P B-555, p. b-3; 610, p. b-4; 070, p. b-9; 300, p. b-6). Portions of the channels appear to be recovering, as well. Outside the municipalities, there are no riparian setbacks to protect the riparian areas from encroachment.

Damaging flooding problems have been noted at Collins Pond in Ravenna, which is now connected only by culvert to the Wahoo Ditch drainage system (4P B-160, p. b-10, 170, p. b-11), along Wahoo Ditch near Route 59 (4P B-070, p. b-9), and near the confluence of Breakneck Creek and Brimfield Ditch. Reed and Hudson Ditches are largely channelized and appear to collect large volumes of stormwater from the developed landscape, becoming incised at their downstream ends (4P B-305, p. b-6; 420, p. b-5; 430, p. b-5; 360, p. b-7).

Downstream of the confluence of these ditches with Breakneck Creek, the creek appears to be experiencing erosion due to high volumes of water. (4P B-260, p. b-2) A large wetland system at the confluence of the two ditches is likely providing substantial flood storage. Hudson ditch appears to be channelized through the wetland, reducing the flood-storage and treatment available. Preservation of this area and potentially restoring some connection to the wetland may help continue to reduce the influence of these ditches on the creek.

It is important to protect the undisturbed riparian corridor protecting Breakneck Creek and its tributaries. Along the ditches, there may be room to improve flood storage, hydrology, or water treatment, in undeveloped parcels. Use of green infrastructure would be important in the urbanized areas to reduce stormwater loading into the channels.

Potter Creek

Congress Lake Outlet is channelized. Portions of Potter Creek and its tributaries appear to be intact or recovering (4P Po-020, p. po-1; 050, p. po-1; 72, p. po-2; 180, p. po-9). Much of the channel length has been channelized for agriculture (Po-070, p. po-2, Po-420, p. po-6; 430, p. po-6; 380, p. po-7), and there are varying degrees of buffer being used to protect the streams. Erosion is apparent at an unrestricted livestock access along Randolph ditch (4P Po-310, p. po-8) and along some unmapped streams that cross Randolph Ditch. Congress Lake tends to be eutrophic, and the upstream end of Congress Lake Outlet also appears to have high amounts of weeds and algae. (4P Po-170, p.po-5)

Based on observations, substantial portions of Congress Lake Outlet, Randolph Ditch, Reidinger Ditch, Cranberry Creek, are channelized as ditches and appear to lack floodplain access. Some of the headwaters and other tributaries appear to be intact, recovered, or in two-stage ditches.

The wetlands along the lower end of Potter Creek are important to protect, as they are providing some of the only wetland treatment for the tributary. It would be beneficial to improve the level of riparian function and best management practices were possible along the tributaries.

4d Physical Attributes of Streams

- 3 Forested Riparian Corridor Assessment

Forested Riparian Corridor Assessment: Background

Background: Forested Riparian Corridor Assessment

One of the landscape elements providing great benefit to stream corridors is the quality of the riparian zone and riparian buffer. As noted in the Section 4d Background, the riparian zone is the transition zone between wetland and upland, where, often, the plants are rooted in groundwater that is in direct contact with the stream. The riparian buffer is undisturbed land adjacent to the stream corridor, which may be wetland or upland.

Functions provided by intact riparian zones and buffers include:
- Slowing down and storing storm water
- Absorbing, infiltrating precipitation
- Nutrient uptake
- Filtering sediment, allowing it to settle
- Bank stability
- Habitat
- Cooling

Wetlands and forested riparian zones are nearly equal in their ability to remove nutrients. (Lake Erie Nutrient Task Force Report, 2010.) Wooded riparian areas provide greater bank stability and cooling. Where stream systems are vertically stable, wooded banks help maintain a stable form. However, where unforested banks are not vertically stable, it would be unwise to simply plant trees and stabilize an undesirable form. If incremental improvements were sought for a stream with a degraded form, it may be more appropriate to establish grasses, shrubs, wetlands or floodplains first to improve functions such as form, hydrology, nutrient uptake or sediment removal, then later consider establishing trees if the stream form recovered.

Numerous studies have documented the value of riparian buffers and the effect of width on function. Generally, it is agreed that smaller headwater streams require much smaller buffers than or those with larger watersheds. The specific widths differ between studies. However, generally buffers of 25-30 feet are considered the minimum needed to protect headwater streams. Summit County’s riparian ordinance requires setbacks of 75 feet for watersheds up to 20 square miles, 100 feet for watersheds up to 300 square mile, and 300 feet beyond that. These ranges are similar to recommended distances in riparian setback literature.

Land cover was mapped with CCAP data within buffers of varying widths of water courses to determine if there were substantial differences in inner versus outer buffer land cover. The land cover percentages were similar, so for the purposes of this analysis, land cover within 75 feet was mapped. The mapped land cover may not reflect conditions on the ground, as CCAP data has data units of 30 m (approx. 100 feet) on a side. The results of this mapping indicate areas where land cover is likely to be beneficial to the stream (e.g., wetlands, woods) or may be encroaching on the integrity of the stream corridor. Limited observations were conducted at road crossings, but more in-depth field assessments will be needed in all cases to determine actual conditions. Land cover was measured in acres and calculated as percentages. The length of stream channel adjacent to the land cover was estimated applying the percent of land cover to the length of the streams estimated in the channel condition section. This is a rough estimate and may not accurately reflect disturbed versus intact or undisturbed buffer. The pixels are 30m on a side, which does not allow small features to be distinguished. In addition. There may be some narrow areas of woods that occur along the streams but would not be considered undisturbed. However, this estimate is adequate for general comparison.

This analysis focuses on riparian *buffer*, which can be mapped at the subwatershed scale, to some extent. Determining the condition (intactness) of riparian *zones* can be attempted with high resolution topographic information and photographs but often requires field work to determine conditions on the ground.

Findings:
Forested Riparian Corridor Assessment

Findings: Forested Riparian Corridor Assessment

Figure 4d-8 and Table 4d-2 summarize land cover mapped by the NOAA Coastal Change Analysis Program within 75 feet of the streams. Figure 4d-8 also shows the location of example Section 4P photograph sites within the mapped buffers. Large areas of intact wooded riparian corridor are present along the Main Stem, Breakneck Creek, Feeder Canal, and Plum Creek. Tributaries, Potter Creek, and Fish Creek tend to have more altered riparian corridors.

While the riparian corridor assessed acres of land cover, length of wooded riparian corridor could be estimated assuming that the area percentages translate to linear corridor. Table 4d-2 includes an estimate of linear miles of land cover along the riparian corridor.

- In the Main Stem subwatershed, mapping indicates that wooded riparian corridor is found only along 4 miles of tributaries and 5 miles of the main stem. However, these streams also flow through very steep valleys, which may limit the accuracy of the land cover mapping by satellite.
- In the Fish Creek subwatershed, approximately 4 miles (less than one-fourth) of the corridor is wooded. Much of this is at the lower end of the creek.
- In the Plum Creek subwatershed, 11 miles (nearly half) is woods, scrub-shrub, or wetland. Most of this is along the main stem of the tributary, although the headwaters near the Mogadore Reservoir are surrounded by woods and wetlands.
- Approximately 40 miles of Breakneck Creek and its tributaries flow through wooded riparian corridors. Like Plum Creek, this is about half. Also like Plum Creek, the main stem of the creek has substantial wooded buffer, and both have severely altered tributaries.
- Approximately 9 miles of the Potter Creek riparian corridors are wooded or wetlands. Although this represents only about 20 percent of the watercourse length in the subwatershed, there are some areas of large and diverse wetlands along Potter Creek, and Congress Lake Outlet flows through some relatively undisturbed wetland/wooded areas.

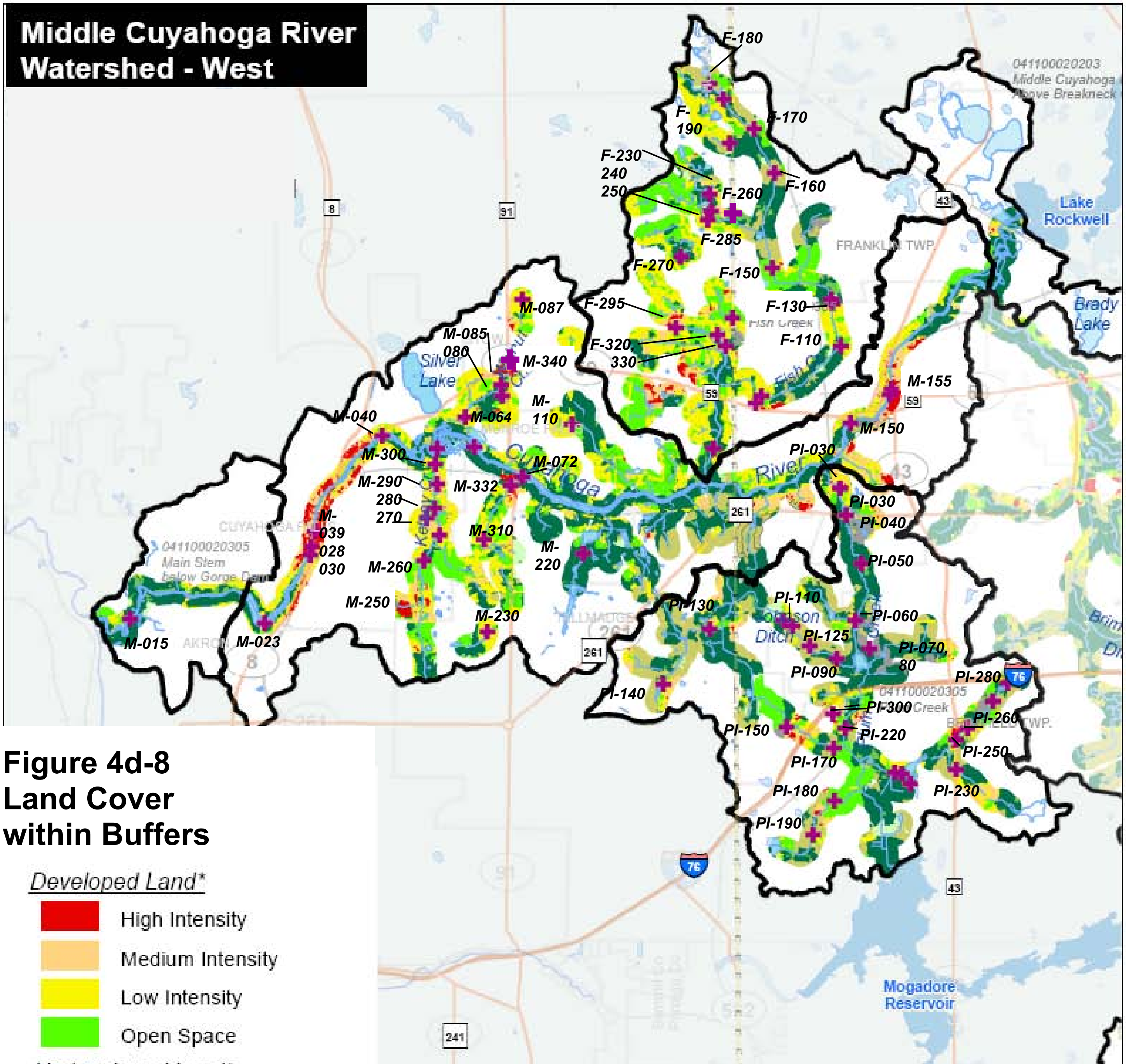


Figure 4d-8 Land Cover within Buffers

*Developed Land**

- High Intensity
- Medium Intensity
- Low Intensity
- Open Space

*Undeveloped Land**

- Agricultural
- Grassland
- Forest/Wetland
- Scrub/shrub
- Open Water

4P Photo Location

PL-230 Photo No.

Streams and Rivers
Lakes
WWH Aquatic Life Use Designation
041100020305 Fish Creek — Subwatershed, 12-Digit HUC

Local Jurisdictions
Interstate Highways
State Divided Highways
State Numbered Routes
Local Roads
Counties

N

Developed land intensity based on imperviousness (e.g. buildings, parking lots, roofs): High - 80-100% (e.g., commercial/industrial, large parking lots); Medium - 51-79% ; Low - 21-50% Open Space - <20% impervious.

Feet
0 4,000 8,000 16,000
1 inch = 8,000 feet

**Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2011.*

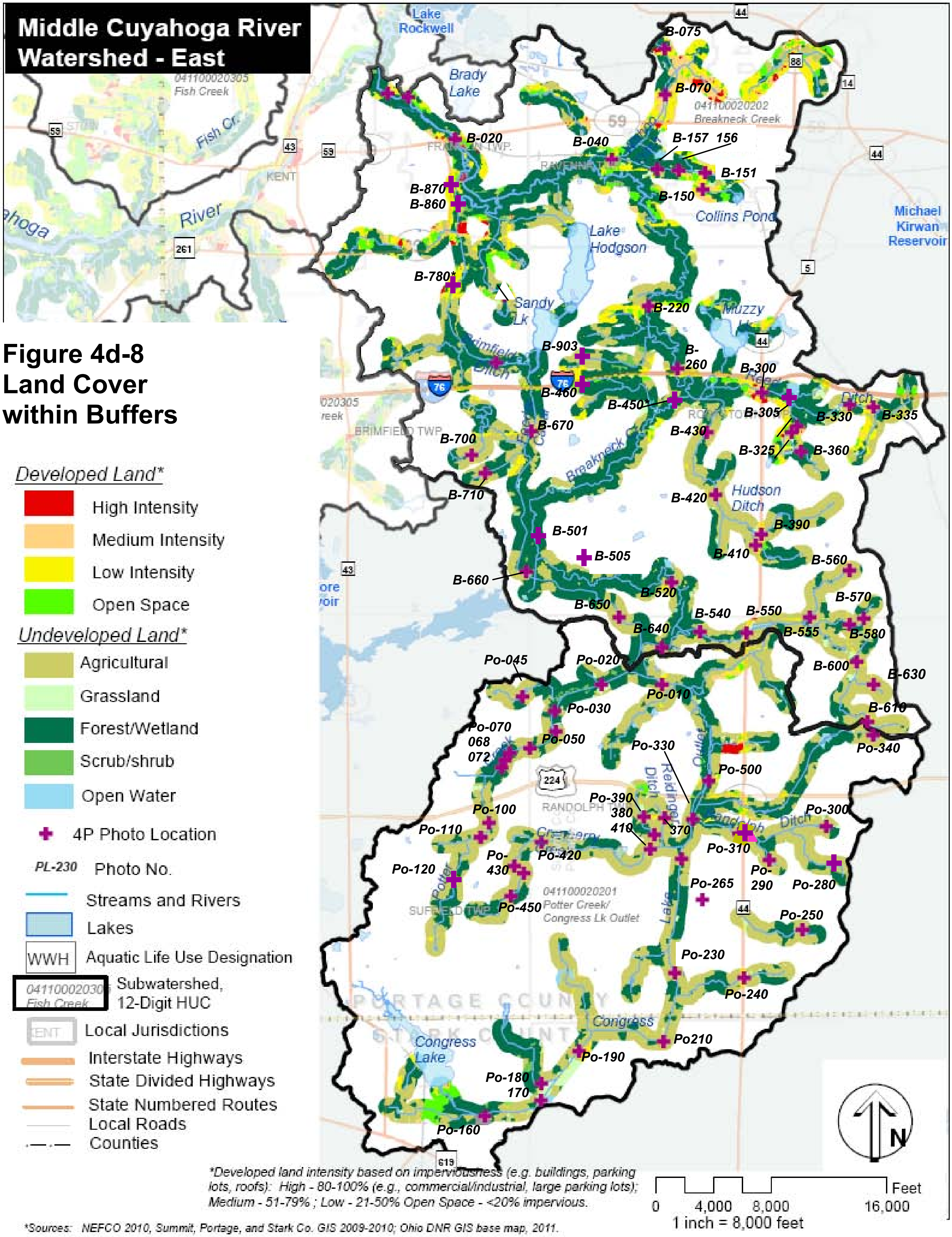


Figure 4d-8 Land Cover within Buffers

Table 4d-2
Land Cover in 75-foot Buffer

Main Stem Tributaries

Land Cover	*Walnut Creek* Acres	*Walnut Creek* Percent	*Kelsey Creek* Acres	*Kelsey Creek* Percent	**Main Stem tributaries** Acres	**Main Stem tributaries** Percent	**Main Stem tributaries** Miles*	**Cuyahoga River** Acres	**Cuyahoga River** Percent	**Cuyahoga River** Miles*
High density development	11	0.7%	17	1.4%	1	0.1%	0	144	2.9%	0
Moderate density development	19	1.2%	81	6.5%	85	8.5%	2	291	5.9%	1
Low density development	1,507	92.6%	733	58.6%	483	48.6%	9	2,037	41.2%	7
Developed open space	36	2.2%	295	23.6%	37	3.7%	1	490	9.9%	2
Cultivated Crops	0	0.0%	0	0.0%	6	0.6%	0	0	0.0%	0
Hay/Pasture	0	0.0%	0	0.0%	158	15.9%	3	11	0.2%	0
Grass	0	0.0%	2	0.2%	0	0.0%	0	7	0.1%	0
Deciduous Forest	45	2.8%	114	9.1%	201	20.2%	4	1,353	27.4%	4
Evergreen Forest	0	0.0%	1	0.1%	0	0.0%	0	0	0.0%	0
Mixed Forest	0	0.0%	0	0.0%	0	0.0%	0	0	0.0%	0
Scrub-shrub	0	0.0%	0	0.0%	1	0.1%	0	27	0.5%	0
Forested Wetland	9	0.5%	4	0.3%	21	2.1%	0	361	7.3%	1
Scrub-shrub Wetland	0	0.0%	0	0.0%	0	0.0%	0	0	0.0%	0
Emergent Wetland	0	0.0%	0	0.0%	0	0.0%	0	55	1.1%	0
Barren		0.0%	0	0.0%		0.0%	0	0	0.0%	0
Water		0.0%	3	0.2%		0.0%	0	167	3.4%	1
Total	1,627		1,252		992		18	4,944		16

Land Cover	**Fish Creek** Acres	**Fish Creek** Percent	**Fish Creek** Miles*	**Plum Creek** Acres	**Plum Creek** Percen	**Plum Creek** Miles*	**Breakneck Creek** Acres	**Breakneck Creek** Percent	**Breakneck Creek** Miles*	**Potter Creek** Acres	**Potter Creek** Percent	**Potter Creek** Miles*
High density development	84	0.8%	0	16	0.3%	0	46	0.3%	0	40	0.3%	0
Moderate density development	322	3.1%	1	65	1.4%	0	534	3.6%	3	18	0.1%	0
Low density development	4,874	47.1%	8	355	7.5%	2	1,577	10.5%	9	171	1.2%	1
Developed open space	1,802	17.4%	3	425	9.0%	2	258	1.7%	1	192	1.4%	1
Cultivated Crops	418	4.0%	1	220	4.7%	1	2,237	14.9%	13	5,452	39.4%	18
Hay/Pasture	544	5.3%	1	1,103	23.3%	5	2,651	17.7%	15	4,989	36.0%	16
Grass	51	0.5%	0	72	1.5%	0	79	0.5%	0	134	1.0%	0
Deciduous Forest	1,717	16.6%	3	1,713	36.1%	8	5,017	33.4%	28	2,219	16.0%	7
Evergreen Forest	10	0.1%	0	4	0.1%	0	28	0.2%	0	117	0.8%	0
Mixed Forest	2	0.0%	0	3	0.1%	0	6	0.0%	0	5	0.0%	0
Scrub-shrub	123	1.2%	0	39	0.8%	0	44	0.3%	0	18	0.1%	0
Forested Wetland	328	3.2%	1	548	11.6%	3	2,074	13.8%	12	727	5.3%	2
Scrub-shrub Wetland	2	0.0%	0	0	0.0%	0	48	0.3%	0	26	0.2%	0
Emergent Wetland	19	0.2%	0	0	0.0%	0	16	0.1%	0	8	0.1%	0
Barren	27	0.3%	0	134	2.8%	1	0	0.0%	0	58	0.4%	0
Water	18	0.2%	0	43	0.9%	0	395	2.6%	2	292	2.1%	1
Total	10,342		18	4,738		22	15,012	100.0%	84	14,467		45

*Estimated by totaling the length measured for channel conditions.

Miles of wooded versus disturbed stream bank would be double the channel lengths. This is a rough estimate, because wooded riparian corridor was often not evenly distributed on both sides of a stream channel, and measurement of narrow wooded areas may not adequately reflect whether they function as disturbed or undisturbed wooded areas. However, these estimates, combined with the mapping, may provide direction in re-establishing wooded corridors.

The mapping of the wooded riparian corridors appears to be reflected in the observed conditions in the stream channels. Based on the limited observations at road crossings, in many cases, the stream systems with intact riparian landscapes (woods or wetlands) appear to have a relatively stable form with riparian zones, well-formed banks, and substrate that may be conducive to warm water species (e.g., gravel), where the flows are high enough (Breakneck, which generally has high quality, is such a low-gradient stream it tends to be silty). In some cases, the stream appears to have recovered somewhat, possibly reflecting reforestation and lack of disturbance. (e.g., 4P Po-030, p. po-1; 072, p. po-2; MS-220, p. ms-6, PL-090, p. pl-2)

Where the mapping indicates that the riparian corridor has been altered to other uses (e.g., developed open space, residential, or agricultural) tributaries are often – but not always – degraded:

- Incised - possibly reflects excessive water loads and the lack of stabilizing riparian vegetation. (e.g., tributaries in Fish Creek, Main Stem, Breakneck Creek, subwatersheds) (e.g., 4P BC-610, p. b-4; FC-330, p. f-7; MS-110, p. ms-6; 132, p. ms-6)

- Silted in- from eroding stream banks and a channel that has eroded down and wider and is no longer able to generate adequate flows to remove fine-grained sediment or deposit sediment on floodplains. These are found along Wahoo Ditch, portions of Potter Creek, Cranberry Creek, and ditches and tributaries in the Breakneck, Plum, and Potter Creek watersheds (e.g., 4P BC-040, b-9; Po-070, p. po-2).

- Along many tributaries that have buffers mapped as “developed open space,” riparian vegetation has been replaced by sod, which provides only minimal watershed function. , The riparian corridor has been altered, but the stream still retains a form that appears stable over the short term. The short, dense root zone of sod and the compacted soil allows very little infiltration and provides almost no bank stability, reduction of flood energy, or pollutant uptake and are likely to degrade. Such areas occur in parks, golf courses, cemeteries, campuses and other large parcels, residential areas, and near many public or quasi-public buildings, and are apparent in the developed portions of all subwatersheds. If these areas can be planted with more appropriate riparian vegetation, it may be possible to prevent costly erosion and restoration problems. (PL-180, p. pl-4; Po-100, p. po-2).

- Along tributaries with buffers mapped as pasture or cropland, the condition of the riparian buffer varies. In some cases, a narrow vegetated buffer remains. In some, the agricultural producer has installed filter strips or has fenced off livestock, providing some protection to the channel. In some, the stream may actually be recovering within a deeper channel. In other cases, the agricultural uses extend almost entirely up to the stream channels. (4P Pl-105, p. pl-2; 110, p. pl-2; Po-240, p. po-9, 390, p. po-7; 110, p. po-3)

The mapping of buffer land cover can be used to target areas for further investigation and possible restoration or improvement. For instance, in areas mapped as developed open space or lower intensity uses, it may be possible to improve vegetative buffer conditions by planting shrubs or trees. In agricultural areas, it would be worth conducting field work and outreach to determine if the producer is using grassed buffers that do not appear on photographs, and whether the producer would be willing to use buffer practices that offer greater protection.

4d Physical Attributes of Streams
- 4 Permanent Protection

As noted in Section 4a-iv, permanent protection in this watershed includes:

- Riparian setbacks – in place in Tallmadge, Munroe Falls, Kent, Ravenna, and Brimfield. Their effectiveness depends on enforcement practices and the specific requirements.
- Conservation Lands – State Nature Preserves at Kent Bog (Cooperider Bog) and Triangle Bog
- Park districts – three parks in Summit County, two in Portage County
- Easements, as shown on Figure 4a-21, are limited.

4d Physical Attributes of Streams
- 5 Altered Stream Network

The stream form and networks develop in response to – and in equilibrium with – the surrounding landscape, influx of water and sediment, and substrate. Many of the important stream functions noted in the introduction to this section are related to an intact stream network and elements of the stream form. This section discusses how the stream forms have evolved and been altered in the Middle Cuyahoga River watershed.

As noted previously, the Middle Cuyahoga River watershed and many of its stream systems have been substantially altered over time, beginning with ditching, canals, and dams, and continuing with recent development and alterations for drainage or agricultural use. In many cases, these alterations reduce the ability of the watershed landscapes to provide the functions necessary for healthy, resilient stream systems, e.g., to absorb precipitation and runoff, filter and absorb pollutants, store floodwater, reduce sediment loads, maintain stability of the stream channel and banks, and support suitable habitats and biological communities.

To show hydrology from approximately 100 years ago, digital versions of early 20th century US Geological Survey topographic maps were processed to suppress all colors but blue (hydrology), tiled together by matching roads and township lines, and overlain by a map of the watershed and current roads and townships. Hydrological changes in recent decades is apparent by comparing NEFCO mapping from the 1990s with current mapping.

Findings:
Altered Stream Network

Findings: Altered Stream Network

Figure 4d-9 shows the stream system mapped in the early 20th century by the U.S. Geological Survey. Overall, the basic patterns of drainage do not appear to have changed substantially from the early 1900s. However, there are also some notable changes. Some may reflect which features were visible and mapped, but some probably represent changed hydrology.

- Figure 4d-9 shows the Congress Lake Outlet but, inexplicably, not the Feeder Canal, both of which comprise the dug canal connecting Congress Lake with Lake Hodgson. As noted previously, a control structure at the lower end of the Potter Creek watershed allows flow from the Congress Lake Outlet to be diverted to the Feeder Canal on demand, which occurs only occasionally during summer (dry) months.

- It appears that many of the streams may have been straightened and channelized (e.g., the lower end of Breakneck Creek, much of Fish Creek, Wahoo Ditch, Cranberry Creek, Reed Ditch, Hudson Ditch, smaller tributaries, etc.)

- In some areas (e.g., upper Plum Creek watershed), it appears that ditches have been extended, most likely into former wetlands. (Historical accounts and mapping show extensive wetlands in the Plum Creek watershed that have been replaced by ditched streams.)

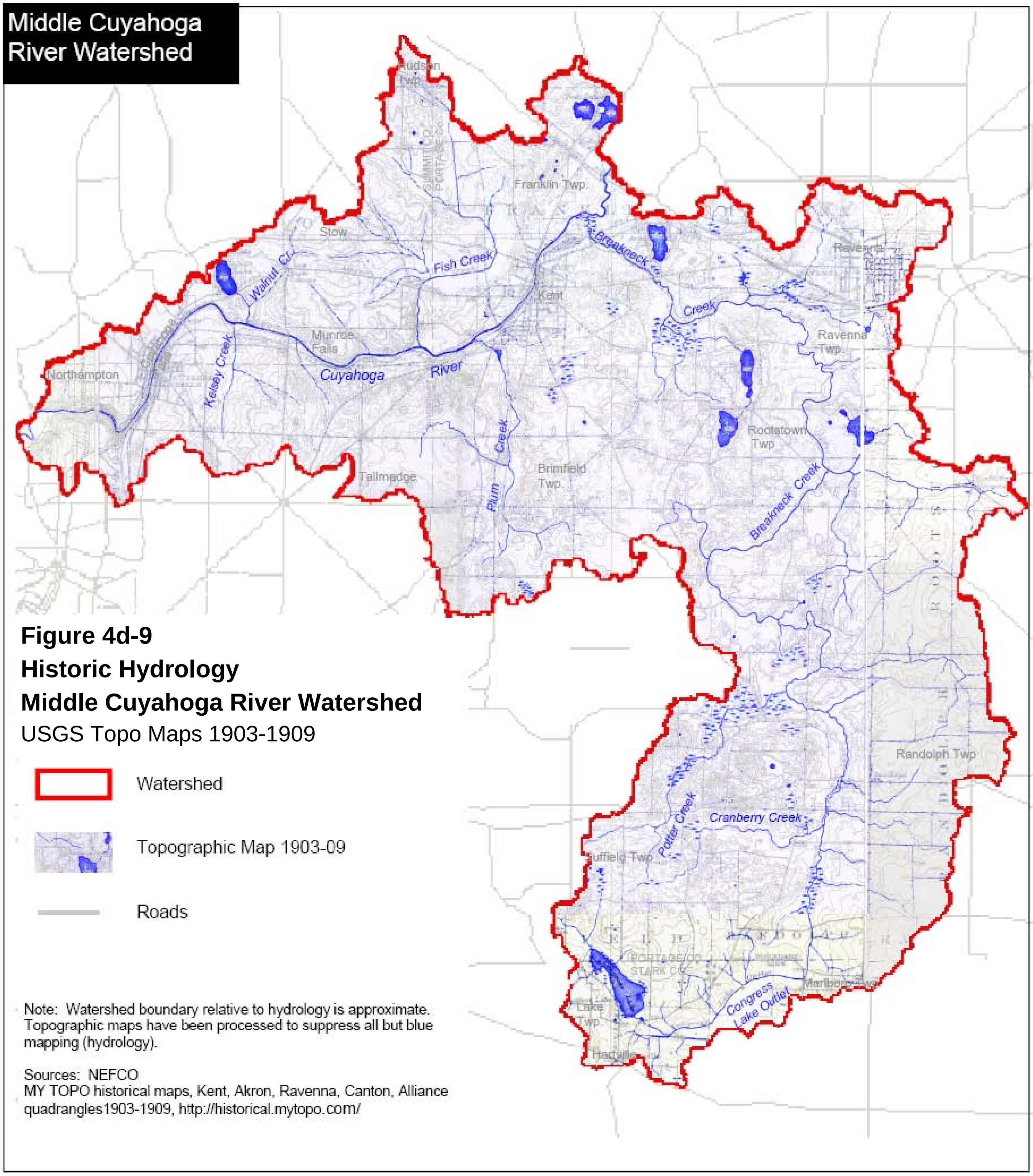


Figure 4d-9
Historic Hydrology
Middle Cuyahoga River Watershed
USGS Topo Maps 1903-1909

Note: Watershed boundary relative to hydrology is approximate. Topographic maps have been processed to suppress all but blue mapping (hydrology).

Sources: NEFCO
MY TOPO historical maps, Kent, Akron, Ravenna, Canton, Alliance quadrangles1903-1909, http://historical.mytopo.com/

- Once-continuous stream systems at Collins Pond in Ravenna and along Fish Creek have been segmented, as streams have been put into pipes. In the Fish Creek subwatershed, many of these changes occurred between the 1990s and 2006, as apparent from previous mapping of the area. (See Figure 4d-10). Stream systems have been further segmented by the presence of impoundments and storm water basins.

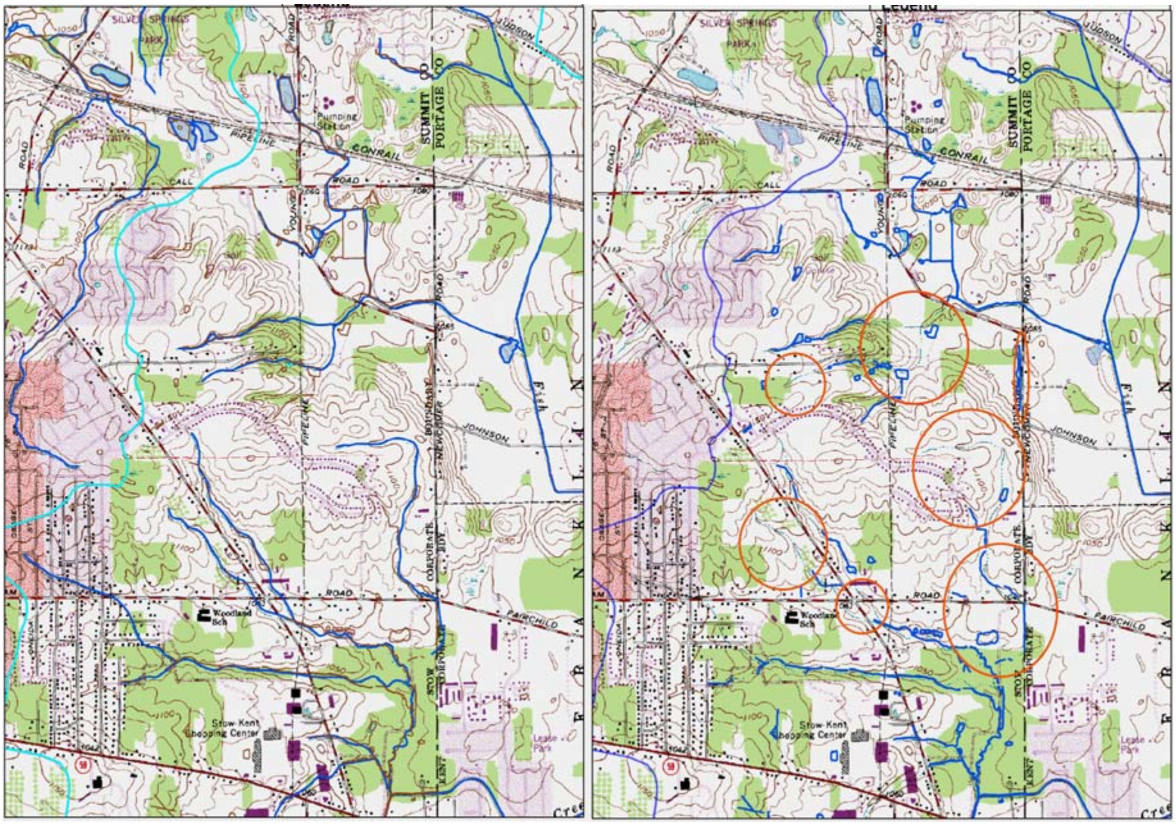
- There seems to be more water in the system. Areas that appeared as wetlands in the 1900s now appear as ponds. Streams that appeared to be ephemeral in the 1900s (e.g., Wahoo Ditch and Fish Creek) now appear to be perennial. Where streams formerly came together, there now appear to be large ponds to retain the water.

- In many of the areas that currently experience flooding problems in developed areas, the hydrology has been altered (e.g. Collins Pond, Brimfield Ditch/Breakneck Creek confluence, Walnut Creek headwaters.)

Headwater Streams

The character of headwater stream corridors has great importance to the water quality and the functioning of stream systems further downstream. Along numerous small headwater streams, water, pollutants, and energy enter the system. The riparian buffer, wetlands, floodplains, and riparian zone take up a relatively large area compared with the volume of water in headwater streams, and play an important role in moderating the amount and quality of the water coalescing downstream from the headwaters.

Studies of streams in their landscapes often quantify the density of streams in their watersheds, finding that the ratio of combined stream length to watershed size increases with soil runoff potential. In landscapes with relatively permeable soils, stream densities can be less than 1 km of stream length per square kilometer of watershed. As the landscape becomes less permeable (e.g., a change in soil types from sand to clay), more water runs off the landscape, creating a denser network of headwater streams.



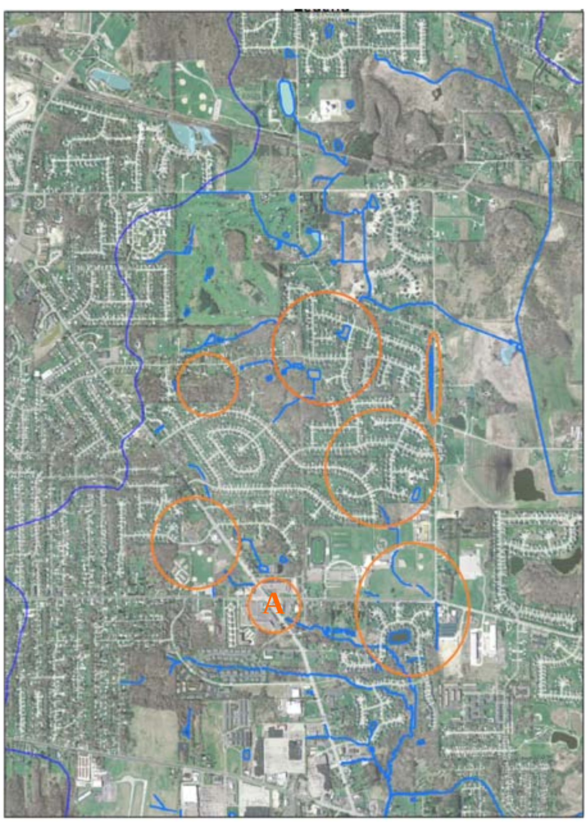


Figure 4d-10. **Hydrologic Changes Fish Creek Watershed.** The hydrology of Fish Creek tributaries has changed radically in just a few years as the watershed became developed. The upper two maps contrast the stream network from the 1990s (left) with 2006. The circles highlight areas where the hydrology has changed. At location “A” the stream has been covered by a parking lot and encased in a pipe.

The landscape of the Middle Cuyahoga River watershed has changed, becoming more impermeable with development and soil compaction. At first glance, it does not appear that the stream network has responded by generating more headwater streams. However, it is important to note that urban and roadway drainage in pipes, along streets, and in ditches, have become the new headwater streams. The density of the headwater stream network has, in fact, increased, since each road functions as a headwater stream. The volume of water entering the stream system has increased, and the large amount of altered landscape at the periphery of these new headwater streams precludes the important stream channel functions noted in Section 4d Introduction (e.g,. storm water absorption, filtering, flood reduction, sediment and nutrient uptake, energy transformation, cooling, and habitat).

Figure 4d-11
New Headwater Streams

The new urban headwater streams found in the developed areas contribute volume but do not provide any treatment provided by undisturbed riparian landscapes.

4d – Physical Attributes of Streams
- 6 Dams, Levees, and Petition Ditches

Dams

The main stem of the Middle Cuyahoga River has been characterized by dams and dam pools for over a century. Dams in the upper portion of the Middle Cuyahoga have already been removed or altered, restoring natural flow along the main stem, Plum Creek, and Kelsey Creek. (See Figure 4d-12). The remaining three dams on the Middle Cuyahoga River in Cuyahoga Falls are being considered for removal, which will restore free flow to a segment of the river that will likely return to rapids.

As shown in Figure 4d-12 numerous small dams still remain in the watershed. Dams are present on most if not all lakes, even though the watershed lakes are mostly naturally occurring kettles. Some of these may be left over from canal period water storage. The largest impoundments include:
- Lake Rockwell, which controls the City of Akron water supply,
- Lake Hodgson – the northern outlet is controlled by a dam
- Congress Lake, a privately owned recreational lake

In addition, there are several publicly owned smaller lakes controlled by dams, including:
- Munroe Falls Park, which impounds a recreational lake
- Muzzy Lake

For the most part, the remaining dams provide smaller recreational lakes and are privately owned.

Levees

The Middle Cuyahoga River and its tributaries do not have the extensive flood-control levees that characterize other rivers in Ohio. Considering levees to be structures that control overflow of a river or creek, the following areas have embankments or walls that control flow:

- A short portion of Walnut Creek in Silver Lake was contained within steel bulkheads to prevent the banks from collapsing in a development built in a wetland.

- Along the channelized portion of Fish Creek near Johnson Rd., the creek is lined with tall banks, presumably made from dredge spoil when the creek was channelized.

- The watershed contains a number of deeply carved ditches that no longer provide floodplain access, including Hudson and Reed ditches, Cranberry Creek, portions of Potter Creek, and Congress Lake Outlet/Feeder Canal.

Petition Ditches

There are four petition ditches in the watershed, all in Portage County. The largest is Wahoo Ditch. These are maintained as a district by Portage County. There is still the potential for improving flood storage (e.g., floodplain access) along petition ditches by working with the affected parties.

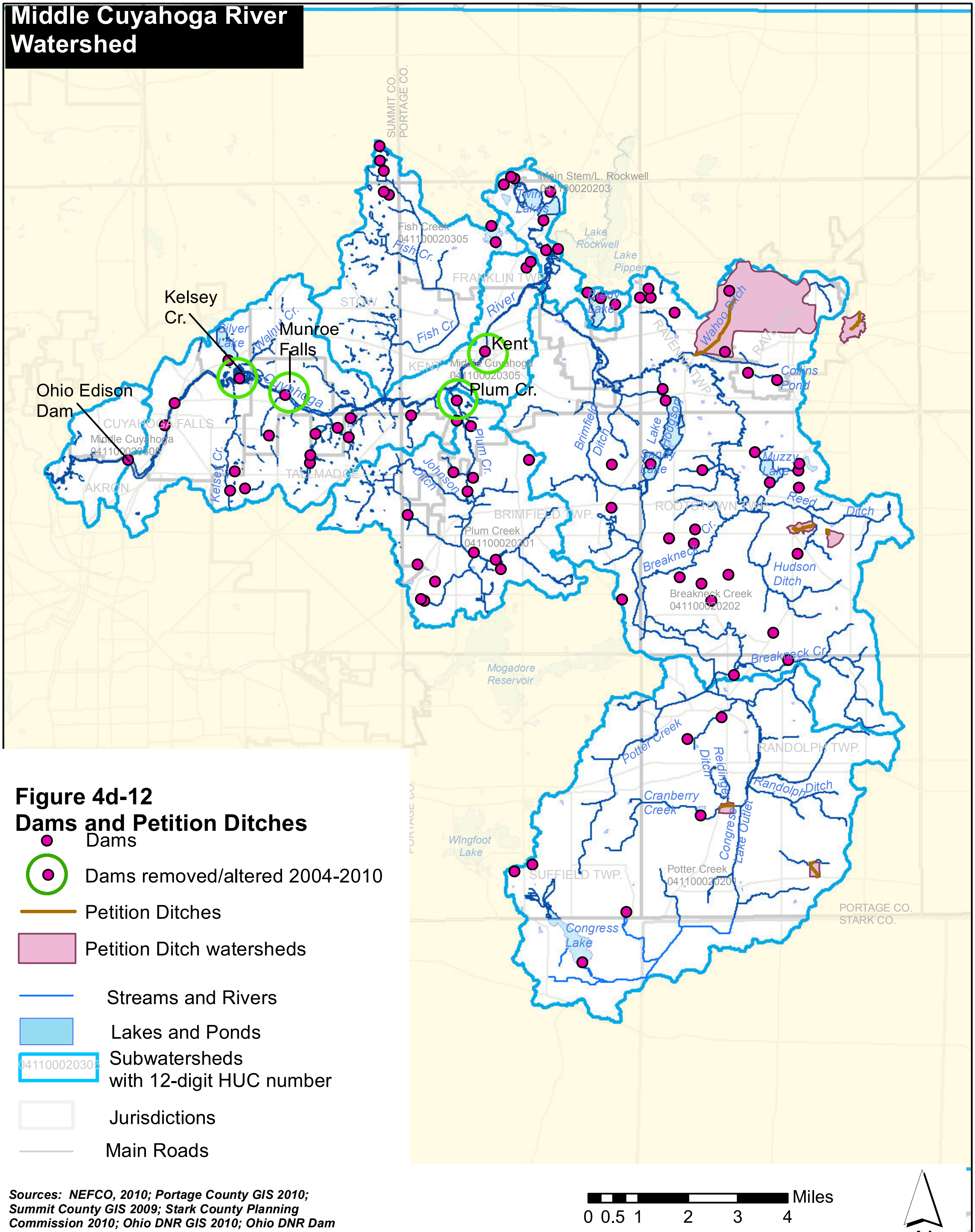


Figure 4d-12
Dams and Petition Ditches

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; Ohio DNR Dam Inventory 2010

4d- Physical Attributes of Streams
- 7 Status and Trends

The altered nature of the watershed has been highlighted in several sections. The intact segments include Breakneck Creek, lower Plum Creek, and the Cuyahoga River outside of the dam pools. These are areas to focus on for preservation.

Many of the remaining tributaries have been altered by ditching, urban development, removal of riparian vegetation, or erosion. The presence of wooded buffers seems to be correlated with improved channel quality, especially where the stream has not been channelized. These altered streams present opportunities for restoration or enhancement. Streams that have not yet begun to erode may offer opportunities to prevent erosion if planted with suitable riparian vegetation.

4d – Physical Attributes of Streams
- 8 Expected Development

At present, the development pressure that characterized watershed communities until 2007 has dwindled, and it is not clear when economic recovery will again spur growth in the region. When the pace of development increases again, it is likely that it will continue to occur in the general locations that had been growing during the previous growth period, i.e, primarily in Brimfield and Rootstown, the Plum Creek and Breakneck Creek subwatersheds, near Route I-76 and the available sewer service, quite possibly in the locations of the platted but unbuilt subdivisions. Any new development that occurs will be covered by stormwater management requirements in place at the time in terms of construction stormwater runoff.

4d – Physical Attributes of Streams
- 9. Expected Road Construction

The AMATS (Akron Metropolitan Transportation Study) develops long-term transportation plans for Summit, Wayne, and Portage Counties. Their long-term transportation planning includes:

- Continued improvements of safety, congestion management
- Continue to work with communities to reduce the burden of development on the transportation system
- Continued promotion of transit opportuntiies
- Limited additional capacity

Two construction projects are currently under way, as of June, 2011, reconstruction of the Crain Avenue bridge in Kent and traffic safety and flow improvements to Summit Road in Kent.

Future projects included in the watershed include primarily safety improvements with some limited capacity expansion on existing roads, including widening along Graham Rd. at Route 91 in Stow, Route 59 in Kent, Howe Ave. in Cuyahoga Falls. Other improvements anticipated include intersection improvements to improve safety, through stoplight modifications and turning lanes.

It is worth remaining aware of upcoming projects. A recent roundabout at Howe Ave. might have been an interesting site for some stormwater infiltration. Bridge projects or possibly road widening could accommodate bicycle traffic. However, most of the projects described in the long term highway recommendations do not lend themselves easily to additional water quality improvements due to their limited scope. It is also worth remaining aware of other road projects anticipated for the watershed, which could provide the need for wetland mitigation.

4e Designated Use and Attainment
-1 Water Quality Attainment, Causes and Sources of Impairment

Designated Use Attainment and Other Water Quality Concerns: Background

Designated Use Attainment and Other Water Quality Concerns - Background

The Ohio EPA conducts physical, chemical, and biological monitoring to determine
- the extent to which assigned use designations are being attained,
- whether the designations are appropriate and attainable, and
- whether there have been changes in physical, chemical, or biological indicators over time.

The assessments focus on biological indicators, because the biological communities reflect the long-term quality of the environment, water chemistry, and stream channel. The assessments also include physical and chemical characteristics and nuisance species that affect aquatic life use and other designations as well (e.g., recreation, water supply).

Habitat – QHEI - and other Biological Indicators

In evaluating the biological communities, the Ohio EPA determines four numerical indices based on the composition of the biological community and habitat characteristics. The premise is that the healthiest systems will have high diversity, an assemblage dominated by pollutant-sensitive species, and few if any species tolerant of pollution. Three of the indices reflect the biological community:
- Index of Biological Integrity (IBI) and the modified Index of Well-Being (MIwb), which focus on the response of the fish community (e.g., health, amount, diversity, and pollutant tolerance of the fish community); and
- Invertebrate Community Index (ICI), which assesses the community of macroinvertebrates (e.g., insects and insect larva, mollusks, snails, crustaceans)

For full attainment of WWH standards, streams and rivers must have biological community scores as follows:

IBI	37/40/40 – WWH Wading/boat-sampled/headwaters, respectively; 24 – MWH-C
MiWB	7.9/8.7 – WWH Wading/boat
ICI	34 – WWH wading/boat; 22 – MWH-C

Scores below the state standards indicate a degraded biological community. The range of scores of each category can help determine what is stressing the communities.

In addition, the biological assessment includes the Qualitative Habitat Evaluation Index (QHEI) method, which evaluates characteristics of the habitat and stream morphology. If the biological indicators suggest that the designated use is impaired, it may well be due to altered habitat. Conversely, if the biological communities are healthy, a reduced QHEI may suggest that the habitat is being degraded, and the biological community may be affected.

The QHEI assessment evaluates six general categories of stream channel characteristics, listed in Table 4e-1, which reflect the quality of habitat, likelihood that biological communities will attain water quality criteria, and to a great extent, the overall health or stability of the system. These variables can provide a positive or negative influence on biological communities and the overall health of a stream, and are scored accordingly in the QHEI as WWH attributes or MWH (modified) attributes, respectively. The target score for WWH is 60 or higher. Characteristics are also rated descriptively from very poor to excellent, based on the score.

Table 4e-1 Habitat Characteristics Measured in QHEI

Variable	**Warm water habitat characteristic**	**Modified warm water habitat characteristic**	**High Influence MWH characteristic**
Substrate*	Large particles clear of silt	Silt, embeddedness (degree to which silt fills in spaces between particles)	Embeddedness, silt/muck substrate
Channel characteristics	Sinuous	Straightened channel	Channelized, no sinuosity
Pool and Riffle quality	Pools > 40 cm, low-normal embeddedness	Lack of distinct pools & riffles	Max. depth < 40 cm
Riparian corridor	Vegetated with trees/ shrubs, floodplain access	Altered, denuded	
In-stream cover	Places for fish to hide – root wads, woody debris, boulders, overhanging banks	Few cover types, lack of in-stream cover	Sparse Cover
Drainage area and gradient	Fast current, eddies	No fast current	

*Ohio EPA has not developed standards for sediment as a pollutant, but the degree of embeddedness of the substrate acts as a surrogate indicator.

The highest scores for habitat, i.e., the most likely to support high quality warm water communities, are assigned to streams with pool-riffle sequences, well-formed banks, gravel substrate, cover in the form of boulders, woody debris, or undercut banks, stable banks, wide forested buffers, sinuous pattern, and accessible floodplain. As stream systems are altered, the indicators are degraded. A 1999 Ohio EPA technical bulletin, *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams (MAS/1999-1-1),* found that if two or more of the key indicators (e.g., substrate, channel form) are determined to be “modified” or “poor,” the water course is unlikely to support the appropriate communities to attain warm water habitat standards. As noted in Section 4d, the attainment of Warm Water Habitat standards thus depends in part on stream morphology.

When biological communities do not meet state water quality criteria, an assessment of habitat characteristics along with chemical parameters may indicate areas that should be improved. The 1999 Ohio EPA technical bulletin documents the correlation between biological communities (IBI) and habitat, noting that when only one or two key characteristics (scored as “high influence”) are modified, the habitat is unlikely to support WWH biological communities, as shown in Table 4e-2. The technical bulletin also identifies targets that can be used in improving/restoring physical channel characteristics in order to significantly improve habitat and biological scores.

Table 4e-2
Effect of Modified Attributes on Attainment of Water Quality Critera

	QHEI Attribute Scores for WWH Attainment	
Attribute	**WWH**	**EWH**
Number of modified attributes	4 or fewer	2 or fewer
High influence modified attributes	1 or fewer	0
Substrate metric score	13 or higher	15 or higher
Substrate embeddedness score	3 or higher	4
Channel metric score	14 or greater	15 or greater
Overall QHEI	60 or greater	75 or greater

Source: Ohio EPA, 1999

Determining Causes and Sources of Non-Attainment

Should a water course fail to meet biological criteria for its designated use, the Ohio EPA evaluates other conditions to determine what might be affecting the biological community (e.g., habitat, dissolved oxygen, turbidity, toxicity) and what the likely sources of the stressor are (e.g., dam pool, flow alteration, non-point sources from surrounding land uses, effluent, etc.). Each cause and source would be addressed by a different type of response.

Other Water Quality Concerns

While attainment of designated uses incorporates some measures of water body health, there are other relevant concerns in the watershed, including:

Sediment and Nutrients–Both sediment and nutrients are of great concern downstream due to their potential effects on Lake Erie and their effect on local waters. Sediment carries with it metals, toxins, and nutrients. Sediment damages habitat, increasing the potential for non-attainment and affecting stream functions such as oxygenation. Removal and disposal of sediment in navigation channels is a costly problem.

The Ohio EPA 1999 technical bulletin on stream health noted the importance of nutrient levels in the health of water bodies and attainment of water quality standards. Biological communities can be stressed with excess nutrients, and excessive levels can result in nuisance algae. Nutrient levels entering Lake Erie have been a concern since the 1960s, when the anoxic "Lake Erie Dead Zone" drew attention to the problem, and nuisance algal blooms fouled the shores. Limits on phosphorous in detergents and sewage treatment plant effluent, and improved farming practices reduced the input of nutrients to the lake problems of anoxia. However, recently, anoxic conditions and nuisance algal blooms have started to recur in Lake Erie during summer months, drawing attention again to the concern of nutrients and the sediment that carries them. A study published in 2010 indicated that changing agricultural practices in the Maumee basin were likely responsible.

Sediment and nutrients are addressed further both as part of this section and Section 4e-3, nonpoint source pollution, as appropriate.

Findings: Use Attainment by Subwatershed

Findings: Use Attainment

Conditions in the Middle Cuyahoga River and tributaries have been documented in several studies that compile data from various periods of monitoring. Table 4e-3 and Figure 4e-1 summarize the use attainment assessed over a period of approximately 20 years in the Middle Cuyahoga River and tributaries. The areas of study differ, reflecting the focus of each:

- The 1997 Technical Support Document (TSD) documented conditions between Lake Rockwell and the Little Cuyahoga River, as part of a study of the entire river.
- The 2000 Total Maximum Daily Load (TMDL) assessment focused on the area between Lake Rockwell (RM 57.7) and Water Works Park (RM 48.6)
- The 2007 TSD documents biological assessment of the same reach as the 2000 TMDL, following removal/alteration of the dams at Brust Park and Kent. In 2007, Ohio EPA monitored as far downstream as Waterworks Park but noted there was no significant change downstream of that point, since there was essentially no change to the downstream dam pools. The Munroe Falls dam site was re-surveyed in 2010 and found to be in full attainment of WWH criteria.
- The 2003 TMDL addressed the river downstream of Brust Park but focused primarily on the conditions below the Little Cuyahoga River. The 2003 Lower Cuyahoga River TMDL briefly addressed habitat, oxygen, and nutrient conditions from Water Works Park to the Little Cuyahoga. However, since there had not been significant changes to this reach, the 2003 document did not provide a detailed discussion of the condition of the dam pools but focused on the combined sewer overflows and downstream concerns. It is assumed that more recent monitoring and the 1997 and 2000 documents adequately reflect conditions between Water Works Park and the Little Cuyahoga River. Habitat alteration was listed as a non-load based impairing cause in the 2003 TMDL.

The assessments over the years, summarized in Table 4e-3, have documented the following:

- Degraded conditions in the Cuyahoga River dam pools,
- Substantially improved habitat and biota in former dam pools with restored flow,
- Intact habitat in Plum Creek and much of Breakneck Creek
- Habitat conditions in the upper portions of Fish Creek reflect its nature as a channel, in the lower portions of Fish Creek, habitat is not a limiting factor.
- Habitat in Kelsey Creek is “fair” (QHEI score 53.5) but may degrade further
- Habitat conditions in other tributaries have not been formally assessed. However, in Section 4d-2, apparent channel conditions are noted. Tributaries identified as eroding or channelized are likely affected by one or more of the high influence factors, may be degraded/degrading, and should be assessed further for contributing factors and opportunities. Tributaries identified as “intact” or “recovering” appear to have characteristics of intact channels and should be protected.

The most recent findings, of full attainment from Kent down to Munroe Falls on the main stem, reflect changes to the river after two dams were altered or removed in Kent and Munroe Falls in response to the 2000 Total Maximum Daily Load (TMDL) analysis. Prior results along the main stem are included for comparison, to demonstrate the dramatic improvements that occurred.

The Ohio Integrated Report includes the impairment listing, known as the Section 303(d) list, which identifies which water bodies are not in attainment of water quality standards and which require implementation of a TMDL to reach attainment. The causes and sources identified are included in Table 4e-3. The results, briefly, are as follows:

- Fish Creek/Cuyahoga River – Reporting status 4A – impaired, no TMDL needed. Priority points 6 out of 20. Watershed Score 60.7. Main stem recreational use score is 89.
- Plum Creek – Reporting status 1Ht – attaining designated use, historical data
- Breakneck Creek. Reporting Status 4Ah – impaired, no TMDL needed, historical data. Watershed score 22.2, Wahoo ditch monitored recently, non-attainment.
- Potter Creek – Reporting status 4Ah – impaired, no TMDL needed, historical data.

While most of the monitored waters in the watershed are impaired to some degree, they are generally a relatively low priority for TMDL. With the exception of the Cuyahoga River, they use historic data. The next monitoring for all is scheduled in 2020, with TMDLs due in 2023.

Table 4e-3
Water Quality Attainment

Subwatershed, HUC 04110002…, Segment, *Assess Date/Report*	**Desig. Uses***	**Location, RM (River Mile) and collection type (b = boat, w = wading)**	**ALU Attain/ 2010 AU score**	**IBI**	**MI wb**	**ICI**	**QHEI**	**Causes/Sources of Non-Attainment**	**Comments**
Middle Cuyahoga									
0203, *OEPA 2010 (sampled 2008), OEPA 2008, OEPA 2000a*	WWH, AWS, IWS, PCR	DST Lake Rockwell dam, 57.67	Partial/ 80					2010, 2000a. Organic enrichment/DO (high); habitat alterations (t); siltation; flow regulation/modification – development (high); minor munic. Point source (slight), land development (t), non-irrig. Crop production	*2008.* City of Akron has maintained flow > 3.5 mgd since resolution of lawsuit. 2000a. Most severe section of non-attainment immediately DST from L. Rockwell, assoc. with hypolimnetic dam releases.
Main Stem 0305, after dam removal/ alteration *Ohio EPA 2008 Ohio EPA 2010*	WWH, AWS, IWS, PCR	Data/sites from Ohio EPA 2008 Kent , Grant St. 55.6 b Kent , Brady's Leap 55.0 b Kent , Tannery Park 54.6/54.0 w Stow, Fish Cr WWTP 51.8/52.0 b Stow, DST FC WWTP 51.0 b MF, former dam site 49.0/50.0 b CF, Water Works Pk 48.7 b	Full Full full partial partial partial non AU score 55	46 42 41 30 32 31 23	8.3 8.2 8.5 7.5 8.4 8.7 6.4	36 36 36 50 NS 44 42	69 76 79.5 61.5 71 66.5 58	Dissolved oxygen throughout dam pool above MF dam meets criteria. - DST Kent - Fish populations recovering after MF dam removal - Scores below MF dam not significantly different than previous score 2010: causes/sources – habitat alteration, flow alteration, nutrients, organic enrichment, siltation, total toxics, unknown toxics; sources – channelization, CSO, dam, major municipal point source, natural, septic tanks, sewer line construction, urban runoff/NPS	Potential enrichment lingering dst of Lake Rockwell – as indicated in elevated phosphorous, nitrate+nitrite levels compared to state and EOLP criteria, invertebrate species, diurnal fluctuations in oxygen. No apparent effects on indicators yet, but nutrients should be monitored Remaining dam pools have not improved since previous studies.

Table 4e-3
Water Quality Attainment (cont'd)

Subwatershed, HUC 04110002…, Segment, Assess Date/Report	Desig. Uses*	Location, RM (River Mile) and collection type (b = boat, w = wading)	ALU Attain/ 2010 AU score	IBI	MI wb	ICI	QHEI	Causes/Sources of Non-Attainment	Comments
Main Stem *before* dam removal/ alteration *Ohio EPA 2000* Main Stem 1997 TSD (Ohio EPA 1999)	WWH, AWS, IWS, PCR	Kent – Grant St., 55.7 dp Kent – Tannery Pk, 55.2/54.4 - ff Kent – Middlebury, 53.4 - dp Stow – UST Fish Cr.53.0/52.6 dp Stow – DST FC WWTP, 51.0 dp MF – Dst dam, 49.7/49.8 - ff CF– Water Works Pk, 48.7/48.4 Dp CF – Dst Cuy. Falls 46.0/45.9 CF – Dst Edison dam 44.0 Akron – Ust Little Cuyahoga 42.8 (dp = dam pool, ff = free flowing)	Non Partial Partial Non Non Partial Non Partial Full Partial	28 28 31 31 30 34 22 28 35 38	8.2 7.6 7.7 7.7 6.2 8.4 5.0 6.7 7.6 6.9	Ns 44 38 18 NS 42 38 34 38 40	51 70 38 64 48.5 83.0 36 67 76 82	Low dissolved oxygen, low assimilative capacity, enriched in P relative to region, due to flow alteration/low stream flow	
Potter Creek 0201	WWH, AWS, IWS, PCR								
Potter Creek, *Ohio EPA 2010, Ohio EPA 2000a Data coll. 1996, 2000*	WWH, AWS, IWS, PCR	Potter Cr. at Trares 1.8/1.5	Partial/ Non AU score 80	24		34	41	Sediment from ag. runoff and poor channel development factors of non-attainment. Habitat/flow alteration (high); siltation (high); organic enrichment/DO (mod); sources: channelization – ag. (high); flow regulation/ modify-cation – development; nonirrig. crop production (high); major/minor municipal points source; natural limits	Segment recovering from past channelization. 2000 TMDL noted that Potter Cr. did not contribute significant COD or BOD to the main stem and that evolution/return to free-flowing state and recovery of riparian area may be enough to improve attainment.
- Congress Lk Outlet	MWH-C, AWS, IWS, PCR								
Breakneck Creek 0202									

Table 4e-3
Water Quality Attainment (cont'd)

Subwatershed, HUC 04110002…, Segment, Assess Date/Report	Desig. Uses*	Location, RM (River Mile) and collection type (b = boat, w = wading)	ALU Attain/ 2010 AU score	IBI	MI wb	ICI	QHEI	Causes/Sources of Non-Attainment	Comments
Breakneck Creek *Ohio EPA 2010* *Ohio EPA 2000a*	WWH, AWS, IWS, PCR	Breakneck Cr (Ohio EPA 2000) - ust WWTP, 2.6 – dst Franklin Hills WWTP, 2.5 – dst Franklin Hills WWTP, 1.6 Breakneck Cr (Ohio EPA 1997/2000) - DST Homestead Ave. 14.1 - Background/reference 9.5 - Reference site 6.8/6.9 - Ust. Wahoo Ditch 5.2 - Breakneck Cr. Ust Wahoo - Dst. Wahoo Ditch 3.1 - DST Franklin Hills WWTP 1.7/1.8 - DST abandoned landfill 0.1/0.5 –	 Partial Partial partial (Full) (Full) Partial Full Partial Non Non Partial 2000a: Partial, 2.0 full 9.5, non 3.8 2010 AU score 80	 44 40 42 -- 46 30 40 41 38 15 44	 7.1 6.3 7.2 -- NA NA NA 6.0 5.1 4.6 7.2	 50 -- 44 46 -- 48 36 44	 -- 67.5 66.5 68.0 -- 56.5 59 69	Upstream of WWTP full attainment except for one exceptionally pooled area. Dst of WWTP severe impacts to fish comm. Some recovery near confluence with Cuyahoga. Improvements since 1984. 2000a. Unknown toxicity (high); flow alteration (high); organic enrichment/DO (mod); major/minor municipal point source (high); natural (high)	2000a. Fish communities showed impacts from Ravenna and Franklin Hills WWTP. Future monitoring recommended.
- Feeder Canal	MWH-C, AWS, IWS, PCR								
- Lake Hodgson	PWS								

Table 4e-3 (cont'd)
Water Quality Attainment

Subwatershed, HUC 04110002…, Segment, Assess Date/Report	Desig. Uses*	Location, RM (River Mile) and collection type (b = boat, w = wading)	ALU Attain/ 2010 AU score	IBI	MI wb	ICI	QHEI	Causes/Sources of Non-Attainment	Comments
Wahoo Ditch, *OEPA 2009, OEPA 2000a, Ohio EPA 2000 Data coll. 1996, 2009*	MWH-C, AWS, IWS, PCR*	RM 2.6 RM 2.5 RM 2.2 Wahoo Ditch DST WWTP (Ohio EPA 2000), RM 0.4	Non Non Non Non	Poor Poor Poor		24 22 26 Poor	Fair, Fair Good	Habitat alterations (High), organic enrichment (mod) unknown contaminants, urban runoff, channelization, sediment PAH, legacy contaminants, severe ditchlike condition; channelization and major municipal point source (2000)	2009 - Sediment PAH levels elevated above probable effect concen.; Channel embedded; DST site had cobble. 2000a – Extensively modified by channelization, choked with macrophytes, substrates several feet deep in silt and muck. Ammonia concen. elev. due to Ravenna WWTP on Hommon Ave. Ditch, but 1984 sampling showed similar poor conditions UST and DST of Hommon Ave. Ditch
- Hommon Ave. Ditch	LRW, AWS, IWS, SCR								
Plum Creek 0301 Ohio EPA 2010 (sample years 2000, 2005, 2006)	WWH, AWS, IWS, PCR		AU score 49					Causes: Direct habitat alteration, flow alteration nutrients, organic enrichment/DO, siltation, total toxicity, unknown toxicity Sources: channelization – development, CSO ?? dam construction, major municipal point source; natural; septic systems; sewer constr.; urban runoff	

Table 4e-3 (cont'd)
Water Quality Attainment

Subwatershed, HUC 04110002…, Segment, Assess Date/Report	Desig. Uses*	Location, RM (River Mile) and collection type (b = boat, w = wading)	ALU Attain/ 2010 AU score	IBI	MI wb	ICI	QHEI	Causes/Sources of Non-Attainment	Comments
Fish Creek, 0305 *EPA 2010, EPA 2000*			AU score 55						
RM 1.3-River	WWH, AWS, IWS, PCR	RM 0.1/0.4	Non	32	N/A	F*	70.5	Unknown (high) Urban runoff (high), highway maintenance, spills, natural (slight)	"Fair" ranking for fish, macroinvertebrates; habitat not limiting
- UST RM 1.3	MWH-C, AWS, IWS, PCR								Due to channelization for flood control, creek UST of RM 1.3 designated MWH-C

Abbreviations RM = River Mile mapped from confluence/mouth to headwaters UST = upstream DST = downstream

Designated Uses: ALU = Aquatic Life Use
WWH = Warm Water Habitat MWH-C= Modified Warm Water Habitat, Channel modification LRW = Limited Resource Waters
AWS = Agricultural Water Supply IWS = Industrial Water Supply PWS = public water supply
PCR = Primary Contact Recreation SCR = Secondary Contact Recreation

Biological Community Indices **EOLP Ecoregion Target Scores**:

IBI = Index of biological integrity (fish) WWH 38/40 (Wading/boat); 40 headwaters MWH C - 24 (headwaters, wading, boat)
MIwb = Modified Index of Well-being (fish) WWH 7.9/8.7 (Wading/boat) MWH C --
ICI = Invertebrate community index WWH 34 MWH C - 22 (fair)
QHEI = Qualitative Habitat Evaluation Index WWH 60 MWH C --
QHEI scores: Excellent 70-100 Good 55-69 Fair 43-54 Poor 30-42 Very poor <30

Sources:
1) Ohio EPA 2010 Integrated Report
Ohio EPA 2009. Biological and Water Quality Assessment of **Wahoo Ditch** (Former White Rubber Property), 2009. Portage County, Ohio
Ohio EPA 2008. **Cuyahoga River** Aquatic Life Use Attainment Following the **Kent and Munroe Falls** Dam Modifications. Portage and Summit Counties, Ohio
Ohio EPA 2000. Total Maximum Daily Load Middle Cuyahoga River.
Ohio EPA 2000a 305(b) Report Appendix D1 Rivers and Streams. Reporting cycle 1998, data generally collected 1996.
Ohio EPA 1997. 1997 TSD - Biological and Water Quality Study of the **Cuyahoga River and Selected Tributaries**. Geauga, Portage, Summit and Cuyahoga Counties, Ohio

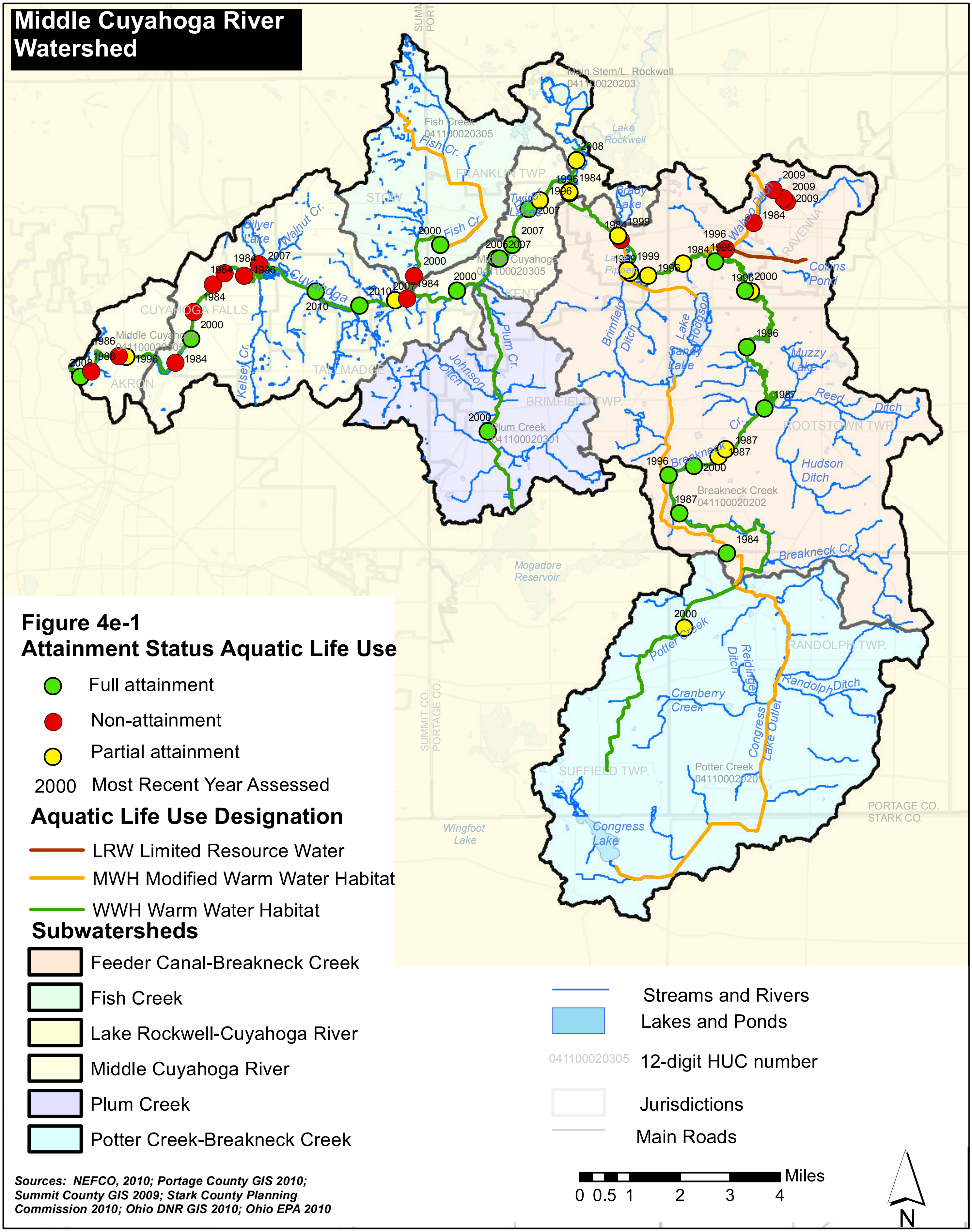


Figure 4e-1
Attainment Status Aquatic Life Use

Main Stem

Middle Cuyahoga River TMDL and Follow-up – Breakneck Creek to Water Works Park

The Middle Cuyahoga River TMDL covers a portion of the river extending roughly from Breakneck Creek to Water Works Park.

The 2000 TMDL reported that this portion of the river was in non-attainment of WWH standards: QHEI scores ranged from 46 to 70 between Lake Rockwell and the Ohio Edison dam pool, and in almost all cases, were adversely affected by the presence of silt and embeddedness, and lack of sinuosity and fast currents.

- The IBI scores were depressed from Lake Rockwell due to the impoundments and low dissolved oxygen, showing a decrease in round-bodied suckers and lithophils and an increase in tolerant fish. Tolerant species were most abundant downstream of Fuller Park in Kent, possibly reflecting the influence of Breakneck Creek nutrients.
- The MIwb, an indicator of biomass, also declined downstream of Lake Rockwell.
- The macroinvertebrate scores, which depend less on habitat, met the WWH criteria except downstream of Lake Rockwell.

The 2000 TMDL found that nutrient enrichment, low dissolved oxygen, and poor habitat caused the river to be in non-attainment, all of which stemmed from the hydromodification related to the dam pools. The TMDL recommended restoration of flow at the dams at Kent and Munroe Falls, increased flow from Lake Rockwell, and improvements or monitoring at various water and wastewater treatment plants. The dams at Kent and Munroe Falls have been altered or removed, the City of Akron has been required to increase its daily release from Lake Rockwell, and wastewater treatment plans were upgraded.

The Ohio EPA has conducted monitoring following the flow restoration, publishing results in its 2007 report, Cuyahoga River Aquatic Life Use Attainment Following the Kent and Munroe Falls Dam Modifications. In the years following dam removal/alteration, the habitat and biota between the Munroe Falls Dam site and Lake Rockwell recovered to full attainment status. By changing the substrate composition, stream morphology, and hydrology, habitat improved and effects of nutrient enrichment declined. The 2007 assessment reported QHEI scores throughout the reach ranging from 58 downstream of the Munroe Falls dam site to 79.5, well above the level needed for WWH biological communities. By 2010, fish populations had reached full attainment throughout the dam pools.

The QHEI for the former dam pools indicated the following improvements to habitat:

- Substrate upstream of the former Munroe Falls Dam is predominantly cobble, bedrock, boulders, and gravel
- Improved riparian zone – newly formed in response to the lowered water level
- Positive channel and riparian features fully developed or recovering - channel form, riffle-run-pool sequences. While the riparian zone was vegetated, riparian cover was sparse in places due to the early stage of bank recovery and lack of trees.
- In-stream cover – the river bottom is predominantly cobble. In-stream cover was somewhat limited, as the riparian trees had grown and fallen along the edge of the former dam pool. The riparian zone of the downstream portion of the former Munroe Falls dam pool has little tree cover due to the wide band of dam-pool sediment along the margin.

Since 2007, observation indicates that additional bedrock and cobble/gravel substrate has been exposed, as sand has been transported out of the reach. In-stream cover is increasing as trees have fallen into the river and been lodged along the margins or carried downstream.

Cuyahoga River below Water Works Park/Munroe Falls Dam (Upper reaches of Lower Cuyahoga TMDL (RM 48.6 to 42.6)

The Lower Cuyahoga River TMDL covers the area between Water Works Park and the confluence with the Little Cuyahoga River. The 1999 TSD/2003 TMDL noted that in much of the Lower Cuyahoga, physical habitat attributes are generally high quality and include wooded riparian corridors, coarse substrates, and natural channel. Some areas of the corridor are urbanized, with altered channels and riparian corridors, and impacts to aquatic life. The QHEI score in the free-flowing portion of the Gorge upstream of the Ohio Edison dam and in the free-flowing portion downstream of the dam ranged from 67 to 82, and biological communities met WWH criteria but upstream (dam pools) the scores ranged from 46.5 to 56, reflecting the negative habitat features noted above (silt cover, embeddedness, lack of sinuosity).

The site at Water Works Park is downstream of the Munroe Falls and Kent dam pools and was assessed during the 2007 study. The post-dam removal QHEI score (58) at RM 48.6 in Water Works Park, downstream of the Munroe Falls Dam site, had not significantly changed from before the dam removal. Sand from the former dam pools has collected at the quiet waters in the upper portions of the Cuyahoga Falls dam pools, but it has not affected the QHEI score.

The 2003 Lower Cuyahoga TMDL noted that non-attainment in the Lower Cuyahoga was related to a shift in biological communities from sensitive species, top carnivores, and benthic insectivores (e.g., darters, insectivorous minnows, redhorse, and esocids) to tolerant species, generalists, and detritivores (e.g., carp, creek chub, bluntnose minnow, white sucker, and green sunfish). The 2000 bioassessment indicates low biomass and high occurrence of DELT anomalies, evidence of nutrient enrichment. In 2007, fish samples at RM 48.7 were not significantly different from pre-dam removal conditions, ranked “poor,” and were in non-attainment of state standards. The IBI did not change significantly from pre-removal (26 in 1996 to 23 in 2007), but the MiWB declined (7.1 to 6.4), possibly due to the migration downstream of carp from the former dam pools. Predominant species were tolerant species and omnivores: carp, bluegill, northern hog-sucker, bluegill, small-mouth bass, and white sucker.

The 2003 TMDL states that in the section of the Cuyahoga River between Lake Rockwell and the Little Cuyahoga River, primary causes of impairment were organic enrichment, low dissolved oxygen, flow and habitat alteration due to impoundments and reservoir releases. The portion immediately downstream of Water Works Park (mile 48.6) was in non-attainment due to nutrient enrichment and hydromodification.

Since habitat conditions and biological communities have not improved significantly since the initial work, the remaining dam pools can still be considered to be in non-attainment due to poor habitat and nutrient enrichment resulting from the impoundment by the dams.

Removing the Munroe Falls dam caused downstream migration of sediment as flow increased, and the sediment has been moving in a relatively cohesive lens downstream to the next dam pool in the series in Cuyahoga Falls. However, two low-head dams (less than 12 feet high) are scheduled to be removed in Cuyahoga Falls in 2012, and studies are under way to analyze the feasibility of removing the 57-foot tall Ohio Edison dam. Restoration of unimpeded flow would likely address the remaining water quality impairments along the main stem. Sediment that has accumulated in the uppermost remaining dam pool will likely be transported down to the Ohio Edison dam. The sediment behind the Ohio Edison dam would be removed and disposed in a suitable location prior to dam removal.

Tributaries

Biological monitoring has been conducted along the tributaries to a smaller degree than the Cuyahoga River. Data from Ohio EPA reports is supplemented with qualitative observations, which are also discussed further in Sections 4d-2 and 5a.

Kelsey Creek

Kelsey Creek in Kennedy Park was assessed in 2012 in response to incising related to urban runoff and removal of a low-head dam. The QHEI was 53.5. Modified influences included embeddedness, silt substrate, eroding banks, lack of cover, lack of riparian zone, lack of floodplain access. The assessment noted that many positive features still remain at the location, including riffles and pools, areas of gravel substrate. The assessment also noted that while the creek had not eroded to an irrecoverable state, if vertical erosion continued, the creek likely would degrade past the point of recovery.

Observation suggests that where the creek flows through wooded riparian areas, the substrate is less silty. Upstream of Kennedy Park, Kelsey Creek flows through the wooded Galt Park, the City of Cuyahoga Falls Brookledge golf course, a wooded riparian buffer in a subdivision, and an altered wetland at its headwaters. The creek and buffer area in Galt Park appears to have been affected by excessive runoff from development, with areas of heavily eroded banks, but appears to be recovering and has a gravelly substrate, with pools that hold water during summer dry months interspersed along an ephemeral gravelly stream bed and a wooded riparian buffer. In the riparian area within the residential subdivision, the substrate has a greater proportion of fine-grained particles, but this is near the headwaters, a low-gradient wetland area so level that the watershed divide is indistinct. Primary headwater tributaries of Kelsey Creek largely flow as drainageways through a developed landscape and are often hardened, lacking any habitat characteristics. The main stem of Kelsey Creek begins in a disturbed wetland dominated by *Phragmites*, that appears to be affected by urban runoff from nearby development. The creek appears to cross the watershed divide in the wetland, with one portion flowing north to the Middle Cuyahoga River and another flowing south to the West Branch of the Little Cuyahoga River.

Walnut Creek

Ohio EPA has not formally assessed this creek. The uppermost headwaters of Walnut Creek are largely urban drainageways. The creek flows through two parks in Stow. In both cases, the creek exhibits many positive characteristics, including heavily wooded riparian corridor, gravel or bedrock substrate. However, in both cases, the creek also shows signs of excessive loading, with eroding banks, likely a combination of steep gradient and heavily developed landscape. In Adell Durbin Park, severe erosion occurred on the hillside adjacent to Route 91. Near the confluence with the Cuyahoga River, this creek was confined in between sheet metal walls to stabilize the banks within a development that occurred on a wetland/floodplain adjacent to the creek.

Other Mainstem Tributaries

The other tributaries entering the river in the Main Stem subwatershed are headwater streams smaller than Kelsey and Walnut Creeks. Many are incising, likely a result of runoff from the heavily urbanized landscape and steep slopes. They exhibit lack of floodplain access, lack of sinuosity, rapidly eroding banks, and minimal riparian vegetation. The exception is the stream within the Munroe Falls MetroPark. MetroParks staff note that they have assessed this stream and it attains the QHEI criterion. The stream is controlled by a series of impoundments, but the portion within the park exhibits broad, vegetated riparian zone, gravel substrate, floodplain access, sinuosity, riffles and pools, and a wooded riparian buffer.

Fish Creek

The portion of Fish Creek upstream of River Mile (RM) 1.3 was re-designated MWH-C (channelized) in the early 1990s, reflecting the channelized nature of much of the creek. This portion of the creek has been in attainment of MWH-C water quality standards. The portion downstream of Spaulding Road exhibits riffles and some sinuosity within the channelized area. Upstream, the substrate of the channel appears to be silty. From the Portage County line and downstream, the creek lacks floodplain access, flowing through channelized wetlands. The primary headwaters of the creek largely flow through developed areas and exhibit varying degrees of alteration. Some flow through shaded riparian buffers; some have been protected with fringing wetlands; some flow unprotected with banks and riparian areas vegetated in sod, some are simply urban drainageways, as shown in section 4-d, Channel Conditions and Altered Riparian Zone. Many of the primary headwaters are much more steeply sloping than the main channel.

The lower 1.3 miles of the creek, still designated WWH, was not in attainment during bioassessments conducted in the mid-1990s. Biological and habitat quality were not severely degraded (IBI score 26; QHEI 70.5), but fish population data suggested stressed communities. The TMDL suggested that contributing factors included the channelization of much of the upper reaches of Fish Creek, runoff from recent construction, urban development, and agriculture. Both IBI and QHEI scores declined between 1991 and 2000, a period of rapid development in the Fish Creek subwatershed. It is likely that this portion of the creek has been degraded by upstream influences in the developed – and highly altered – portion of the watershed in Summit County and the ditched creek in Portage County. With such limited watershed functions, the high degree of imperviousness, and the non-point source pollution coming from the built watershed, this stream is overloaded with contaminants and water, and has very limited ability to mitigate the effects through assimilation, filtering, uptake, flood storage, etc.

Another factor may have an effect on the lowermost section of the channel. When the most recent bioassessment was conducted, the main stem of the Cuyahoga River was still a dam pool at a higher elevation. The water level has since been lowered. Ohio EPA staff have speculated that perhaps lowering the base level of Fish Creek (at the river) has increased the velocity in the undisturbed section enough to improve water quality attainment. It is important to re-assess the lower portion of Fish Creek to determine if the conditions have changed significantly.

Plum Creek

Plum Creek was assessed at two locations in 2000, 3 miles upstream of the confluence with the river and downstream of a small low-head dam, both of which were in full attainment, with QHEI scores of 68.5 and 62.5, respectively. Because the sampling sites are within wooded, relatively undisturbed corridors, they are likely to continue attaining the habitat criteria. However, the area has undergone substantial development in the ensuing years, and it would be valuable to re-assess periodically to determine if the changing watershed is affecting water quality. A low-head dam immediately upstream of Cherry St. was removed in 2010, restoring flow, and a portion of the creek within Plum Creek Park upstream of the dam was restored to re-establish sinuosity, floodplain access, and in-stream cover (boulders). This portion of Plum Creek is no longer a stagnant dam pool but exhibits meanders, riffles, pools, and appears to be developing a gravel substrate.

As described further in Section 4d, the lower 4-5 miles of the creek remains largely intact, flanked by extensive wetlands and floodplains, which likely contribute to the high quality of the stream. Approximately 12 miles of the upper reaches of Plum Creek have been channelized or modified to provide drainage in developed or agricultural areas and exhibit modified characteristics (lack of riparian vegetation, lack of floodplain access, eroding banks, embeddedness, lack of sinuosity). Portions of this modified landscape have been either improved (oversize stormwater basin near Munroe Rd. in Tallmadge replacing a ditch) or left undisturbed (JayCee Park on Howe Ave. in Tallmadge), improving but not entirely restoring the habitat characteristics. Portions of the creek are rapidly eroding and lack riparian vegetation in agricultural areas or golf courses. This subwatershed experienced rapid development between 2000 and 2007, the beginning of a multi-year economic slowdown. Once development begins again, it is likely that this area will again be the focus of growth. It is important to continue monitoring this creek and enforcing and improving upon the use of vegetated setbacks to protect the intact portion of the creek.

Breakneck Creek

Breakneck Creek is described as a low-gradient swamp creek with channel modification in several areas. The QHEI scores are affected by substrate and silt-free substrate categories, reflecting a relatively low velocity, and occasionally channelized sections. However, the 1997 TSD describes the biological communities between RM 5 and 15 as good to exceptional quality in full attainment of WWH criteria. This portion of the creek has abundant positive habitat characteristics, including instream cover from the largely intact wooded riparian corridor, submerged aquatic vegetation, floodplain access and deep pools.

Downstream of Summit Road, portions of the creek are channelized, and biological communities are influenced by urban development and wastewater treatment plants.

During the 1980s, macroinvertebrate sampling exceeded the WWH biocriterion from upstream to downstream of the wastewater treatment plants, and the fish community and habitat provided an excellent example of a swamp stream, with submerged aquatic vegetation, northern pike, darters, and horneyhead chubs. Between the 1980s and 1996, the fish indices downstream from the Franklin Hills wastewater treatment plant declined, indicating in-stream toxicity. During subsequent sampling in 1999, following reductions in bypasses at the Ravenna WWTP, IBI scores in the lower reaches of the creek met or were within non-significant departure of the EOLP criteria, ranging from 40 to 42. However, none of the downstream sites met MIwb criteria (ranging from 6.3-7.2, compared to the biocriterion of 7.9), indicating probable impacts from nutrient enrichment. The lowest dissolved oxygen concentration occurred just downstream from the Franklin Hills WWTP, at the same location of the lowest-scoring biological indicators. An increase in tolerant fish at RM 3.1 compared to RM 5.2 indicated impairments were related to the Franklin Hills and Ravenna wastewater treatment plants. The 2000 TMDL notes that fish communities in the Cuyahoga River downstream of Breakneck Creek declined, suggesting effects of nutrient enrichment from Breakneck Creek.

According to the 2007 EPA monitoring report on the Middle Cuyahoga River, upgrades have occurred at both wastewater treatment plants. It is important to re-assess the lower portion of Breakneck Creek to determine if the upgrades improved water quality or if the altered watershed has affected water quality.

As described further in Section 4d-2 and 5a, several tributaries to Breakneck Creek and the uppermost reaches (above the confluence with Congress Lake Outlet/Potter Creek) are channelized and are influenced by factors such as:

- eroding banks from runoff or agricultural activity, including unrestricted livestock access
- urban runoff
- lack of vegetated riparian buffers, floodplain access, and sinuosity,
- high degree of embeddedness.

In spite of habitat impairments along the channelized ditches and headwater streams, it appears that the extensive flanking wetlands and floodplains of the middle portion of Breakneck Creek buffer the impacts from the upstream tributaries.

Wahoo Ditch

Wahoo Ditch has been in non-attainment of modified WWH standards for channels from the first studies in the 1980s to 2009, when it was assessed as part of a Voluntary Action Plan for remediation at the former White Rubber Corp. Factors in non-attainment included of habitat alterations, organic enrichment, unknown contaminants, urban runoff, channelization, sediment PAH, legacy contaminants, its severe ditchlike condition, channelization, and a major municipal point source (2000), Wahoo Ditch is a maintained ditch, with severely altered hydrology, flowing through a heavily urbanized and industrialized area. There is some open land alongside portions of the ditch. It may be possible to improve conditions at isolated locations in the ditch.

Wahoo Ditch was assessed for the 1997 TSD and also more recently for a Voluntary Action Plan (VAP) for a cleanup on a property along Wahoo Ditch. The 2000 TMDL indicated that macroinvertebrate communities in Wahoo Ditch, designated MWH, were very poor downstream of the Ravenna WWTP and were in non-attainment of MWH standards. The TMDL noted that toxicity effects from the WWTP effluent were probably exacerbated by the extremely severe ditch-like conditions of the channel. Nitrate, phosphorous, and ammonia concentrations in Wahoo Ditch were higher than in Breakneck Creek. The 2009 bioassessment reported that the ditch was still in non-attainment. IBI scores at three sites near the proposed VAP property ranged from 22 to 26, which marginally attained MWH criteria, except at RM 2.5, where the fish community was dominated by pollution/habitat tolerant species. ICI narrative scores were "poor," ranging from 21-28, and habitat scores of 44.5-55, were described as fair to good for channelized conditions. See Table 4e-3. Conditions affecting the scores included embeddedness, silt substrate, channelization. All sites were severely embedded. The 2009 report identified the causes and sources of non-attainment as:

- Causes - Habitat, unknown contaminant, PAHs
- Sources - Channelization, urban runoff- discharge, legacy contaminant sediments.

Chemical analysis of the Wahoo Ditch sediments indicated that all three sampling sites had PAH compounds in the sediment that exceeded the Probable Effect Concentration (PEC) a level of concentration above which effects are likely to be observed.

Potter Creek

The 2000 TMDL noted that Potter Creek was in attainment of chemical standards, but did not fully meet WWH standards due to a poor fish community. The TMDL noted that the creek was recovering from prior channelization, with a narrow riparian corridor becoming established along portions and free-flowing conditions beginning to develop. However, the TMDL noted that the creek was still degraded by embedding silt and poor channel development. Based on field visits to road crossings and a potential restoration site, all these observations still appear to be valid: While portions of Potter Creek (especially in wooded or wetland areas) are recovering stream form and habitat characteristics, many portions of the creek are still embedded with silt and exhibit poor channel formation, lacking many important stream channel elements and functions.

Recent observations indicate that the riparian corridor continues to develop at the sampling location (Trares Rd.). Upstream of the sampling site, a portion of Potter Creek was evaluated for a potential stream restoration/improvement project within an agricultural field near Conley Road. Within the agricultural field, Potter Creek is channelized and severely embedded. Upstream of the agricultural field, the creek habitat is clearly recovering as it flows undisturbed through a wooded reach and exhibits gravel substrate, and shallow pools and riffles. Observed conditions along the length of Potter Creek vary, including severely channelized and embedded sections, reaches that are recovering in woods or adjacent to livestock yards, a narrow grassed channel in a residential area, and an apparently intact section within a wetland complex at the lower end. Channel conditions are discussed further in Section 4d-2.

Bacteria

Bacteria

Water quality standards include bacteria limits in recreational waters. The 2003 Lower Cuyahoga River TMDL listed bacteria exceedences as one of the quantifiable causes of impairment of the Lower Cuyahoga River. Bacteria level exceedences listed in the TMDLs and subsequent monitoring are shown in Table 4e-4. August 10, 2000, was a period of relatively high flow (500 cfs, falling from 900 cfs three days earlier).

Table 4e-4 Bacteria Exceedences

Location	Date	Fecal coliform/e. coli mpn*
Cuyahoga River		
Cuyahoga St., RM 42.6	8/10/2000	5,300/3,600
Cuyahoga St., RM 42.6	7/14/2008	--/1,200
Broad Blvd (RM 46.25)	8/10/2000 8/3/2000	2000/140 1,000/630
Water Works Park (RM 48.38)	8/10/2000	5,200/2,600
Tributaries		
Fish Creek at Spaulding Dr.	8/3/2000	1,100/1,400
Fish Creek at N. River Rd. RM 0.4	8/3/2000	1,000/580
Plum Creek at Cherry	8/3/2000	1,700/530

* *State Rec. Waters e. coli criteria: Cat. A - 298 Cat. B - 523*

Bacteria exceedences along the Cuyahoga River corresponded to higher flows in the river.

Beneficial Use Impairments – Area of Concern

Beneficial Use Impairments: Area of Concern (AOC)

The Cuyahoga River Area of Concern extends to the area of the Gorge in Cuyahoga Falls. The AOC had originally been designated as far upstream as the Ohio Edison Dam but has recently been extended into the Gorge area in Cuyahoga Falls to include sediment in the dam pool upstream of the Ohio Edison dam.

Beneficial use impairments identified in the Remedial Action Plan include:

- Cultural eutrophication (nutrients)
- Toxic substances
- Bacterial contamination
- Habitat modification
- Sedimentation

Sources include:

- Municipal and industrial discharge
- Bank erosion
- Commercial/residential development
- Atmospheric deposition
- Hazardous waste disposal sites
- Urban stormwater runoff
- Combined sewer overflows
- Wastewater treatment plant bypasses

Chemistry: Nutrients - Background

Nutrient enrichment in the Cuyahoga River has been a concern in all recent restoration efforts, and nutrient enrichment has again become a concern in Lake Erie. The 2000 Middle Cuyahoga TMDL focused on dissolved oxygen levels and nutrient enrichment. Dam removal/modification and upgrades to wastewater treatment plants reduced but did not entirely eliminate the enrichment. The Lower Cuyahoga River TMDL lists nutrients as a major cause of non-attainment and urban runoff as a major source. Within the Cuyahoga River AOC, cultural eutrophication was listed as a cause of impairment of beneficial use attainment.

Key nutrients in the Cuyahoga River are phosphorous and nitrogen. Phosphorous is the limiting nutrient in the aquatic system of the Cuyahoga River and Lake Erie downstream, meaning that as levels of phosphorous increase, algal growth will likely increase.

In its 1999 technical bulletin, Ohio EPA assessed the effects of nutrients on quality of habitats and eutrophication throughout the state. Waters with greater amounts of nutrients relative to the ecoregion median were considered enriched in nutrients. Ohio EPA is using the 75th percentile value of nutrients as a statewide target for nutrients. (See Table 4e-5.)

Table 4e-5
Nutrient targets and median values for EOLP communities in attainment

	Total P (mg/l)		**Nitrate + Nitrite (mg/l)**	
	EOLP Median/Target	Statewide Target *WWH MWH*	EOLP Median/Target	Statewide Target *WWH MWH*
Headwaters (drainage area <20 sq. mi.)	0.05	0.08 0.34	1.0	1.0 1.0
Wadable streams (drainage area (20-200 sq. mi.)	0.07	0.01 0.28	1.05	1.0 1.6
Small rivers (drainage area 200-1,000 sq. mi.)	0.12	0.17 0.25	1.42	1.5 2.2

Total Phosphorous includes dissolved phosphorous (DRP/SRP – dissolved or soluble reactive phosphorous, phosphate) and orthophosphorous. Orthophosphorous, which sorbs to fine sediment, increases with storm water runoff and accumulates at the bottom of lakes and dam pools. DRP is more readily available for biological uptake. It is closely associated with animal waste products and is influenced by levels in treated wastewater and agricultural runoff. Reducing the adverse effects of nutrient enrichment requires reducing phosphorous from both sources.

Several nitrogen compounds are available for and part of algal growth in fresh waters. Nitrate and nitrite are associated with animal waste and may be found in wastewater treatment effluent.

Findings: Nutrients in the Cuyahoga River and Tributaries

Assessments of the Cuyahoga River have included a multi-faceted assessment of indicators, which suggest that the Cuyahoga River is somewhat enriched in nutrients. The following are discussion points raised in the 1999 TSD, 2000 TMDL, 2003 TMDL, and 2007 Bioassessment following dam removal/alteration:

- Levels of total and dissolved phosphorous in the river are occasionally higher than the state median values for the ecoregion (0.12 mg/l), ranging from <0.05 mg/l to 0.46 mg/l. (See Table 4e-6). The higher values on July 11-12, 2007, shown on Table 4e-6, occurred during or after a rain event, suggesting that runoff is contributing phosphorous to some degree.

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous			Nitrogen					
			TP (mg/l)	Exceed State	Exceed EOLP Median	Nitrate + Nitrite (mg/l)	Exceed State	Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Cuyahoga River Main Stem											
State Criteria				0.17			1.5			Class A rec.	298
EOLP Median					0.12			1			
Cuyahoga Street RM 42.6	7/19/00	300, falling from 1,000 cfs on 7/14	0.09	FALSE	FALSE	1.14	FALSE	**TRUE**	11	210	FALSE
	7/25/00	120, falling	0.06	FALSE	FALSE	1.16	FALSE	**TRUE**	<5	64	FALSE
	8/3/00	165, falling	0.06	FALSE	FALSE	1.35	FALSE	**TRUE**	<5	220	FALSE
	8/10/00	550, falling from 900 on 8/7; turbid, high flow								3600	**TRUE**
	9/14/00	130, level	0.1	FALSE	FALSE	1.97	**TRUE**	**TRUE**	<5	69	FALSE
	7/10/01	125, falling from 180	0.075	FALSE	FALSE	1.48	FALSE	**TRUE**	<5		
	7/12/01	110, falling	0.079	FALSE	FALSE	1.36	FALSE	**TRUE**	<5		
	8/29/01	84, falling from 120	<.05	FALSE	FALSE	1.84	**TRUE**	**TRUE**	6		
	8/30/01	65	<.05	FALSE	FALSE	1.68	**TRUE**	**TRUE**	5		
	6/25/08	250 falling from 400 on 6/23	0.054	FALSE	FALSE	1.46	FALSE	**TRUE**	10		
	7/14/08	250 falling from 400 on 7/13	0.079	FALSE	FALSE	0.88	FALSE	FALSE	14	1200	**TRUE**
	7/28/08	180 falling from 220	0.08	FALSE	FALSE	1.42	FALSE	**TRUE**	6	88	FALSE
	8/4/08	100, level	0.046	FALSE	FALSE	0.82	FALSE	FALSE	<5	160	FALSE
	8/21/08	200 falling from 400 on 8/14	0.045	FALSE	FALSE	0.86	FALSE	FALSE	9	94	FALSE
DST of Gorge Dam RM 43.8	8/28/01	225, rising	0.099	FALSE	FALSE	1.9	**TRUE**	**TRUE**	<5		
	8/29/01	225, falling from 240	<.05	FALSE	FALSE	1.74	**TRUE**	**TRUE**	<5		
Edison Dam Pool (RM 45.1)	8/30/01	180, falling	0.053	FALSE	FALSE	1.79	**TRUE**	**TRUE**	5		
Oak Park Blvd (RM 47.6)	8/29/01	200, falling	0.112	FALSE	FALSE	2.02	**TRUE**	**TRUE**	7		
	8/30/01		0.055	FALSE	FALSE	1.93	**TRUE**	**TRUE**	15		
Broad Blvd (RM 46.25)	7/19/00		0.1	FALSE	FALSE	1.31	FALSE	**TRUE**	19	360	**TRUE**
	7/25/00		0.08	FALSE	FALSE	1.77	**TRUE**	**TRUE**	11	120	FALSE
	8/3/00		0.08	FALSE	FALSE	1.54	**TRUE**	**TRUE**	11	630	**TRUE**
	8/10/00		0.1	FALSE	FALSE	0.521	FALSE	FALSE	13	140	FALSE
	8/10/00		0.12	FALSE	FALSE	0.579	FALSE	FALSE	21		
	9/14/00		0.12	FALSE	FALSE	1.98	**TRUE**	**TRUE**	6	130	FALSE

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous TP (mg/l)	Exceed State	Exceed EOLP Median	Nitrogen Nitrate + Nitrite (mg/l)	Exceed State	Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Broad Blvd (cont'd)	5/16/01	190, falling from 200	0.298	TRUE	TRUE	1.49	FALSE	TRUE	11		
	6/12/01	150, falling from 180 on 6	0.11	FALSE	FALSE	1.26	FALSE	TRUE	12		
	7/11/01		0.113	FALSE	FALSE	1.4	FALSE	TRUE	11		
	6/5/02		0.079	FALSE	FALSE	1.09	FALSE	TRUE	15		
Waterworks (RM 48.38)	7/11/07	120, peaking	0.14	FALSE	TRUE	3.02	TRUE	TRUE	105		
	7/12/07	100, falling from 120	0.146	FALSE	TRUE	2.12	TRUE	TRUE	95		
	8/27/07	500, falling from 2,000 on	0.06	FALSE	FALSE	0.88	FALSE	FALSE	11		
	9/19/07	90 and level	0.054	FALSE	FALSE	3.96	TRUE	TRUE	<5		
	9/20/07	90 and level	0.044	FALSE	FALSE	4.11	TRUE	TRUE	5		
Bike Trail Bridge (RM 49.07)	7/11/07		0.082	FALSE	FALSE	2.12	TRUE	TRUE	12		
	7/12/07		0.09	FALSE	FALSE	2.39	TRUE	TRUE	26		
	9/19/07		0.05	FALSE	FALSE	3.89	TRUE	TRUE	10		
	9/20/07		0.043	FALSE	FALSE	4.34	TRUE	TRUE	10		
Munroe Falls Dam (RM 49.9)	8/28/01		0.107	FALSE	FALSE	2.18	TRUE	TRUE	9		
	8/30/01		0.054	FALSE	FALSE	2.17	TRUE	TRUE	5		
	8/29/01		<.05	FALSE	FALSE	2.26	TRUE	TRUE	<5		
	6/29/05	135, level	0.065	FALSE	FALSE	1.68	TRUE	TRUE	<5		
	8/2/05	170, falling from 350	0.08	FALSE	FALSE	1.01	FALSE	TRUE	9		
	8/18/05	140, falling from 200	0.141	FALSE	TRUE	1.84	TRUE	TRUE	73		
	7/11/07		0.075	FALSE	FALSE	3.36	TRUE	TRUE	34		
	7/12/07		0.066	FALSE	FALSE	2.59	TRUE	TRUE	<5		
	7/12/07		0.075	FALSE	FALSE	2.82	TRUE	TRUE	7		
	7/12/07		0.072	FALSE	FALSE	3.02	TRUE	TRUE	6		
	8/27/07		0.061	FALSE	FALSE	0.92	FALSE	FALSE	11		
	9/19/07		0.062	FALSE	FALSE	4.18	TRUE	TRUE	5		
	9/20/07		0.042	FALSE	FALSE	4.34	TRUE	TRUE	6		
Munroe Falls MetroPark (RM 50.1	7/11/07		0.128	FALSE	TRUE	5.79	TRUE	TRUE	20		
	7/11/07		0.106	FALSE	FALSE	3.85	TRUE	TRUE	65		
	7/12/07		0.114	FALSE	FALSE	3.26	TRUE	TRUE	51		
	7/12/07		0.15	FALSE	TRUE	2.74	TRUE	TRUE	5		
	9/19/07		0.078	FALSE	FALSE	4.27	TRUE	TRUE	5		
	9/20/07		0.079	FALSE	FALSE	4.59	TRUE	TRUE	6		

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous TP (mg/l)	Phosphorous Exceed State	Phosphorous Exceed EOLP Median	Nitrogen Nitrate + Nitrite (mg/l)	Nitrogen Exceed State	Nitrogen Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Downstream Fish Creek (RM 51.64)											
	7/11/07		0.075	FALSE	FALSE	2.6	TRUE	TRUE	5		
	8/28/07		0.067	FALSE	FALSE	1.15	FALSE	TRUE	11		
	9/19/11		0.08	FALSE	FALSE	4.29	TRUE	TRUE	5		
	9/20/11		0.088	FALSE	FALSE	4.39	TRUE	TRUE	<5		
Middlebury (RM 52.63)											
	8/29/01		0.208	TRUE	TRUE	3.83	TRUE	TRUE	87		
	8/30/01		0.159	FALSE	TRUE	3.47	TRUE	TRUE	<5		
	7/11/07		0.102	FALSE	FALSE	3.37	TRUE	TRUE	20		
	7/12/07		0.078	FALSE	FALSE	3.17	TRUE	TRUE	5		
	9/19/07		0.082	FALSE	FALSE	6.01	TRUE	TRUE	<5		
	9/20/11		0.078	FALSE	FALSE	5.12	TRUE	TRUE	<5		
0.8 mi UST Middlebury RM 53.4	7/11/07		0.072	FALSE	FALSE	3.94	TRUE	TRUE	<5		
	7/12/07		0.089	FALSE	FALSE	4.55	TRUE	TRUE	7		
	7/12/07		0.081	FALSE	FALSE	3.58	TRUE	TRUE	10		
	8/28/07		0.067	FALSE	FALSE	1	FALSE	FALSE	11		
	8/28/07		0.064	FALSE	FALSE	1.05	FALSE	TRUE	10		
	9/19/07		0.091	FALSE	FALSE	5.13	TRUE	TRUE	<5		
	9/20/07		0.075	FALSE	FALSE	5.81	TRUE	TRUE	<5		
Fuller Park UST Kent WWTP RM	7/11/07		0.129	FALSE	TRUE	1.82	TRUE	TRUE	61		
	7/12/07		0.074	FALSE	FALSE	2.64	TRUE	TRUE	8		
	7/12/07		0.131	FALSE	TRUE	2.94	TRUE	TRUE	54		
	9/19/07		0.07	FALSE	FALSE	2.96	TRUE	TRUE	7		
	9/20/07		0.053	FALSE	FALSE	2.95	TRUE	TRUE	10		
Crain Ave. (RM 55.2)	8/13/98		0.1	FALSE	FALSE	1.22	FALSE	TRUE	13		
	6/29/05		0.088	FALSE	FALSE	1.58	TRUE	TRUE	7		
	8/2/05		0.07	FALSE	FALSE	1.17	FALSE	TRUE	10		
	8/18/05		0.087	FALSE	FALSE	1.38	FALSE	TRUE	9		
	7/11/07		0.09	FALSE	FALSE	2.54	TRUE	TRUE	14		
	7/12/07		0.152	FALSE	TRUE	2.78	TRUE	TRUE	72		
	9/19/07		0.074	FALSE	FALSE	2.88	TRUE	TRUE	<5		
	9/20/07		0.062	FALSE	FALSE	2.66	TRUE	TRUE	<5		

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous			Nitrogen					
			TP (mg/l)	Exceed State	Exceed EOLP Median	Nitrate + Nitrite (mg/l)	Exceed State	Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Standing Rock (RM 55.8)	8/13/98		0.14	FALSE	TRUE	1.22	FALSE	TRUE	14		
	6/29/05		0.081	FALSE	FALSE	3.11	TRUE	TRUE	5		
	8/2/05		0.052	FALSE	FALSE	2.37	TRUE	TRUE	9		
	8/18/11		0.083	FALSE	FALSE	2.03	TRUE	TRUE	12		
Riverbend (RM 56.2)	8/13/98		0.12	FALSE	FALSE	1.14	FALSE	TRUE	18		
	7/11/07		0.373	TRUE	TRUE	2.21	TRUE	TRUE	300		
	7/12/07		0.299	TRUE	TRUE	2.8	TRUE	TRUE	211		
	7/19/07		0.044	FALSE	FALSE	39.8	TRUE	TRUE	<5		
	9/20/07		0.075	FALSE	FALSE	3.03	TRUE	TRUE	9		
UST Breakneck Cr. (RM 56.83)	8/13/98		0.14	FALSE	TRUE	0.21	FALSE	FALSE	8		
	7/11/07		0.061	FALSE	FALSE	0.19	FALSE	FALSE	0.26		
	7/11/07		0.034	FALSE	FALSE	0.18	FALSE	FALSE	<5		
	7/12/07		0.081	FALSE	FALSE	0.14	FALSE	FALSE	<5		
	8/27/07		0.03	FALSE	FALSE	<.01	FALSE	FALSE	9		
	9/19/07		0.015	FALSE	FALSE	0.18	FALSE	FALSE	5		
	9/20/07		0.023	FALSE	FALSE	0.13	FALSE	FALSE	<5		
DST Lake Rockwell (RM 57.67)	8/13/98		0.18	TRUE	TRUE	0.33	FALSE	FALSE	10		
	8/28/01		0.059	FALSE	FALSE	0.13	FALSE	FALSE	<5		
	8/30/01		<.05	FALSE	FALSE	0.15	FALSE	FALSE	7		
	8/30/01		0.066	FALSE	FALSE	0.13	FALSE	FALSE	7		
	7/10/02		0.11	FALSE	FALSE	0.13	FALSE	FALSE	7		
	6/25/08		0.052	FALSE	FALSE	<.1	FALSE	FALSE	9	<25	
	7/14/08		0.05	FALSE	FALSE	0.13	FALSE	FALSE	9		16
	7/28/08		0.064	FALSE	FALSE	0.15	FALSE	FALSE	9		15
	8/4/08		0.049	FALSE	FALSE	0.27	FALSE	FALSE	8		15
	8/21/08		0.071	FALSE	FALSE	<.1	FALSE	FALSE	9		3
	7/11/07		0.464	TRUE	TRUE	0.34	FALSE	FALSE	20		
	7/11/07		0.046	FALSE	FALSE	0.15	FALSE	FALSE	7		
	7/11/07		0.043	FALSE	FALSE	0.17	FALSE	FALSE	7		
	7/12/07		0.047	FALSE	FALSE	0.16	FALSE	FALSE	6		
	9/19/07		0.027	FALSE	FALSE	0.13	FALSE	FALSE	9		
	9/20/07		0.045	FALSE	FALSE	0.1	FALSE	FALSE	16		

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous TP (mg/l)	Phosphorous Exceed State	Phosphorous Exceed EOLP Median	Nitrogen Nitrate + Nitrite (mg/l)	Nitrogen Exceed State	Nitrogen Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Fish Creek											
Statewide Criteria - MWH				0.34			1			Cat. B. rec.	523
EOLP Median					0.19			0.42			
Spaulding	7/19/00		0.05	FALSE	FALSE	0.125	FALSE	FALSE	7	590	**TRUE**
	8/3/00					0.116	FALSE	FALSE	7	1400	**TRUE**
	9/14/00		<.05			0.1	FALSE	FALSE	8	240	FALSE
North River Rd.											
Statewide Criteria - WWH				0.08			1				
EOLP Median					0.05			0.42			
	7/19/00		0.07	FALSE	**TRUE**	0.297	FALSE	FALSE	<5		
	8/3/00		0.06	FALSE	**TRUE**	0.22	FALSE	FALSE	<5		
	9/14/00		<.05	FALSE	FALSE	0.191	FALSE	FALSE	<5		
	8/29/01		1.08	**TRUE**	**TRUE**	0.34	FALSE	FALSE	<5		
	8/30/01		<.05	FALSE	FALSE	0.3	FALSE	FALSE	10		
	7/11/07		0.054	FALSE	**TRUE**	0.48	**TRUE**	**TRUE**	11		
	7/11/07		0.05	FALSE	FALSE	0.46	**TRUE**	**TRUE**	11		
	7/12/07		0.024	FALSE	FALSE	0.21	FALSE	FALSE	<5		
	7/12/07		0.022	FALSE	FALSE	0.2	FALSE	FALSE	<5		
	8/27/07		0.052	FALSE	**TRUE**	0.29	FALSE	FALSE	<5		
	9/19/07		0.22	**TRUE**	**TRUE**	0.34	FALSE	FALSE	<5		
	9/20/07					0.14	FALSE	FALSE	<5		

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous			Nitrogen					
			TP (mg/l)	Exceed State	Exceed EOLP Median	Nitrate + Nitrite (mg/l)	Exceed State	Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Plum Creek											
Tallmadge Rd.	7/19/00		0.05	FALSE	FALSE	0.299	FALSE	FALSE	5	260	FALSE
	8/3/00		<.05	FALSE	FALSE	0.283	FALSE	FALSE	<5	100	FALSE
	9/14/00		0.05	FALSE	FALSE	0.23	FALSE	FALSE	<5	54	FALSE
Cherry	7/19/00		0.08	FALSE	TRUE	0.19	FALSE	FALSE	31	410	FALSE
	8/3/00		0.05	FALSE	FALSE	0.106	FALSE	FALSE	15	360	FALSE
	9/14/00		0.06	FALSE	TRUE	<.1	FALSE	FALSE	21	130	FALSE
	8/29/01		<.05	FALSE	FALSE	<.1	FALSE	FALSE	11		
	8/30/01		<.05	FALSE	FALSE	<.1	FALSE	FALSE	23		
	7/11/07		0.042	FALSE	FALSE	0.29	FALSE	FALSE	20		
	7/12/07		0.04	FALSE	FALSE	0.2	FALSE	FALSE	24		
	7/12/07		0.053	FALSE	TRUE	0.2	FALSE	FALSE	40		
	8/27/07		0.04	FALSE	FALSE	0.12	FALSE	FALSE	8		
	9/19/07		0.03	FALSE	FALSE	0.21	FALSE	FALSE	6		
	9/20/07		0.027	FALSE	FALSE	<01	FALSE	FALSE	6		
Breakneck Cr.											
Statewide Criteria				0.1			1				
EOLP Median WWH					0.07			0.43			
Mouth	8/13/98		0.19	TRUE	TRUE	1.28	TRUE	TRUE	27		
	7/11/07		0.18	TRUE	TRUE	7.43	TRUE	TRUE	35		
	7/12/07		0.17	TRUE	TRUE	4.57	TRUE	TRUE	47		
	8/27/07		0.08	FALSE	TRUE	0.68	FALSE	TRUE	11		
	9/19/07		0.109	TRUE	TRUE	5.72	TRUE	TRUE	<5		
	9/20/07		0.111	TRUE	TRUE	5.26	TRUE	TRUE	<5		
Summit Road											
	7/19/00		0.08	FALSE	TRUE	0.413	FALSE	FALSE	<5	340	FALSE
	7/25/00		0.07	FALSE	FALSE	0.638	FALSE	TRUE	8	370	FALSE
	7/25/00		0.07	FALSE	FALSE	0.515	FALSE	TRUE	6	330	FALSE
	8/3/00		0.14	TRUE	TRUE	0.346	FALSE	FALSE	<5	180	FALSE
RM 14.6	7/19/00		0.13	TRUE	TRUE	0.379	FALSE	FALSE	24	470	FALSE
	7/25/00		0.07	FALSE	FALSE	0.537	FALSE	TRUE	6	220	FALSE
	7/25/00		0.065	FALSE	FALSE	0.68	FALSE	TRUE	5	200	FALSE
	8/3/00		0.08	FALSE	TRUE	0.291	FALSE	FALSE	<5	490	FALSE

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous TP (mg/l)	Phosphorous Exceed State	Phosphorous Exceed EOLP Median	Nitrogen Nitrate + Nitrite (mg/l)	Nitrogen Exceed State	Nitrogen Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Potter Creek											
Statewide Criteria				0.08			1				
EOLP Median WWH					0.05			0.42			
Saxe Rd.											
	7/19/00		0.16	TRUE	TRUE	0.473	FALSE	TRUE	6	810	TRUE
	7/25/00		0.05	FALSE	FALSE	0.664	FALSE	TRUE	<5	270	FALSE
Feeder Canal											
Statewide Criteria											
EOLP Median MWH											
	7/25/00		0.06	FALSE	TRUE	7.32	TRUE	TRUE	<5		
	8/3/00		0.075	FALSE	TRUE	0.328	FALSE	FALSE	<5		
Congress Lake Outlet*						***note: only nitrate reported***				fecal coliform	
Statewide Criteria - MWH				*0.34*			*1*				
EOLP Median MWH					*0.19*			*0.42*			
Congress Lake	winter		0.25	FALSE	TRUE	0.55	FALSE	TRUE		20	
	spring		0.05	FALSE	FALSE	0.9	FALSE	TRUE		0	
Quail Hollow	winter		0.24	FALSE	TRUE	0.5	FALSE	TRUE		60	
	spring		0.11	FALSE	FALSE	0.7	FALSE	TRUE		1200	
Pinedale	winter		0.08	FALSE	FALSE	0.19	FALSE	FALSE		70	
	spring		0.08	FALSE	FALSE	0.6	FALSE	TRUE		100	
Alexander Rd.	winter		0.08	FALSE	FALSE	0.19	FALSE	FALSE		80	
	spring		0.07	FALSE	FALSE	1	FALSE	TRUE		20	
Waterloo Rd.	winter		0.08	FALSE	FALSE	0.18	FALSE	FALSE		300	
	spring		0.07	FALSE	FALSE	1	FALSE	TRUE		70	
Hartville Rd.	winter		0.07	FALSE	FALSE	0.14	FALSE	FALSE		200	
	spring		0.09	FALSE	FALSE	0.9	FALSE	TRUE		110	
Statewide Criteria - MWH > 20 sq. mi				0.28			1.6				
EOLP Median MWH > 20 sq. mi.					0.25			0.43			
BNC Tallmadge Rd.			0.04			0.11	FALSE	FALSE		80	
			0.08			0.7	FALSE	TRUE		40	

Source: Bonetta Guyette MS Thesis

- Nitrate+nitrite nitrogen levels vary from 0.13 mg/l upstream of Breakneck Creek to 6.01 mg/l at Middlebury, compared with the EOLP median value of 1 mg/l. High values of nitrate-nitrite are recorded during higher flows of July 11-12, 2007, as well as relatively low flows of September 19, 2007, indicating that the nitrogen is entering both from wastewater treatment plants and runoff.
- Biological communities – The 1999 TSD and 2000 TMDL reports noted higher numbers of hydra, flatworms, oligocheates, omnivores, detritivores, and tolerant species. The report notes that a low IBI score, combined with an MiWB score (biomass) similar to EOLP median values, suggests nutrient enrichment is affecting the biological communities.
- The 2007 Bioassessment noted large diurnal swings in oxygen in the Middle Cuyahoga River, by as much as five mg/l upstream of Fish Creek and 15 mg/l at Water Works Park in the 2007 study. The swings in dissolved oxygen suggest algae levels are high, producing oxygen during the day and consuming it at night.
- Low dissolved oxygen levels in the former dam pools – low levels during summer months indicate anoxic conditions due to the decay of algae. The standard for 24-hour mean dissolved oxygen is 5 mg/l, minimum 4 mg/l.
- Supersaturated oxygen levels – greater than what would occur in an unenriched environment at the same temperature – these values are often greater than 95 or 100 percent saturation, indicating daytime oxygen production by algae.

Dam pools and lakes may result in increased algal production and anoxic conditions:

- They trap sediment and the adsorbed phosphorous
- Decaying algae in the lower, unmixed portions of the stagnant pools uses up oxygen
- Without moving water and biological activity, the incoming nutrients are not assimilated and transformed.

The degree of nutrient enrichment in the former dam pools has improved considerably with dam removal. In the area of the former dam pools, the river is no longer eutrophic or anoxic and the river meets biological water quality standards. Phosphorous levels have dropped, as the river has been able to assimilate the phosphorous or transport it downstream.

The 2007 report notes that lack of tree cover along portions of the river may increase algal production.

Table 4e-6 shows water quality chemistry (phosphorous and nitrate+nitrite) and bacteria data posted on the Ohio EPA website for sites within the watershed. For each component, the table lists the EOLP target/median and the state target, and indicates whether the measurement exceeded the targets (TRUE, highlighted in bold red), or did not exceed the targets (FALSE).

In reviewing the data, these are some of the characteristics that may influence levels of nutrients:

- Wastewater treatment plants operate along the lower portion of Breakneck Creek, in Kent between Fuller Park and Middlebury, and at Fish Creek. Four CSOs (combined sewer overflows) have been documented in the Gorge section of the river in Cuyahoga Falls.
- Three dams remain along the Cuyahoga River in this watershed: two low-head dams in Cuyahoga Falls, and the sixty-foot tall Ohio Edison dam at RM 42.6.
- Upstream of RM 49.8, the measurements may show differences between dam-pool conditions and free-flow conditions. Flow was restored at the Kent dam in 2004 and at the

Munroe Falls dam in October, 2005. The dam at Plum Creek upstream of Cherry St. was removed in spring, 2010. Measurements prior to these dates reflect dam-pool conditions, after these dates reflect freely flowing conditions.

- The Portage Path stream gage showed increased flows during July 11-12, 2007, suggesting stormwater influence. During another period of interest, September 19-20, 2007, the Portage Path stream gage recorded extremely low flow typical of dry summer periods, less than 100 cubic feet per second.

The chemistry data suggest that all the subwatersheds have some level of nutrient enrichment, with different sources of influence:

- The phosphorous data for the Cuyahoga River after dam removal indicates that phosphorous levels exceeded state and EOLP targets during July 11 and 12, 2007, immediately following a rain event, suggesting that non-point source pollution/runoff contributes to the phosphorous loading. Nitrate+nitrate levels frequently exceeded state and EOLP targets. Levels increased both during the rainy July 11-12, 2007, period, and also during the extremely low-flow period in 9/19-20/2007, possibly indicating influence from non-point source pollution as well as wastewater treatment plants.
- The Lower Cuyahoga River TMDL noted TP levels in 2000 ranging from 0.05 to 0.6 mg/l, with a median 0.17 mg/l, which exceeds the 0.12 mg/l target for small rivers. National Park Service measurements at Ira Road in the Lower Cuyahoga averaged 0.22 mg/l.
- The WWH portion of Fish Creek exceeded the EOLP phosphorous target for WWH headwaters several times, including during the rainy period of July 11, 2007. The levels upstream at Spaulding Rd. were approximately half as high as at North River Road, which is downstream of an area with denser and older development, and which likely lacks stormwater controls that were instituted in recent years.
- Plum Creek at Cherry St. (downstream of the former Plum Creek dam pool) exceeded EOLP phosphorous target three times, once during the rainy period of July 11-12, 2007. At Tallmadge Road, Plum Creek equaled the EOLP phosphorous target. The nitrate+nitrite levels were twice as high at Tallmadge Road as at Cherry Rd. It should be noted that the upstream portions of Plum Creek are heavily channelized, and Plum Creek subwatershed has undergone rapid development since 2000. Should development and alteration of riparian features continue, nutrient enrichment in this portion of Plum Creek may increase.
- Breakneck Creek at the lower end exceeded state and EOLP targets for both phosphorous and nitrate+nitrite during most of the measurements in 1998 and 2007. There are two wastewater treatment plants upstream, and this is the most heavily urbanized portion of the watershed. The measurements during the rainy July 11-12 2007 period were higher than others. Breakneck Creek at Summit Road and RM 14.6 exceed EOLP targets for both nitrogen and phosphorous in measurements taken during 2000. Because the sample dates differed from the upstream and downstream portions of Breakneck Creek, it is difficult to trace patterns from upstream to downstream.
- Potter Creek exceeded EOLP targets for both nitrogen and phosphorous in one sample in July, 2000, and equaled or exceeded EOLP targets during the other July, 2000, sample.
- The Feeder Canal exceeded EOLP targets for phosphorous in two samples taken in 2000, and exceeded nitrogen targets in one sample.
- Nutrient levels in Congress Lake Outlet measured for a Masters Degree thesis indicated that two sites at the upstream end, toward Congress Lake, exceeded EOLP targets for MWH waters. Nitrate levels exceeded EOLP targets of Nitrate + Nitrite at most of the sites in the spring samples, and at the furthermost upstream sites in the winter samples.

Dissolved Oxygen

Dissolved Oxygen

The 2003 TMDL notes that dissolved oxygen was the primary chemical component below RM 48.9 not meeting WWH standards (5 mg/l average, 4 mg/l minimum over 24 hours). The TMDL notes that low dissolved oxygen was a concern in the Lower Cuyahoga. However, the only exceedences of the dissolved oxygen criteria listed in the 2003 TMDL occurred along the Feeder Canal at Saxe Rd. and Breakneck Creek at Summit Rd., both in July, 2000. Low dissolved oxygen was reported at numerous locations downstream, and some may have been influenced by oxygen demanding substances or nutrients from upstream. The TMDL notes that CSOs and waste water treatment plants contribute oxygen demanding substances. There are no wastewater treatment plants in between Brust Park and the Ohio Edison Dam. There are four CSOs in the Gorge section of Cuyahoga Falls. As discussed previously, dissolved oxygen deman and swings in saturation levels are related to nutrient levels and algal activity, as well.

- The 2003 Lower Cuyahoga River TMDL notes diurnal swings of 80 percent in oxygen saturation levels at several stations (mostly dam pools) between Water Works Park and the Little Cuyahoga in August 2001, with values as low as 40 percent and as high as 160 percent. The values immediately downstream of the then-present Munroe Falls dam ranged from 80 to 100 percent.
- Dissolved oxygen exceedences occurred at the Feeder Canal/Potter Creek at Saxe Road (4.44 mg/l) and Breakneck Creek at Summit Rd. (4.6 mg/l) on July 19, 2000.
- The 1999 TSD did not report any oxygen exceedences along the Middle Cuyahoga River.
- The 2000 TMDL reported that 24-hour average dissolved oxygen levels taken in 1996 throughout the river between Brust Park (RM 49.9) and Lake Rockwell ranged from 2.66 to 4 mg/l, with minima of 0-3 mg/l. Both daily average and minimum readings failed to meet state criteria for the summer low-flow (critical) period. The 2000 TMDL noted that the impoundments and flow modification altered the flow hydraulics, reducing the ability of the stream to assimilate nutrients and incorporate oxygen. However, with restoration of free-flow conditions, the dissolved oxygen levels consistently exceeded 7 mg/l.
- The 2003 Lower Cuyahoga TMDL listed bacteria and phosphorous as the impairing causes of non-attainment. Low dissolved oxygen was described as an impairing cause that was not load-based.

4e-1b Lakes Quality

Findings:
Lakes Quality

Lake Hodgson is monitored as a public water supply. Ohio EPA has conducted studies on Congress Lake because of its eutrophic condition. Kent State faculty have recently installed monitoring equipment in Sandy Lake and Twin Lakes, with the permission of the lake associations.

Lake Hodgson

Water from Lake Hodgson meets drinking water standards. The City of Ravenna notes that taste and odor are constant concerns related to Lake Hodgson water. Monitoring indicates chlorophyll counts in the upper 25 feet increase periodically during the year. In the spring, counts rise from less than four mg/l to 6-7 mg/l. In the summer, there is a dramatic increase in chlorophyll counts, as high as 23 mg/l. For most of the year, when the control structures are closed, the watershed of Lake Hodgson is quite limited, less than seven square miles. Flow in the Feeder Canal when the control structures are closed indicates groundwater flow into the Feeder Canal. Throughout the year, the levels of phosphates at the surface remain relatively constant at 0.05 to 0.08 mg/l, with the highest levels in August. However, in August, as lower depths of this kettle lake become anoxic, the levels of phosphates at depth increase to 0.16 mg/l, twice that of the surface measurements, suggesting that phosphates are remobilizing from the sediment under anoxic conditions. The increase in chlorophyll levels coincide roughly with the increases in phosphates.

Determining the inputs to Lake Hodgson is complicated by the connection to Congress Lake, via the Feeder Canal-Congress Lake Outlet, which is occasionally opened during the dry summer months. During that period, the watershed size increases dramatically. In addition, the connection allows the hyper-eutrophic water to flow from Congress Lake into the Lake Hodgson system. This system should be studied further to determine the source of nutrients.

Congress Lake

Congress Lake is a privately owned, hyper-eutrophic lake that has experienced nuisance algae blooms. It is of concern, because it is at the head of the watershed for Lake Hodgson when the control structure is open, and Breakneck Creek when the control structure is closed. Ohio EPA, the Portage and Stark County health departments, and Portage County SWCD have investigated potential sources of nutrients to the lake. The Ohio EPA report on Congress Lake indicated that an investigation of a nearby farm operation was inconclusive. The drainage tiles at this farm have since been destroyed. Potential sources of nutrients include nearby septic systems, the golf course, agricultural runoff, and legacy sediments in the kettle lake. The lake association has apparently installed deep aerators to reduce anoxic conditions at depth.

4e-1c Water Quality Attainment - Wetlands

Wetlands Quality: Background – Altering Wetlands

Effects of Altering Wetlands

Since early settlement times, wetlands have been altered to reduce flooding, make use of fertile wetland soils for agriculture, reduce mosquito breeding areas, or develop the landscape. However, altering wetlands reduces the important functions they provide for watersheds, increasing flooding problems, pollution, removing valuable habitat. Furthermore, wetlands are not well suited for development and may also present difficult moisture conditions in which to grow crops, unless the water regime is managed. Even when they are filled or drained, or their soil is removed, the conditions that allowed water to collect and remain in the soil often persist. In many cases, altered wetlands collect and retain water during storm events, creating flooding problems, instability, septic system failures, wet basements in areas developed on wetlands, and marginal areas for crops.

Regulating wetland alteration

The U.S. Army Corps of Engineers, U.S. EPA, and Ohio EPA regulate discharges to (filling of) wetlands and other waters. Filling or altering wetlands generally may be permitted only if:

- There is a demonstrated justification,
- No other alternatives to filling in the wetland,
- Alteration is minimized, and
- The negative impacts from alteration compensated for through mitigation.

In considering whether proposed alteration is justified, these agencies assess the value of the wetlands being altered or used, the watershed functions that would be lost or degraded by use of or alteration to the wetlands.

State water quality regulations include a mandatory antidegradation requirement that prohibits lowering water quality unless it is demonstrated to be necessary and unavoidable. In Ohio, the degree of justification needed to use the resource and the minimization/mitigation requirements depend on the wetland category assigned through a functional assessment. The Ohio EPA has developed the Ohio Rapid Assessment Method, ORAM, which provides the basic data needed to determine the wetland category.

- Category 1 wetlands are considered of limited value for habitat and/or wetland functions. They are often degraded by invasive species and tend to be isolated from flowing water. Because of the limited amount of functions they provide, the Ohio Revised Code (ORC) 3745-1-05(A) identifies them as "limited quality waters." The Ohio EPA does not require social or economic justification to use or alter them, and lower standards of avoidance, minimization, and mitigation apply.

  Ranking a wetland as category 1 means it provides less value and function compared to Category 2 or 3 wetlands. Examples include depressions or wet agricultural lands. However from a watershed perspective, these features may still provide important functions, even if their value for habitat has been severely degraded. For example, in urbanized settings, the habitat value of wetlands may be severely degraded, but they may be the only natural landscape features remaining to provide flood storage and pollutant/nutrient uptake.

- Category 2 wetlands make up the large category between categories 1 and 3. They support “moderate” wildlife habitat or hydrological functions, and serve as functioning, diverse, healthy water resources providing ecological integrity and human value. Some category 2 wetlands are considered degraded but retain enough existing or potential functions that they could be restored. Determination of category 2 “degraded” is not intended to allow further degradation.

- Category 3 wetlands provide the highest level of habitat quality and hydrological functions. These include high levels of diversity, native species, and hydrological function. These contain or provide habitat for threatened or endangered species and include mature wetland mature forested wetlands, bogs, fens, vernal pools, or regionally scarce habitats. Classification as Category 3 is based on having some but not necessarily all of the high value attributes. For example, a flood-plain wetland might be considered high value even if without a mature forest. Reducing the quality of category 3 wetlands is permitted only if it is demonstrated that the alteration is necessary to meet a public (i.e., societal) need.

In a recent study, the Cuyahoga River RAP compared mapped wetlands and landscape characteristics with ORAM scores of sample wetlands in several subwatersheds of the Cuyahoga River. The study found that high ORAM scores and the greatest value for habitat and other wetland functions, such as groundwater recharge, occurred in wetland complexes of the greatest diversity and size.

Mitigation for Permitted Filling of Wetlands

Often when filling wetlands is permitted, the regulatory agencies require compensatory mitigation to replace the lost functions. Replacement can be on-site or off-site in larger combined wetland mitigation areas/banks. Mitigation banks are large-scale constructed wetlands that are funded through mitigation credit fees. Federal permitting agencies favor replacing wetlands in mitigation banks. The Ohio EPA favors replacing lost wetland functions on-site. There are no wetland mitigation banks in the Cuyahoga River watershed. Instead, wetland mitigation credits are used to extend wetlands in the Grand River watershed or others draining to Lake Erie. However, wetland mitigation does not necessarily have to occur within mitigation banks. Any approved wetland restoration, construction, or enhancement project can be used as mitigation for impacts elsewhere. The Ohio EPA has established a clearinghouse where designed wetland projects can be used to mitigate impacts.

Findings: Wetland Alteration and Quality

Findings: Wetland Alteration

The hydric soil mapping is a likely indicator of where wetland conditions existed in the past. Because aerial mapping of wetlands is uncertain, it is difficult to determine visually just how much of the former wet landscape has been altered. Existing land cover was compared with the extent of hydric soils to identify areas where non-wetland land cover occurs on hydric soils, indicating areas where wetlands have likely been altered, reducing the watershed services they perform in an area. In areas that were already urbanized when the soils were mapped, the hydric status of the soils could not be determined.

The CCAP land cover data was overlain on mapping of hydric soils and soils with hydric inclusions. Land cover mapped as woods or wetland on hydric was assumed to be wetland, mapped as some other use was assumed to be altered. This does not include the County wetland mapping and should be used as a general guide of where wetlands may have been altered and where it may be possible to restore wetland functions**.** The results are summarized in Table 4e-7 and Figure 4e-2.

As shown on Figure 4e-2 and Table 4-e7, a substantial amount of hydric soils have been converted to developed, developed open space, or agricultural use since the 1970s, when the soil maps were developed. This is consistent with accounts of substantial wetland loss in this region. Historical accounts of early settlement note extensive efforts to muck out swamps.

Table 4e-7 Non-Wetland Land Cover on Hydric Soils

Subwatershed	Hydric/ Hydric Incl.	Converted to Developed (ac)	Converted to Devel. Open Space (ac)	Converted to Agric. (ac)	Converted to Barren (ac)	Total
Main Stem	H	243	170	39	0	451
	HI	1,495	537	134	0	2,167
Fish Creek	H	305	274	153	3	734
	HI	832	581	44	3	1,461
Plum Creek	H	248	157	267	26	697
	HI	283	197	440	25	946
Breakneck Cr.	H	518	175	1,044	2	1,739
	HI	1,753	499	3,784	2	6,039
Potter Cr.	H	137	53	2,379	16	2,585
	HI	575	262	3,941	42	4,819
Total	H	1,451	827	3,882	47	6,207
	HI	4,938	2,077	8,344	73	15,432

- In Stark County, the extensive area of hydric soils along the Congress Lake Outlet is the site of muck farms, where farmers raise and lower the water table regularly to take advantage of the fertile muck (organic) soils.

- Cranberry Creek, Randolph Ditch, Hudson Ditch, Brimfield Ditch (western tributary), Fish Creek, and portions of Plum Creek appear to have extensively altered (drained) wetlands. These have lost the substantial benefits provided by functioning wetlands.

- Three of the areas described as having repeated flooding problems, headwater tributaries to Walnut Creek, Brimfield Ditch at Breakneck Creek, and the southern portion of Fish Creek in Kent, occur along or at the downstream end of streams flowing through altered (ditched, channelized) wetlands: Each of these areas is in a developed or developing landscape. It is worth considering whether the wetland loss and development are related to the flooding problems: the development would generate additional stormwater, and converting wetlands would substantially reduce flood storage to handle the additional load. It is also worth considering whether restoring wetlands in these areas could help alleviate flooding problems nearby.

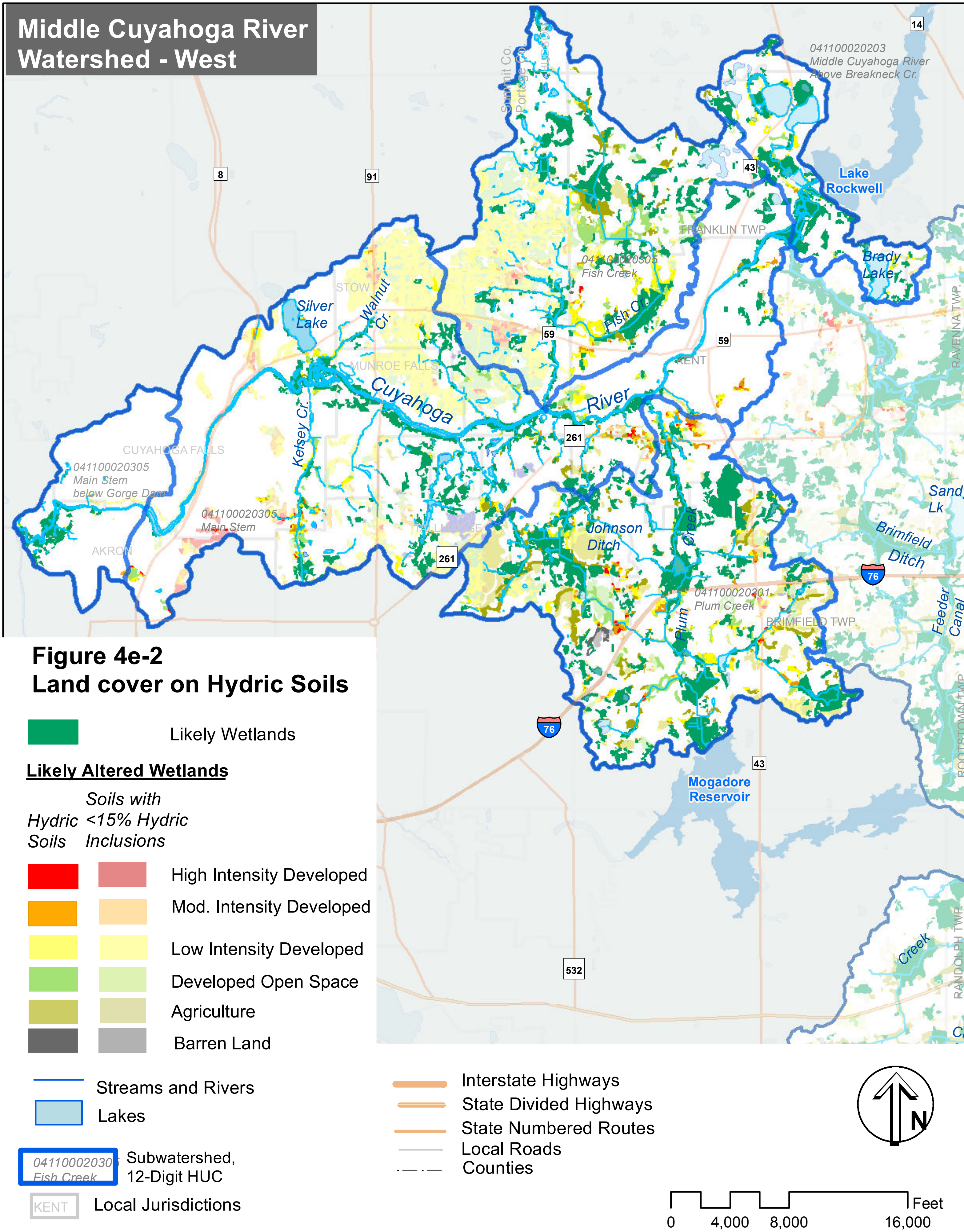


Figure 4e-2
Land cover on Hydric Soils

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2010.
Wetland mapping: Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004.
Stark County -2003 land cover mapping; watershed - CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

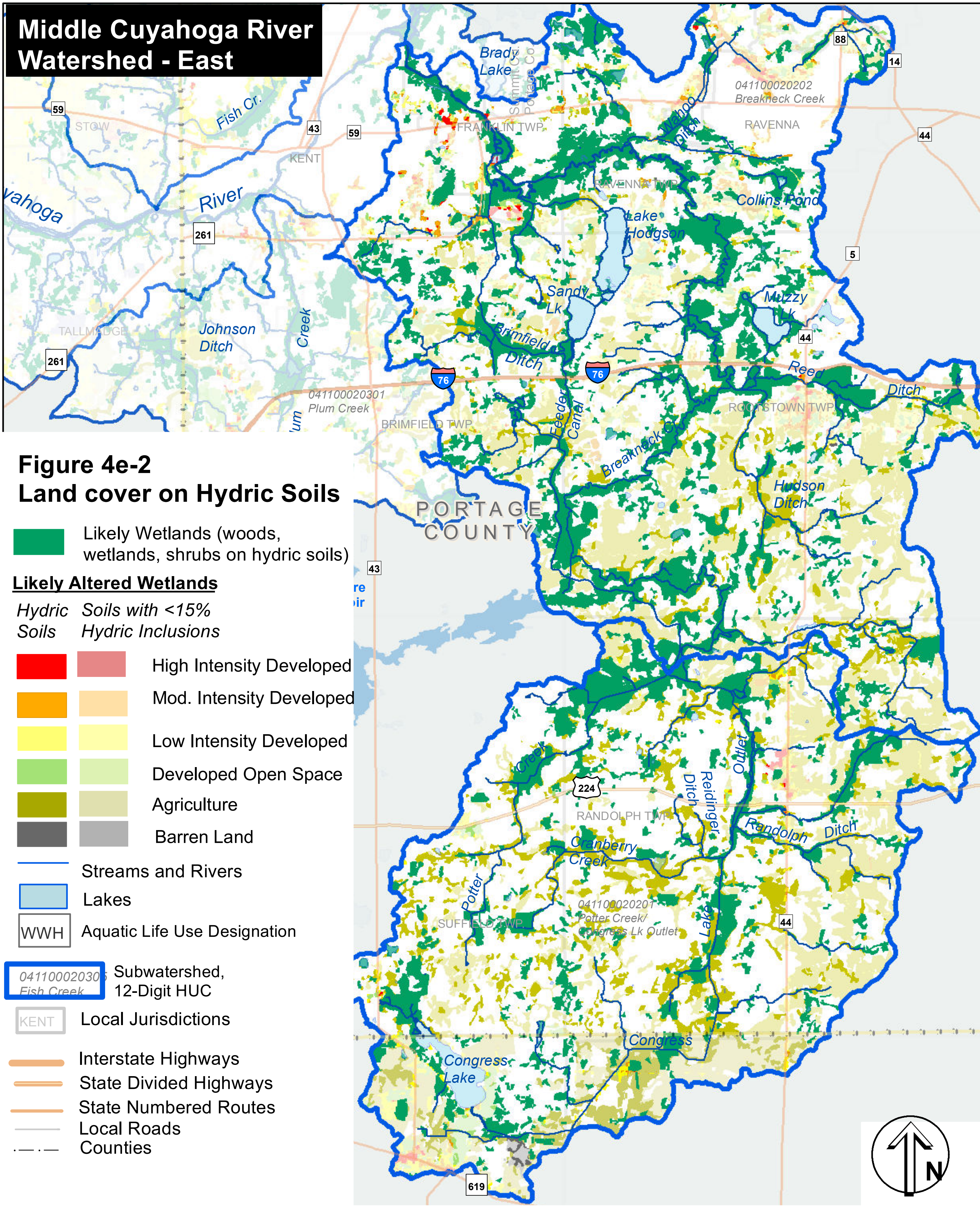


Figure 4e-2
Land cover on Hydric Soils

Feet
0 4,000 8,000 16,000
1 inch = 8,000 feet

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2010. Wetland mapping: Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; watershed - CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

- In other cases, (e.g., Walnut Creek headwaters and lower end, Collins Pond, etc.) community officials report that where wetlands (hydric soils) have been converted to development, properties experience repeated flooding.

- Soils described as having hydric inclusions were also compared with developed/agricultural areas, as these areas probably contained smaller wetlands on the patches of hydric soil included in other types. While other, poorly drained soils may also show wetland conditions, these areas were not included specifically in the mapping if they were not listed as either hydric soils or soils with hydric inclusions.

- A comprehensive assessment of wetland quality has not been conducted. Encroachment of development or agriculture can degrade wetlands, so they no longer receive the regulatory protection they once did. Mapping done for a proposed project in the Fish Creek watershed indicates the large remaining wetlands have been degraded, requiring a substantial investment to remove invasive species. Undisturbed, larger, and more complex systems, such as along Breakneck Creek, Plum Creek, and portions of Potter Creek, likely retain their high quality.

It may be possible to restore some wetland functions in hydric soils in agricultural or urban recreational lands. Hydric soils converted to developed uses are much less likely to be restored. Where intact wetland systems remain, it would be beneficial to afford them some protection.

4e-1d Water Quality Attainment - Groundwater

Potential Groundwater Contamination

Inventoried Sites

The Kent Source Water Protection Plan and Ohio EPA Division of Environmental Response and Revitalization database indicate the presence of several uncapped or abandoned landfills and other potential sources of contamination, shown on Figure 4e-3. Several are found near the Kent wellfield, fewer are in the vicinity of Cuyahoga Falls, Lake Hodgson, or Portage County supplies. According to the Source Water Protection Plan, the old Kent dump is on the opposite side of a groundwater flow divide from the wellfield. Determining the status of the other sites is important, as is monitoring near the wellfields for potential contamination.

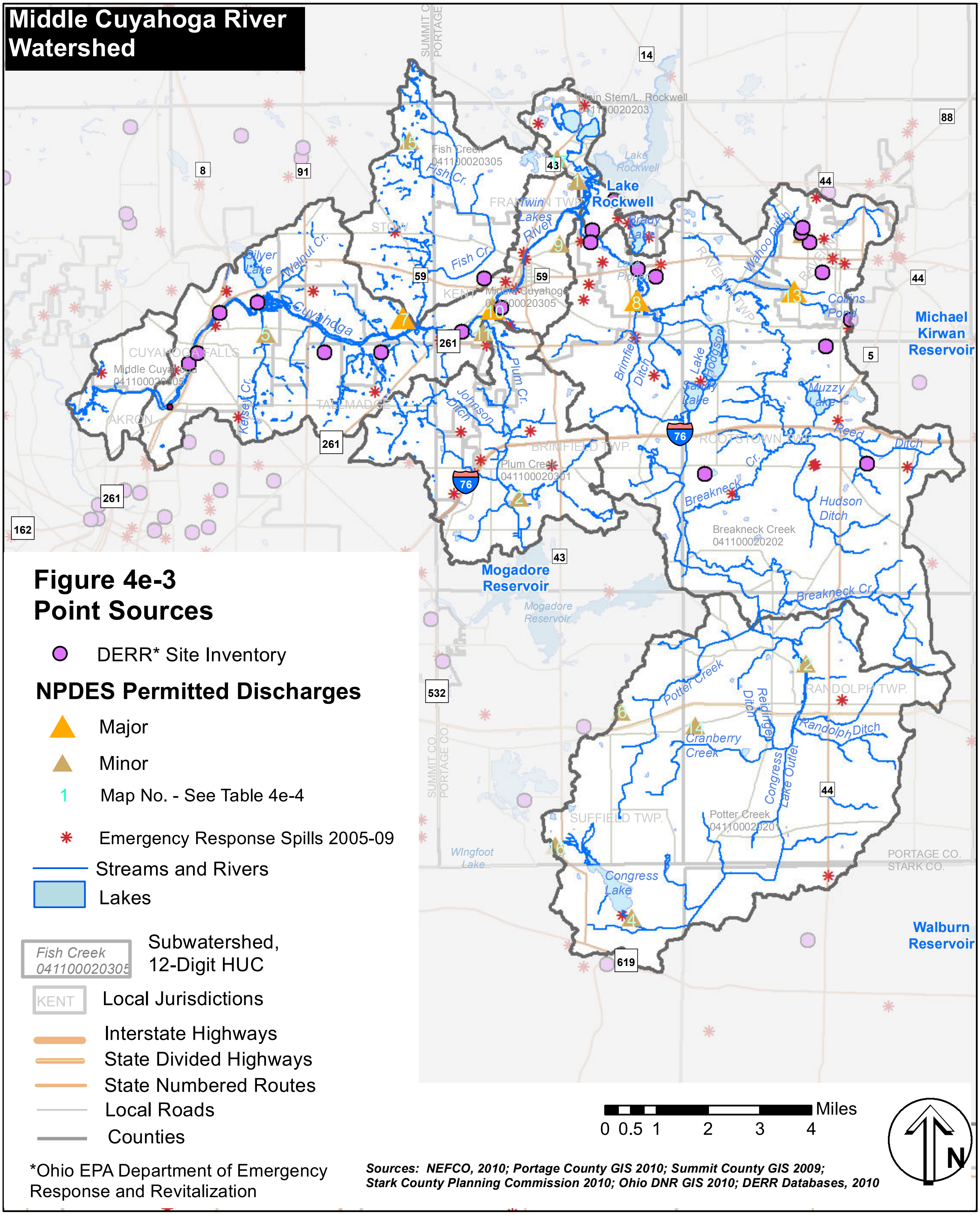
Oil and Gas Wells

One area of potential concern expressed by watershed partners is contamination of groundwater supplies from oil and gas wells. Potential sources of contamination include

- fracturing of the well casings, allowing petroleum products to enter the groundwater;
- spills and improper disposal of brine;
- contamination of groundwater supplies from hydraulic fracturing (fracking) used in stimulating deep wells in the Marcellus and Utica Shales.

Local governments do not have jurisdiction over siting the oil and gas wells, which are regulated, permitted, and inspected by the Ohio DNR Minerals Management program. According to Ohio DNR staff, communities can request notification of permits applications and can work with the DNR County inspectors to identify potential risks and conditions to minimize risks. Knowledge of the location of the most sensitive surface and groundwater resources is important in protecting water supplies.

Recent measures have increased the level of protection in drilling and stimulating deep wells. Fluids used to conduct the hydraulic fracturing must be disposed of in underground injection control wells, which are regulated by the Ohio EPA. The debates over the safety of this process will continue, in response to recent reports of groundwater contamination resulting from hydraulic fracturing processes.


Middle Cuyahoga River Watershed
Figure 4e-3
Point Sources
DERR* Site Inventory
NPDES Permitted Discharges
Major
Minor
1 Map No. - See Table 4e-4
Emergency Response Spills 2005-09
Streams and Rivers
Lakes
Fish Creek 041100020305
Subwatershed, 12-Digit HUC
KENT
Local Jurisdictions
Interstate Highways
State Divided Highways
State Numbered Routes
Local Roads
Counties
*Ohio EPA Department of Emergency Response and Revitalization
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; DERR Databases, 2010
Miles
0 0.5 1 2 3 4
N
Lake Rockwell
Michael Kirwan Reservoir
Mogadore Reservoir
Walburn Reservoir
Fish Creek 041100020305
Main Stem/L. Rockwell 041100020203
Middle Cuyahoga 041100020305
Plum Creek 041100020301
Breakneck Creek 041100020202
Potter Creek 041100020201
Fish Cr.
Cuyahoga
Walnut Cr.
Silver Lake
Twin Lakes River
Brady Lake
Breakneck Cr.
Potter Creek
Cranberry Creek
Randolph Ditch
Congress Lake
Congress Lake Outlet
Hudson Ditch
Muzzy Lake
Reed Ditch
Collins Pond
Plum Cr.
Johnson Ditch
Kelsey Cr.
Brimfield Ditch
Wahoo Ditch
Lake Hodgson
Sandy Lake
Reidinger Ditch
Wingfoot Lake
FRANKLIN TWP.
STOW
KENT
CUYAHOGA FALLS
AKRON
TALLMADGE
BRIMFIELD TWP.
ROOTSTOWN TWP.
RAVENNA TWP.
RANDOLPH TWP.
SUFFIELD TWP.
SUMMIT CO.
PORTAGE CO.
STARK CO.

4e- 2 Point sources
-a Permitted Discharges, effluent volume

As shown on Figure 4e-3 and Table 4e-8, within the watershed are four major and 12 minor permitted dischargers. The major dischargers are the wastewater treatment plants along the Cuyahoga River and its tributaries, which, under their expansions in 2007, contribute up to 20 million gallons per day (MGD). According to the 2007 Ohio EPA 2007 Cuyahoga River Aquatic Life Use Assessment report, this constitutes 53 percent of the volume during low flows before expansion and 56 percent afterward. Releases from Lake Rockwell constitute about 16 percent of the river flow.

Table 4e-8
NPDES Point Source Dischargers

Map No.	TYPE	Major/ Minor	Site	Address	City/Village/ Township	Avg. Flow (mgd)	Monitored/ Design Flow
1	I	Minor	Akron WTP	1570 Ravenna Rd	Kent	1.1	M
2	I	Minor	Brimfield WTP	3785 Grace Rd	Ravenna	0.027	D
3	I	Minor	Colonial Rubber Co	706 Oakwood St	Ravenna	0.002	D
4	P	Minor	Congress Lake Clubhouse	1 East Dr	Hartville	0.015	D
5	I	Minor	Cuyahoga Falls WTP	2028 Munroe Falls Ave	Cuyahoga Falls	0.115	D
6	P	Minor	Fairlane WWTP	1879 Whitehall Dr	Suffield Twp	0.03	D
7	P	Major	Fishcreek WWTP No 25	2910 N River Rd	Stow	8	D
8	P	Major	Franklin Hills WWTP	5756 Hodgeman Ln	Portage	2	D
9	I	Minor	Gougler Industries Inc	705 Lake St	Kent	0.000355	M
10	P	Major	Kent Water Reclamation Facility	641 Middlebury Rd	Kent	5	D
11	I	Minor	Parker Hannifin Corp Brass Products Div	838 Overholt Rd	Kent	0.021	D
12	P	Minor	Randolph WWTP	2053 State Rte 44	Ravenna	0.3	D
13	P	Major	Ravenna STP	3722 Hommon Rd	Ravenna	2.8	D
14	P	Minor	St Joseph Parish WWTP	2643 Waterloo Rd	Randolph	0.015	D
15	I	Minor	Sun Pipe Line Co Hudson Pump Station	5161 Young Rd	Stow	0.037	M
16	I	Minor	Trelleborg Wheel System Americas Inc	61 State Route 43 N	Hartville	0.049	D
17	P	Minor	Twin Lakes WWTP	7240 State Rte 43	Kent	0.456	D
	I = industrial			*total*		19.96736	
	P = public						

4e-2b Point Sources - Spills

Figure 4e-3 shows spills from 2004-2009 included in the Ohio DNR Division of Environmental Response and Revitalization database. The database may not reflect all spills. Most are concentrated along the major roads. These can be of concern to public water supplies.

4e-2c Point Sources – Combined Sewer Overflows

Combined Sewer Overflows (CSOs) occur where storm and sanitary sewers have been physically combined and discharge without passing through a waste water treatment plant, discharging raw sewage into the rivers. CSOs have been identified as the source of oxygen demanding substances and bacteria violations, which are concerns to a degree in the Middle Cuyahoga River watershed, and which are major concerns for the river downstream.

CSOs operate under National Pollutant Discharge Elimination System (NPDES) permits, as they constitute discrete discharges to water courses. The City of Akron has 37 CSOs along the Cuyahoga and Little Cuyahoga Rivers, four of which occur upstream of the Little Cuyahoga River. (See Figure 4e-4 and Table 4e-9.) Under the 2010 NPDES permit, each discharge of untreated sanitary waste is considered a violation and must be monitored.

The City of Akron has been performing studies and developing designs since the 1990s to address the CSOs. Their results indicate that:

- No areas of the Cuyahoga River within the CSO area fall below the 5 mg/l dissolved oxygen criterion
- Bacteria levels remain elevated above ambient conditions in the Cuyahoga River upstream of the confluence with the Little Cuyahoga.
- The Cuyahoga River within and downstream of the CSO area has difficulty meeting bacteriological standards for 5-6 months of the recreational season (May 1-Oct. 31).
- Upstream at Broad Street in Cuyahoga Falls, the river fails to meet bacteriological standards every month during the recreational period. The source is undetermined.

Figure 4e-4 Combined Sewer Overflows

Source: City of Akron Long Term Control Plan Amendments 2011

Table 4e-9 CSOs and Discharges

CSO Station No.	Typical Number of Annual Discharges 2010	Avg. Volume per Discharge (millions of gallons)
32	37	15.3
33	3	0
34	48	2.8
35	29	46.7

The City of Akron has submitted to the U.S. EPA a Long Term Control Plan that calls for a 20-foot wide tunnel 10,000 feet long to contain all discharges from the four CSOs within the watershed. The LTCP includes a stipulation that to the extent that green infrastructure can achieve the same result, it will be allowed as an alternative. Additional sources of high bacteria levels upstream of the CSO area should be determined as well.

4e-3a Non-point sources: Home Sewage Treatment Systems

Septic system failure and above-ground discharging systems can be a significant source of water quality problems, introducing nutrients and pathogens into surface waters. In 2000, agencies from seven northeast Ohio counties collaborated on a home sewage system study to document the conditions most likely to result in septic system failure. They found that certain soils limitations were the most likely to result in failure: Soils rated “severe” limitations for septic systems exhibiting a combination of seasonal high water table, ponding, and slow permeability.

Portage County Health Department staff indicated that in these severely limiting soils, it can be assumed that 70 percent of the septic systems of older homes built before 1990 would fail. More recent homes have been constructed using different procedures for septic systems, which address factors such as soils limitations and depth to bedrock. The more recently constructed septic systems tend to use newer construction methods as well, such as mound systems, which substantially reduce the rate of failure.

When septic systems fail, remedies can include cleaning, upgrading, or replacing septic systems or tying into a sewer system, if available. Recent construction of the Randolph wastewater treatment plant addressed frequent septic system failures in that area. Surface discharging systems are currently prohibited. However, since many were installed under previous rules, they constitute a permitted system, and compelling the owners to upgrade may prove difficult.

It should be noted that Portage County has recent (2010) begun implementing its new stormwater program County-wide. The program includes an emphasis on investigating potential illicit discharges and seeking correction of the problem. The County has enacted a stormwater fee, a portion of which is intended to help homeowners remedy failing or inadequate home sewage disposal systems.

Findings:
Home Sewage Treatment Systems

Findings: Home Sewage

Figure 4e-5 shows the soils characterized by the number of limitations for septic systems, overlain by mapping of existing and proposed sewer service. Breakneck Creek and the remaining unsewered portion of the Fish Creek subwatersheds predominantly have soils with severe limitations, reflecting the poorly draining and often hydric soils. The Potter Creek subwatershed has much less severely limiting soils. It should be noted that the soils in the proximity of Congress Lake are severely limiting. The unsewered portion of the Plum Creek subwatershed has minimal severely limiting soils.

The Portage County Health District has developed a database identifying potential illicit discharges, with an estimate of 3,445 suspected illicit discharges in the county and 1,457 in watershed communities as of December 30, 2011. Table 4e-10 summarizes the number of potential illicit discharges identified by township. Estimates of amount for the watershed were based on the presence of severely limiting soils and sewered areas in the watershed.

Approximately 437 systems in watershed communities are in annual inspection programs. In addition, Portage County Health Department investigates reports of illicit discharges. In 2011, Portage County Health Department inspected 119 suspected illicit discharges in Portage County, of which 52 were confirmed, 22 were addressed, and 30 are pending resolution. As shown on Table 4e-11, Portage County Health Department inspected 59 suspected illicit discharges in watershed communities, of which 25 were confirmed, seven were eliminated during 2011, and 18 are pending replacement or repair.

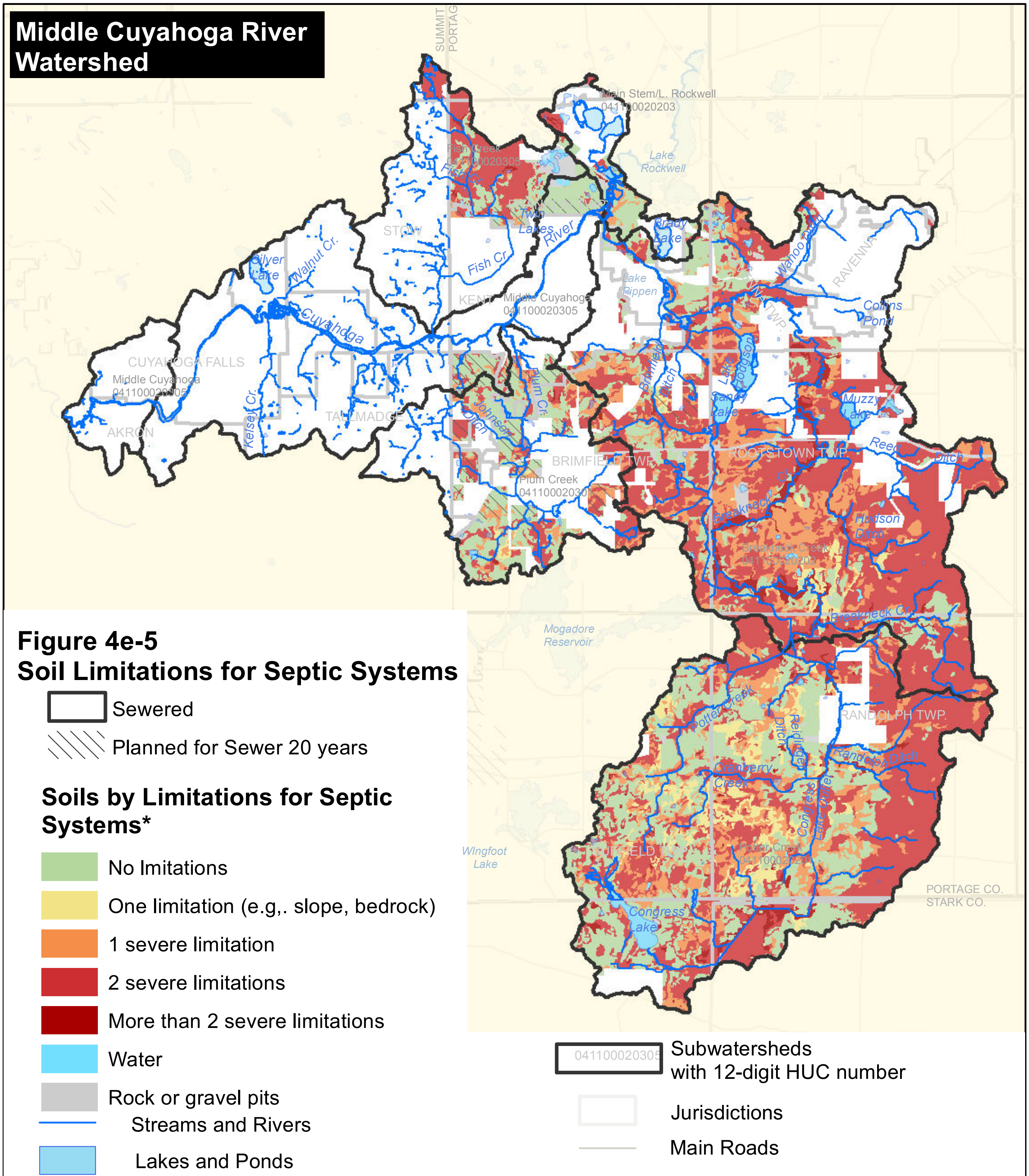


Figure 4e-5
Soil Limitations for Septic Systems

* Northeast Ohio Sewage Report notes that septic system failures were most likely in soils that were identified as having two or more severe lmitations to septic systems.

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; SSURGO soils database; Clean Water Plan prescriptions Lake Erie Basin; Portage and Summit Cou Ohio Sewage Report

Table 4e-10 Potential Illicit Discharges in Portage County, 2011

Township	Estimated Potential Illicit Discharges by Township 2011	Systems in Annual Inspection Program	Other Potential Illicit Discharges	Estimate in Watershed Based on soils 2011
Brimfield	200	78	122	*
Franklin	161	30	131	110
Randolph	188	45	143	94
Ravenna	436	137	299	109
Rootstown	372	99	273	279
Suffield	103	48	55	25

*Minimal soils with severe limitations, but potentially some failing aeration systems near the northeast border with Tallmadge.

Table 4e-11 Inspections and Corrections of Illicit Discharges in Portage County, 2011

Township	Suspected Illicit Discharges Inspected	Total Confirmed Illicit Discharges	Total Illicit Discharges Eliminated	Total Illicit Discharges Pending Replacement/ Repair
Brimfield	13	8	0	8
Franklin	4	2	1	1
Randolph	6	2	1	1
Ravenna	16	8	2	6
Rootstown	4	2	1	1
Suffield	6	3	2	1

The Portage County Health Department is continuing to address illicit discharges by inspecting storm drains for dry weather discharges.

The Stark County Health Department indicated that there have been septic system failures in Stark County townships within the watershed, and that measures were being taken to correct failing systems in the vicinity of Congress Lake.

4e-3b New homes

Figure 4a-25 shows concentrations of development activity in Portage County prior to the economic downturn. In Summit County, only a few large parcels remain. In Portage County, considerable development was proposed in Brimfield and Rootstown near Route I-76. Once the economy rebounds, these are likely sites of future development, as platted subdivisions are built. The hummocky terrain increases the potential for erosion and sedimentation.

4e-3c Animal feeding operations

The Ohio EPA online database indicates there are no concentrated animal feeding operations in the watershed. As noted in Section 4a-iv, there are several livestock operations in the watershed.

4e-3d Highly Erodible Land Soils

The NRCS has developed a list of highly erodible soils based on factors such as grain size and composition, and slope. As shown on Figure 4e-6, most of the watershed is designated as "potentially highly erodible." Highly erodible soils are concentrated on the knolls of the kame moraine in the east and the steep-sided valleys in the west.

Section 5a-3 models the sediment yield from erosion within the watershed.

Note: ***Sections 4e-4j and 4e-4k,*** *dams and petition ditches, were addressed under section 4d.*

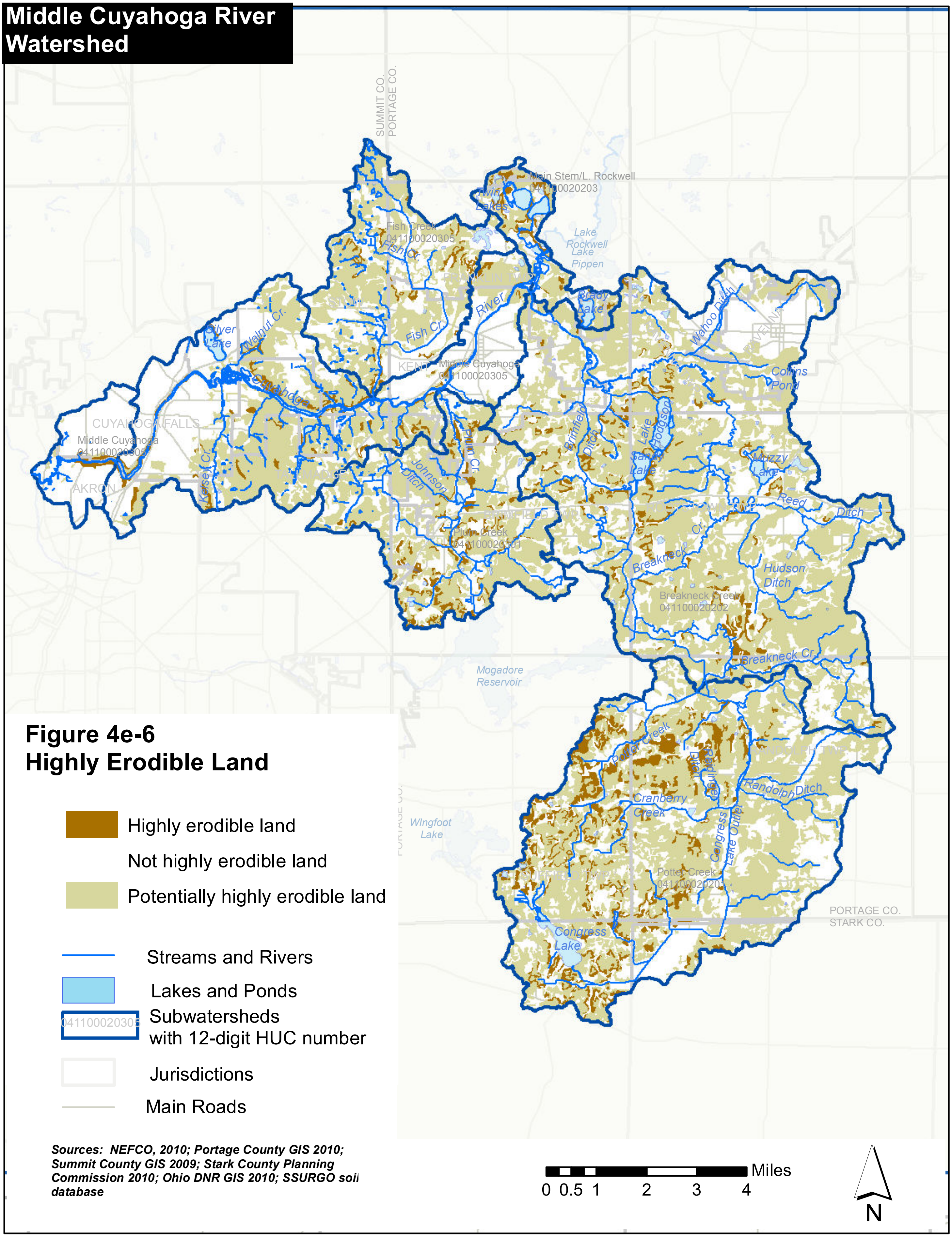


Figure 4e-6
Highly Erodible Land

4e-4 Water Quality Attainment: Status and trends

As noted previously in Section 4d, the greatest water quality improvements have come from removing or altering dams along the main stem and Plum Creek, restoring natural hydrology, improving habitat, and increasing nutrient uptake. The highly developed, altered, and impermeable nature of the subwatersheds and the resulting non-point source pollution and runoff are among the greatest remaining threats to water quality.

In the older urban areas, including Ravenna, Kent, and Cuyahoga Falls, there is potential for ground or surface water contamination from older land uses such as uncapped landfills (Kent) or industrial uses (Ravenna, Cuyahoga Falls).

A new source of concern is the potential for damage from hydraulic fracturing ("fracking") used to drill deep oil and gas wells into the Utica shale. Partners have expressed concern because of the lack of local control over siting oil and gas wells and the potential for contamination between aquifers resulting from imperfect casing practices.

Main Stem

The quality of the main stem has been improving with the removal or alteration of dams, as indicated by increased dissolved oxygen and QHEI and fish scores, with the river generally attaining water quality standards upstream of the former Munroe Falls dam. As remaining dams are removed or altered, this trend is expected to continue.

Fluctuations in dissolved oxygen and slightly elevated phosphorous levels suggest the Middle Cuyahoga River is still somewhat enriched in phosphorous, and nitrogen levels are consistently higher than state targets. Elevated levels of nutrients and bacteria during higher flow suggest the influence of non-point source pollution. The City of Akron's CSO Long Term Control Plan will reduce bacteria levels in the Gorge and downstream. Communities are increasing recreational opportunities along the river. The main stem should be monitored for changes in biological indicators and bacteria levels.

Main Stem tributaries are greatly affected by the imperviousness of the watershed. With excess water flowing through the channels and limited access to floodplain, many of the Main Stem tributaries are incising, which negatively affects habitat by increasing silt cover and embeddedness along the channels and reducing beneficial features such as gravel substrates and floodplain/riparian access.

The City of Cuyahoga Falls public water supply is on the floodplain of the Cuyahoga River. The City is finalizing its wellhead protection plan and owns much of the area over the five-year time of travel zone, which is used as a park. The wellfield is susceptible to surface water influence, as the river is used to recharge the wells.

Fish Creek

The lower portion of Fish Creek was in non-attainment of WWH standards when it was last assessed in 2000. With the removal of the Munroe Falls dam, it is possible that lowering the base level of this tributary has increased velocity enough to improve measured water quality. The lower portion of Fish Creek also exhibits levels of phosphorous and nitrogen in excess of state targets for WWH waters.

The remainder of Fish Creek has been redesignated MWH-C. This portion of the creek met the lower MWH water quality standards in 2000. However, the watershed has developed substantially in the meantime, increasing the loading into the creek and reducing the amount of treatment provided by the landscape. In Portage County, substantial undeveloped areas remain that could conceivably be developed over time and increase the load to the creek. Long-time residents noted that "there used to be fish in Fish Creek," possibly reflecting degradation of the system since the intense development since 1990. Along most of the creek, the channel appears to be embedded and the water turbid.

Plum Creek

The two monitored stations along Plum Creek were in full attainment of WWH standards in 2000. The Tallmadge Rd. site remains in a wooded corridor and appears to have features of an intact stream corridor, including floodplain access, sinuosity, and a wooded riparian corridor. The Cherry Ave. site was downstream of the Plum Creek dam, and with removal of the dam and restoration of habitat upstream of the former dam, this portion of the creek appears to be improved, with positive features such as boulders for cover, access to floodplain, sinuosity, and a gravel substrate. The subwatershed has undergone substantial development in recent years, raising the risks of degradation from non-point source pollution, altered hydrology, and runoff. Recent measurements along Plum Creek suggest that phosphorous levels are elevated compared to state targets. Most of the upstream portions of Plum Creek have been severely channelized and straightened, reducing habitat values in these portions of the creek. Immediately upstream of the restored portion in Plum Creek Park is a large expanse of wetland mosaic, which is partially protected in the Cooperrider preserve.

One major development is adjacent to "Hidden Lake." Stewardship by homeowners would be important here to reduce non-point source pollution.

A golf course is within the Portage County public water supply well field's five-year time of travel. This would be an important location for stewardship and best management practices.

Breakneck Creek

Breakneck Creek offers varied water quality, ranging from attainment along much of the near-pristine sections of the creek to non-attainment of limited resource water in Ravenna. Contributing sources are likewise varied, including non-point source pollution and runoff from developed areas, potential contamination from old industrial sites or landfills, agricultural runoff, and failing septic systems. Hudson, Reed, Brimfield, and Wahoo Ditches have been channelized and exhibit lack of floodplain access, vegetated riparian areas, channel development, and sinuosity. The main stem of Breakneck Creek flows through a largely intact wooded and wetland riparian corridor.

Areas in Brimfield, Ravenna and Rootstown Townships were the most rapidly developing. It is important that development not encroach on the riparian corridor of Breakneck Creek, as it appears that this corridor has buffered the creek from upstream influences. Addressing brownfields is important in the older urban areas. Increased development controls to encourage green infrastructure and protect natural features, stewardship, and best management practices are important in the developing areas. In the agricultural areas, it is important to encourage and increase the use of best management practices.

Lake Hodgson, which occasionally draws water from Congress Lake, has shown elevated chlorophyll counts and taste-odor problems associated with algae blooms. These appear to have increased during recent years. Recent development near the lake may have increased non-point source pollution into Lake Hodgson.

Phosphorous levels in the lower Breakneck Creek were elevated compared to state targets for WWH waters. Phosphorous levels at stations further upstream were occasionally higher than state targets in 2000, when they were measured, but these stations cannot be compared with the more recently sampled station at Summit Road due to the difference in sampling dates.

Potter Creek

Much of Potter Creek remains channelized or recovering, resulting in nearly 30 miles that offer few positive habitat features. The Trares Road site apparently has not changed substantially since sampling in 2000. This site was not limited by habitat but rather, poor fish communities. Reidinger Ditch, Cranberry Creek, and Randolph Ditch have been channelized. In spite of substantial alteration of weltands in agricultural fields, large wetland complexes at the northern portion of Potter Creek offer diverse habitat and help protect the creek from degradation. In measurements during 2000, Potter Creek occasionally exceeded state targets for phosphorous and nitrogen. Land use does not appear to be changing rapidly in this subwatershed.

5. Impairments and Pollution Sources

Previous water quality studies have identified some impairments along the river and tributaries. Observations made while developing this inventory and in the course of other efforts have identified characteristics that are likely to contribute to water quality impairments. Impairments have been described in previous sections and are summarized as follows:

Bacteria and CSOs – Along the Cuyahoga River, Fish Creek, and Potter Creek, bacteria levels have occasionally exceeded state criteria for recreational waters. Four CSOs in the Gorge section of the Cuyahoga River are unpermitted discharges occurring under the NPDES permit for the City of Akron wastewater treatment plant. These contribute to high bacteria levels in the Gorge and downstream, but elevated bacteria levels have also been observed upstream of the Gorge section. Elevated bacteria levels are of concern in the Cuyahoga River, as it is being increasingly used and promoted for recreation. It is worthwhile to determine whether elevated bacteria levels are correlated with certain weather events or water quality characteristics (e.g., high turbidity), so paddlers are aware of the potential risk during certain conditions.

Dam Pools – The 2003 and 2000 TMDLs documented impaired habitat conditions, elevated nutrient levels, and decreased oxygen levels in the dam pools along the river. Three dam pools in Cuyahoga Falls remain. Two dams will be removed in 2012, and the Ohio Edison dam is being evaluated for removal.

Nutrients – The Main stem and all tributaries exceed state nutrient targets to varying degrees. Along the Cuyahoga River, effects of nutrient enrichment are evident in diurnal oxygen swings and somewhat elevated levels. While it appears that nitrogen levels along the Main Stem and Breakneck Creek are likely related to wastewater treatment plants to a degree, they also increase with higher flow, indicating a runoff component. Nuisance algae have been observed in Congress Lake and Lake Hodgson.

Sediment – There are no state standards for sediment loading. However, siltation has been identified as a cause of impairment in the Cuyahoga River, Plum Creek, and Potter Creek. Sediment is a concern downstream in the Shipping Channel and Lake Erie. The 2008 Lake Erie Protection and Restoration Plan notes that 1.1 million tons of sediment is transported each year down the Maumee, Sandusky, Cuyahoga, and Grand Rivers, triple the desired load calculated in the Lake Erie Quality Index as necessary to reduce negative impacts from sediment loading. It should be noted that the Ohio Edison dam has stored sediment for the past 100 years. Before the dam is removed, the sediment will be removed, but the dam will no longer retain sediment from the river upstream. The river below the dam is so turbulent that virtually all sediment not deposited on floodplains will eventually move downstream out of the watershed.

Sediment in the watershed tributaries severely affects the habitat quality, biological communities, and stream channels. Many of the streams at road crossings appear to be embedded, suggesting that sediment input is greater than the ability of the streams to remove it. Embedded conditions are one of the key QHEI factors that can impair habitat quality enough to degrade the biological communities. Sediment also carries nutrients and other toxins with it.

Habitat – Habitat impairments have been documented along the Cuyahoga River in the dam pools, with nearly immediate improvements after restoration of flow. Habitat impairments that have been observed in the watershed include:

- Siltation/embedded substrate
- Poor channel form, lack of sinuosity due to channelization or channel incision
- Lack of vegetated riparian buffer/floodplain access
- Degraded, channelized, or altered wetlands
- Invasive species

Contamination - Wellhead protection, fracking, and the potential for contamination from inadequately sealed dumps and landfills in Kent are concerns related to public water supplies.

Section 7 includes tables for each subwatershed that summarize conditions and impairments, providing the basis for statements of problems, goals, objectives, and actions. Section 5a presents results of pollutant loading models or studies, Section 5b presents habitat and hydrologic concerns, and opportunities for conservation.

5a Pollution Loading

5a-iii Agricultural and other land use Inputs

Background: Agricultural and other Land Use Inputs

Non-point source pollution in the watershed stems from developed land, agricultural runoff, septic systems, and channel erosion due to factors such as excess stormwater, inadequate flood storage, and change in length or slope of stream channels.

Agricultural Inputs

Agricultural use represents 30,000 acres or 30 percent of the watershed as a whole, and 62 percent, 32 percent, and 25 percent of the Potter, Breakneck, and Plum Creek subwatersheds, respectively. As noted above, it can be a major source of sediment. Inorganic phosphorous adheres to sediment, so sediment loading can increase phosphorous levels. Nitrogen and dissolved phosphorous tend to be more mobile in the water and enter from runoff. Best management practices to reduce the loading of nutrients can include:

- Use of cover crops,
- Mulch tillage,
- Conservation tillage,
- No-till,
- Grass buffer strips,
- Timing the application of fertilizers to increase uptake and reduce fertilizer loss through runoff
- Wetlands,
- Riparian buffers planted in shrubs or trees, or
- Functional floodplains and riparian zones.

In areas with milkhouses and large numbers of livestock, nutrients and pathogens can enter the water from milkhouse waste or animal waste. In areas with unrestricted livestock access to streams, the streams can be affected by erosion and sedimentation as well as the pathogens and nutrients from animal waste.

Within the agricultural portions of the watershed, primarily Potter and Breakneck Creek subwatersheds, agricultural producers are using best management practices to varying degrees. Much of the crop land has adequate residue and has been cropped using conservation tillage. Even with good crop rotation and conservation tillage, sheet and rill erosion can contribute up to a ton of sediment per acre to the stream in areas without buffers. Few fields are systematically tiled. In tiled fields, clay soils filter substantial amounts of nutrients before the drainage reaches the tile lines. Surface runoff is a contributing factor to both sediment and nutrients entering the stream. Buffers can help stop sediment and filter surface runoff before it can negatively impact water quality.

Unrestricted livestock access and over grazing are problems in the watershed to some extent contributing to sediment and nutrient load. NRCS staff estimate that 90 percent of streams that pass through grazing lands in the watershed allow livestock unrestricted access to streams.

With the use of fencing and related measures, as well as improved buffers, erosion and non-point source pollution into these streams could be greatly reduced.

Urban Runoff

Runoff from developed landscapes contains a variety of contaminants, including nutrients, sediment, pathogens, toxic metals, petroleum products. Sources of contaminants in urban runoff include fertilizers and pesticides, pet and other animal waste, septic systems, toxins associated with automobiles and industry, and legacy sediments from urban/industrial sites. Runoff from construction sites can be especially high in sediment, as unprotected land is eroded. Recent changes to the National Pollution Discharge Elimination System (NPDES) stormwater permitting are intended to reduce the amount of sediment and other contaminants leaving construction properties.

Eroding roadside ditches also contribute to sediment and nutrients in the watershed. Since these are functioning as headwater streams, they could benefit from the addition of buffers or deeper-rooted vegetation, which would reduce pollutants entering the water and possibly reduce the requirements for ditch maintenance.

Pollutant Load Modeling – STEP-L

The US EPA Region 5 Spreadsheet Tool for Estimating Pollution Loading (STEPL) model was used to estimate non-point source pollutant loadings by subwatershed and land cover type. The model uses the Revised Universal Soil Loss Equation (RUSLE) for general land cover and soil types. For this analysis, CCAP land cover data were used. The model allows inputs for failing septic systems, livestock, agricultural practices, eroding stream channels, and best management practices, but it is only a rough approximation of what is entering the water from the land:

- The model uses many simplifying assumptions regarding pollutant loading (e.g., all agricultural uses contribute the same amount of each material, regardless of conditions or practices, when comparing various land uses).
- The model was developed for use on individual sites to determine relative pollutant load reduction through use of certain techniques.
- Individual use of best management practices is not known.
- It is quite likely that loading of nutrients has changed over the years, as the chemistry and application of fertilizers has changed.
- The categories differ between the model and the CCAP land cover data. For the purposes of modeling, high intensity land cover was assumed to be commercial, institutional, industrial, and multi-family uses; and low-moderate intensity was assumed to be residential.

The STEPL model illustrates relative contributions by subwatershed. It will prove useful in the future as projects are developed to reduce certain pollutants, allowing a before-after comparison and an estimate of pollutant loading reduced.

Findings: Pollutant Load Modeling

Findings: Annual Pollutant Loading

Pollutant Loading by Land Cover Type

Results of the STEP-L modeling are presented in Table 5a-1 for each subwatershed. The model indicates that the pollutant loadings reflect the proportions of land cover, failing septic systems, and stream erosion in each subwatershed.

Sediment - The amount of sediment from urban versus agricultural land cover types reflects the proportions of each land cover type in the subwatersheds. In all subwatersheds, eroding streambanks contribute substantial amounts of sediment.

- Potter Creek contributes the greatest amount of sediment due to the high proportion of agricultural land.
- In the Breakneck Creek subwatershed, agriculture, urban land, and streambank erosion all contribute substantial amounts.
- In the Main Stem subwatershed, eroding streambanks account for more sediment loading than the developed land.
- The Plum Creek subwatershed contributes comparatively low amounts of sediment, equally distributed between land use types and eroding stream banks.
- The Fish Creek subwatershed contributes the least sediment, predominantly from developed land.

Nitrogen/Phosphorous

The models indicate that the predominant sources of nutrients are agricultural use, urban land cover, and failing septic systems. The loading from wastewater treatment plants has not been included in these totals. In developed watersheds (all except Potter), this represents an additional load, especially of nitrogen.

- The Breakneck Creek subwatershed contributes high amounts of nitrogen and phosphorous. Septic systems, developed areas, and agricultural areas contribute approximately equal amounts of nitrogen. Phosphorous loadings are greatest from septic systems.
- The Potter Creek subwatershed contributes the second highest amounts of these nutrients. In this subwatershed, the predominant source of both nutrients is agriculture, but failing septic systems contribute a similar amount of phosphorous as pastureland.
- The Main Stem subwatershed contributes the third-highest amount of nutrients, with urban land contributing the greatest amount of both.
- The Fish Creek subwatershed contributes approximately half of the nutrient load of Breakneck Creek, predominantly from urban uses and septic systems.
- The Plum Creek subwatershed contributes the lowest amounts of nutrients, predominantly from developed land and septic systems.

Given the uncertainties associated with the model, it would be beneficial to conduct a survey of fertilizer use and best practices within all the subwatersheds to better understand the loading of nutrients and sediment.

Table 5a-1 Non-point Source Pollutant Load Main Stem

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	53882.2	9391.3	198355.8	2338.2
Total	53882.2	9391.3	198355.8	2338.2

2. Total load by land uses (No BMP)

Sources	Acres/ amount	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban		48,873.38	8,174.58	185,064.27	1,201.27
Cropland		375.88	91.59	776.38	44.37
Pastureland		2,552.12	253.18	8,045.33	62.27
Forest		726.63	350.61	1,761.35	34.52
Feedlots		0.00	0.00	0.00	0.00
User Defined		0.00	0.00	0.00	0.00
Septic		0.00	0.00	0.00	0.00
Gully		0.00	0.00	0.00	0.00
Streambank	8,000 lf x 2 banks x 3.5 ft	1,354.22	521.37	2,708.44	995.75
Groundwater	0	0.00	0.00	0.00	0.00
Total	6,549	53,882.23	9,391.34	198,355.77	2,338.17

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005;
CCAP Land Cover data, 2006

Table 5a-1 Non-point Source Pollutant Load - Fish Creek

1. Total load by subwatershed(s)

Watershed	Annual Load (no BMP) N	P	BOD	Sed.
	lb	lb	lb	tons
W1	30,765.7	5,810.3	103,301.8	895.5
Total	30,765.7	5,810.3	103,301.8	895.5

2. Total load by land uses (No BMP)

Sources	Acres/ amount	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban		23,884.28	3,880.39	80,399.42	611.66
Cropland		1,228.30	314.83	2,529.87	166.34
Pastureland		2,181.30	228.79	6,826.34	65.72
Forest		308.56	147.74	742.98	17.77
Feedlots		0.00	0.00	0.00	0.00
User Defined	0	0.00	0.00	0.00	0.00
Septic	100 failing	3,108.82	1,217.62	12,694.36	0.00
Gully	0	0.00	0.00	0.00	0.00
Streambank	2 banks @ 200 lf eroding	54.40	20.94	108.80	34.00
Groundwater	0	0.00	0.00	0.00	0.00
Total	6,549	30,765.67	5,810.32	103,301.76	895.49

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005; CCAP Land Cover data, 2006

Table 5a-1 Non-point Source Pollutant Load Plum Creek

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	30774.1	5813.5	103318.5	895.6
Total	30774.1	5813.5	103318.5	895.6

2. Total load by land uses (No BMP)

Sources	Acres/ amount	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban		23,874.08	3,876.31	80,253.37	610.76
Cropland		1,189.20	304.67	2,489.95	160.10
Pastureland		2,181.30	228.79	6,826.34	65.72
Forest		308.56	147.74	742.98	17.77
Feedlots		0.00	0.00	0.00	0.00
User Defined		0.00	0.00	0.00	0.00
Septic		3,108.82	1,217.62	12,694.36	0.00
Gully		0.00	0.00	0.00	0.00
Streambank	2 banks x 1.5' x 2,500 ft	62.79	24.17	125.58	34.13
Groundwater	0	0.00	0.00	0.00	0.00
Total		30,724.76	5,799.31	103,132.58	888.48

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005; CCAP Land Cover data, 2006

Table 5a-1 Non-point Source Pollutant Load Breakneck Creek

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	86616.1	18429.0	287478.8	3693.8
Total	86616.1	18429.0	287478.8	3693.8

2. Total load by land uses (No BMP)

Sources	Acres/ amount	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	7,975	32,333.77	5,408.21	122,439.65	794.75
Cropland	3,962	9,381.48	2,237.79	29,276.47	856.80
Pastureland	4,354	19,261.73	1,873.42	60,871.60	432.25
Forest	7,635	1,292.79	625.47	3,141.01	56.85
Feedlots	0	0.00	0.00	0.00	0.00
User Defined	0	0.00	0.00	0.00	0.00
Septic	0	15,544.11	6,088.11	63,471.78	0.00
Gully	0	0.00	0.00	0.00	0.00
Streambank	17,000 lf x 2 banks 1.5' mod 1,000 lf 2 banks 3' severe	614.04	236.41	1,228.08	451.50
Groundwater	0	0.00	0.00	0.00	0.00
Total	6,549	78,427.91	16,469.41	280,428.59	2,592.14

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005;
CCAP Land Cover data, 2006

Table 5a-1 Non-point Source Pollutant Load - Potter Creek

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	77878.3	15651.7	222287.8	4686.8
Total	77878.3	15651.7	222287.8	4686.8

2. Total load by land uses (assumes 75% cultivated fields in reduced till)

Sources	Acres/ amount	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban		7,166.45	1,183.07	24,468.48	193.39
Cropland		16,057.22	3,854.90	49,920.02	1,503.83
Pastureland		29,846.26	2,925.26	94,231.04	692.33
Forest		964.13	465.98	2,340.38	43.71
Feedlots		0.00	0.00	0.00	0.00
User Defined		0.00	0.00	0.00	0.00
Septic		9,326.47	3,652.87	38,083.07	0.00
Gully		0.00	0.00	0.00	0.00
Streambank		435.20	167.55	870.40	320.00
Groundwater		0.00	0.00	0.00	0.00
Total		63,795.72	12,249.63	209,913.38	2,753.26

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005;
CCAP Land Cover data, 2006

Additional Sediment Estimates

The STEP-L pollutant modeling was supplemented with two additional estimates of sediment loading. Both the STEP-L and HIT2 models incorporate the Revised Uniform Soil Loss Equation (RUSLE), but use different modifying assumptions. STEP-L includes modifications for use of best management practices, HIT2 includes the effect of landscape features and topography. All three methods resulted in similar estimates for annual sediment loading, approximately 8,300-9,500 tons per year, in spite of widely varying methods. The two subwatershed-specific models (STEP-L and HIT2) indicated that the Breakneck Creek/Potter Creek watersheds supply the largest amounts of sediment.

University of Akron Ohio Edison Dam Sediment Study

A University of Akron geology student sampled sediment behind the Ohio Edison dam and ^{210}Pb-dated a sediment core to determine the amount of sediment trapped annually behind the dam. While the existing sediment will be removed prior to removal of the dam, the annual deposits represent a new source of sediment loading to the Cuyahoga River downstream once the dam is removed. (K. Mann, unpub. MS theses, 2012). The study demonstrated that

- Sediment loading increased during the middle decades of the 1900s, coinciding with population growth and intense development
- In 2006, approximately 8,300 tons of sediment was deposited in the dam pool. It is likely that some of this resulted from the removal of the Munroe Falls dam.
- Sediment loading increased after removal of the Munroe Falls dam restored flow in the Middle Cuyahoga River
- It appears that increased sediment loading may also be related to intensifying weather patterns
- The loading from the Middle Cuyahoga River watershed, as measured at the Ohio Edison dam pool, represents approximately 5 percent of the loading measured downstream at Independence.
- It appears that the Ohio Edison dam is a relatively efficient sediment trap.

HIT2 Sediment Model

The recently developed sediment loading/sediment reduction model for Great Lakes States, High Impact Targeting (HIT 2) was used to map areas where sediment delivery to streams may be reduced through best management practices. The HIT model demonstrates the importance of landscape features in affecting delivery of sediment to receiving waters. The costs and benefits of several BMPs are presented in Section 6. The HIT2 model uses RUSLE, the Revised Uniform Soil Loss Equation, to determine erosion rates, but also combines it with topography and location relative to streams to model how much sediment is delivered to streams. The high-erosion and high-sedimentation locations are then shown on a map, allowing managers to better identify likely areas of high priority for erosion control. As with any mapping and modeling, these results are to be used as guidelines. Field investigation and an understanding of the practices in use are necessary to determine site-specific conditions. Source: http://35.9.116.206/hit2/about.htm

Table 5a-2 HIT2 Model of Sediment Erosion and Delivery

Subwatershed	HUC	Acres	Sediment Eroded Total(tons/yr)	Sediment Delivered to Streams Total(tons/yr)
Feeder Canal-Breakneck Creek	41100020202	28,804	17,207	2,944
Fish Creek-and Cuyahoga River	41100020305	22,641	9,030	1,634
Lake Rockwell-Cuyahoga River	41100020203	39,215	42,545	6,168*
Plum Creek	41100020301	8,293	3,479	492
Potter Creek-Breakneck Creek	41100020201	21,859	17,893	2,578

*The HIT model develops sediment loading for the entire subwatershed upstream of Breakneck Creek. Only a small portion of the subwatershed is within the Middle Cuyahoga watershed.

As shown in Tables 5a-1 and 5a-2 and Figure 5a-1, the Breakneck Creek and Potter Creek subwatersheds represent the greatest amount of erosion and sediment delivery to the streams. (The portion of the Lake Rockwell-Cuyahoga River subwatershed is so small that most of the erosion and sedimentation occurs upstream of the Lake Rockwell dam.) The model also demonstrates that of the erosion occurring in the watershed, approximately one-seventh of the sediment is likely to be deposited in streams. The rest is deposited on the land downslope of the eroding material.

- In the western subwatersheds, areas with high sediment delivery occur along the steep-walled valley of the Cuyahoga River, along some of the steeper tributaries, along the headwaters of Fish and Plum Creeks, and at the head of Johnson Ditch in Tallmadge.
- In the Breakneck Creek subwatershed, the areas with greatest sediment delivery are scattered among the hummocky landscape. Hudson Ditch, Reed Ditch, Brimfield Ditch, and headwater tributaries of Breakneck Creek are areas where sediment delivery is high.
- In the Potter Creek subwatershed, the effects of the hummocky landscape are again apparent. Portions of most of the tributaries in the watershed are near areas of high sediment delivery.

The HIT2 model incorporates existing land cover into the model of erosion and sediment delivery. However, current conditions may not accurately reflect likelihood of erosion and sedimentation, if the land uses are likely to change. For instance, approximately one-third of the Plum Creek subwatershed is currently wooded, presenting low erosion potential. However, because this area still has many platted but un-built lots, the protective woods are likely to be converted to unprotected lots during construction. This area is very hummocky, increasing the potential of erosion on the steep slopes. In rapidly developing areas, it is important to enforce effective use of BMPs for construction.

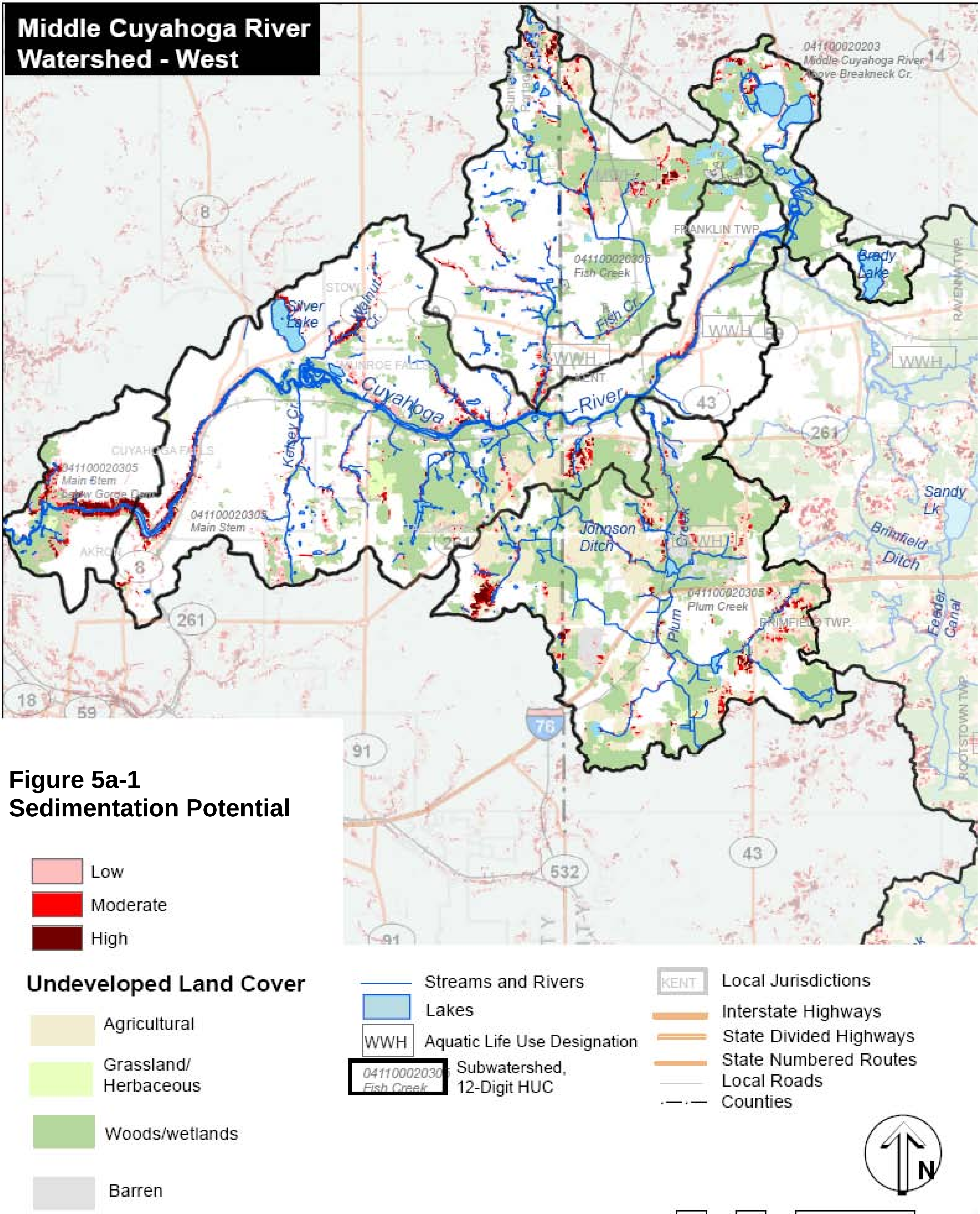
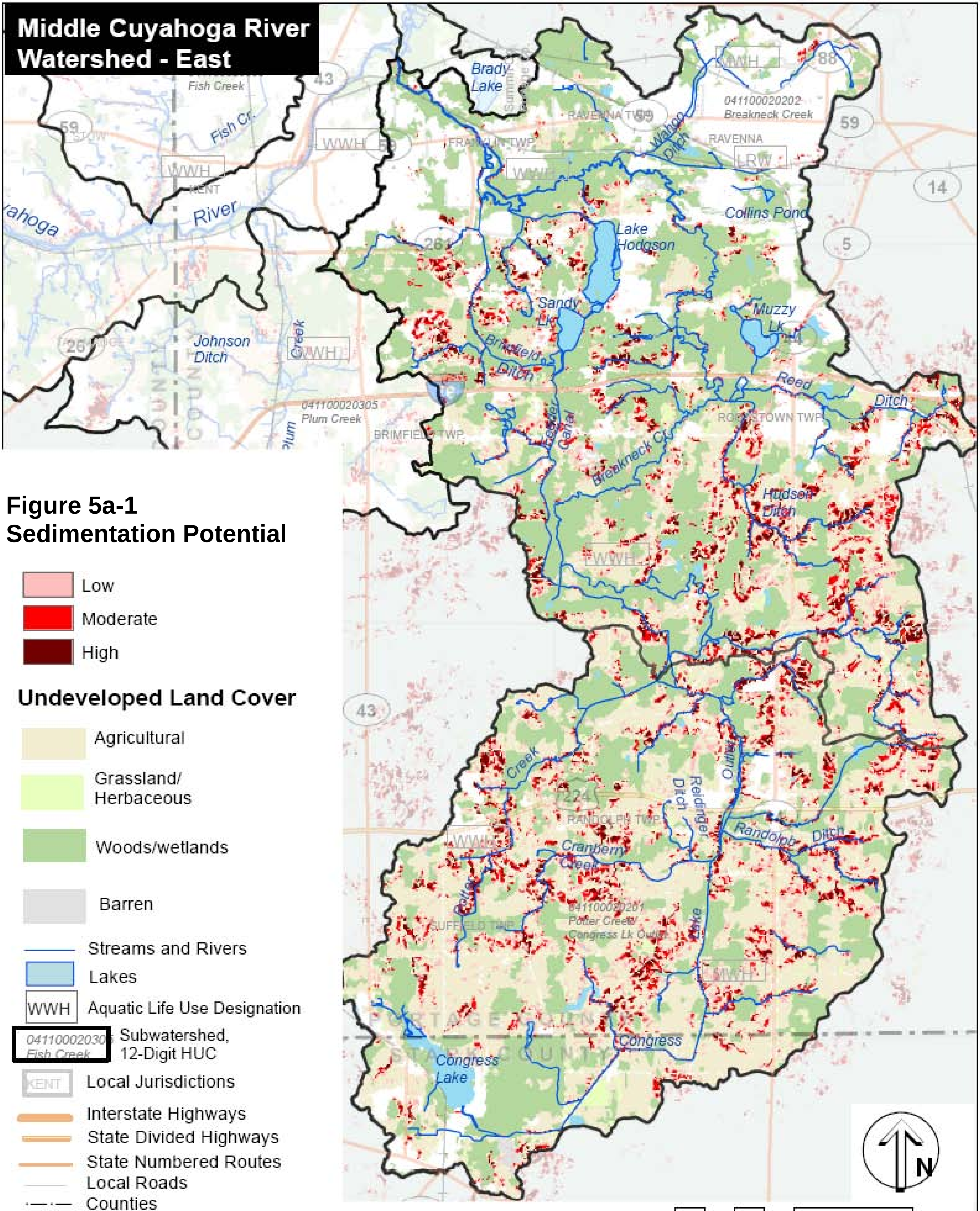


Figure 5a-1
Sedimentation Potential

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map; 2011. CCAP 2006 Land Cover Data; HIT (High Impact Targeting) Sediment Reduction Model for Great Lakes States



*Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map; 2011. CCAP 2006 Land Cover Data; HIT (High Impact Targeting) Sediment Reduction Model for Great Lakes States

Stormwater Volume, Bank Erosion, Channel Incision – Effects on Sediment and Habitat

Erosion of exposed soil in agricultural and construction sites, while significant, is not the only source of sediment entering watershed streams. A Heidelberg college study of 30 years of water quality data in Lake Erie tributaries (Richards, et al.,2008) indicated that:

- The sediment load of the Cuyahoga River has increased in recent years, and
- The peaks in suspended sediment coincide with the rising limb of storm hydrographs, suggesting that the sediment source is bank erosion from excessive stormwater volume.

As described in Section 4d, net streambank erosion occurs when the load exceeds the capacity of the channel. The additional runoff generated from impervious surfaces often overloads channels. As noted in Section 4a-iv (Land Use), the Middle Cuyahoga River watershed and its subwatersheds are nearly 13 percent impervious as a whole, ranging from nearly 3 percent in the Potter Creek subwatershed to over 26 percent in the urbanized Main Stem subwatershed.

Table 5a-3 compares the volume runoff generated during current conditions versus undeveloped conditions during the ¾ inch storm, the state-specified water quality volume for purposes of stormwater control. Runoff volumes were determined using the formula in the Ohio NPDES General Permit for Construction Activities, which was developed to better represent small storms than the more commonly used TR-55 or Rational Methods. As shown in Table 5a-3, the imperviousness in the subwatersheds has resulted in an increased volume of runoff by 1-1/2 to 5 times the pre-development volumes. Stream channels that developed in equilibrium with an undisturbed landscape could accommodate the flows prior to development. However, with such a significant increase in volume, many of the channels are now severely overloaded, eroding banks as the channel adjusts to the increased volume. Eroding banks of incised streams serves as a sediment source to the tributaries and river, the channels often can no longer access their floodplains, and the tributary habitats are degraded with siltation and poor channel form. In addition, the alteration of wetlands and stream corridor landscapes, and incision of streams below their floodplains, have reduced the ability of the stream corridor landscape to buffer or ameliorate the effects of excess runoff and pollutants. Reduction of imperviousness and improvement of riparian corridor elements are priorities in the watershed.

Table 5a-3 Rainfall Runoff Estimates by Subwatershed - Current and Undeveloped

		Current Condions				Undeveloped Conditions	
	Total	Developed	Undeveloped	Runoff 3/4" Storm		Runoff 3/4" Storm	
Subwatershed	Acres	acres	acres	Cu. Feet	Gallons	Cu. Feet	Gallons
Main Stem	17,813	12,054	5,759	10,267,997	76,804,620	1,939,836	14,509,971
Fish Creek	6,800	4,095	2,705	2,803,230	20,968,161	740,520	5,539,090
Plum Creek	8,292	2,884	5,408	2,527,671	18,906,981	902,999	6,754,431
Breakneck Cr.	28,802	7,975	20,827	8,463,937	63,310,251	3,136,538	23,461,303
Potter Creek	21,857	1,810	20,047	3,434,240	25,688,113	2,380,227	17,804,100

Runoff volume, Q = p x c x a, where p = precipitation (3/4") c is runoff coefficient, $c=.858i^3-.78i^2+.774i+.04$, i = % imperviousness, and a = area, with appropriate conversions from inches to feet. Ohio NPDES General Permit, Long-term analysis of rainfall data indicates that 85% of storm events in Ohio result in a rainfall of 0.50 inches or less. Multiplying this amount by 1.5 (which represents a mid-range regression coefficient for maximizing storm event and volume capture) results in 0.75 being used as the average events. Ohio EPA and the Ohio Department of Natural Resources felt that this was a sufficient precipitation depth to control pollutants in runoff, but also minimize channel and stream bank erosion due to runoff from developed areas. Sources: Stormwater Post-Construction Questions And Answers, http://epa.ohio.gov/dsw/storm/CGPPCQA.aspx#07; Authorization for Discharges Associated with Construction Activity Under the National Pollutant Discharge Elimination System, April 2008, http://www.epa.ohio.gov/LinkClick.aspx?fileticket=y8Ff9MECTVQ%3d&tabid=3466.

The urbanized sub-watersheds and would benefit from green infrastructure (e.g., permeable pavement, rain gardens, biofiltration measures), restoration of riparian vegetation, and other practices to reduce non-point source pollution. Opportunities for green infrastructure demonstration projects include older neighborhoods, redevelopment or enhancement of commercial areas, sidewalks, road rights of way, and public parking lots/buildings.

Streambank erosion from overloaded channels can occur in agricultural landscapes as well as developed ones. Agricultural uses do not create the same degree of imperviousness as development, but the agricultural uses may increase runoff by reducing interception of rain water. Channelizing the streams reduces their capacity to handle flood water, by removing them from floodplains and wetlands, and reducing their length through straightening. In portions of the watershed (e.g., Breakneck Creek headwaters upstream of Congress Lake Outlet) severely eroding banks have been observed in highly channelized stream systems in agricultural areas.

5b-1 Habitat and Hydrologic Concerns - Habitat

Table 5b-1 summarizes known and potential impairments and concerns in the watershed. Problem areas related to land use and channel conditions are shown in Figures 5b-1 and 5b-2. Section 7 (vol. II) includes individual maps and lists of characteristics/concerns for each subwatershed.

As noted in previous sections, the watershed as a whole is characterized by altered habitat. In the urbanized areas of the Main Stem, Fish Creek, and portions of Breakneck and Plum Creek subwatersheds, the alteration is related to development of the area. Tributaries in the rural portions of the watershed, such as portions of Plum Creek, Potter Creek, and Breakneck Creek, have also been altered. Habitat concerns in the watershed include:

- Remaining dam pools along the Cuyahoga River have degraded habitat, excessively silted in, nutrient-rich and oxygen-poor. Two dams will be removed in 2012, and the Ohio Edison dam is being evaluated for removal. Small low-head dams throughout the watershed may impair habitat downstream.
- Incising channels in Main Stem subwatershed – a portion of Kelsey Creek has been assessed as “fair” but degrading. Other tributaries in the Main Stem subwatershed are actively incising, impairing habitat with siltation, embeddedness, poor channel formation, lack of floodplain/riparian access. This subwatershed is 26% impervious, contributing to excessive channel loading.
- Channelized/altered streams, including Wahoo Ditch, Fish Creek, upper portions of Plum Creek, headwaters in urbanized areas, agricultural ditches
- Altered wetlands and riparian corridors, lack of vegetated riparian corridors
- Congress Lake, which is hyper-eutrophic, is at the head of the watershed, feeding Congress Lake Outlet, Breakneck Creek, and occasionally, the Feeder Canal and Lake Hodgson.

In spite of the alteration, the watershed still contains areas that offer important habitat. It is important that these areas not be degraded by encroaching development:

- Intact riparian habitat remains along the Breakneck Creek, lower Plum Creek, and tributaries that are protected by woods and wetlands. Large portions of the riparian corridors not only provide habitat for terrestrial and amphibious species, but also providing important habitat corridors.
- The Cuyahoga River, Breakneck Creek, and portions of Plum (and possibly Fish) Creek offer good quality habitat for aquatic life;
- In some of the undeveloped areas of the watershed, the glacially formed landscape includes numerous wetlands, including rare habitats such as bogs and fens.
- It is important to protect the intact areas from disturbance.

Main Stem

In the remaining dam pools, habitat is likely still degraded, with high proportions of silty substrate and embeddedness, but removal of the remaining three dams would substantially improve the habitat. Tributaries flow through a highly altered landscape. Many exist only as urban drainage. Many of the existing streams are overloaded and incised, degrading the habitat of the tributaries and introducing additional water and sediment to the river. Along the Middle Cuyahoga River and the former dam pool along Kelsey Creek, the woody riparian cover is as yet sparse.

Table 5b-1
Summary of Impairments/Concerns and Causes by Subwatershed

Sub-watershed	Habitat	Nutrients/Oxygen	Sediment	Bacteria	Contamin-ation	Land Use	Flooding
Main Stem 04110002 0305	Remaining dam pools – degraded habitat due to hydromodification, siltation, lack of sinuosity Restored river/stream sections lack woody vegetation/cover Altered riparian buffer: 60% Altered wetlands: 451 ac Altered/channelized streams: 31 miles	Excessive nutrients and low oxygen in dam pools Nutrients in restored sections still exceed state targets, large diurnal oxygen swings Urban land, eroding streambanks, pasture contributing nutrients – increases during low and high flow 2003 TMDL lists Phosphorous as cause of impairment	Siltation identified as a cause of non-attainment; sediment a concern in the shipping channel and as input to Lake Erie; Beneficial Use Impairment of AOC due to sedimentation	Bacteria levels exceed state standard for recreational waters, predom-inantly in the Gorge section and downstream, due to 4 CSOs 2003 TMDL lists bacteria as non-attainment cause. Elevated bacteria occasionally also UST of Gorge	CF public water supply vulnerable Concerns about fracking 8 sites on DERR list	Highly altered land-scape	Downstream flooding and riverbank erosion are major concerns Imperv. 26%
- Main Stem Tribs	Incision degrades habitat through siltation, poor channel form. Kelsey Creek QHEI 53 = “fair” but degrading due to vertical instability. Riparian buffers: frequently altered – 90-95% of Kelsey & Walnut Creek riparian buffers altered. Eroding streams 4.9 mi Channelized streams 9.7 mi.	Included in above	Incising streams are a sediment source to river, silty substrates degraded habitat			Highly altered land-scape	Localized flooding problems along headwater tributaries – primary concern is eroding channels

Sub-watershed	Habitat	Nutrients/Oxygen	Sediment	Bacteria	Contamin-ation	Land Use	Flooding
Fish Creek 04110002 0305 (part)	UST of RM 1.3 – channelized, altered/ channelized wetland, lack of riparian buffers North River Rd. – not in attainment due to low QHEI/IBI scores, stressed fish communities from urban runoff/upstream channelization.	Phosphorous exceeds state targets Septic system failure in unincorporated areas Sources (in decreasing order): urban runoff, failing septic systems, ag., eroding streambank	Bank erosion – excessive water, no floodplain access – Spaulding Rd.	Bacteria levels exceed recreational criteria		Potential impacts from develop-ment	Flooding problems Newcomer Rd. and McKinney Ave. area, some headwater tributaries Imperv.: 21%
Plum Creek 04110002 0301	Habitat at monitoring sites appears to be intact At last measurement, stream was in full attainment Removal of dam, stream restoration improved habitat Extensive wetlands at lower end of creek protect quality Upper portion altered Development pressure 12 mi streams channelized 698 ac wetlands altered 51% riparian corridor alt.	Phosphorous exceeds state targets Soils present few areas with severe limitations for septic systems Sources (in decreasing order): urban runoff, septic systems, ag., eroding streambank	Siltation a cause of non-attainment Erosion/sediment from ag fields, unrestricted livestock access, incising stream		Portage County public water supply	Golf course near public water supply Focus for develop-ment	

Sub-watershed	Habitat	Nutrients/Oxygen	Sediment	Bacteria	Contamin-ation	Land Use	Flooding
Breakneck Cr. 04110002 0201	Habitat largely intact upstream of urbanized area – extensive floodplains, wetlands Invasive species – Brady Lake Headwaters altered/channelized – Hudson, Reed, Brimfield ditches Headwaters incising Channelized – 47.4 mi Altered wetlands 1,739 ac Altered riparian corridor 49%	Nutrient levels exceed state targets Lake Hodgson has nuisance algae/taste/ odor problems Urban runoff, Septic system failures and ag contributing nutrients DO exceedence July 2000 at Summit (4.6 mg/l)	Headwater streams incising Unrestricted livestock access, erosion from ag fields, stream-bank erosion		Kent and Ravenna public water supplies 11 sites on DERR list Fracking a concern	Densely developed northern portion Golf courses	Brimfield Ditch, confluence of Breakneck Cr. & Wahoo ditch, Brady Lake Imperviousness northern portion:
- Feeder Canal	Channelized, attain MWH standards		Eroding banks				
- Wahoo Ditch	Non-attainment – habitat alteration – channelization Embeddedness Urban runoff		Eroding banks		PAHs in sediment exceed probable effects criterion; brownfields and legacy contamin-ants	Highly urbanized	Flooding a concern at trailer park Maintained/ petition ditch

Sub-watershed	Habitat	Nutrients/Oxygen	Sediment	Bacteria	Contamin-ation	Land Use	Flooding
Potter Creek 04110002 0202	Partial attainment – fish communities poor; many portions of creek heavily embedded, silted, channelized, poor channel development; lack of floodplain access, lack of riparian vegetation; some recovering Large wetland complexes in northern portion Streams channelized: 29.5 mi Wetlands altered: 2,585 acres Riparian corridor altered: 79%	Nutrient levels exceed state targets L. Hodgson (downstream), Congress Lake have nuisance algae Agricultural runoff, Failing septic systems,	Potter Creek appears to be silted, embedded Sediment erosion from ag fields and unrestricted livestock access			Agricultural, residential Potential agricultural residential impacts to Cranberry Creek, Reidinger Ditch, Potter Cr.	
- Congress Lake Outlet	Channelized, Riparian buffer largely vegetated	Nutrient levels at uppermost sections exceed state MWH criteria	Incising streams Unrestricted livestock access				

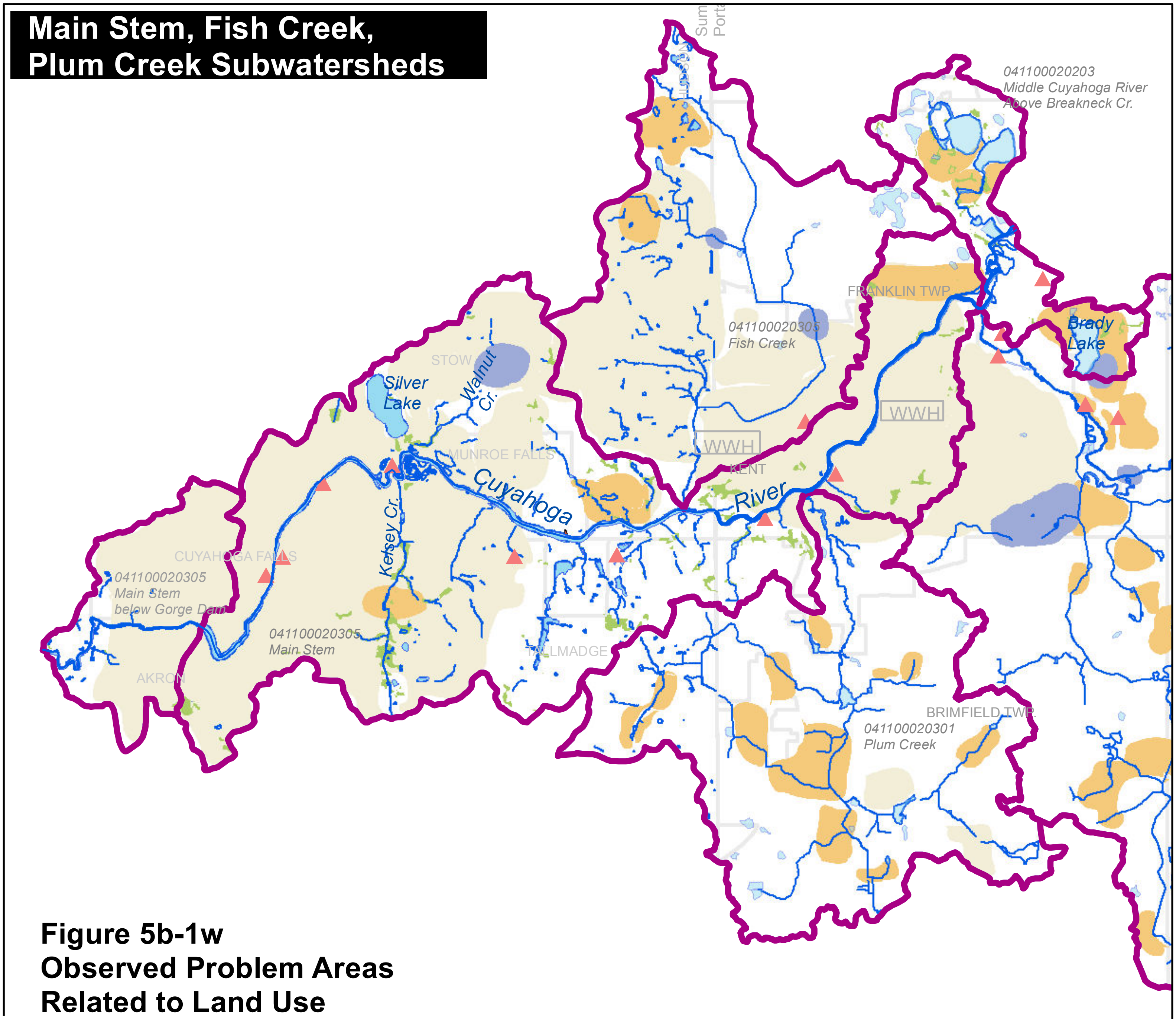


Figure 5b-1w
Observed Problem Areas
Related to Land Use

Altered Landscape/Hydrology
Neighborhood Flooding Reported
Altered Wetlands
Potential impacts due to proximity of land use (agriculture, golf courses, development)
Site on DERR (Division of Environmental Response & Revitalization) database

**Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography.*

Breakneck Cr., Potter Cr. Subwatersheds

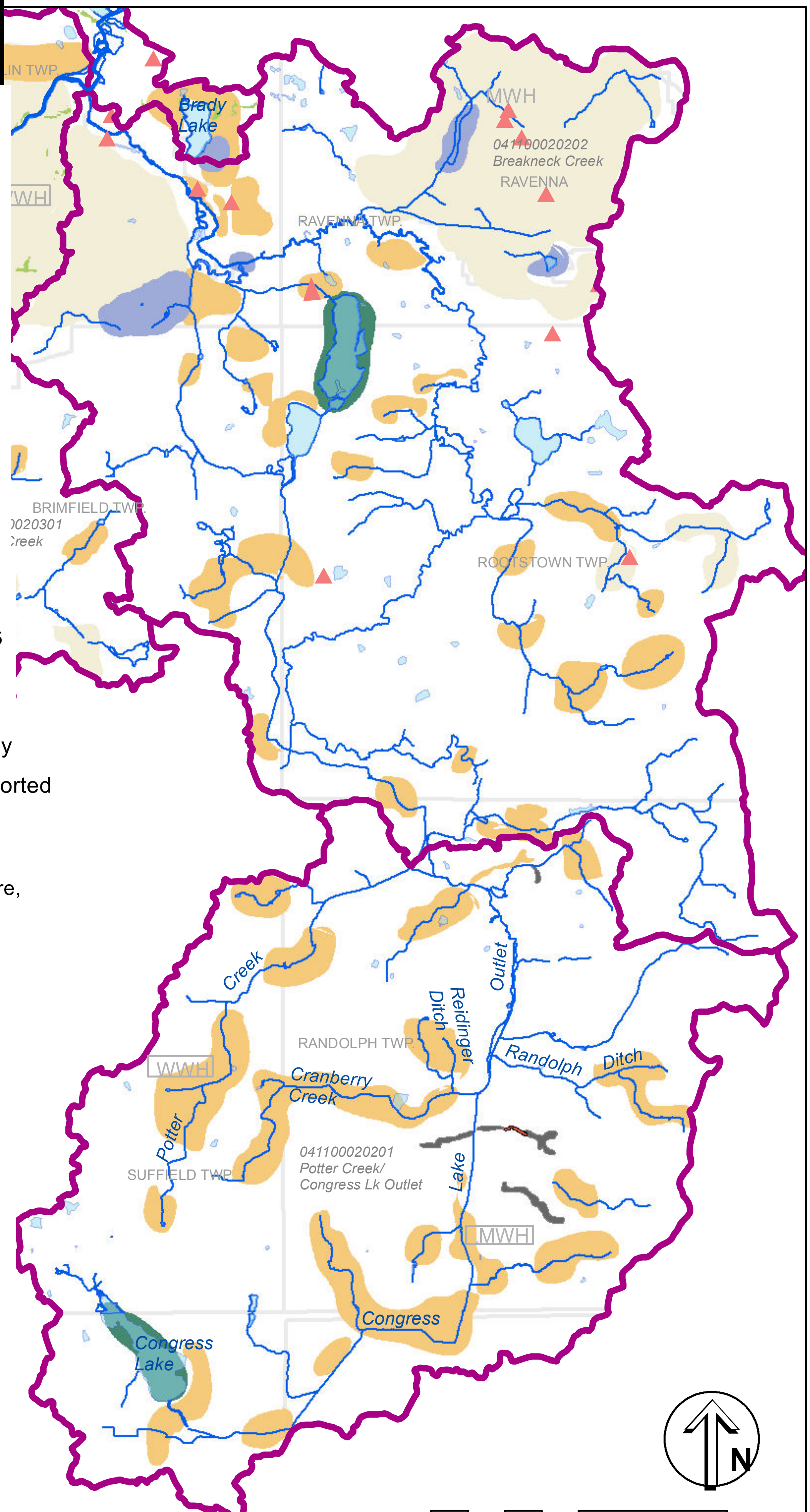


Figure 5b-1e
Observed Problem Areas Related to Land Use

- Altered Landscape/Hydrology
- Neighborhood Flooding Reported
- Altered Wetlands
- Potential impacts due to proximity of land use (agriculture, golf courses, development)
- Nuisance Algae
- Site on DERR (Division of Environmental Response and Revitalization) database
- Streams and Rivers
- Lakes
- WWH Aquatic Life Use Designation
- 041100020201 Potter Creek — Subwatershed, 12-Digit HUC
- Local Jurisdictions

**Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography.*

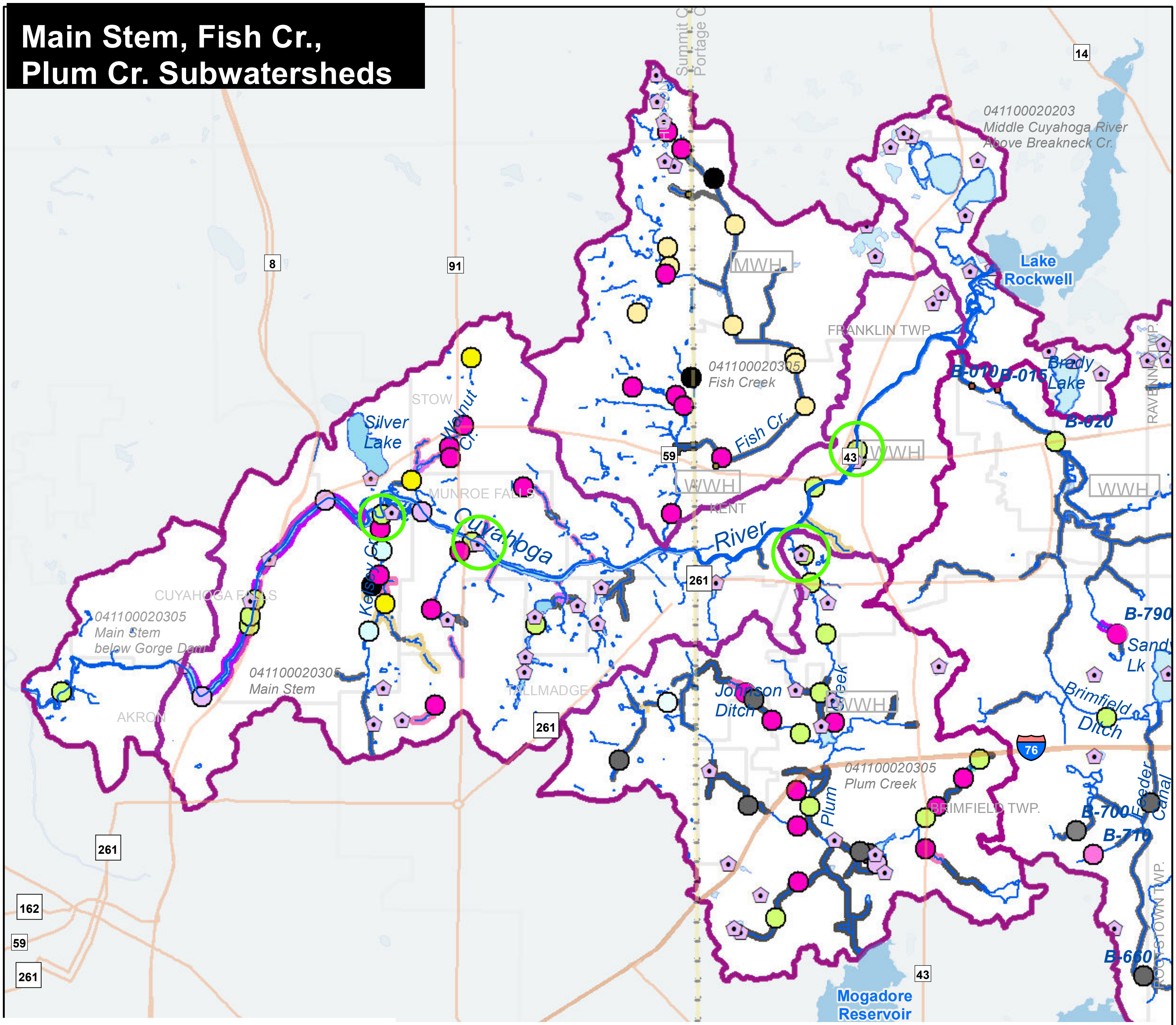


Figure 5b-2w
Observed Problem Areas - Channel Conditions

Channel	At Sites	Condition
		Intact
		Recovering
		Eroding Channel
		Channelized
		Altered
		Impounded
		Dam
		Dam removed/altered between 2004 and 2010

Streams and Rivers

Lakes

WWH Aquatic Life Use Designation

041100020305 Fish Creek Subwatershed, 12-Digit HUC

Local Jurisdictions

Interstates

State Divided Highways

Numbered State Routes

Counties

N

0 4,000 8,000 16,000 Feet

1 inch = 8,000 feet

*Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography, Ohio DNR dam inventory database 2011.

Breakneck Cr., Potter Cr. Subwatersheds

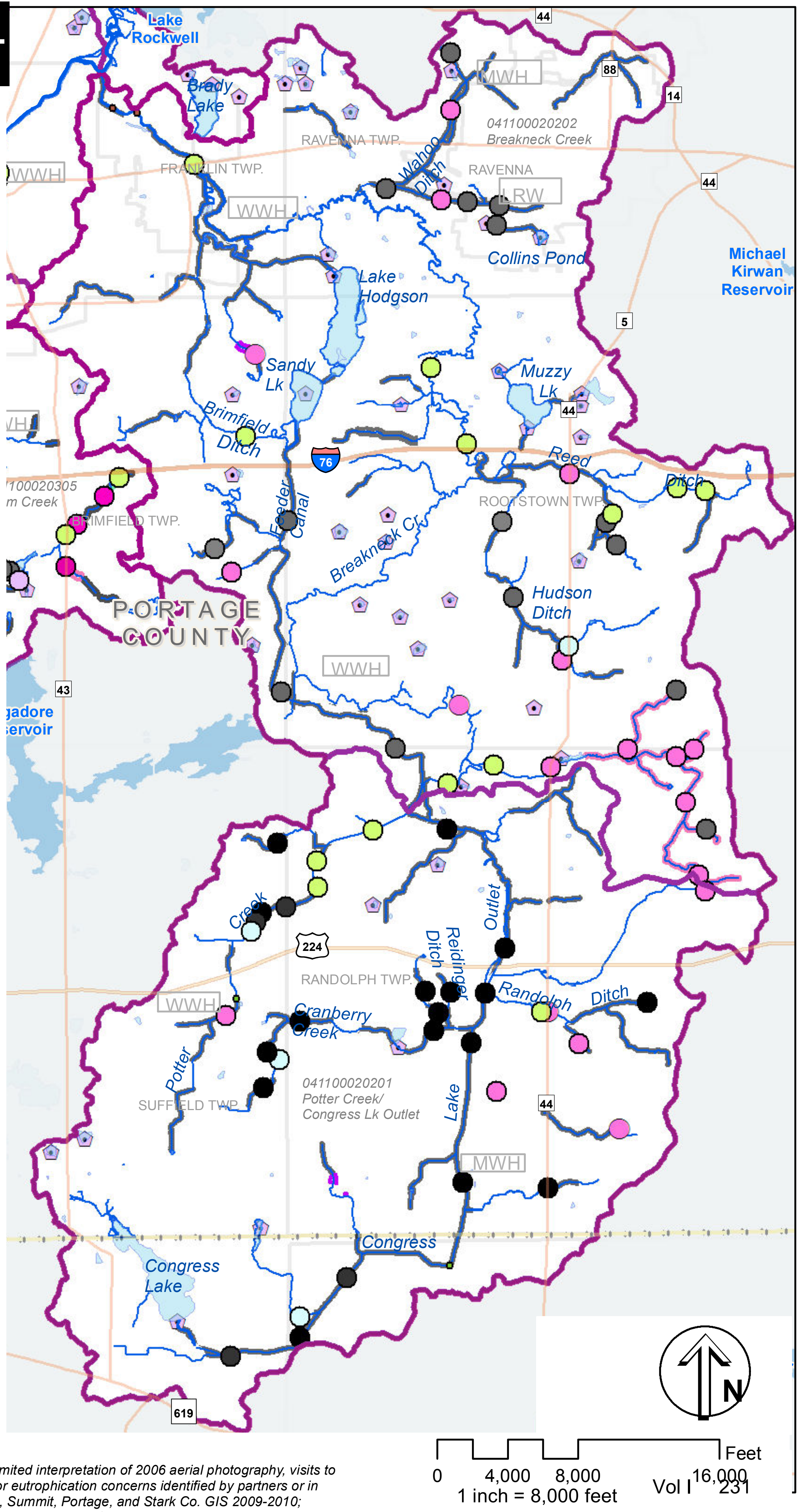


Figure 5b-2e Observed Problem Areas - Channel Conditions

Channel	At Sites	Condition
		Intact
		Recovering
		Eroding Channel
		Channelized
		Altered
		Impounded
		Dam

Streams and Rivers

Lakes

WWH Aquatic Life Use Designation

041100020201 Potter Creek — Subwatershed, 12-Digit HUC

Local Jurisdictions

Interstates

State Divided Highways

Numbered State Routes

Counties

*Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography, 2011 Ohio DNR dam inventory.

Fish Creek

In the lower 1.3 miles of Fish Creek, still designated WWH, declining QHEI and IBI scores during the 1990s may have reflected water quality declines with rapid development of the watershed during that decade. The recent lowering of the base level of the creek may improve flow in this section of the creek.

Large portions of Fish Creek, now designated MWH-C, flow through altered wetlands in Kent, Franklin Township, and Stow. Because these areas are channelized, they no longer access the wetland or floodplains. While some wooded or shrubby wetlands remain, much of the wetlands appear to be dominated by phragmites. Channel conditions within the altered wetlands appear to be highly embedded. The portions of Fish Creek within Portage County are generally very low-gradient. Prior to development and channelization, it is likely that this, like Breakneck Creek, would have been characterized as a swamp stream. Informal descriptions by Stow officials suggest that the stream channel anastomosed through wetlands in Stow.

Many of the Fish Creek headwater tributaries appear to be largely altered and flow as drainage-ways through residential developments. However, some have protective riparian zones. Drainage ways without protective riparian vegetation might be appropriate for riparian plantings.

Plum Creek

As described further in Section 4d, the lower 4 miles of the creek remains largely intact, flanked by extensive wetlands and floodplains, which likely contribute to the high quality of the stream. Approximately 12 miles of the upper reaches of Plum Creek have been channelized or modified to provide drainage in developed or agricultural areas and exhibit modified characteristics (lack of riparian vegetation, lack of floodplain access, eroding banks, embeddedness, lack of sinuosity). Agricultural fields and unrestricted grazing serve as a source of sediment in the agricultural portions of the watershed, while the developed and developing areas clearly contribute to channel overloading and streambank erosion.

Portions of this modified landscape have been either improved (oversized stormwater basin near Munroe Rd. in Tallmadge replacing a ditch) or left undisturbed (JayCee Park on Howe Ave. in Tallmadge), improving but not entirely restoring the habitat characteristics. Portions of the creek are rapidly eroding and lack riparian vegetation in agricultural areas or golf courses. This subwatershed experienced rapid development between 2000 and 2007, the beginning of a multi-year economic slowdown. Once development begins again, it is likely that this area will again be the focus of growth. It is important to continue monitoring this creek and enforcing and improving upon the use of vegetated setbacks to protect the intact portion of the creek.

Breakneck Creek

As described further in Section 4d several tributaries to Breakneck Creek and the uppermost reaches (above the confluence with Congress Lake Outlet/Potter Creek) are channelized and are influenced by factors such as:

- eroding banks from runoff or agricultural activity, including unrestricted livestock access
- urban runoff
- lack of vegetated riparian buffers, floodplain access, and sinuosity,
- high degree of embeddedness.

Channelized streams include Reed, Hudson, and Brimfield Ditches, as well as portions of Breakneck Creek near the confluence with the Cuyahoga River. The lower portion of the creek appears to be influenced by wastewater treatment plants and the urban landscape.
In the agricultural areas, the headwater habitats become degraded by channel erosion and livestock access. In spite of habitat impairments along the channelized ditches and headwater streams, it appears that the extensive flanking wetlands and floodplains of the middle portion of Breakneck Creek buffer the impacts from the upstream tributaries.

Wahoo Ditch has continually been in non-attainment of MWH-C criteria, with channelization, embeddedness, flow alteration, legacy contaminants, and urban runoff contributing to degraded habitat and biota.

Potter Creek
Potter Creek and its tribuaries are largely altered for agriculture, but there are areas where the creek appears to be recovering. In spite of the high degree of riparian and wetland alteration, but there are two large wetland complexes remaining at the northern end of Potter Creek. Congress Lake Outlet is maintained as a drainage channel, but the riparian buffer along the outlet is largely vegetated.

5b-2 Hydrologic concerns

As noted above, the altered landscape has adversely affected the hydrology of the watershed.

- In the urbanized areas, excess runoff, altered hydrology, and altered riparian landscapes, have resulted in overloading of many streams, especially in the steeply sloping areas. The high volumes are eroding streambanks, causing streams to incise, removing them from their floodplains and exacerbating flooding, streambank erosion, and sedimentation downstream. Evidence of stream channel overloading was also observed at the Breakneck Creek headwaters, many of which are eroding and becoming incised.

- Frequent flooding problems have been noted at several locations, where altered hydrology may have reduced the ability of the streams to handle floods, including: along Fish Creek at Newcomer Road and at several locations along Fish Creek in Kent; Breakneck Creek at Summit Rd.; the mouth of Walnut Creek; headwater tributaries of Walnut Creek; Wahoo Ditch near Route 59; and the margin of Collins Pond.

- Ditching wetlands has reduced the flood-storage ability of portions of the watershed. Wetlands that have been altered and degraded may no longer have the same level of regulatory protection as ones that remain intact.

- Agricultural ditching and channelization/alteration for drainage, has removed tributaries from their floodplains, has resulted in siltation and embedding, and has reduced the ability of the stream network to handle flood events.

- Three dams remain on the Cuyahoga River in Cuyahoga Falls. Numerous small dams are in place at impoundments.

5b-3 Problem Areas and Priorities for Conservation

Problem Areas: Background

Figures 5b-1 and 2 present an overview of problem areas and priorities for conservation, compiled from previous maps. These maps are presented individually for each subwatershed in Section 7, Problems, Goals, Objectives, Actions. They can be used to help direct the actions the partners wish to pursue. They represent a general understanding of watershed problems and preservation potential. However, they do not necessarily represent all the important areas or the highest priorities. Field investigation is necessary before projects can be designed.

Problem areas were mapped using a combination of factors, including:

- Observations from 2006 aerial photographs and limited visits to stream crossings;
- Reports of eutrophication, impoundments, neighborhood flooding, or other concerns;
- Areas where many wetlands have been altered;
- Streams with eroding channels
- Channelized areas;
- Areas where land cover in stream buffers is predominantly agricultural or developed; and
- Areas where the landscape and stream channels have been culverted or severely altered.

The categories shown on Figures 5b-1 and 5b-2, as well as the problem figures in Section 7, are summarized as follows and suggest certain types of actions:

Problem Areas: Land Use Related Concerns

- Altered landscape and hydrology – Stream channels and wetlands have been severely altered by channelization, filling, or development. Field visits are necessary to determine what the opportunities are for each area. Appropriate actions would minimize the effects of development/alteration and restoring function where possible. Examples include: increasing infiltration with green infrastructure, daylighting streams, restoring floodplain access, reconnecting streams with adjacent wetlands/floodplains.
- Potential proximity effects – based on aerial photograph interpretation and limited field visits, it appears that stream channels could be negatively affected by nearby land uses, e.g., developed areas, golf courses, agricultural fields. Site visits are necessary to determine whether the land uses appear to be affecting the water courses/water bodies. Appropriate actions would minimize the negative effects of nearby land uses (e.g., agricultural or urban runoff, erosion), including: restoration of riparian buffer; best management practices to reduce runoff, erosion, sedimentation, and nutrient input (e.g., soil testing, cover crops, grass filters, green infrastructure, Audubon habitat practices for golf courses).
- Altered Wetlands – the presence of hydric soils in altered landscapes suggests that these areas were wetlands that have been altered. In these areas, there may be opportunities for wetland restoration. There may be vacant lands or fields that were once in use but can be restored, or channelized wetlands that could be evaluated for restoration of stream connection/wetland hydrology. Restoration of wetlands, where possible, could help reduce downstream flooding, improve nutrient uptake, and improve/increase habitat.

Areas with hydric soils are more likely to be successfully restored to wetlands than creating wetlands in previously non-hydric environments.

- Areas of problem flooding – While all undisturbed streams flood, flooding becomes a problem when it threatens land use, public safety, and infrastructure. Flooding problems may arise due to altered hydrology or watersheds on-site, upstream, or downstream. Often, specific hydrologic studies are needed to determine the local causes and opportunities to address the problem. Potential actions can include restoration of floodplain access, wetland connection, and channel form, increasing flood storage, and/or reducing inputs through reduction of imperviousness and increasing infiltration (e.g., through downspout disconnect programs, green infrastructure, rain gardens, etc.) on-site or upstream. In some areas, problem flooding results because development is located within a floodplain, and the most effective solution is to remove the development from the floodplain. This necessity has arisen in some of the watershed communities.

Problem Areas – Channel Conditions

- Intact – the channel appears to be connected to a floodplain with a vegetated riparian buffer. This is not a problem area but one that should be protected as is.
- Recovering – the stream appears to have been channelized or otherwise affected but appears to be recovering access to floodplain, sinuosity, form. Actions in these areas might include identification of the previous source of impact, assessment of current floodplain/stream form, protection by a vegetated riparian buffer, and being left alone to recover.
- Channelized – the stream has been straightened, deepened, and no longer has floodplain access. In this type of stream, the habitat has likely been degraded, and the stream probably no longer accommodates flood water or sorts sediments as an undisturbed system would. Because it does not allow flooding, it increases channel erosion locally and increases downstream flooding and channel erosion. Appropriate actions, where practicable, would include restoration of floodplain access or channel morphology and riparian vegetation, if that has been reduced.
- Eroding/incised – the streambanks are eroding more than a system in equilibrium would do so. This degrades habitat and signals other potential sources of problems, such as lack of floodplain access, excessive water, lack of deep-rooted riparian vegetation, change in vertical stability. Appropriate actions would include determining and addressing the cause of erosion and stabilizing the banks, for example:
    - livestock access – provide alternative water supply, restrict access;
    - riparian vegetation – restore deep-rooted riparian vegetation where missing;
    - impervious watershed – downspout disconnect programs, green infrastructure, rain gardens, infiltration practices;
    - change in stream slope – stabilize vertical drop;
    - floodplain access/wetlands – restore watershed features.
- Impounded – observed stream conditions reflect impoundment – still, stagnant water. Appropriate actions, where practicable, would involve removing the impoundment. It should be noted that removing a low-head dam changes the slope of the stream, possibly resulting in stream incision, unless the vertical change is stabilized.
- CSOs – combined sewer outfalls are found in the portion of the Middle Cuyahoga that begins in the Gorge section of Cuyahoga Falls. These result in high amounts of bacteria pathogens and nutrients in the river.

Findings:
General Problem Areas

Generally, the channel conditions in the subwatersheds are as follows:

- Main Stem – This subwatershed is highly impervious and altered. There is a public water supply that should be protected. The Cuyahoga River itself and its riparian area are generally intact. There are some remaining wetlands, some affected by nearby development, some apparently higher quality in wooded areas. The tributaries are predominantly altered and incised, lower portion of the Middle Cuyahoga River is impounded in sections and affected by CSOs.

- Fish Creek – Land use concerns include highly altered and impervious watershed, and large-scale wetland alteration. Fish Creek is channelized upstream of RM 1.4. The tributaries are altered and lack riparian vegetation, some are eroding.
- Plum Creek – Land use concerns include potential impacts to a public water supply, run-off and ereosion along golf courses, agricultural land (runoff, livestock access), and industrial/developed areas. The upper portions of Plum Creek and its tributaries are generally channelized. The lower portion is intact with a substantial wetland/floodplain buffer.
- Breakneck Creek – Land use concerns include the highly altered northern portion; potential brownfields sites; local flooding problem areas; potential impacts from developed areas, a golf course, and agriculture; and the presence of two public water supplies. Channel conditions include intact portions in extensive wetland/floodplain complexes, severely channelized sections (e.g., agricultural/stormwater ditches, Wahoo Ditch), areas with livestock access, and incising channels in headwater areas.
- Potter Creek – Land use concerns are largely related to potential impacts from adjacent agricultural uses. Stream channel conditions include substantial amounts of channelized streams, some severely eroding areas due to upstream influences or livestock access, areas that are recovering, and some that appear largely intact within wetland complexes.

Section 7 includes maps of problem areas and actions specific to each subwatershed.

Priority Areas for Conservation

Priority Conservation Areas: Background

Figure 5b-3 presents an overview of areas identified as high priority for conservation. These represent a general understanding of some of the high value areas to protect. The areas have been identified based on a combination of factors, including:

- Portage County Watershed Plan
- Summit County Comprehensive Plan Environmental section.
- Wellhead and source water protection areas
- Areas with unique species or habitats
- Areas identified as high value in a series of resource protection workshops held by Western Reserve Land Conservancy
- Large wetland complexes
- Wetlands or riparian landscapes that appear to be providing benefit at key locations, e.g., intact riparian corridors, urbanized watersheds, junctures of ditches or eroding tributaries with undisturbed streams.

Conservation/Protection Priority Areas Main Stem, Fish Cr., Plum Cr.. Subwatersheds

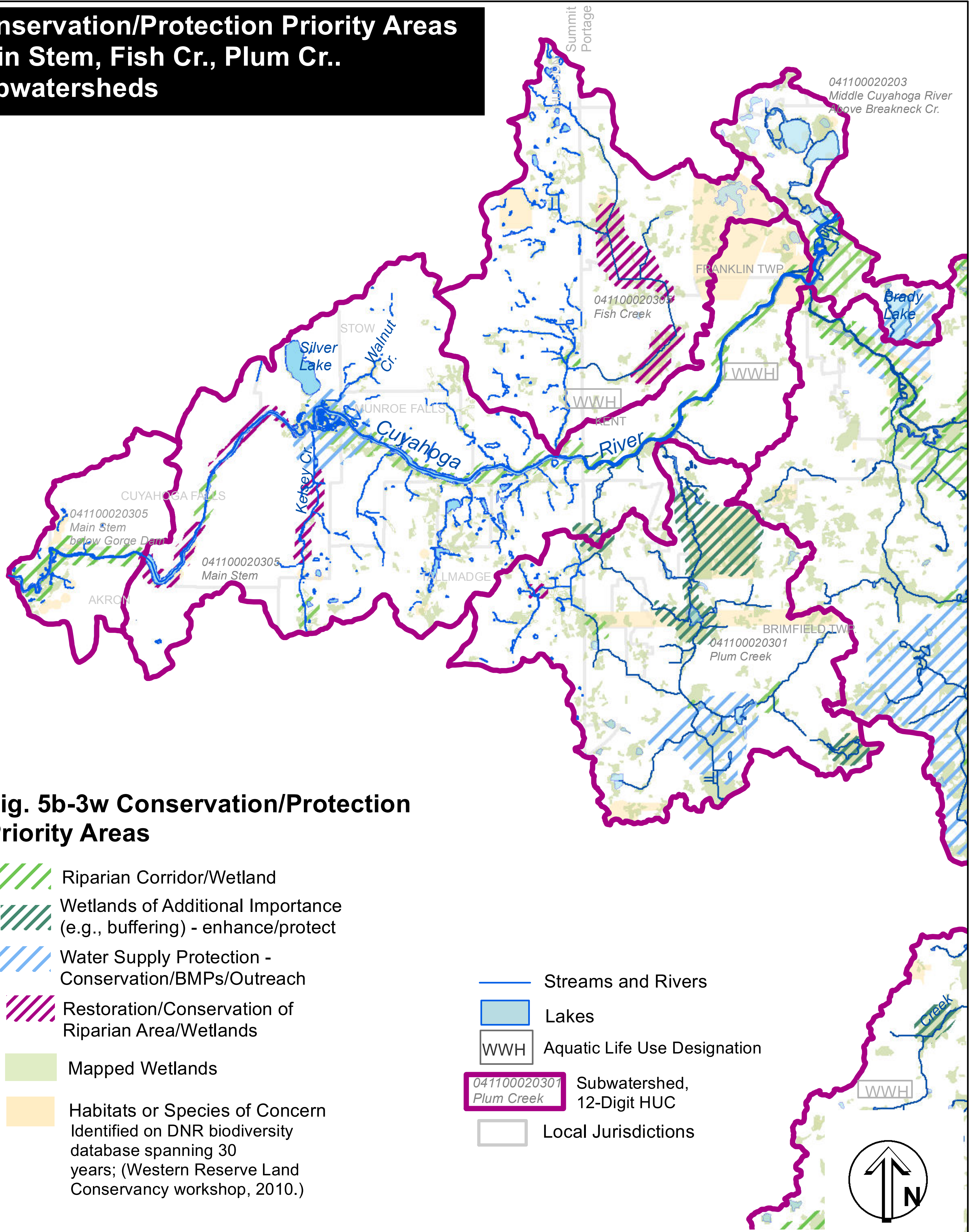


Fig. 5b-3w Conservation/Protection Priority Areas

Riparian Corridor/Wetland

Wetlands of Additional Importance (e.g., buffering) - enhance/protect

Water Supply Protection - Conservation/BMPs/Outreach

Restoration/Conservation of Riparian Area/Wetlands

Mapped Wetlands

Habitats or Species of Concern
Identified on DNR biodiversity database spanning 30 years; (Western Reserve Land Conservancy workshop, 2010.)

Streams and Rivers

Lakes

WWH Aquatic Life Use Designation

041100020301 Plum Creek — Subwatershed, 12-Digit HUC

Local Jurisdictions

0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet

*Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

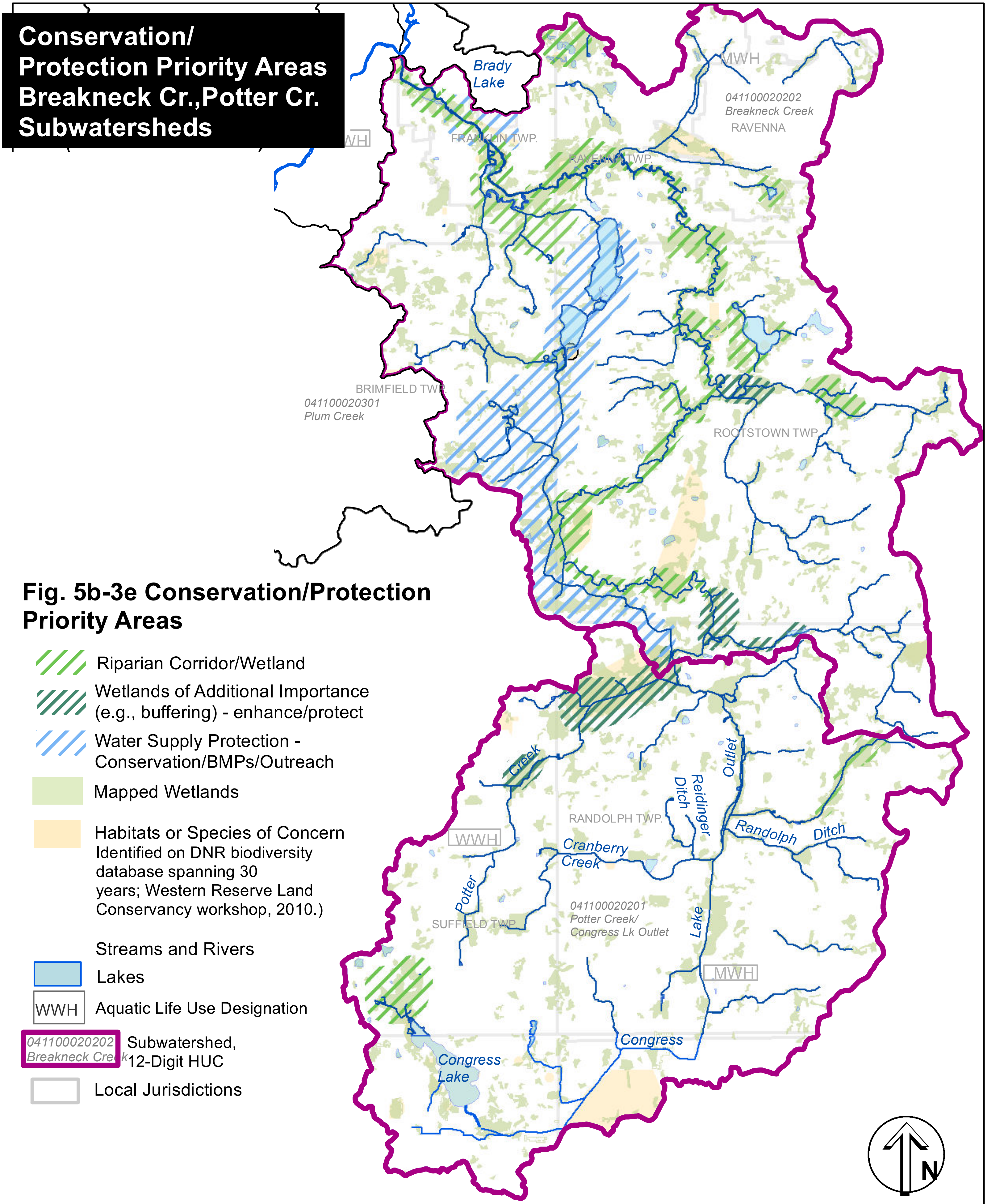


Fig. 5b-3e Conservation/Protection Priority Areas

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

Areas identified as especially high priority include wellhead protection areas and wetlands that provide additional buffering or habitat benefit. These areas often appear as overlapping shading or hatching, as certain areas provide many valuable functions. There are likely other high priority areas for conservation, as well.

General Findings:
Priority Conservation Areas

The high priority conservation areas shown in Figure 5b-3 include riparian areas along Plum and Breakneck Creek, large wetland complexes, remaining wetlands in the Fish Creek subwatershed, wellhead protection areas, and areas containing species or habitats of concern. Tools to protect these include acquisition of land or easements, enhancing or restoring areas that have been degraded to some extent, increasing stewardship, and encouraging best management practices and better riparian management among owners of large parcels. Of special interest is continuing to restore the Cuyahoga River, clean up debris, increase recreational use, increase stewardship and awareness, and establish the river as a river trail.

Section 7 (Vol. II) includes maps of conservation priorities and actions specific to each subwatershed.

6. Implementation Discussion

Chapter 7 includes summaries of concerns related to each subwatershed, problem statements, goals, objectives, and actions.

Development of these statements incorporated partner priorities, consistency with the Lake Erie Management Plan, and implementation considerations, as discussed below.

Partner Priorities

1. Water quality – Restore or improve water quality in impaired areas and degraded systems, prevent further degradation, and protect high quality resources.
2. Hydrology – Reduce the risks of property damage, bank failure, and stream instability due to excessive water volumes, altered stream channel morphology, and altered riparian corridor features such as floodplain access, vegetation, or wetlands.
3. Habitat – Protect and restore important upland, wetland, and riparian habitats, increase biodiversity, protect species of concern, and increase the presence of native species.
4. Recreation – Promote, increase recreational use of the river and tributaries in balance with protecting water quality, well-functioning hydrology, habitat protection, and property owners' rights.

Consistency with Lake Erie Protection and Restoration Plan

The Lake Erie Protection and Restoration Plan sets out a number of goals and objectives for the Lake Erie watershed that are generally consistent with those identified by the watershed partners. The general guidelines for activities within the Lake Erie watershed are excerpted below, and the goals and policies that are applicable to the Middle Cuyahoga River Watershed are summarized after the excerpt. The goals, objectives, and actions that the Middle Cuyahoga River Watershed partners have agreed are priorities support and promote attainment of the goals for Lake Erie.

Activities in the Ohio Lake Erie watershed should:

1. Maximize reinvestment in existing core urban areas, transportation, and infrastructure networks to enhance the economic viability of existing communities.

2. Minimize the conversion of green space and the loss of critical habitat areas, farmland, forest and open spaces.

3. Limit any net increase in the loading of pollutants or transfer of pollution loading from one medium to another.

4. To the extent feasible, protect and restore the natural hydrology of the watershed and flow characteristics of its streams, tributaries and wetlands.

5. Restore the physical habitat and chemical water quality of the watershed to protect and restore diverse and thriving plant and animal communities and preserve our rare and endangered species.

6. Encourage the inclusion of all economic and environmental factors into cost/benefit accounting in land use and development decisions.

7. Avoid development decisions which shift economic benefits or environmental burdens from one location to another.

8. Establish and maintain a safe, efficient and accessible transportation system that integrates highway, rail, air, transit, water and pedestrian networks to foster economic growth and personal travel.

9. Encourage that all new development and redevelopment initiatives address the need to protect and preserve access to historic, cultural and scenic resources.

10. Promote public access to and enjoyment of our natural resources for all Ohioans.

Lake Erie Preservation Plan Goals, Policies, Priorities

- Reduce agricultural sediment input to Lake Erie by 33% from the 2007 baseline.
- Facilitate adoption of (model) regulations regulating stormwater management and requiring riparian and wetland setbacks.
- Apply pesticides and fertilizers more efficiently.
- Re-establish more natural flow regimes in Lake Erie tributaries.

- Protect and restore headwater tributaries.
- Reduce bacterial and other contamination from inadequate or non-functioning home sewage treatment systems.
- Eliminate Combined Sewer Overflows according to each community's Long Term Control Plans.
- Clean up brownfield sites to eliminate loading to Lake Erie and its tributaries.
- Promote diversity of native flora and fauna by protecting and restoring habitat.
- Protect, restore, and enhance wetlands and their functionality and expand wetland acreage within the watershed.
- Protect, enhance, and restore important habitats and species, including…fish spawning areas, caves, riparian and instream habitat in channels and in streams that are subject to impacts from hydromodification.
- Restore habitat through the removal of non-beneficial dams, install fish passages in dams that remain.
- Practice and promote sustainable development practices that protect the natural resources of the Lake Erie Basin and make them available for current and future generations to enjoy.
- Ensure urban areas are sustainable, minimize impacts to the Great Lakes ecosystem, and improve quality of life for residents of watershed communities.
- Responsibly utilize Lake Erie resources and maximize recreational opportunities.
- Preserve and protect valuable farmland for future agricultural uses.
- Reduce significant adverse impacts of repeated flooding on resources, people, and property.
- Identify and address gaps in the green infrastructure system in urban communities within the Lake Erie basin.
- Enhance and increase public access opportunities to Lake Erie, public beaches, parks, nature preserves, and wildlife areas.
- Create new water- and land-based recreational opportunities along or near Lake Erie. Provide a diversity of recreational fishing opportunities for Ohio anglers on Lake Erie and its tributaries.

Implementation Considerations

Many of the proposed actions in this document involve assessing specific sites to determine the degree of intactness or alteration, and to identify which measures could be taken to improve the hydrology, reduce runoff or non-point source pollution, improve flood storage, etc. Before presenting the specific actions, this section discusses some of the general criteria the partners will be using in assessing opportunities for preservation, enhancement, or restoration.

Implementation: Identifying Potential Priority Locations

Implementation: Priorities

Importance of headwaters

The headwaters are the numerous, small, collectors feeding the larger streams. Because they have relatively high amounts of riparian corridor to water volume, the quality, intactness, degree of alteration, and potential for restoration of the headwater riparian corridors play an especially important role in protecting and improving water quality and the functioning of the stream system. Because they all coalesce to form the larger streams, effects to individual headwater streams can be magnified as they join with others that are similarly affected.

Protecting, improving, or restoring altered headwater streams can have a substantial benefit downstream:

- Because headwater streams carry small amounts of water, a relatively narrow buffer can provide tremendous benefit downstream, resulting in less impact to individual properties than further downstream, where wider buffers would be needed to provide similar benefit.

- Infiltrating, intercepting, or storing stormwater in a dispersed way through the headwater areas is a highly efficient and cost-effective way to reduce damaging floods downstream.

- A study by Pappas et al. (2008) indicated that impervious land cover at the headwaters has a greater runoff impact than lower in the watershed, generating three to five times the amount of sediment as imperviousness further downslope. (Source: Pappas et al. , 2008. Impervious Surface Impacts to runoff and sediment discharge under laboratory rainfall simulation. Catena 72 (2008): 146-152; available on-line at sciencedirect.com; www.elsevier.com/locate/catena)

- Many headwaters have been altered, in the urban areas, as road drainage or channelized (or piped) streams; in the rural areas as ditches. Throughout the watershed, headwater riparian corridors have been reduced to mown sod, which offers little or no protection or treatment for streams.

In identifying areas for protection or restoration, the partners will seek opportunities in the headwaters.

Sediment Reduction

Sedimentation is one of the factors degrading many of the stream systems of the watershed. Sediment carries pollutants and is a concern downstream in the Cuyahoga River and shipping channel. Much of the watershed is considered “potentially highly erodible soils.”

The HIT2 model, described in Section 5a, estimates how much sediment reduction can be achieved by strategically using best management practices on exposed soil. Table 6-1 presents the type of reduction that can be achieved by installing various practices on the ten percent of the erosion areas that result in the greatest erosion or sediment delivery.

The HIT2 model shows that benefits and costs of the BMPs vary between the subwatersheds. Fish Creek is the most costly in which to prevent both erosion and sediment delivery. In the Potter Creek and Breakneck Creek subwatersheds, the model suggests that best management practices for erosion/sedimentation reduction would be quite effective.

In implementing erosion/sedimentation control measures, the HIT2 model can help identify areas where erosion and sedimentation from exposed soils may be of greatest concern. In these areas, erosion control practices should be applied with care in construction. In agricultural areas, these may be good areas to target for additional best management practices, such as grassed buffer strips, grassed water ways, tillage practices, or riparian corridor restoration.

According to the model, the most effective measure would be to plant grass on the most highly erosive areas. The sediment erosion map can provide some guidance concerning areas of likely erosion/sedimentation. However, the specific application of BMPs depends on a number of factors, including landowner awareness of various practices, cost, how much land would be lost from production, landowner willingness, funding assistance available, and the restrictions that would be placed on the land. The agricultural producers in the watershed currently use a variety of BMPs, with varying degrees of success. The Natural Resources Conservation Service (NRCS) staff conduct numerous field visits to verify site-specific conditions and work with agricultural producers to improve the use of BMPs at each site. NRCS staff have indicated that it would be helpful to survey the agricultural producers in the watershed to determine what practices are currently in use.

Table 6-1 Amount and Cost of Reduced Erosion with Agricultural BMPs

Name, HUC ending 410002-	Acres		Mulch Till on Worst 10% of Area				No Till on Worst 10% of Area			
			Total Reduced				Total Reduced			
		Total tons/yr	tons/yr	%	BMP cost @$10/ ac	BMP cost-Benefit ($/ton red.)	tons/yr	%	BMP cost @ $10/ac	BMP cost-Benefit ($/ton reduced)
Breakneck -0202	**28,804**	**17,207**	**2,844**	**17%**	**$28,804**	**$10**	**3,793**	**22%**	**$40,326**	**$11**
Fish & Cuy 0305 L	**22,641**	**9,030**	**286**	**3%**	**$22,641**	**$79**	**381**	**4%**	**$31,697**	**$83**
Rockwell 0203	**39,215**	**42,545**	**8,242**	**19%**	**$39,215**	**$5**	**10,989**	**26%**	**$54,901**	**$5**
Plum 0203	**8,293**	**3,479**	**373**	**11%**	**$8,293**	**$22**	**498**	**14%**	**$11,610**	**$23**
Potter 0201	**21,859**	**17,893**	**3,090**	**17%**	**$21,859**	**$7**	**4,120**	**23%**	**$30,602**	**$7**
Total	**120,812**	**90,154**	**14,835**	**13%**	**$120,812**	**$8**	**19,781**	**18%**	**$169,136**	**$9**

Name/ HUC ending 410002-	Acres	Total tons/ yr	BMP: Grass on Worst 10% of Area — Total Reduced tons/ yr	%	BMP cost @$10/ ac	BMP cost Benefit ($/ton red.)	BMP: 30-ft. Grass Buffer of Ag on all Streams — Total Reduced tons/yr	%	BMP cost @$10/ ac	BMP cost-Benefit ($/ton reduced)
Breakneck -0202	28,804	17,207	7,822	45%	$126,737	$16	608	4%	$8,836	$15
Fish & Cuy 0305	22,641	9,030	786	9%	$99,620	$127	74	1%	$1,546	$21
L. Rockwell 0203	39,215	42,545	22,665	53%	$172,546	$8	1,058	2%	$13,210	$12
Plum 0203	8,293	3,479	1,027	30%	$36,488	$36	46	1%	$1,438	$31
Potter 0201	21,859	17,893	8,497	47%	$96,179	$11	636	4%	$12,339	$19
Total	120,812	90,154	40,797	37%	$531,570	$13	2,422	2%	$37,369	$15

Table 6-1 (cont'd) Amount and Cost of Reduced Sediment Delivery with BMPs

			Mulch Till on Worst 10% of Area				No Till on Worst 10% of Area			
			Total Reduced				Total Reduced			
Name, HUC ending 410002-	**Acres**	**Total tons/yr**	**tons/yr**	**%**	**BMP cost @$10/ ac**	**BMP cost-Benefit ($/ton red.)**	**tons/yr**	**%**	**BMP cost @ $10/ac**	**BMP cost-Benefit ($/ton reduced)**
Breakneck - 0202	**28,804**	**2,944**	**503**	**17%**	**$28,804**	**$57**	**671**	**23%**	**$40,326**	**$60**
Fish & Cuy 0305	**22,641**	**1,634**	**55**	**3%**	**$22,641**	**$410**	**74**	**5%**	**$31,697**	**$431**
L. Rockwell 0203	**39,215**	**6,168**	**1,246**	**20%**	**$39,215**	**$31**	**1,661**	**27%**	**$54,901**	**$33**
Plum 0203	**8,293**	**492**	**60**	**12%**	**$8,293**	**$139**	**80**	**16%**	**$11,610**	**$146**
Potter 0201	**21,859**	**2,578**	**490**	**19%**	**$21,859**	**$45**	**653**	**25%**	**$30,602**	**$47**
Total	**120,812**	**13,816**	**2,354**	**14%**	**$120,812**	**$51**	**3,139**	**19%**	**$169,136**	**$54**

			Grass on Worst 10% of Area				30-ft. Grass Buffer of Ag on all Streams			
			Total Reduced				Total Reduced			
Name/ HUC ending 410002-	**Acres**	**Total tons/yr**	**tons/yr**	**%**	**BMP cost @$10/ ac**	**BMP cost Benefit ($/ton red.)**	**tons/yr**	**%**	**BMP cost @$10/ ac**	**BMP cost-Benefit ($/ton reduced)**
Breakneck - 0202	**28,804**	**2,944**	**1,384**	**47%**	**$126,737**	**$92**	**307**	**10%**	**$8,836**	**$29**
Fish & Cuy 0305	**22,641**	**1,634**	**152**	**9%**	**$99,620**	**$656**	**35**	**2%**	**$1,546**	**$45**
L. Rockwell 0203	**39,215**	**6,168**	**3,426**	**56%**	**$172,546**	**$50**	**470**	**8%**	**$13,210**	**$28**
Plum 0203	**8,293**	**492**	**164**	**33%**	**$36,488**	**$223**	**25**	**5%**	**$1,438**	**$59**
Potter 0201	**21,859**	**2,578**	**1,346**	**52%**	**$96,179**	**$71**	**294**	**11%**	**$12,339**	**$42**
Total	**120,812**	**13,816**	**6,472**	**39%**	**$531,570**	**$82**	**1,131**	**7%**	**$37,369**	**$33**

High Priorities for Restoration

Some of the areas identified in Figure 5B-1 would likely benefit from restoration of morphology, riparian plantings, floodplain access, or hydrology. Choosing specific sites will depend on site-specific assessment of conditions, landowner and community willingness, feasibility, permitting requirements, and the availability of resources. Additional sites may be identified with further field work or as a result of changes to the landscape.

Within each subwatershed are areas where restoration or improvement of riparian functions would be beneficial:

- Main stem – incised streams – restoration/stabilization if necessary and re-planting mown banks with taller (more deeply-rooted) herbaceous plants, shrubs, or trees;
- Fish Creek – altered wetlands and hydrology; riparian corridors that have been replaced by mown sod – the latter represent an opportunity to prevent damaging channel erosion if addressed early enough;
- Plum Creek – altered channels, streams with unrestricted livestock access;
- Breakneck Creek – channelized streams, ditches; eroding channels at the headwaters; altered wetlands; streams with unrestricted livestock access;
- Potter Creek – channelized streams, ditches, especially where contributing to erosion; altered wetlands; streams with unrestricted livestock access.
- In addition, flooding problems have been reported at several locations throughout the watershed. In each case, it is likely that altered hydrology reducing the capacity of the stream system to handle the flows. Investigation may identify areas where improvements to floodplain access, wetlands, or channel morphology could improve the way the streams function and reduce flooding problems.

When addressing eroding stream channels and problem flooding, it is important to understand and address the cause, which can include lack of floodplain access or wetlands; increased runoff from impervious or even agricultural lands; streambanks with minimal protective vegetation that erode and become incised; or straightening or otherwise steepening the channel.

An additional consideration in restoration is the complexity, size, and connectivity of resource areas. Large, diverse, interconnected systems provide greater benefit for habitat, may be more resilient, and may function better over time. To the extent possible, fragmented systems should be re-connected, and diverse habitat complexes and corridors should be re-established.

Restoration is typically funded through grants, large nearby projects (such as road projects), and local funding sources. However, if suitable sites can be identified, they may provide opportunities for mitigation of impacts under wetland alteration permits, allowing mitigation to occur within the Cuyahoga River watershed instead of elsewhere. One priority of this plan is to continue to develop mapping indicating restoration priority areas and to develop some restoration concept plans to encourage mitigation within the Middle Cuyahoga River watershed.

Restoration or Improvement of Select Watershed Functions

In many cases, full restoration of stream morphology is not feasible or necessary. For instance, in the agricultural areas or those identified on Figure 5B-1 as "Altered," it may not be feasible to fully restore channel morphology. However, there may be great benefit in restoring or improving elements of a riparian system. For example:

- improving plantings, e.g., replacing sod with taller grasses, shrubs, or trees, in altered riparian corridors could help stabilize the stream banks before they start to erode. This would be a more cost-effective approach than conducting a full restoration after erosion takes place.

- It may be possible to improve floodplain/wetland access and remove some floodwater from the channel without full restoration of the channel morphology. This approach could prove more feasible than full restoration at sites like agricultural parcels, or channelized streams within relatively narrow corridors;

- Reducing the load of water into the channels through increasing stormwater interception or infiltration, e.g., through use of rain barrels, bio-infiltration, or permeable pavement in developed areas.

- Improving stormwater treatment in roadway drainage through the use of no-mow grass, vegetated swales, or daylighting enclosed drainage.

- Restoration of wetlands in marginally productive farmed areas,

- Improving conservation practices, riparian buffers, and plantings, on farms, publicly owned, institutional, or homerowners association parcels.

- Encouraging publicly or privately owned golf courses to use practices that lead to Audubon International habitat certification and protect water resources.

In highly developed or agricultural areas, such projects can serve as demonstration and outreach projects, to help watershed citizens better understand their connection to the water. Such projects can begin to incrementally improve watershed function, just as the watersheds were altered incrementally. It may also be possible to improve watershed functions at a large enough scale to make a difference in a nearby water body. For instance, by retrofitting an entire neighborhood with green infrastructure, runoff may be reduced enough to prevent stream channel erosion. Some stormwater utilities offer incentives to install stormwater best management practices, which may help encourage their use.

Importance of Stewardship, Understanding, and Outreach

The primary concerns in the Middle Cuyahoga River Watershed focus on reducing, preventing, and, ultimately, reversing the effects of alteration throughout the watershed. Just as altering the watershed took place incrementally, parcel by parcel, improving conditions will require actions – changes - by many throughout the watershed. Many recommended measures are not especially costly or difficult but require:

- An understanding of how individual parcels affect the watershed,
- A new and different approach to managing the landscape and water, and
- Resources and impetus to put watershed improvement measures into place.

An important part of this watershed management effort will be to increase the understanding among residents, business owners and employees, and local officials, of the benefits to the community of a well-functioning watershed, what they can do to improve watershed conditions, how these measures may differ from previous practices, and what resources are available to assist them in their efforts.

The partners have identified several objectives that focus on the importance of education, information, outreach, and stewardship. These can be the focus of efforts, such as:

- Establishing new tributary stewardship groups, clean-ups, or lake monitoring;
- Increasing the use of best management practices or riparian/native plantings on large parcels (e.g., schools, public buildings, churches, institutions)
- Surveys to determine fertilizer use,
- Watershed photo contests or art events,
- Development of a multi-faceted watershed website, or
- Workshops for officials.

Education also can – and should – be incorporated into restoration, enhancement, and preservation projects. In addition, the educational aspect of all restoration or protection projects is highly valuable. In projects ranging from full stream restoration to improving permeability through rain gardens or permeable pavement, demonstrating that techniques are effective, manageable, and attractive, improves the likelihood that they will be used elsewhere.

High Priorities for Conservation

Figure 5b-3 presents some of the areas that provide important benefits to water quality, flood reduction, and habitat. Many of the areas are wetlands, riparian corridors, and contiguous woods, and perform multiple functions, including buffering, flood storage/reduction, pollutant uptake, habitat, and wildlife corridors. Large, diverse systems and habitat corridors are especially valuable. Figure 5b-2 is a starting point for identifying key areas to protect. It is likely over time that additional sites will be identified as important. One of the priorities of this plan is to continue to develop a map of priority conservation areas with input from various resource managers.

Continued Collaboration

Numerous groups and efforts are underway that can improve conditions in the watershed. The partners wish to continue collaborating with other groups that are pursuing similar interests.

Implementation: Proposed Actions

Development of Priority Actions

Identifying the priority actions has involved several iterations of discussion:

- Throughout the months of developing problem statements, goals and policies, and actions, partners brainstormed ideas that would be helpful in the watershed.
- The watershed coordinator gave presentations to or held meetings with officials from the Cities of Kent, Munroe Falls, Cuyahoga Falls, and Ravenna city officials, Kent Environmental Council, Kent State University biology department faculty, Portage and Summit County stormwater PIPE/task force groups, and NEFCO's Environmental Resource Technical Advisory Committee. Potential actions were discussed at each of these.
- The proposed problem statements, goals and policies, and list of actions was e-mailed to over 100 people in various organizations, with requests for comments.
- Over a period of many weeks and months, the partners who attended monthly meetings reviewed the proposed actions within each watershed, prioritizing them in the process.
- During review of this draft document, the Watershed Coordinator will contact other communities and organizations that have not been regular participants at the meetings to determine what measures they are interested in pursuing, in addition to the actions identified here.

These actions represent measures that the partners who attended the meetings wish to undertake and are comfortable pursuing, contingent on availability of funding, staff, suitable sites, landowner cooperation, and a favorable permitting environment. Some initial suggestions were given a lower priority based on perceived need or feasibility, including survey of residents concerning use of lawn chemicals, discouraging waterfowl or waterfowl feeders, and creating a volunteer clearinghouse with equipment, training, and listings of opportunities. However, the partners would welcome the opportunity to implement these or other actions that promote the goals and objectives identified in Section 7, should the opportunity arise with adequate funding, permitting feasibility, landowner cooperation, etc. The partners also welcome the opportunity to achieve more than listed in the tables in vol. II. This WAP will be periodically updated and amended to reflect newly identified needs, opportunities, and priorities.

Funding Strategy

The partners identified many actions that they are initiating on a small scale already and anticipate continuing, using funding from various sources. To an extent, combining efforts will increase efficiency of project implementation. However, to achieve many of the larger scale objectives (e.g., stream restoration), the partners will need outside funding.

The watershed coordinator anticipates assisting partners with grant proposal writing. With no guaranteed source of funding as yet, the watershed coordinator will begin implementation by seeking outside funding for the position or specific projects, which will allow the partners and the coordinator to achieve some successes, solidify the partnership, and revisit the funding strategies over time.

Consistency with Coastal Non-Point Source Plan

One of the requirements of this plan is that it be consistent with the Ohio Coastal Non-point Source Plan. As this WAP focuses largely on non-point source pollution in the watershed, the goals, objectives, and actions listed in Vol. II help promote the policies in the Non-point Source Plan, as noted in Table 6-2.

The actions identified in this plan are voluntary. The watershed partnership can help implement the coastal non-point source plan by initiating on-the-ground projects to improve conditions or preserve important resource areas, where landowners and communities/agencies are willing, obtaining funding, conducting education and outreach to encourage reviewers to protect watershed features.

Certain of the coastal non-point source requirements fall under the jurisdiction of existing programs.

- All but two of the communities covered by the watershed plan are Stormwater Phase II communities. One of the communities not covered by Stormwater Phase II requirements is within the Portage County stormwater management district. The partners generally have expressed interest in encouraging development that minimizes impacts to water resources. The plan includes outreach, workshops, demonstration projects, and review/updating of local codes to encourage the use of green infrastructure and best management practices. The coordinator will continue to work with County and City engineers and planners, and the three Soil and Water Conservation Districts to facilitate practices that reduce non-point source pollution from development and roadways.
- Stream diversion, and impacts to wetlands and water courses fall under the jurisdiction of Ohio EPA.
- Septic system siting and maintenance fall under the jurisdiction of the Health Departments, all of which have inspection programs and require consideration of soils characteristics in siting septic system.

Table 6-2 Consistency with Ohio Non-Point Source Plan

Ohio Non-Point Source Plan	Middle Cuyahoga River WAP	Watershed(s)	Problem Statements/ Goals/Objectives (see Sect. 7)
Grazing management	Installation of fencing, watering measures, crossings, survey of BMPs and use of additional BMPs/outreach as necessary.	Fish, Plum, Breakneck, Potter	Sediment, N, P habitat
Irrigation water management	n/a		
Watershed management	Outreach to encourage use of riparian setbacks, green infrastructure. Demonstration projects to plant streambanks and riparian corridor. Stream/ floodplain/wetland restoration and preservation goals. Survey and assistance with agricultural BMPs.	All	Sediment, nitrogen, phosphorous, flooding, habitat
Site development	Encourage use of green codes, riparian setbacks, education/ outreach. Most communities are required to comply with NPDES MS4 stormwater permits, which also addresses site development.	All	Sediment, nitrogen, phosphorous, flooding, habitat
On-site disposal systems	County health depts require septic systems to be engineered based on soils characteristics. Receiving waters are not nitrogen limited.	All subwatersheds except Main Stem have septic sytems	Nitrogen/ phosphorous
Operating on-site disposal systems	County health depts are inspecting septic systems and seeking correction. Water bodies are not nitrogen limited.	A concern in all watersheds except Main Stem	Nitrogen/ phosphorous
Local roads	Siting not addressed in plan but does require permitting at state level if wetlands/water courses are involved. WC to coordinate on permit reviews. Proposed demonstration projects address existing drainage and increase infiltration/treatment; code review and workshops to address/ increase use of green infrastructure.	All	Sediment, nitrogen, phosphorous, flooding
Channelization/ channel modification	Plan includes restoration of riparian, vegetation, channel, banks, floodplain, wetlands, potential for daylighting streams, and modification to two-stage/overwide. Stream diversion review is under the jurisdiction of Ohio EPA.	All	Sediment, nitrogen, phosphorous, flooding, habitat
Dams	Plan includes removal of 3 dams, as well as channel/ riparian restoration and feasibility study for removal of small low-head dams	Dam removal – Main Stem; feas. study – all	Dams, habitat
Eroding streambank	Plan includes stabilizing/restoring streambank, vertical stability	All watersheds	Sed., N, P, flooding, habitat

End of Volume 1, Middle Cuyahoga River Watershed Action Plan

Middle Cuyahoga River Watershed Action Plan—Volume II
Problem Statements, Goals, Objectives, Actions, end pieces

June, 2012

7. Problem Statements, Goals, Objectives, Actions

Organization

This section combines several elements of the Appendix 8 outline into a single section. Whereas the outline includes separate sections for Problem Statements, Goals, Objectives, and Actions, this section includes all elements, with a separate sub-section for each subwatershed. Each subwatershed section includes:

- Overview maps and discussion,
- Tables of
    - Subwatershed characteristics,
    - Impairments,
    - Summary of actions, and
    - Detailed tables listing the problem statements and goals, policies, and actions to address the problem statements.

Introduction

The problem statements, goals, objectives, and actions for the watershed were developed through a series of discussions at monthly meetings of watershed partners. All stakeholders have had the opportunity to comment on the goals, objectives, and implementation statements via e-mail and open houses. *Note: The Appendix 8 outline refers to the problem statements, goals, objectives, and actions as chapters 5-7. In order to consolidate these related items, the entire section is numbered chapter 7.*

Mission

The Middle Cuyahoga River Watershed partners agreed on the following mission statement for the watershed:

Protect, restore, and improve Middle Cuyahoga River, its tributaries, and watershed by protecting the elements that are achieving a high quality, improving, enhancing, or restoring degraded systems, and reducing the effects of the altered watershed.

Problem Statements, Goals, Objectives, Actions

The format for problem statements, goals, objectives, and actions is very specific.

Problem Statements: Focus on one impairment and one cause of impairment, e.g., sediment affecting habitat.

Goals: How to improve one water quality indicator mentioned in the problem statement from one source. E.g., Tons of sediment from eroding stream banks, nitrogen from agricultural runoff. There are likely to be more than one goal per problem statement.

Objectives: Quantified reductions using various practices, i.e., the practices to achieve the goals. There are 4 types of objectives:

- Protective (e.g., easements)
- BMPs – cover crops, grass filter strips
- Restoration – moving things around on the ground

- Regulation – stormwater manual, zoning changes

Examples:
- XX tons of XX using rain gardens
- XX tons of XX using green infrastructure

The same types of objectives can be used to address multiple sources of impairment causes.

Actions:
More detailed, e.g., How the sediment reduction projects are going to be carried out, includes tasks such as:
- Submit grant proposal
- Hold workshops
- Assess farm practices

The actions may be modified as necessary to carry out the objectives. The actions will be used to define tasks for grants or work programs.

Table 7-1 summarizes the proposed actions for the entire watershed. Each subsection of this chapter includes an individual summary of actions for one subwatershed, in addition to the detailed tables that list the goals, objectives, and actions for each problem statement/area of concern. While not specifically listed for each objective, where feasible, it is important that the effectiveness of actions be monitored as part of the construction contract or as a separate monitoring effort.

Sections 8 and 9 are presented after Table 7-1, as they are brief. Following Sections 8 and 9, the problem statements, goals, policies, and actions of each subwatershed are presented in a separate section, with:
- Overview of conditions, with maps specific to the subwatershed
- Summary table of actions
- Detailed Problem Statement/Goal/Objective/Action tables.

Table 7-1 Action Item Summary by Subwatershed

12-digit HUC/ Water Body	**Dams**	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	**Category/**Practices	**Target amt by 2023**	**Units**	**Priority (*h igh-m od*)**	**Time Frame (yr or On-going)**	**Cost**	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020305 Main Stem & tribs																		
										Dam Removal								
Main Stem	√			√	√			√		Remove low-head dams	**2**	Dams	*h*	0-1	1 million			
Main Stem	√			√	√			√		Remove Gorge dam	**1**	Dams	*h*	by 2018				
										CSO Containment/Diversion								
Main Stem watershed - Gorge		√								Containment	**105/yr reduced by 2028**	overflows reduced per yr (4 sites)	*h*	by 2028				
										Contamination								
Main stem watershed			√							Determine status of DERR listed sites	**9**	sites	*h*	yr 1				
MS watershed			√							Brownfields inventory	**1**		*h*	yr 1-5				
Main stem			√			√				Initiate cleanup	**2**		*m*	yr 4-8				
										Riparian Restoration								
Main stem tribs				√	√		√	√		Restore Streambank	**8,000**	Linear Feet	*h/m*	KC-1-3 others by 2023	$25-200/lf	490	686	264
Main Stem watershed				√	√		√	√		Riparian plantings - native plants/trees/shrubs	**25**	Acres	*m*	start in yr 1-2		11	150	20
Watershed, lakes								√		Remove/treat Invasive Species	**50**	Acres	*m*	yr 3-5				
MS watershed								√		Feasibility study low-head dam removal tribs	**1**	study	*m*	yr 3-5				
										Stream Restoration								
Main Stem tribs				√	√		√	√		Restore Flood Plain	**8**	Acre-foot	*h/m*	KC-1-3 others 3-10		3.5	50	7
Main stem tribs				√	√		√	√	√	Restore Channel	**4,000**	Linear Feet	*h/m*	KC 1-3	$100-200/lf			
										Wetland Restoration								
Main stem watershed				√	√		√	√		Reconstruct, Restore, Reconnect Wetlands	**10**	Acres	*m*	by 2023	$5k-100k/ac.	10	280	62
										Urban runoff and green infrastructure								
MS watershed				√	√		√			Rain gardens	**20,000**	sq feet	*m*	yr 3-10	$500,000		2	0.50

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	**Dams**	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	**Category/**Practices	Target amt by 2023	Units	Priority (*h igh- m od)*	Time Frame (yr or On-going)	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
MS watershed		√		√	√		√			Parking lot retrofit - Bioinfiltration/ perm pavemt	10,000	sq feet	*h*	yr 3-10	$200,000		2	0.4
MS watershed				√	√		√			Storm water inventory	1	inventory	*h*	yr 1-3				
MS watershed				√	√					Storm water retrofits for water quality	100	ac treated	*h*	on-going	$400-17k/ ac	4.5	70	10
MS watershed				√	√					No-mow ditch/veg swale/ daylight	1,000	linear feet - treats 4 ac	*m*	yr 3-8		0.1	1	0.4
Middle Cuyahoga River watershed		√		√	√		√			Neighborhood-scale green infrastructure	1		*h*	by 2023	$25-50k design $20k bumpouts	5	200	25
										Conservation Easements								
MS watershed				√	√		√	√	√	Acquire Wetlands/ easements	25	Acres	*h*	by 2023	$5-25k/ac	25**	1,400**	316**
	√	√	√	√	√	√	√	√	√	**Education and Outreach**								
MS watershed										Develop Brochures/Fact Sheets	6	Brochures/ Fact Sheets	*m*	ongoing				
MS watershed										Watershed Festivals	10	Festivals	*h*	ongoing				
MS watershed										Websites	1	Website	*h*	yr 1				
MS watershed										Install Signs	10	Signs	*m*	ongoing	$200-500			
MS watershed										Stream Clean-Ups	15	Clean-Ups	*h*	ongoing				
MS watershed										New lake/stream stewardship groups	1	new group active	*m*	yr 2-6				
MS watershed										Golf course certification outreach	4	golf course contacted	*h*	yr 2-6				
MS watershed										Stencil Storm Drains	100		*m*	ongoing				
MS watershed										Workshops/ Training	5	Workshops	*h*	ongoing				
MS watershed										Develop Manual(s)	1	Manuals	*h*	by 2015				
MS watershed										Rain barrel workshops	50	rain barrels	*h*	ongoing				
MS watershed										Develop Newsletters	10	Newsletters	*m*	ongoing				
MS watershed										Outreach for dams	2	Press Relea	*h*	yr 1				
MS watershed										maintain stream database	1	database	*h*	ongoing				
										Local Policy								
MS watershed				√	√		√	√		Green code audit/update	2	audits/	*h*	yr 1-5				

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	**Dams**	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	**Category/**Practices	**Target amt by 2023**	**Units**	**Priority (high-mod)**	**Time Frame (yr or On-going)**	**Cost**	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
										Monitoring								
Cuy River		√							√	Bacteria sampling	**6**	Samples	*h*	yr 1, O				
Cuy River/tribs					√			√		Chemical Sampling	**3**	Sites	*m*	yr 2-5				
Cuy River/tribs				√	√			√		Macroinv./Fish/QHEI Sampling	**4**	Sites	*m*	yr 3-6				
										Recreation								
Cuy river									√	Develop water trail	**1**	water trail	*h*	yr 1-10				
Cuy river									√	Construct/improve access	**5**	site	*m*	by 2023				
Cuy river/tribs									√	Boardwalk/trail	**8,000**	lf	*m*	by 2023				
MS watershed									√	Economic benefit study	**1**	study	*m*	yr 2-5				
MS watershed									√	Develop quest(s)/ virtual watershed tour	**2 quests/**		*m*	yr 2-5				
															subtotal	*674*	*1871*	*518*
041100020305 (part) Fish Creek																		
										Riparian Restoration								
Fish Creek				√	√		√	√		Restore Streambank ***	**3,000**	Linear Feet	*h*	start yr 1	$25-200/lf	34	54	20
Fish Cr. & tribs				√	√		√	√		Riparian plantings	**25**	Acres	*h*	start yr 1		25	200	35
Fish Cr. & tribs								√		Treat for Invasive Species	**40**	Acres	*m*	start yr 2				
										Stream Restoration								
Fish Creek				√	√		√	√		Restore Flood Plain	**50**	Acre-foot	*h*	start yr 1		22	300	41
Fish Creek & tribs							√			Hydrological study in flood-prone area	**1**	study	*m*	yr 3-5				
Fish Cr watershed								√		Feasibility study low-head dam removal tribs	**1**	study	*m*	yr 3-5				
										Wetland Restoration								
Fish Creek				√	√		√	√	√	reconnect/restore Wetlands	**100**	Acres	*h*	start yr 1	$5-100k/ ac.	100	2800	632
										Home Sewage Treatment Systems								
FC watershed					√					correction of failing HSTS	**10**	HSTS	*h*	O			311	122
										Urban runoff and green infrastructure								
FC watershed				√	√		√			Rain gardens	**6,000**	sq feet	*m*	start yr 3	$150,000		1	0.1
FC watershed				√	√		√			Retrofit parking lot - bioinfiltration/perm pavmt	**10,000**	square feet	*m*	start yr 3		0.04	2	0.2

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Category/Practices	Target amt by 2023	Units	Priority (*h*igh- *m*od)	Time Frame (yr or On-going)	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
FC watershed				√	√		√			Storm water inventory	1	inventory	*h*	yr 1-3				
FC watershed				√	√					Stormwater water quality retrofits	60	acres treated	*h*	ongoing	$400-17k/ ac	4.5	70	10.2
FC watershed				√	√					No-mow ditch/veg swale/ daylight	1,000	linear feet - treats 4 ac	*m*	yr 3-8		0.1	2	0.4
Mid Cuy R				√	√		√			Neighborhd green infrastr.	1		*h*	by 2023	see above			
										Conservation Easements								
FC watershed				√	√		√	√	√	Acquire Wetlands/easemts	75	Acres	*h*	by 2023	$5-25k/ac	75**	2100**	474**
			√	√	√	√	√	√	√	**Education and Outreach**								
FC watershed										Brochures/Fact Sheets	10	Fact Sheets	*m*	ongoing				
FC watershed										Websites	1	Website	*h*	yr 1				
FC watershed										Install Signs	5	Signs	*m*	ongoing	$200-500			
FC watershed										Stream Clean-Ups	3	Clean-Ups	*m*	start yr 3				
FC watershed										New stewardship groups	1	new group	*m*	start yr 2				
FC watershed										Workshops/ training	5	Workshops	*m*	ongoing				
FC watershed										Develop Manual(s)	1	Manuals	*h*	by 2015				
FC watershed										Rain barrel workshops	50	rain barrels	*h*	ongoing				
FC watershed										Develop Newsletters	10	Newsletters	*m*	ongoing				
										Local Policy								
FC watershed				√	√		√	√		Green code audit/update	2	audits/ updates	*h*	yr 1-5				
FC wshed				√	√		√	√		Riparian setback**	1	Jurisd.	*h*	yr 2-8		14**	200**	35**
										Monitoring								
Fish Creek					√			√		Chemical Sampling	3	Sites	*h*	start yr 2				
Fish Creek				√				√		QHEI/HHEI Sampling	3	Sites	*h*	start yr 2				
FC watershed				√	√		√	√	√	Maintain stream database	1	database	*h*	ongoing				
										Recreation								
Fish Creek				√	√		√	√	√	Acquire conserv. Land/trail	20	ac	*h*	ongoing				
Fish Creek									√	Construct trail	3	mi	*m*	by 2023				
Fish Creek									√	Construct access sites	1	site	*m*	by 2023				
FC watershed									√	Economic benefit study	1	study	*m*	yr 2-5				
FC watershed									√	quest/ virtual watershed tour	2	2 quests/1 tc	*m*	yr 2-5				
															Subtotal	*336*	*3849*	*867*

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Category/Practices	Target amt by 2023	Units	Priority (high-mod)	Time Frame (yr or On-going)	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020301 Plum Creek and Tribs																		
										Riparian Restoration								
Plum Cr./tribs				√	√			√		Restore/stabilize eroding Streambank	1000	Linear Feet	*h*	yr 2-8	$25-200/lf	6	13	5
Plum Cr./tribs				√	√			√		streambank stabilization - pasture	3000	lf	*h*	yr 2-8		14	38	10
Plum Cr. Tribs				√	√		√	√		Riparian plantings	8	Acres	*h*	start in yr 1-2	$4,000 + labor	4	67	7
										Stream Restoration								
Plum Cr. Tribs				√	√		√	√		Restore Flood Plain	10	Acre-foot	*m*	yr 2-8		4	60	8
Plum Cr./tribs										Restore Channel	1000	Linear Feet	*h*	yr 2-8	$100-200/lf	20		
Plum Cr watershed								√		Feasibility study low-head dam removal tribs	1	study	*m*	yr 3-5				
										Wetland Restoration								
Plum Cr. Tribs				√	√		√	√		Reconstruct, Restore, Reconnect Wetlands	25	Acres	*h*	start in yr 1-2	$5k-100k/ac.	25	700	158
										Home Sewage Treatment Systems								
Plum Cr.					√					Repair/Replace HSTS	10	HSTS	*h*	ongoing			311	122
										Urban runoff and green infrastructure								
Plum Cr.				√	√		√			Rain gardens	6000	sq feet	*m*	yr 3-10			1	0.1
Plum Cr.										Parking lot retrofit - bioinfiltration/perm. pavemt	5000	sq ft	*m*	yr 2-8		0.02	1	0.14
Pl. C. watershed				√	√		√			Storm water inventory	1	inventory	*h*					
Plum Cr.				√	√					Storm water retrofits	60	acres treated	*h*	ongoing	$400-17k/	2.7	30	12
Pl. Cr watershed				√	√					No-mow ditch/veg swale/ daylight	500	linear feet	*m*	yr 3-8		0.05	0.4	0.2
Mid Cuy wshed										Neighborhd green infra.	1		*h*	by 2023	see above			
				√	√					**Agricultural BMPs**						150	110	6
Pl C watershed				√	√					Survey of practices	1	survey	*h*	yr 1-3				
Pl Cr/tribs				√	√					2-Stage Channel/overwide	500	Linear Feet	*m*	by 2023			147	46
Plum Cr. and tribs										Grassed Waterways/ vegetated buffer strips	50	Acres treated	*h*	yr 5-8		72	211	113
Pl Cr watershed										Cover crops	100	acres	*h*	yr 3-6		110	256	128
Pl Cr watershed										Residue applied to fields	50	acres	*h*	yr 3-6		55	128	64
Plum Cr. and tribs										Livestock Crossings	1	Crossings	*h*	yr 3-5				

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	***Dams***	*CSOs*	*Contamin. Sites*	*Sed*	*Nutrients*	*GW contam*	*Flooding*	*Habitat*	*Recreation*	**Category/**Practices	**Target amt by 2023**	**Units**	**Priority (*h igh- m od*)**	**Time Frame (yr or On-going)**	**Cost**	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Plum Cr. and tribs				√	√			√		Livestock Excl. Fence & accompanying measures	**3,000**	Linear Feet	*h*	yr 3-5	$11,300 + watering	7	56	12
										Conservation Easements								
Pl Cr and tribs				√	√		√	√	√	Acquire Wetlands/ conserv. land/ easemts	**100**	Acres	*h*	start in yr 1-2	$5-25k/ac	100**	2800**	632**
			√	√	√	√	√	√	√	**Education and Outreach**								
Pl Cr and tribs										Brochures/fact sheets	**10**	fact sheets	*m*	ongoing				
Plum Creek										Watershed Festivals	**2**	Festivals	*h*	ongoing				
Plum Creek										Websites	**1**	Website	*h*	ongoing				
Pl Cr watershed										Install Signs	**10**	Signs	*m*	ongoing	$200-500			
Plum Creek										Stream Clean-Ups	**5**	Clean-Ups	*h*	start yr 2				
Plum Creek										New stewardship groups	**1**	new group	*m*	yr 2-6				
Pl Cr watershed										Conduct Workshops	**5**	Workshops	*h*	ongoing				
Pl Cr watershed										Conduct Training		Training Ses	*h*	ongoing				
Pl Cr watershed										Develop Manual(s)	**1**	Manuals	*h*	by 2015				
Pl Cr watershed							√			Rain barrel workshops	**50**	rain barrels	*h*	ongoing				
Pl Cr watershed										Outreach for golf courses	**2**	golf courses	*h*	yr 2-4				
Pl Cr watershed										Develop Newsletters		Newsletters	*m*	ongoing				
										Local Policy								
Pl Cr watershed				√	√		√	√		Green code audit/update	**2**	audits/	*h*	yr 1-5				
										Monitoring								
Plum Creek					√			√		Chemical Sampling	**1**	Sites	*h*	start yr 1				
Plum Creek				√				√		Macroinv./Fish/QHEI Sampling	**3**	Sites	*h*	start yr 1				
										Recreation								
Pl Cr watershed									√	Construct trail	**1**	mile	*m*	by 2023				
Plum Creek									√	Construct access sites	**1**	site	*m*	by 2023				
Pl Cr watershed									√	Economic benefit study	**1**	study	*m*	yr 2-5				
Pl Cr watershed									√	Quest/ virtual watershed tour	**2**	2 quests/1 tc	*m*	yr 2-5				
															Subtotal	469.8	2129	691.4

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Category/Practices	Target amt by 2023	Units	Priority (high-mod)	Time Frame (yr or On-going)	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020202 Breakneck Creek																		
										Brownfields								
Br Cr watershed			√			√				brownfields inventory	1	inventory	*h*	yr 2-5				
Br Cr watershed			√			√				status of listed sites	11	sites	*h*	yr 1				
Br Cr watershed			√			√				Brownfields plan	1	plan	*m*	yr 4-8				
										Initate clean-up	1		*m*	yr 4-10				
										Riparian Restoration								
Br Cr/tribs				√	√					Restore Streambank	3,000	Linear Feet	*h*	start yr 1	$25-200/lf	207	300	112
Breakneck Cr./tribs				√	√		√	√		Riparian plantings	12	Acres	*h*	start yr 1	$6,000 + labor	6	93	17
Br Cr. watershed										Treat Invasive Species	50	Acres	*m*	start yr 2				
										Stream Restoration								
Br Cr/tribs				√	√		√	√		Restore Flood Plain	50	Acre-foot	*h*	start yr 1		22	300	41
Br Cr/Tribs										Restore Channel	5000	Linear Feet	*h*	start yr 1	$100-			
Br Cr/tribs							√			Hydrological study in flood-prone area	1	study	*m*	yr 3-7				
Br Cr watershed								√		Feasibility study low-head dam removal tribs	1	study	*m*	yr 3-5				
										Wetland Restoration								
Br Cr watershed				√	√		√	√		Reconnect/Restore Wetlands	80	Acres	*h*	start yr 2	$5-100k/ac	80	2240	506
										Home Sewage Treatment Systems								
Br Cr. Wshed					√					Correction of failing HSTS	30	HSTS	*h*	ongoing			933	366
										Urban runoff and green infrastructure								
Br Cr watershed				√	√		√			Rain gardens	20,000	sq feet	*m*	yr 2-10	$500,000		2	0.50
Br Cr watershed					√		√			Parking lot retrofit - perm. pavemt/ biofilt.	10,000	sq feet	*h*	yr 3-8	$200,000		2	0.4
Br Cr watershed				√	√		√			Storm water inventory	1	inventory	*h*	yr 1-3				
Br Cr watershed				√	√					Storm water retrofits	100	acres		start yr 3	$400-17k/	4.5	70	10
Br Cr watershed				√	√					No-mow ditch/veg swale/ daylight	2,000	linear feet - treats 8 ac	*m*	yr 3-8		0.2	2	0.8
Middle Cuy Watershed										Neighborhd green infr.			*h*	by 2023	see above			
				√	√					**Agricultural BMPs**								
Br Cr watershed				√	√					Survey of practices	1	survey	*h*	yr 1-2				

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	**Category/**Practices	Target amt by 2023	Units	Priority (*h*igh- *m*od)	Time Frame (yr or On-going)	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Br Cr/tribs				√	√			√		Livestock Excl. Fencing, accompanying measures	3,000	Linear Feet	*h*	yr 2-8	$11,300 + watering	140	280	140
Br Cr/tribs				√	√			√		Alternative Water Supplies	1	Supplies	*h*	yr 2-8				
Br Cr tribs				√	√			√		2-Stage Chan./overwide	1,000	Linear Feet	*m*	yr 6-10			295	91
Br Cr/tribs				√	√					Grass. Waterw/veg. buffer	100	Ac. treated	*h*	start yr 3		177	466	26
Br Cr watershed				√	√					Cover crops	100	acres	*h*	start yr 3		101	240	120
Br Cr watershed				√	√					Residue applied to fields	200	acres	*h*	start yr 3		202	480	120
Br Cr/tribs				√	√			√		Livestock Crossings	1	Crossings	*h*	yr 2-8				
										Conservation Easements								
Br Cr watershed				√	√		√	√	√	Acquire Wetlands/easemts	100	Acres	*h*	start yr 1	$5-25k/ac	100**	2800**	632**
Br Cr watershed			√	√	√	√	√	√	√	**Education and Outreach**								
Br Cr watershed										Brochures/Fact Sheets	10	Brochure	*m*	ongoing				
Br Cr watershed										Watershed/trib Festivals	10	Festivals	*h*	ongoing				
Br Cr watershed										Websites	1	Website	*h*	yr 1, O				
Br Cr watershed										Install Signs	24	Signs	*m*	yr 3-10	200-500			
Br Cr watershed										Stream Clean-Ups	3	Clean-Ups	*h*	ongoing				
Br Cr watershed										New stewardship groups	1	new group	*m*	yr 2-6				
Br Cr watershed										Workshops/Training	5	Workshops	*h*	ongoing				
Br Cr watershed										Develop Manual(s)	1	Manuals	*h*	ongoing				
Br Cr watershed							√			Rain barrel workshops	250	barrels	*h*	ongoing				
Br Cr watershed										Develop Newsletters	10	Newsletters	*m*	ongoing				
										Local Policy								
Br Cr watershed				√	√		√	√		Riparian setback	1	code	*h*	yr 2-6		22**	320**	57**
Br Cr watershed				√	√		√	√		Green code audit/update	2	audits/	*h*	yr 1-5				
										Monitoring								
BCr/ feeder Canal/ Lake H					√					Chemical Sampling	4	Sites	*h*	yr 1-3				
Br Cr/tribs										Fish (IBI) Sampling	3	Sites	*m*	yr 2-6				
Br Cr/tribs										QHEI/HHEI Sampling	3	Sites	*m*	yr 2-6				
										Recreation								
Br Cr watershed									√	Construct trail	2	miles	*m*	yr 3-10				
Breakneck Cr.									√	water trail/access sites	1	site	*m*	yr 5-10				
Br Cr watershed									√	Economic benefit study	1	study	*m*	yr 2-5				
Br Cr watershed									√	Quest/virtual wshed tour	3	Quests/1 tr	*m*	yr 2-5				
															Subtotal	939.7	5703	1551

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Category/Practices	Target amt by 2023	Units	Priority (high-mod)	Time Frame (yr or On-going)	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020201 Potter Cr. (and Congress Lake Outlet, CLO)																		
										Riparian Restoration								
Po Cr/CLO/tribs				√	√			√		Restore streambank	1,600	Linear Feet	*h*	start yr 3	$25-200/lf	110	160	60
Po Cr/CLO/tribs				√	√		√	√		Riparian plantings	5	Acres	*m*	start yr 3	$2,500 + labor	2.8	40	7
Po Cr watershed								√		Remove/treat Invasive Species	50	Acres	*m*	start yr 3				
										Stream Restoration								
Po Cr/CLO/tribs				√	√		√	√		Restore Flood Plain	10	Acre-foot	*m*	start yr 3		4.4	60	8
Po Cr watershed								√		Feasibility study low-head dam removal tribs	1	study	*m*	yr 3-5				
										Wetland Restoration								
Po Cr/CLO/tribs				√	√		√	√		Reconnect/Restore Wetlds	50	Acres	*h*	start yr 3	$5-100k/ac	50	1400	316
										Home Sewage Treatment Systems								
Po Cr watershed					√					Repair/Replace HSTS	15	HSTS	*h*	ongoing			466	183
										Urban runoff and green infrastructure								
Po Cr watershed				√	√		√			Rain gardens	1000	sq feet	*m*	start yr 4			0	0.04
Po Cr watershed				√	√					Storm water retrofits	20	acres treated	*m*	start yr 3	$400-17k/	0.9	10	4
Po Cr watershed				√	√					No-mow ditch/veg swale	500	linear feet	*m*	yr 3-8		0.05	0	0.2
Mid Cuy wshed										Neighborhd green infrastr.	1				see above			
				√	√					**Agricultural BMPs**								
Po Cr/CLO				√	√					Survey of practices	1	survey	*h*	yr 1-3				
Po Cr/tribs				√	√			√		Livestock Excl. Fence, accompanying measures	3,000	Linear Feet	*h*	yr 2-8	$11,300 + watering	140	280	140
Po Cr/tribs				√	√					Alternative Water Supplies	1	Supplies	*h*	yr 2-8				
Po Cr/tribs				√	√					2-Stage Channel/overwide	1,000	Linear Feet	*m*	yr 6-10			295	91
Po Cr/CLO/tribs				√	√			√		Grassed Waterways/ vegetated buffer strips	100	Acres treated	*h*	start yr 3		177	466	26
Po Cr wshed				√	√					Cover crops	100	acres	*h*	start yr 3		101	240	120
Po Cr wshed				√	√					Residue applied to fields	200	acres	*h*	start yr 3		202	480	120
Po Cr wshed				√	√					Conservation cover	100	acres	*h*	start yr 3		101	240	120
Po Cr/tribs				√	√					Livestock Crossings	1	Crossings	*h*	yr 2-8				

Select projects will be monitored for effectiveness.

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Category/Practices	Target amt by 2023	Units	Priority (high-mod)	Time Frame (yr or On-going)	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
										Conservation Easements								
Potter Cr.watershed				√	√		√	√	√	Acquire riparian buffer/ Wetlands/ easements	50	Acres	*h*	start yr 1	$5-25k/ac	50**	1400**	316**
Po Cr wshed			√	√	√	√	√	√	√	**Education and Outreach**								
Po Cr wshed										Brochures/Fact Sheets	4	Fact Sheets	*m*	ongoing				
Po Cr wshed										Websites	1	Website	*h*	ongoing				
Po Cr wshed										Field Days/workshops	3	workshops	*h*	start yr 2				
Po Cr wshed										Develop Manual(s)	1	Manuals	*h*	yr 1-2				
										Local Policy								
Po Cr wshed				√	√		√	√		Riparian setback	1	jurisdiction	*h*	yr 2-6		25**	400**	71**
Po Cr wshed				√	√		√	√		Green code audit/update	1	audits/ updates	*m*	yr 1-5				
										Monitoring								
Po Cr/VLO					√			√		Chemical Sampling	3	Sites	*h*	yr 1-2				
Po Cr./tribs				√				√		(QHEI/HHEI) Sampling	1	Sites	*h*	yr 3-5				
															Subtotal	889.2	4138	1195
															Total	3,309	17689	4,822

* Contingent on Long Term Control Plan, assumes reduce all but 3 overflows/yr at each of 4 locations.

** Amount of additional loading prevented by preservation.

*** Primary reasons for restoring this streambank are flood management and habitat. Pollutant loading calculated for 200 lf of eroding bank.

Select projects will be monitored for effectiveness.

8/9 Monitoring and Plan Revision

Important aspects of the watershed plan include tracking progress, maintaining contact with partner communities/organizations, and amending/updating the plan to reflect newly identified needs and opportunities. The watershed coordinator has held meetings with community officials during the plan development and will be holding workshops and meetings during plan review to identify items not included in this original plan, which will allow the plan to be revised in the year(s) following approval. It is planned that the partners will revisit the goals and objectives at least once per year as a group and will continue to meet on an approximately quarterly basis or as necessary to manage individual projects.

Monitoring

The watershed partners will continue to meet in years following plan adoption. The watershed coordinator will be responsible for demonstrating and assessing progress toward the stated goals, to allow the partners to target projects and revise/amend the watershed action plan. The list of actions in Section 7 allows the partners to assess progress in the following manner:

- Limited sampling is proposed along the Cuyahoga River and tributaries.
- Use of BMPs assumes typical pollutant reduction and often does not involve monitoring. The watershed coordinator will document the amount, location, and type of BMPs installed relative to the plan items, which will allow pollutant load reductions to be modeled.
- Select projects will be monitored for effectiveness (e.g., pollutant reduction), as part of the project contracts or as a separate monitoring effort.
- These efforts will be included in watershed coordinator activities, partner contributions, and specific BMP efforts, which will be funded through sources such as grants or partner contributions, depending on the BMP.

These data will be compiled yearly. The partners will meet approximately quarterly to coordinate on projects and share results. Each year the partners will review progress and assess whether revised goals are needed. The watershed coordinator will report construction of projects as required to Ohio DNR/Ohio EPA.

Plan Update/Revision

To assess progress and update partners, the watershed coordinator will:

- Track progress using the summary tables;
- Hold meetings with partners and discuss plan progress, pending projects, and newly identified project needs at least four times per year or as appropriate to manage projects;
- Maintain contact with/update partners by telephone, e-mail, and newsletter;
- Work with individual partners to implement projects and conduct cleanups; and
- Present updates at regional meetings, e.g., NEFCO/ERTAC, NPDES stormwater general permit Public Involvement Public Education groups.

NEFCO will retain the watershed plan documents and use the web page to post updates, information, discussion materials, upcoming events/coordination, and contact information for those wishing hard copies. Summary packages for each subwatershed based on the summary materials from Section 7 are available for broad distribution.

The e-mail list used during plan preparation included over 100 contacts, including the entities listed on the endorsement sheet, as well as parks districts, the Akron-Summit Homebuilders Association, local resource management consulting firms, soil and water conservation districts,

7-MS Cuyahoga River Main Stem

HUC 041100020305 and a small portion of HUC041100020203 (Upper Cuyahoga, L. Rockwell dam to Breakneck Creek), except Fish Creek

1 Summary of Existing Conditions

Tables MS-1 and 2 summarize key characteristics and impairments of this subwatershed. Figure MS-1 presents a map of the subwatershed and its jurisdictions. Figures MS-2 and 3 show potential areas of concern and resource areas for protection. (Greater detail is shown in the various maps in Vol. I.) Also see photos in Section 4P, Main Stem.

The primary concerns in this watershed focus on continued restoration of the river, protecting the Cuyahoga Falls public water supply, addressing impacts from the altered, urbanized landscape (including non-point source pollution, flooding, bank erosion and channel incision), and increasing recreational opportunities, such as the proposed water trail.

The main stem has been assessed for water quality attainment frequently as part of development and implementation (and follow-up for the Middle Cuyahoga) related to the Middle and Lower Cuyahoga River TMDLs. The tributaries have not been assessed, except for the tributary in Munroe Falls MetroPark, which appears to be in attainment. Limited information is available about the tributaries. Field work has been confined to visual assessments at parks and road crossings.

The descriptions below reflect the information available at this scale. However, in most cases, additional field work is necessary to further assess or quantify various characteristics of specific locations. Additional problem areas or resources may become apparent later. For instance, there is limited water quality sampling along tributaries; mapped buffer characteristics may not accurately reflect actual channel conditions; problems such as erosion or damaging floods may only become apparent after storms; and some areas of interest will be apparent only after more field work is done.

Non-Attainment due to Dams *(Refer to Problem statement MS-1, Table MS 4.1)*

Following decades of hydromodification by dams along the main stem, efforts are on-going to restore 14 miles of the Middle Cuyahoga River to attain biological standards through dam removal. Recent removal or alteration of two dams has restored eight miles of the river between Kent and Brust Park. Downstream of Brust Park, the river is in non-attainment due to the presence of two low-head dams and the 60-foot Ohio Edison dam in the Cuyahoga Falls Gorge. Removal of the remaining three dams would restore flow along an additional five to six miles of river. Improving the water quality will require continued efforts to address existing impairments, provide public information, and restore riverbank and tributaries following dam removal.

CSOs *(Refer to Problem Statement MS-2, Table MS 4.2)*

In the lower reaches of this watershed, the City of Akron has four CSOs. These are the subject of a Long Term Control Plan that is currently being negotiated. The CSO reduction effort may open up opportunities for reducing stormwater flow with green infrastructure.

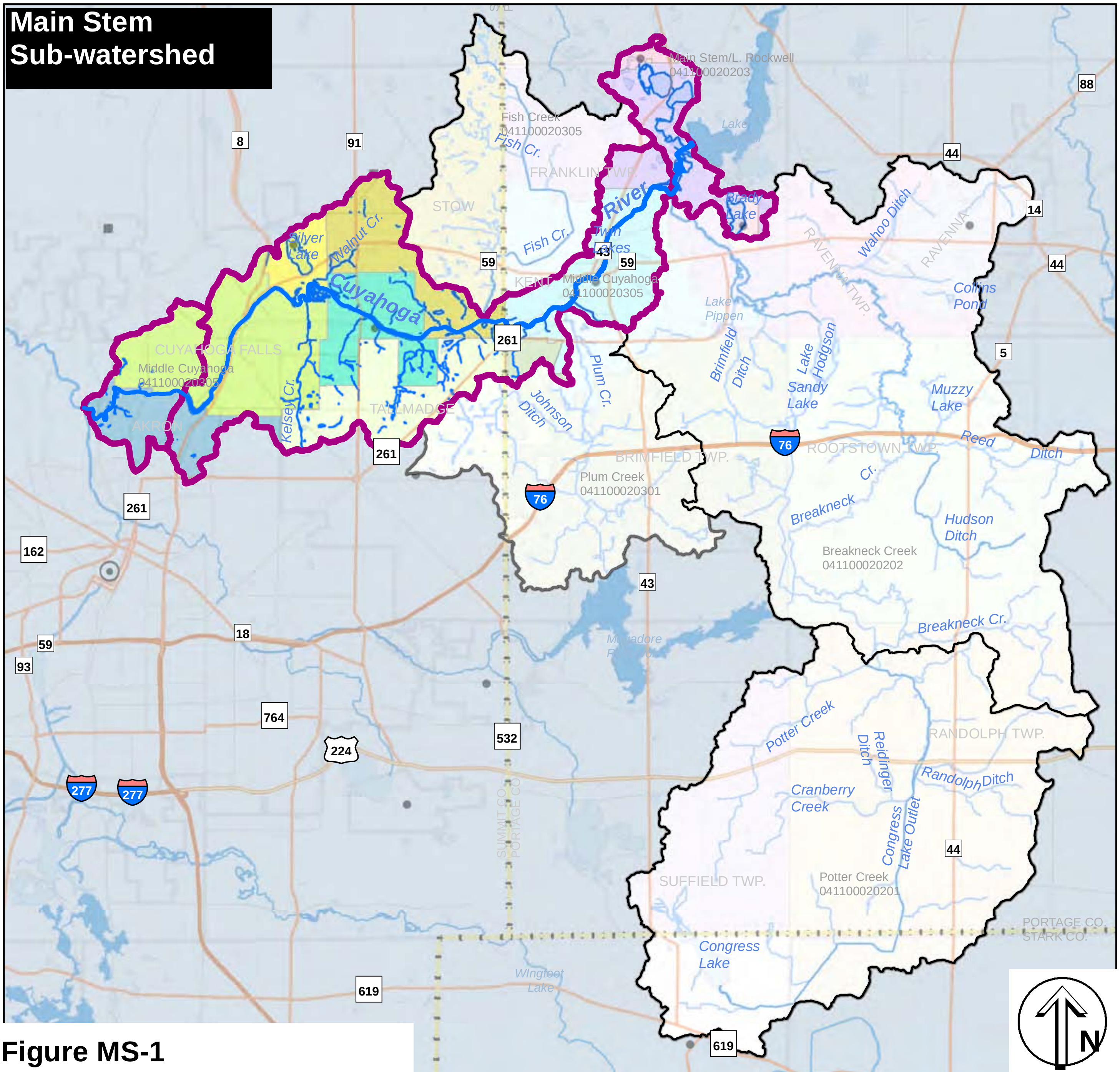


Figure MS-1
Subwatershed Jurisdictions

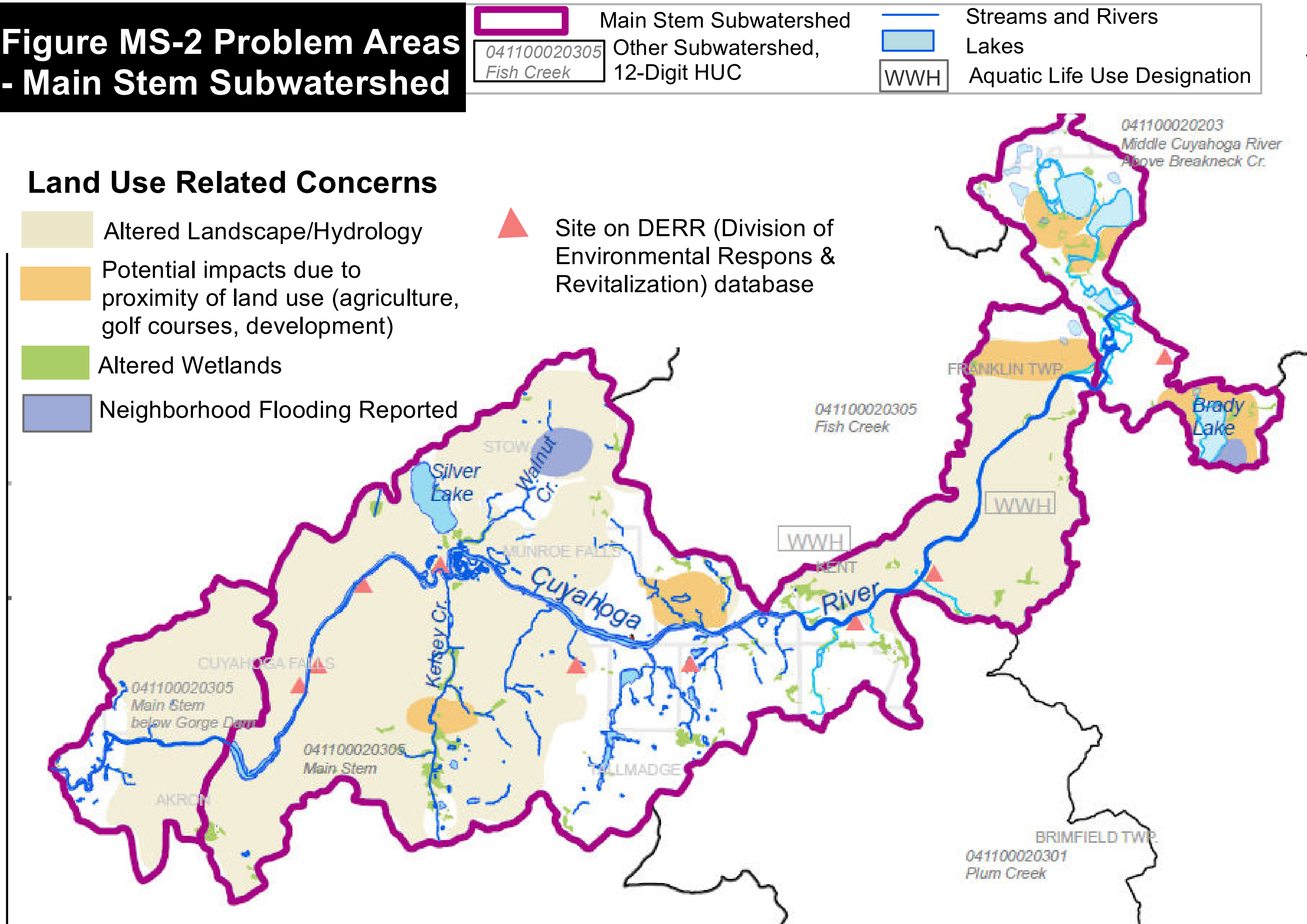
Streams and Rivers
Lakes
Main Stem Subwatershed
12-Digit HUC: 041100020305
Fish Creek 041100020305 Other Sub-watersheds
Counties
Jurisdictions outside watershed
Interstate Highways
State Divided Highways
State Numbered Rtes
Local Roads

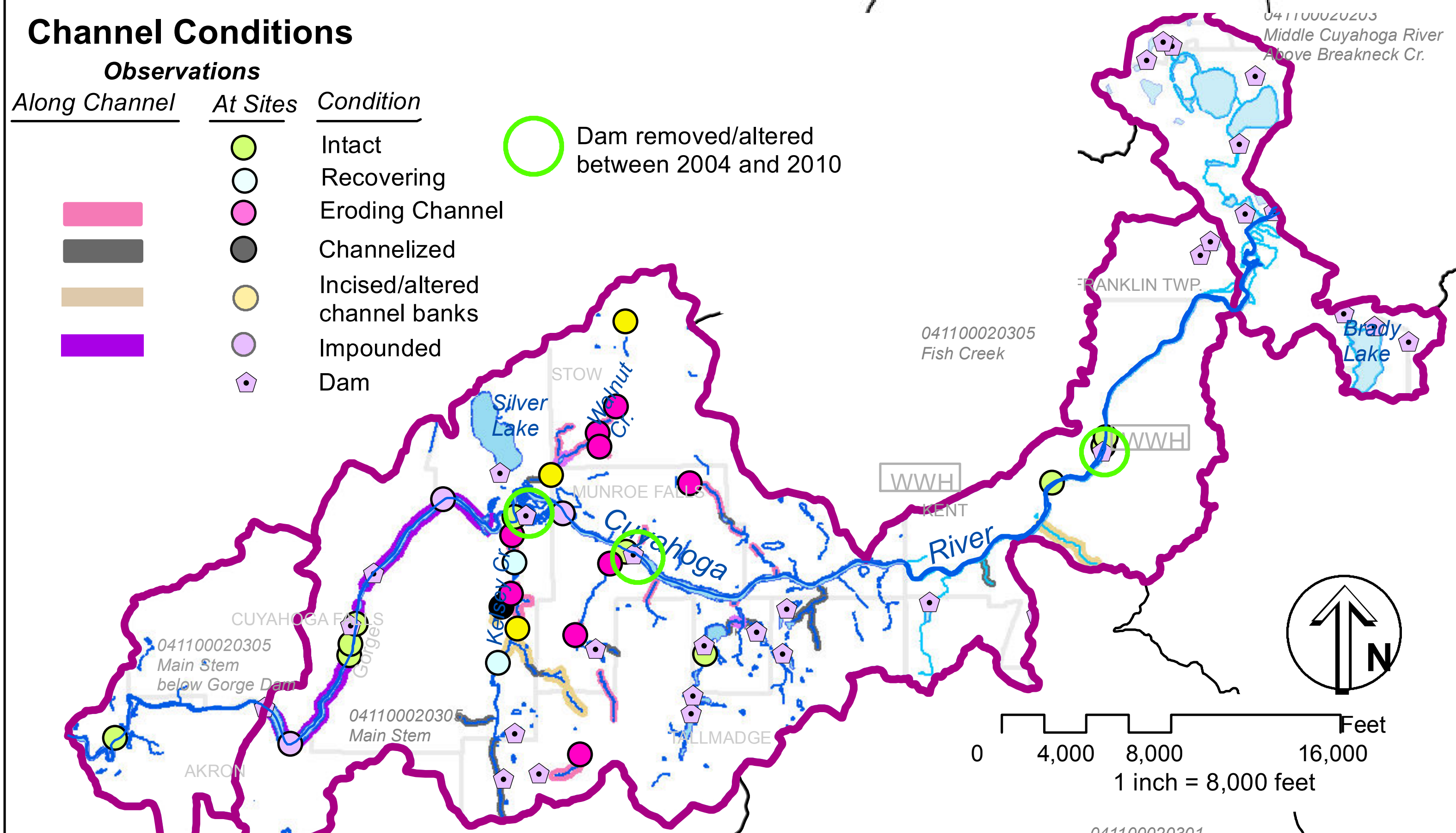
Subwatershed Local Jurisdictions

SILVER LAKE
STOW
CUYAHOGA FALLS
MUNROE FALLS
TALLMADGE
AKRON
STREETSBORO
KENT
FRANKLIN TWP.
BRIMFIELD TWP.
SUGAR BUSH KNOLLS
BRADY LAKE

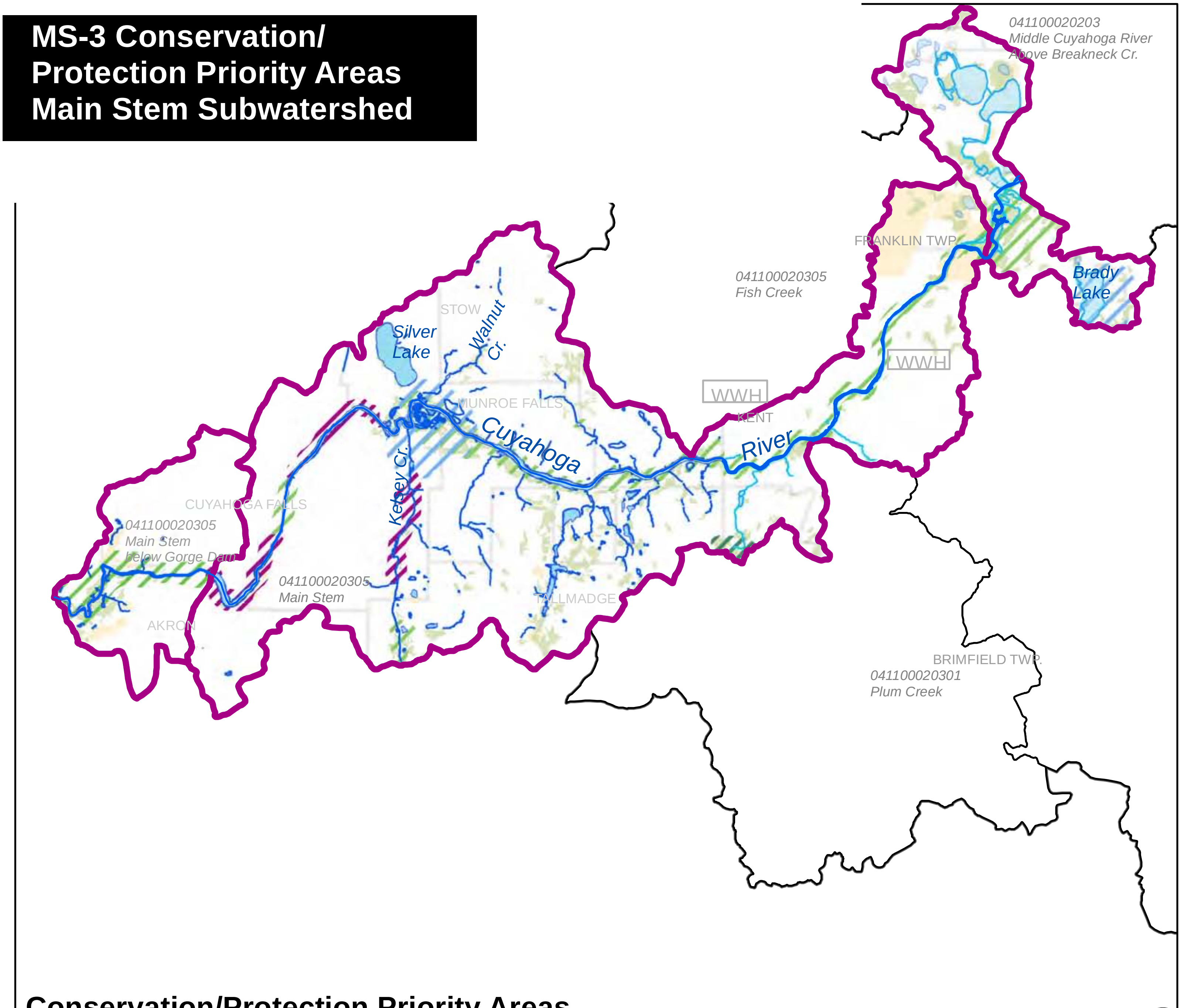
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010

Figure MS-2 Problem Areas - Main Stem Subwatershed





MS-3 Conservation/ Protection Priority Areas Main Stem Subwatershed



Conservation/Protection Priority Areas

- Riparian Corridor/Wetland
- Wetlands of Additional Importance (e.g., buffering) - enhance/protect
- Water Supply Protection - Conservation/BMPs/Outreach
- Restoration/Conservation of Riparian Area/Wetlands
- Mapped Wetlands
- Habitats or Species of Concern
  Identified on DNR biodiversity database spanning 30 years; Western Reserve Land Conservancy workshop, 2010.)

- Streams and Rivers
- Lakes
- WWH Aquatic Life Use Designation
- 041100020305 Main Stem — Subwatershed, 12-Digit HUC
- Local Jurisdictions

N

0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet

*Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

Table MS-1
Summary of Main Stem Subwatershed Characterisitcs

Concern	Amount/Item	Comments
Water Quality Attainment, latest assessed	Main Stem – upper 8 miles in attainment, 5-6 miles in Non attainment; Full attainment below Edison dam; partial at lower end; most recently assessed 2007-2010; occasionally elevated *e. coli* counts at water works park after a storm; Tributaries – mostly not assessed	Causes: organic & nutrient enrichment , low DO, toxicity, habitat mod. Sources: dam pools, CSOs, habitat/riparian mod., urbanization/suburbanization
Public water supplies	Cuyahoga Falls well/river recharge	Developing Source Water Protection Plan, land largely owned by City
Land Cover acres, %	Developed 12,054 66.5% • *High Density 873 4.2%* • *Moderate Density 2,396 12.0%* • *Low Density 6,214 36.2%* • *Dev. Open Space 2,571 14.1%* Agricultural 655 5.1% Grassland/scrub-shrub 370 1.9% Woods/wetlands 4,150 23.6%	
Impervious/runoff	25.7% **Additional runoff ¾ in storm**: 62 million gal.	
75 foot buffer	**Walnut Cr. Kelsey Cr. Cuy R.** Developed 96% 90% 60% - *Dev. Open Space* *24%* (Kelsey Cr.) Agricultural Woods/wetlands 3% (Walnut Cr.) 36% (Cuy R.)	Mapped developed land in buffer may be greater than actual, possibly due to mapping scale, steep valley walls.
Wetlands (ac)	**Mapped** 1,510 **Converted** 451 (hydric) (2167 hydric incl.)	Urban areas may mask earlier wetlands
Development potential	Limited development on few remaining large parcels	
Channel quality (Cuy. River/tributaries**)**	**Intact Altered/channelized Impounded Eroding Recovering** 12.8/2 0.1/9.7 3.1/0.3 0/4.9 0/1.5	
Non-pt source load/yr	**Tot. N (lb)** 53,882 **Tot. P (lb)** 9,391 **Sed. (tons)** 2,338	
Septic systems	Minimal amounts outside sewer service, most areas few limitations	
Problem areas	Incised tribs. at nearly all stream crossings, highly altered watershed	Water volume; tribs intact in woods
Resource areas	Public water supply 5 year zone, habitat/species of concern, wetlands	
Park/ conserv./inst.	Local & park district parks, hiki/bike trails; schools, municipal facilities	
Riparian setback	Tallmadge, Munroe Falls, Kent	
Recreational opportunities	Main stem: canoeing, fishing, water trail, bike-hike trail, city/park district parks/trails; Tribs.– Parks on Walnut & Kelsey Cr., greenway potential	Limited direct access

Table MS-2 Main Stem Impairments
HUC 041100020203, 041100020305

Attainment issue/other concern	Cause	Source	Other likely sources
L. Rockwell – Breakneck Cr. HUC: 041100020203 Partial attainment	Organic enrichment/DO (high) Habitat alteration Siltation Flow regulation/ modification	Development (high) Minor municip. point source Land development Non-irrigated crop production	Most of -0203 is above the L. Rockwell dam
HUC: 041100020305 Cuyahoga River below Breakneck Creek	Habitat alteration Flow alteration Nutrients Organic enrichment Siltation Total Toxics, unknown toxics	Channelization CSO Dam Major municipal point source Natural Septic tanks Sewer line construction Urban runoff/nps	Imperv. 26%. Stream ero-sion/incising streams
Middle Cuyahoga TMDL Breakneck Creek – Water Works Park (Middle Cuy TMDL) – portions of 0203 and -0305 Elevated nutrient levels noted in 2007 OEPA report No change in habitat scores below Brust Park			
Lower Cuyahoga TMDL	Organic enrichment Toxicity Low DO Nutrients Flow alteration bacteria	Municipal discharges CSOs Urban runoff Industrial/ municipal discharges Upstream impoundments	
Support Designated Recreational use (bacteria, debris, water trail)			
Local Concerns:			
Increase stewardship and understanding			
Protect water supply			

Effects of Altered Landscape

Much of the remaining problems that the partners wish to address in this subwatershed relate to the high degree of alteration of the landscape: Sediment, nutrients (nitrogen and phosphorous), flooding, habitat alteration, even the potential for groundwater contamination.

The Main Stem subwatershed is 26 percent impervious, resulting in increased loading of pollutants and water volume as shown in Table MS-1. Streams tend to degrade when imperviousness reaches around 10 percent, and degradation can be reduced or aggravated by the condition of the riparian zone and riparian buffer. In this subwatershed, the increased runoff, combined with the steep slopes and altered riparian features, has resulted in increased channel loading, incised channels at most stream crossings, loss of floodplain access and flood storage, stream instability, sedimentation, nutrient loading, degraded habitat, localized flooding problems, and adverse impacts downstream. Severe erosion has been noted along Kelsey and Walnut Creeks. Nutrients, sediment, bank erosion, and damaging floods are all concerns in downstream communities, the Cuyahoga River, and river bank erosion has become severe in the National Park downstream.

The main stem and tributaries are lined with debris from decades of dumping trash. The debris detracts from the aesthetic and recreational appeal of the river and may affect water quality or habitat as materials spill, leak, or interfere with substrate.

Non-Point Source Pollution (Sediment, Nutrients) from Urban Runoff and Overloaded Channels *(Refer to Problem Statements MS-3, 4, and 5, Tables MS 2.3, 4, and 5, for Sediment, Nitrogen, and Phosphorous, respectively.)*

The largely urbanized Main Stem subwatershed generates 9,391 lb per year of phosphorous, 53,882 lb per year of nitrogen, and 2,338 tons per year of sediment. These contribute to downstream habitat degradation and elevated nutrient levels. Four lakes in the main stem watershed are surrounded by residential development and may be affected by nonpoint source pollution.

- *Sediment* - In addition to urban runoff, tributaries in this subwatershed are undergoing severe bank erosion and loading of sediment and nutrients due to excess volume and reduced flood storage. Approximately 2 miles of headwater tributaries are eroding from excess storm water and inadequate flood storage. Included in this total, approximately 2,500 linear feet of Kelsey Creek in Kennedy Park is incised with banks up to 6 feet tall and is threatening infrastructure. Lower banks in Brookledge Golf Course, upstream of Kennedy Park, and Water Works Park, downstream of Kennedy Park, are also eroding. Walnut Creek in Adell Durbin Park is incised from one foot to several feet, depending on the slope. Small headwater tributaries in Munroe Falls and Stow are incised by one foot.
- *Nutrients* - The Ohio EPA 2007 Aquatic Life Use study indicates that phosphorous levels in the Cuyahoga River are elevated compared to state criteria. Because higher levels tend to occur after rain events, it appears that a component is related to runoff. Nutrients also enter the streams along with sediment eroded from stream banks. The highly altered watershed and riparian features have reduced the natural ability of the system to assimilate or store sediment and nutrients. So far the biological communities in the river have not been adversely affected. However, with an increased concern for nutrients entering Lake Erie, it is important to reduce input and improve uptake as much as possible upstream.

Groundwater Contamination *(Refer to Problem Statement MS-6, Table MS 4.6)*

This subwatershed contains one public water supply, the Cuyahoga Falls wellfield, which relies on a shallow sand and gravel aquifer that is highly susceptible to pollution, and which receives recharge from the river. The City of Cuyahoga Falls owns much of the 5 year time of travel zone of the wellfield, but more than half is privately owned, the DERR database indicates one or more potential sources of contamination, and an abutting landowner has expressed interest in oil and gas drilling, all of which raise concerns of potential contamination.

Flooding *(Refer to Problem Statement MS-7, Table MS 4.7)* Flooding problems and erosion have been observed along tributary sections of Walnut Creek, Kelsey Creek, and un-named tributaries entering the river. These likely reflect altered hydrology and increased runoff.

Habitat and Conservation Areas *(Refer to Problem Statements MS-8,9 - Tables MS 4.8,9)*

Based on preliminary mapping and limited field assessments, it appears that 3,305 acres riparian buffer along headwater tributaries and 451 acres of wetlands on hydric soils have been altered, degrading habitat and reducing water quality. Much of the riparian corridor nearest the Cuyahoga River is undisturbed, due to the steeply sloping river valley. Headwater tributaries in this subwatershed have been culverted and channelized, and many of the tributaries are incised, impairing habitat. Urban encroachment has likely degraded some of the remaining wetlands, as evidenced by large stands of the common reed, *Phragmites* in the more urbanized portion of the watershed. The total amount of altered headwater habitat is likely much higher than estimated, as much of the previous streams and wetlands were altered by development prior to mapping. Development continues to encroach on and damage the remaining wetland and riparian resources. Where dams have been removed, the riparian area is in transition and may lack tree canopy over the creek/river, increasing water temperatures in the area. Numerous small low-head dams are found in the watershed, which often impair upstream habitat.

Within the Main Stem subwatershed, habitats or species of concern have been identified along the cliffs in the Gorge MetroPark, in Munroe Falls MetroPark, Cascade Valley MetroPark, at the Twin Lakes and near Lake Rockwell and the confluence of Breakneck Creek. Local, state, and County park districts protect portions of many resource areas, including intact riparian environments along headwater tributaries and portions of the Cuyahoga River. These can provide nuclei and nodes for larger, more connected habitat areas. Unprotected habitats or species of concern are found near Twin Lakes and the upper portions of the Middle Cuyahoga River. Outside of MetroParks and the immediate vicinity of the river, there are few remaining wetlands in the subwatershed, along headwater tributaries in Tallmadge and Munroe Falls, and they are on land that is privately owned.

Recreation *(Refer to Problem Statement MS-9, Table 6b-MS 4.9)*

Numerous city and park district parks and the bike-hike trail along the Main Stem provide direct access to the river and tributaries at several locations in Kent, Munroe Falls, Cuyahoga Falls, Stow, Silver Lake, and Akron. The Freedom Secondary Bike-Hike trail will provide a continuous trail between Summit and Portage Counties, with links to the Portage bike-hike path along the river. The existing parks could provide the framework for developing further trail connections.

The Cuyahoga River is designated as a Category A recreational water and is being developed as a water trail. Various partners are collaborating in increasing recreational opportunities and access along the Cuyahoga River. A recently completed canoe livery in Kent has increased the number of paddlers on the river. Partners in the region are seeking to establish a Water Trail, which would draw visitors to the entire region. Expert paddling waters are found along a short stretch in Kent and in the Gorge section of the river. Should the Ohio Edison dam and the two smaller dams in Cuyahoga Falls be removed, it is likely that additional expert class rapids will be exposed. Fishing opportunities are likely to change with the removal of the dams, as well.

While recreational use and facilities are increasing along the river, there is a lack of centralized information and adequate pull-outs/access points. Large debris and tires are still found along the Middle Cuyahoga River. Encouraging recreation along the river will require maintenance of additional access, signage, debris removal, and information sites.

Upstream of the combined sewer overflows, levels of *e. coli* are occasionally elevated, possibly related to high flows. With increased recreational use along the river and designation as a Category A recreational waterway, it is important to more fully understand the source and frequency of the high bacteria levels, which could be a result of watershed runoff or localized sources, such as concentrations of waterfowl.

2 Problem Statements, Goals, Objectives, Actions

Table MS 3 summarizes the actions proposed in the subwatershed and their associated pollutant load reductions, listing which problem statements are addressed by these tools, and which tables they can be found in. Tables MS 4.1 through 4.10 present the problem statements, goals, objectives, and actions for each problem area. The tables are numbered to reflect each problem statement number, e.g., Table MS 4.1 corresponds to Problem Statement MS-1. It should be noted that because many of the objectives address more than one goal, the actions associated with each objective are listed only once, in the first table in which they appear (most frequently, Table MS 4.1). All other listings of the same objective refer back to the actions at their first occurrence.

Refer to Sections 6 and 7 Introduction for a discussion of the format of the problem statements, goals, objectives, actions, and considerations for implementation.

Table MS-3 Action Item Summary by Subwatershed: Main Stem

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020305																
Main Stem & tribs										**Dam Removal**						
Main Stem	√			√	√			√		Remove low-head dams - CF lead	2	Dams	1 million			
Main Stem	√			√	√			√		Remove Gorge dam - lead by Ohio EPA	1	Dams				
										CSO Containment/Diversion						
Main Stem watershed - Gorge		√								Containment	105/yr reduced by 2028	overflows reduced per yr (4 sites)				
										Contamination						
Main stem watershed			√							Determine status of DERR listed sites	9	sites				
Main stem watershed			√							Brownfields inventory	1					
Main stem			√			√				Initiate cleanup	2					
										Riparian Restoration						
Kelsey Cr., incised tribs Stow, MF, CF,				√	√		√	√		Restore Streambank (Bio-Engineering/ re-contouring/ re-grading)	8,000	Linear Feet	$25-200/lf	490	686	264
Lg properties schools, golf courses, dam pools, public				√	√		√	√		Plant Native plants, trees, or shrubs in Riparian Areas	25	Acres		11	150	20
Watershed, lakes								√		Remove/treat Invasive Species	50	Acres				
										Stream Restoration						
Kelsey Cr., other tribs				√	√		√	√		Restore Flood Plain	8	Acre-foot		3.5	50	7

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Kelsey Cr., other tribs				√	√		√	√	√	Restore Channel	4,000	Linear Feet	$100-200/lf			
Main Stem watershed	√				√			√		dam removal feasibility study	1					
										Wetland Restoration						
Main stem watershed				√	√		√	√		Reconstruct, Restore, Reconnect Wetlands	10	Acres	$5k-100k/ac.	10	280	62
										Urban runoff and green infrastructure						
MS watershed				√	√		√			Rain gardens - residential/ parks	20,000	sq feet	$500,000		2.00	0.50
MS watershed		√		√	√		√			Bioinfiltration/ permeable pavement - parking lot retrofit	10,000	sq feet	$200,000		2	0.4
MS watershed				√	√		√			Storm water inventory	1	inventory				
MS watershed				√	√					Storm water retrofits - assume 1/2 wetland, 1/2 wq inlet+sand filter	100	acres treated	$400-17k/ ac	4.5	70.1	10
MS watershed				√	√					Retrofit drainage - No-mow ditch/ grassed swale/ daylighting	1,000	linear feet - treats 4 ac		0.1	0.8	0.4
Middle Cuyahoga River watershed		√		√	√		√			Neighborhood-scale green infrastructure	1		$25-50k design $20k bumpouts	5	200	25
										Conservation Easements						
See Fig. MS3				√	√		√	√	√	Acquire Wetlands/ easements	25	Acres	$5-25k/ac	prevent 25	prevent 1,400	prevent 316
										Education and Outreach						
MS watershed	√	√	√	√	√	√	√	√	√	Develop Brochures/Fact Sheets	6	Brochures/ Fact Sheets				
										Watershed Festivals	10	Festivals				
										Websites	1	Website				
										Install Signs	10	Signs	$200-500/ sign			

12-digit HUC/ Water Body	Dams	CSOs	Contamin. Sites	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	**Category/**Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
										Stream Clean-Ups	15	Clean-Ups				
										New lake/stream stewardship groups	1	new group active				
										Golf course certification outreach	4	golf courses contacted				
										Stencil Storm Drains	100					
										Conduct Workshops/ Training sessions	5	Workshops				
										Develop Manual(s)	1	Manuals				
										Rain barrel workshops	50	rain barrels				
										Develop Newsletters	10	Newsletters				
										Outreach for dams	2	Press Releases				
										Local Policy						
			√	√		√	√			Green code audit/update Develop or Customize	2	audits/ updates				
										Monitoring						
		√							√	Bacteria sampling	6	Samples				
					√			√		Chemical Sampling	3	Sites				
				√	√			√		Macroinv./Fish/QHEI Sampling	4	Sites				
										Recreation						
									√	Develop water traill	1	water trail				
									√	Construct/improve access sites - incl. 3 access sites Cuy Falls	5	site				
									√	Boardwalk/trail	8,000	lf				
									√	Economic benefit study	1	study				
									√	Develop quest(s)/ virtual watershed tour	2 quests/ 1 tour					
													Total	674	1871	518

* Contingent on Long Term Control Plan, assumes reduce all but 3 overflows/yr at each of 4 locations.

Table MS-4.1 Main Stem - Dam Removal
041100020305 and 20203 (part)

Problem Statement MS 1: Non-attainment due to dams

The 1999 Cuyahoga River TSD indicated that QHEI scores in the dam pools of the Middle Cuyahoga River ranged from 46.5 to 56 due to hydromodification and embedded substrate, and thus were in non-attainment of WWH standards. Three of the dam pools, totalling 4.7 miles, remain.

Goals / *Objectives* / Actions	**Lead/ cooperating Organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal MS 1a Restore 4.7 miles of the Cuyahoga River to WWH habitat standards by restoring free-flowing conditions.			
MS 1a-1 Remove two low-head dams in Cuyahoga Falls, thereby restoring QHEI along 3 miles of river to WWH standards			2 dams removed by 2014
1 Hire contractor	city of Cuyahoga Falls	Contractor. Funding from NEORSD	
2 Hold informational meetings			
3 Publish brochure or web page article			
4 Monitor for changes			
MS 1a-2 Remove Ohio Edison Dam, restoring QHEI along 1.7 miles of river to WWH attainment			
		Ohio EPA/property owner lead	remove dam by 2019
1 Sediment disposal study and plan	Ohio EPA		
2 Historical investigation?			
3 Permitting			
4 Remove and dispose of sediment			
5 Hire contractor for dam removal			
6 Coordinate with downstream communities and MetroParks, Serving Summit County			
7 Publicity			
8 Remove dam			
9 Monitor for changes			

Table MS-4.2 Main Stem - CSOs
041100020305 and 20203 (part)

Problem Statement MS 2: Bacteria from CSOs or other sources.

OEPA samples and Akron modeling indicate that the Cuyahoga River within and downstream of the CSO area may not comply with recreational water criteria 5 of the 6 months of the recreational season due in part to CSO discharges. Each of the 4 CSOs in the Middle Cuyahoga typically discharges 3-49 times per year, total volume of 64.8 million gallons. OEPA monitoring also indicated single e. coli measurements of 2,600 at RM 48.38, upstream of the CSOs during higher flow.

Goals / ***Objectives*** / Actions	**Lead/ cooperating Organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal MS 2a Reduce number of combined sewer overflows by 105/year at 4 sites in the Gorge area by 2028.			
MS 2a-1 Implement Long-term control plan construction of 4 containment tanks			4 sites by 2028
1 Design studies for tanks	City of Akron		
2 Construct four containment facilities by 2028	City of Akron		
MS 2a-2 Conduct 5 wet-weather monitoring samples at 6 sites to document fecal coliform from other (non-point) sources.			
1 Work with partners to establish protocol			
2 Conduct wet-weather sampling for fecal coliform and TSS		sampling and analysis costs	
3 Document occurrences, work with university students and USGS			
Goal MS 2b Reduce volume of water entering the storm drains in the affected area.			
MS 2b-1 Retrofit existing impervious areas to infiltrate/treat runoff from 10,000 square feet within CSO drainage area e.g., bioinfiltration, permeable pavement)			
MS 2b-2 Conduct outreach concerning reduction of storm water volume			

Table MS-4.3 Main Stem Sediment

041100020305 and -20203 (part)

Problem Statement MS 3: Sediment

Siltation has been identified as a cause of non-attainment in the Middle Cuyahoga River. Excess sediment is of concern downstream in the shipping channel and in Lake Erie, because of the nutrients that enter the water with the sediment. The STEP-L model indicates that the watershed contributes 1,342 tons of sediment from runoff and 995 tons per year from approximately 2 miles of eroding streambanks due to excess storm water and inadequate flood storage. Included in this total, approximately 3,500 linear feet of Kelsey Creek in Kennedy and Water Works Parks and Brookledge Golf Course is incised with eroding banks up to 6 feet tall. Walnut Creek in Adell Durbin Park is incised from one foot to several feet, depending on the slope. Small headwater tributaries in Munroe Falls and elsewhere are incised by one to five feet. Mapping indicates alteration of at least 451 acres of wetland (after soils mapping),loss of riparian features (floodplain access, riparian zone) of nearly 15.5 miles of streams, and alteration of 60-96% of riparian corridor within 75 feet. These figures do not reflect altered pre-existing wetlands or culverted streams in the older urban areas. The loss of beneficial watershed features reduces the flood-storage capacity and vertical stability of watershed tributaries. Potential loss of riparian vegetation with further development could result in increased loading and reduced storage in the future.

Goal *Objective*	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal MS 3a Reduce streambank erosion, thereby reducing sedimentation by 490 tons per year.				
MS 3a-1 Stabilize 4,000 lf of Kelsey Creek banks and restore vertical stability/channel morphology thereby reducing sediment erosion by 245 tons per year.				
	1 Assemble advisory team			
	2 Assess stream segment characteristics and opportunities	City of Cuyahoga Falls	outside consultant	
	3 Develop restoration strategies based on assessment		restoration team	
	4 submit grant proposal(s)	city of CF/wc		
	5 Outreach with neighborhoods/Schnee school			
	6 Restoration work - vertical stability, banks, floodplain		$100-250/linear foot plus plantings	
	7 Encourage volunteer assistance with riparian plantings etc.	City of CF, consultant	plants, planting plan	
	8 Install signage - riparian buffer, etc.			
	9 Coordinate with neighboring communities to reduce stormwater impact, develop stewardship			
MS 3a-2 Develop master plan for Kelsey Creek				
MS 3a-3 Stabilize 4,000 lf of other eroding tributary banks, improve morphology, and restore vertical stability, thereby reducing sediment loading by 245 tons/year. Target areas: eroding streams Cuy Falls, MF, Stow, Silver Springs, Tallmadge, Kent, etc.				
	1 Identify target areas for stabilization using mapping			
	2 Work with communities, partners to determine priorities			
	3 submit grant proposal(s)			

Table MS-4.3 Main Stem Sediment
041100020305 and -20203 (part)

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
4	Develop restoration strategies based on assessment			
5-9	Submit grant proposal, design/build, coordination, signage - see 4-8 in MS 3a-1			
Goal MS 3b Restore riparian features to reduce existing sediment loading by 24.5 tons/year.				
MS 3b-1. Plant 25 ac of deep-rooted riparian vegetation, preferably native vegetation, reducing loading of sediment by 11 tons/yr.				
Target areas: former dam pool sediments, riparian banks lacking deep-rooted vegetation				
1	Submit grant applications e.g., OEEF	WC/SWCDs/partners		
2	Targeted outreach to public, institutional, and other owners of large properties	WC**/SWCDs/ Communities	Lists of golf courses, lake associations, homeowners' associations; maps of large parcels; printed outreach materials.	Target 1 group every 3 years (3 by 2022); improvements to best management practices or riparian management at one site every 4 years(2 sites by 2020); 2 outreach contacts per year
3	Outreach to golf course owners encouraging Audubon-certification		labor, printing	
4	Assist with plantings	SWCDs, master gardeners	native plants/trees and shrubs $250 ($500-1,000 per acre);	
5	Construct and install signage	communities, partners, volunteers (scouts?)	$300-500/sign	
6	Follow-up outreach (individualized guide to riparian zone) and publicize		funding for handouts/brochures	
MS 3b-2 Restore 10 ac of wetland, reducing loading of sediment by 10 tons/year.				
1	Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
2	Hold meetings with landowners to determine interest	WC, partners		
3	Identify wetland restoration site for clearinghouse	WC, Communities, other partners	meetings with landowners; readily available mapping, outside assistance from consultant, possible assistance from Kent State University wetland ecology class	5 concept plans by 2020; 1 every 2 years afterward.
4	Submit grant application			
5	Restore/protect/enhance wetlands	Partners	$5,000-$100,000 per acre, design/build consultant, sites -protection by ease- ments would be at the low end of the range	20 ac by 2022; 10 ac every 5 years afterward
MS 3b-3 Restore 8 acre-feet of floodplain access, storing 3.5 tons/yr sediment. E.g., Kelsey Cr.				

Table MS-4.3 Main Stem Sediment
041100020305 and -20203 (part)

Goal				
Objective	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
	1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
	2 Meet with landowners to determine interest	WC, partners		
	3 Submit grant proposals			
	4 Design & Restore floodplain access/flood storage			
	5 Public outreach			
MS 3b-4 Restore 4,000 lf of incised channel, stabilizing the channels to reduce erosion				
Goal MS 3c Reduce/treat urban runoff to reduce annual loading of sediment by 4.6 tons.				
MS 3c-1 Retrofit stormwater volume devices to improve water quality from 100 acres, reducing loading of sediment by 4.5 tons/year.				
	1 Stormwater retrofit inventory		WC/NEFCO with communities	
	2 Submit grant application.			
	3 Design/construct retrofit for existing stormwater (volume) infra-structure to improve water quality	Communities	Varies, depending on treatment provided (e.g., $400/acre treated to $17,000 per acre treated)	Retrofit approx. 5 by 2022 to treat 100 ac res.
MS 3c-2 Retrofit 1,000 lf of existing drainage as no-mow grass, vegetated swale, or through daylighting to reduce sediment load by 0.1 tons/yr				
	1 Workshop on improving drainage/maintaining ditches for water quality improvements	SWCD		
	2 Install no-mow grass/retrofit			
	3 Stormwater management design manual for Portage County	Portage SWCD	In-house task	1 manual by 2014
MS 3c-3 Facilitate review and update of local codes to include measures for green infrastructure				
	1 Green code audit workshop			
	2 Review codes in two communities for green infrastructure language	partners	volunteers/consultant	
	3 update code language		possibly outside consultant/funding	1 community by 2022
MS 3c-4 Conduct workshops on use BMPs at urban sites				
	1 Stormwater management design manual for Portage County	Portage SWCD	In-house task	1 manual by 2015
	2 Workshops for community officials on developing/enforcing riparian setbacks	partners, PIPE		2 workshops by 2015; additional workshops - included in general workshop series
	3 Workshops for community officials on enforcing bmp requirements			

Table MS-4.3 Main Stem Sediment
041100020305 and -20203 (part)

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
MS 3c-5 Update, increase, and disseminate available information concerning sediment from urban runoff				
1	Continue to compile, centralize, and make available studies, data, information sources on the watershed, including recreational opportunities, volunteer needs, permitting or regulatory issues; green infrastructure information sources, etc.	WC	Website, technical information and outreach materials	Update and develop pages for website by Dec. 2013, then on-going
2	Chemical or biological sampling/assessment along streams - volunteer, intern, or class	Community/partner sponsors, Ohio EPA, KSU interns/classes	possibly funding for stipends, analysis, equipment	Sampling at 1 location every 3 years. 3 sample sets by 2022.
3	Survey of yard management practices	WC/partners		
4	Continue to develop stream database			
5	e-newsletter or article issued 3 times per year	wc	website, share with partners	
6	Develop/reproduce informational brochure/ website article concerning topics of interest, e.g., reducing runoff, recreational opportunities, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	10 by 2022; 1 each year
MS 3c-6 Increase/sponsor 25 stewardship activities related to non-point source pollution and watershed issues.				
1	Establish clean-up/monitoring/planting efforts at additional tributaries and lakes	WC, communities, parks, residents, home-owners' associations, lake associations	Funding or donation of trash disposal, refresh-ments, monitoring supplies, crew leaders, volunteers; training for monitoring/planting	1 new tributary or lake monitoring, clean-up, or other stewardship program by 2018
2	Distribute 50 rain barrels through workshops	SWCDs/ Communities	Space for workshop; rain barrel kits	50 rain barrels distributed
3	Survey of yard management practices	WC/partners		
4	Develop/reproduce informational brochure or website article concerning topics of interest, including reducing runoff, recreational opportunties, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	10 by 2022; 1 each year
5	Educational outreach workshops on topics of importance, including LID/green infrastructure, restoration, field trips for examples	Partners, WC, communities	Location, speaker, supplies	5 workshops by 2022; 1 every 2 years
6	Work with schools or city day camps to develop/encourage use of watershed care activities/curricular items	WC, SWCDs, partners, schools		1 educational outreach program/curriculum item by 2018
7	Breakneck Creek Day (others?)	Portage Parks, partners		1 per year
8	Watershed "brand," logo, art project	WC, Kent State/ Standing Rock Gallery/River Day communities	Host for project, graphic design capabilities	1 logo or art project by 2015, 1 every 3 years after;
9	Create social network or google presence	WC		1 by 2014

Table MS-4.3 Main Stem Sediment
041100020305 and -20203 (part)

Goal				
Objective	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
MCR-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year, phosphorous by 25 lb/yr, and sediment by 5 tons/yr				
	1 Work with communities to identify suitable target neighborhoods	WC, partners		
	2 Workshops/meetings to gauge neighborhood support			
	3 Determine/establish maintenance framework (e.g., easements, homeowner participation)	partner community		
	4 Get grant(s)			
	5 Design/build	outside consultant	Site, outside funding. Design ~$25-50,000; Rain gardens $15-20/sq. foot; Green street bump-outs $20,000 each; per-meable concrete $12-15/ sq. ft	1 project by 2022
	6 Outreach, neighborhood participation			
Goal MS 3d Reduce causes of streambank erosion by reducing channel loading/increasing flood storage by 360,980 cu ft. in a 3/4 in storm.				
MS 3d-1 Increase coordination between communities to reduce stormwater effects				
	1 Coordinate with nearby communities/schools to identify areas of concern or opportunity			2 meetings/yr
	3 Coordinated stormwater study on target areas??		outside funding or assistance	
	2 Workshops with public officials to address shared stormwater concerns			2 workshops
MS 3d-2 Install biofiltration at developed sites totaling 20,000 square feet and reducing runoff by 3,750 cubic feet in a 3/4-inch storm. Target gorge area, other urban				
	1 Identify parcel(s) and landowner(s) for project	partners, WC		
	2 Grants	WC/partners		
	3 Design/construct BMPs	outside consultant		
MS 3d-3 Restore 10 ac of wetland, reducing channel loading by 6,600 cu ft in a 3/4 in event.				
	Actions: See MS 3b-2			
MS 3d-4 Restore 8 acre-feet of floodplain access, increasing storage volume by 348,480 cu ft.				
	Actions: See MS 3b-3			
MS 3d-5 Install 20,000 square feet of rain gardens, to reducing channel loading by 3750 cu ft in a 3/4 in storm				
	1 Identify partners	WC, partners		
	2 Submit grant application	WC/partners		
	3 Workshop/installation	WC/partners		

Table MS-4.3 Main Stem Sediment
041100020305 and -20203 (part)

Goal				
Objective	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
MS 3d-6 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch storm.				
	1 Submit grant proposal/seek community funding			
	2 Obtain rain barrel materials		barrels, plumbing e.g., $40 per barrel setup	
	4 Workshop			2 workshops
	5 Outreach			
Goal MS 3-e Protect wetlands and beneficial watershed features to reduce future loading of sediment by 31 tons/yr				
MS 3e-1 Protect 8,000 linear feet of riparian buffer by increasing the use and effectiveness of riparian setbacks, reducing loading of sediment by 6 tons/yr				
	1 Workshops for community officials on developing/enforcing riparian setbacks	partners, PIPE		2 workshops by 2015; additional workshops - included in general workshop series
	2 Comment on wetland alteration permit applications concerning impacts to watershed functions/riparian setbacks	WC and partners		on-going
	3 Increase the number of communities using riparian setbacks	WC, communities, Counties	Outreach	1 additional community with riparian setbacks by 2022
	4 Install signage for riparian areas in publicly visible places	Partners	$200-$500 per sign. Outside funding or community sign facility	Signs at 2 locations by 2022; signs at 1 additional location every 5 years afterward
	5 Continued outreach	Partners		brochure, workshops on enforcement, outreach to homeowners etc.
MS 3e-2 Protect 25 acres of wetlands through acquisition of land/easements, preventing increased loading of sediment by 25 tons/yr				
Target areas: remaining wetlands in NE Tallmadge, upstream end of Kelsey Creek, other remaining wetlands				
	1 Mapping			
	2 Contact landowners/partner land trusts			
	3 Submit grant proposal			
	4 Acquire wetlands/easements			

Table MS 4.4 Main Stem Nitrogen
041100020305, -20203 (part)

Problem Statement MS 4: Nitrogen

Middle Cuyahoga River nitrate+nitrogen levels measured in 2007 range from 0.9 to 6 mg/l, often exceeding the EOLP median (1.0 mg/l) and the state guidelines (1.5 mg/l). The STEP-L model indicates that the watershed contributes 53,882 lb of nitrogen from runoff and 1,354 lb per year from approximately 2 miles of eroding streambanks due to excess stormwater and and inadequate flood storage. Included in this total, approx. 3,500 linear feet of Kelsey Cr. in Kennedy Park, Water Works Park, and Brookledge Golf Course is incised with eroding banks up to 6 feet tall. Walnut Creek in Adell Durbin Park is incised from one foot to several feet, depending on the slope. Small headwater tributaries in Munroe Falls and other areas are incised by one to five feet. Mapping indicates alteration of at least 451 acres of wetland (after soils mapping), loss of riparian features (floodplain access, riparian zone) of nearly 15.5 miles of streams, and alteration of 60-96% of riparian corridor within 75 feet. These figures do not reflect altered pre-existing wetlands or culverted streams in the older urban areas. The loss of The loss of beneficial watershed features reduces the natural uptake/denitrification of nitrogen, as well as the flood-storage capacity and vertical stability of watershed tributaries, which contributes to bank erosion and associated nitrogen loading.

Loss of riparian vegetation with further development would result in increased loading and reduced storage in the future.

Goal / *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal MS 4a Reduce streambank erosion, thereby reducing nitrogen loading by 668 lb per year.				
MS 4a-1 Stabilize 4,000 lf of Kelsey Creek banks and restore vertical stability/channel morphology thereby reducing nitrogen loading by 334 lb/yr.				
	Actions: See MS 3a-1			
MS 4a-2 Develop master plan for Kelsey Creek				
MS 4a-3 Stabilize 4,000 lf of other eroding tributary banks, improve morphology, and restore vertical stability, thereby reducing nitrogen loading by 334 lb/year. Target areas: eroding streams Cuy. Falls, MF, Stow, Silver Springs, Tallmadge, etc.				
	Actions: See MS 3a-3			
MS 4a-4 Restore 4,000 lf of incised channel, improving vertical stability and reducing streambank erosion.				
Goal MS 4b Restore/improve riparian/channel features to reduce existing nitrogen loading by 530 lb/year.				
MS 4b-1. Plant 25 ac of deep-rooted riparian vegetation, reducing loading of nitrogen by 200 lb/yr.				
	Actions: See MS 3b-1			
MS 4b-2 Restore 10 ac of wetland, reducing loading of nitrogen by 280 lb/year.				
	Actions: See MS 3b-2			
MS 4b-3 Restore 8 acre-feet of floodplain access, storing 50 lb/yr nitrogen. E.g., Kelsey Cr., other incised/channelized streams				
	Actions: See MS 3b-3			
Goal MS 4c Reduce NPS pollution from urban runoff to reduce annual loading of nitrogen by 76.8 lb/yr.				
MS 4c-1 Retrofit stormwater volume devices treating 100 acres to improve water quality, reducing loading of nitrogen by 70 lb/yr.				
	Actions: See MS 3c-1			
MS 4c-2 Retrofit 1,000 lf of existing drainage with no-mow grass, vegetated swale, or daylighting to reduce nitrogen load by 0.8 lb/yr				
	Actions: See MS 3c-2.			
MS 4c-3 Retrofit 20,000 sq ft of developed sites with bioinfiltration/permeable pavement to reduce nitrogen by 4 lb/yr				
	Actions: See MS 3d-2.			
MS 4c-4 Install 20,000 square feet of rain gardens to reduce nitrogen by 2 lb/yr				

Table MS 4.5 - Main Stem Phosphorous
041100020305, -20203 (part)

Problem Statement MS 5: phosphorous

Ohio EPA documents note large diurnal swings in dissolved oxygen and appearance of algae, indicating nutrient enrichment, and phosphorous is the limiting nutrient. Phosphorous levels range from 0.04 to 0.46 mg/l in the Middle Cuyahoga, occasionally exceeding EOLP and state guidelines especially after a rain event. The STEP-L model indicates that the watershed contributes 9,391 pounds/year of phosphorous from runoff and 2 miles of eroding streambanks due to excess storm water and inadequate flood storage. Included in this total, approx. 3,500 linear feet of Kelsey Cr. in Kennedy and Water Works Park, and Brookledge Golf Course is incised with eroding banks up to 6 feet tall. Walnut Creek in Adell Durbin Park is incised from one foot to several feet. Small headwater tributaries throughout the subwatershed are incised by one to five feet.

Mapping indicates alteration of at least 451 acres of wetland (after soils mapping), loss of riparian features (floodplain access, riparian zone) of nearly 15.5 miles of streams, and alteration of 60-96% of riparian corridor within 75 feet. These figures do not reflect altered pre-existing wetlands or culverted streams in the older urban areas.

The loss of beneficial watershed features reduces the flood-storage capacity and vertical stability of watershedtributaries. Potential loss of riparian vegetation with further development could result in increased loading and reduced storage in the future.

Goal / *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal MS 5a Reduce streambank erosion, thereby reducing phosphorous loading by 264 lb per year.				
MS 5a-1 Stabilize 4,000 lf of Kelsey Creek banks and restore vertical stability/channel morphology thereby reducing phosphorous loading by 132 lb/yr.				
	Actions: See MS 3a-1			
MS 5a-2 Develop master plan for Kelsey Creek				
MS 5a-3 Stabilize 4,000 lf of other eroding tributary banks, improve morphology, and restore vertical stability, thereby reducing phosphorous loading by 132 lb/year. Target areas: eroding streams Cuy. Falls, MF, Stow, Silver Springs, Tallmadge, etc.				
	Actions: See MS 3a-3			
MS 5a-4 Restore 4,000 lf of incised channel, improving vertical stability and reducing streambank erosion.				
Goal MS 5b Restore/improve riparian features to reduce existing phosphorous loading by 104 lb/year.				
MS 5b-1. Plant 25 ac of deep-rooted riparian vegetation, preferably native vegetation, reducing loading of phosphorous by 35 lb/yr.				
	Actions: See MS 3b-1			
MS 5b-2 Restore 10 ac of wetland, reducing loading of phosphorous by 62 lb/year.				
	Actions: See MS 3b-2			
MS 5b-3 Restore 8 acre-feet of floodplain access, storing 7 lb/yr phosphorous. E.g., Kelsey Cr., other incised/channelized streams				
	Actions: See MS 3b-3			
Goal MS 5c Reduce NPS pollution from urban runoff to reduce annual loading of phosphorous by 11.9 lb/yr.				
MS 5c-1 Retrofit stormwater volume devices treating 100 acres to improve water quality, reducing loading of nitrogen by 10 lb/yr.				
	Actions: See MS 3c-1			
MS 5c-2 Retrofit 1,000 lf of drainage with no-mow grass, vegetated swale, or daylighting to reduce phosphorous load by 0.4 lb/yr				
	Actions: See MS 3c-2.			
MS 5c-3 Retrofit 20,000 sq ft of developed sites with bioinfiltration/permeable pavement to reduce phosphorous by 0.9 lb/yr				
	Actions: See MS 3d-2.			

Table MS 4.5 - Main Stem Phosphorous
041100020305, -20203 (part)

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
MS 5c-4 Install 20,000 square feet of rain gardens to reduce phosphorous by 0.6 lb/yr				
	Actions: See MS 3d-5.			
MS 5c-5 Facilitate review and update of local codes to include measures for green infrastructure				
	Actions: See MS 3c-3.			
MS 5c-6 Conduct workshops on use BMPs at urban sites				
	Actions: See MS 3c-4.			
MS 5c-7 Update, increase, and disseminate available information concerning pollutants from urban runoff				
	Actions: See MS 3c-5.			
MS 5c-8 Increase/sponsor 25 stewardship activities related to non-point source pollution and watershed issues.				
	Actions: See MS 3c-6.			
MCR-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of phosphorous by 25 lb/yr.				
Goal MS 5d Reduce causes of streambank erosion by reducing channel loading by 360,980 cu ft in a 3/4 inch storm.				
MS 5d-1 Increase coordination between communities to reduce stormwater effects				
	Actions: See MS 3d-1			
MS 5d-2 Install biofiltration at developed sites totaling 20,000 square feet and reducing runoff by 3,750 cubic feet in a 3/4-inch storm. Target gorge area, other urban				
	Actions: See MS 3d-2			
MS 5d-3 Restore 10 ac of wetland, reducing channel loading by 6,600 cu ft in a 3/4 in event.				
	Actions: See MS 3b-2			
MS 5d-4 Restore 8 acre-feet of floodplain access, increasing storage volume by 348,480 cu ft.				
	Actions: See MS 3b-3			
MS 5d-5 Install 20,000 square feet of rain gardens, to reducing channel loading by 3750 cu ft in a 3/4 in storm				
	Actions: See MS 3d-5.			
MS 5d-6 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch storm.				
	Actions: See MS 3d-6			
MS 5d-7 Increase stewardship and understanding of watershed protection				
	Actions: See MS 3c-5, 3c-6			
Goal MS 5-e Protect wetlands and beneficial watershed features to reduce future loading of phosphorous by 172 lb/yr				
MS 5e-1 Protect 8,000 linear feet of riparian buffer by increasing the use and effectiveness of riparian setbacks, reducing loading of phosphorous by 14 lb/yr				
	Actions: See MS 3e-1.			
MS 5e-2 Protect/enhance 25 acres of wetlands, preventing additional phosphorous loading of 158 lb/yr. ***Target areas: remaining wetlands in NE Tallmadge, upstream end of Kelsey Creek, other remaining wetlands***				
	Actions: See MS 3e-2			

Table MS 4.4 Main Stem Nitrogen
041100020305, -20203 (part)

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	Actions: See MS 3d-5.			
MS 4c-5 Facilitate review and update of local codes to include measures for green infrastructure				
	Actions: See MS 3c-3.			
MS 4c-6 Conduct workshops on use BMPs at urban sites				
	Actions: See MS 3c-4.			
MS 4c-7 Update, increase, and disseminate available information concerning sediment from urban runoff				
	Actions: See MS 3c-5.			
MS 4c-8 Increase/sponsor 25 stewardship activities related to non-point source pollution and watershed issues.				
	Actions: See MS 3c-6.			
MCR-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year, phosphorous by 25 lb/yr, and nitrogen by 5 lb/yr				
	Actions: See MS 3a-1			
Goal MS 4d Reduce causes of streambank erosion by reducing channel loading by 360,980 cu ft in a 3/4 inch storm.				
MS 4d-1 Increase coordination between communities to reduce stormwater effects				
	Actions: See MS 3d-1			
MS 4d-2 Install biofiltration at developed sites totaling 20,000 square feet and reducing runoff by 3,750 cubic feet in a 3/4-inch storm. Target gorge area, other urban				
	Actions: See MS 3d-2			
MS 4d-3 Restore 10 ac of wetland, reducing channel loading by 6,600 cu ft in a 3/4 in event.				
	Actions: See MS 3b-2			
MS 4d-4 Restore 8 acre-feet of floodplain access, increasing storage volume by 348,480 cu ft.				
	Actions: See MS 3b-3			
MS 4d-5 Install 20,000 square feet of rain gardens, to reducing channel loading by 3750 cu ft in a 3/4 in storm				
	Actions: See MS 3d-5.			
MS 4d-6 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch storm.				
	Actions: See MS 3d-6			
MS 4d-7 Increase stewardship and understanding of watershed protection				
	Actions: See MS 3c-5, 3c-6			
Goal MS 4-e Protect wetlands and beneficial watershed features to reduce future loading of nitrogen by 1,480 lb/yr				
MS 4e-1 Protect 8,000 linear feet of riparian buffer by increasing the use and effectiveness of riparian setbacks, reducing loading of nitrogen by 80 lb /yr				
	Actions: See MS 3e-1.			
MS 4e-2 Protect 25 acres of wetlands through acquisition of land/easements, preventing increased loading of nitrogen by 1400 lb /yr ***Target areas: remaining wetlands in NE Tallmadge, upstream end of Kelsey Creek, other remaining wetlands***				
	Actions: See MS 3e-2.			

Table MS 4.6 Main Stem Groundwater/Contamination
041100020305, -20203

Problem Statement MS-6: Groundwater, Public Water Supplies

The subwatershed contains the Cuyahoga Falls public water supply, a groundwater supply recharged by surface water and susceptible to contamination from surface spills and leaks to groundwater. The City of Cuyahoga Falls has developed a source water protection plan and owns approximately one-third of the five-year zone of contribution. However, the 5-year zone of influence is partially privately owned and controlled, and the wellfield is recharged by the Cuyahoga River, susceptible to spills.

Goals ***Objectives*** Actions	**Lead/ cooperating Organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal MS 6a Reduce risks of groundwater contamination from fracking or other releases from existing sites.			
MS 6a-1 Determine status of 9 DERR listed sites			
Coordinate with Ohio EPA to determine status of nearby DERR site.			
MS 6a-2 Increase awareness of potential hazards and protective measures associated with fracking			
1 Coordinate with state agencies and communities concerning fracking and controls			
2 Coordinate with state agencies to receive notification of drilling permit requests			
2 Outreach to communities and property owners - website, brochures, etc.			
Goal MS 6b Reduce risks of groundwater contamination from land use or spills.			
MS 6b-1 Provide public and agency outreach efforts to assist with implementation of 2 source water protection plans			
1 Coordinate with water suppliers concerning outreach/education needs			
2 Apply for funding as needed for printing/outreach			
3 Develop and disseminate outreach materials - written, website			
MS 6b-2 Update, increase, and disseminate available information concerning watershed protection			
Actions: See MS 3c-9			
MS 6b-3 Increase/sponsor 25 stewardship activities related to non-point source pollution and watershed issues.			
Actions: See MS 3c-10			

Table MS 4.7 Main Stem Flooding Problems
041100020305, 20203 (part)

Problem Statement MS 7: Flooding/overloaded channels

While flooding is not an extensive problem in this subwatershed, excess water volume and alteration of floodplains and wetlands is causing problems locally and downstream in the Cuyahoga River. Local flooding has been noted at the headwaters, where wetlands and floodplains have been altered by residential development, as shown on Figure MS-2. Downstream in the lower Cuyahoga watershed, neighborhoods are experiencing repeated flooding, roads are threatened or washed out during extreme events, and steep banks of the Cuyahoga River in the National Park are eroding, threatening the historic/recreational towpath trail and scenic railroad. The local bank erosion has been noted under Problem Statement MS-3. The subwatershed is nearly 26% impervious, generating an additional 1 million cubic feet in a 3/4-inch storm compared to an undeveloped watershed. Mapping indicates alteration of at least 451 acres of wetland (after soils mapping), loss of riparian features (floodplain access, riparian zone) along nearly 15.5 miles of streams, and alteration of 60-96% of riparian corridor within 75 feet. These figures do not reflect altered pre-existing wetlands or culverted streams in the older urban areas. The loss of beneficial watershed features reduces the flood-storage capacity and vertical stability of watershed tributaries. Loss of riparian vegetation with further development could result in increased loading and reduced storage in the future.

Goal *Objective*	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal MS 7a Address flooding problems in one area by restoring altered watershed hydrology/watershed characteristics				
MS 7a-1 Conduct 1 stormwater management study focusing on flooding problem area to identify potential landscape restoration opportunities that will reduce problem flooding.				
	1 Develop detailed maps for areas of interest identifying topography, existing and altered wetlands, drainage, and imperviousness.			
	2 Conduct engineering study	partner community	Outside funding for consultant	
	3 Outreach with neighborhoods to discuss feasible approaches			
	4 Submit grant proposal	wc/city or county staff		
	5 Construct improvements		outside consultant	
Goal MS 7b Reduce channel loading or increasing storage by 360,980 cu ft in a 3/4 in storm.				
MS 7b-1 Increase coordination between communities to reduce stormwater effects				
	Actions: See MS 3d-1			
MS 7b-2 Install biofiltration at developed sites totaling 20,000 square feet and reducing runoff by 3,750 cubic feet in a 3/4-inch storm. Target gorge area, other urban				
	Actions: See MS 3d-2			
MS 7b-3 Restore 10 ac of wetland, reducing channel loading by 6,600 cu ft in a 3/4 in event.				
	Actions: See MS 3b-2			
MS 7b-4 Restore 8 acre-feet of floodplain access, increasing storage volume by 348,480 cu ft.				
	Actions: See MS 3b-3			
MS 7b-5 Install 20,000 square feet of rain gardens, to reducing channel loading by 3750 cu ft in a 3/4 in storm				
	Actions: See MS 3d-5.			
MS 7b-6 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch storm.				
	Actions: See MS 3d-6			
MS 7b-7 Restore 4,000 lf of incised channel, improving vertical stability and reducing streambank erosion.				
MS 7b-8 Increase stewardship and understanding of watershed protection				

Table MS 4.7 Main Stem Flooding Problems

041100020305, 20203 (part)

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	Actions: See MS 3c-5, 3c-6			
MCR-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of phosphorous by 25 lb/yr.				
Goal MS-7c Protect wetlands and beneficial watershed features to reduce future channel loading by 26,400 cu ft in a 3/4 in storm				
MS 7e-1 Protect 8,000 linear feet of riparian buffer by increasing the use and effectiveness of riparian setbacks, reducing channel loading by 9,900 cu ft in a 3/4 in storm.				
	Actions: See MS 3e-1.			
MS 7e-2 Protect 25 acres of wetlands through acquisition of land/easements, preventing increased channel loading by 16,500 cu ft /yr ***Target areas: remaining wetlands in NE Tallmadge, upstream end of Kelsey Creek, other remaining wetlands***				
	Actions: See MS 3e-2			

Table MS-8 Main Stem Habitat - Incised
041100020305, 20203 (part)

Problem Statement MS 8: Habitat - Incised Channels

Approximately 4.9 miles of stream channel are incised due to excessive runoff, lack of riparian vegetation, and low-head dam removal. The QHEI analysis for 1800 lf of Kelsey Creek in Kennedy Park (Cuy. Falls) results in a score of 53.5 or "fair." The habitat is affected by unstable form and substrate, reduced pools, lack of riparian features. The QHEI analysis indicates the stream will continue to degrade without stabilization. The remaining incised streams (4.5 miles) present similar characteristics but with less severe downcutting.

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal MS 8a Restore stable form, floodplain access, and vegetated riparian corridor along 2,000 lf of Kelsey Creek, raising QHEI by 5 points to 58.5 in Kennedy Park.				
MS 8a-1 Re-establish floodplain access on 2 banks of Kelsey Creek along 1,000 lf of channel in Kennedy Park.				
	Actions: See MS 3a-1			
MS 8a-2 Replace 1.5 acres of riparian lawn with native shrubs, trees, and wet meadow along Kelsey Creek.				
MS 8-3 Re-establish floodplain access along 1,000 lf of channel in Brookledge Golf Course.				
Goal MS 8b Improve habitat along 2,000 lf of other eroding tributaries.				
MS 8b-1 Stabilize tributary banks along 1,000 lf of other eroding tributaries, improve morphology, and restore vertical stability Target areas: eroding streams MF, Stow, Silver Springs, Tallmadge, etc.				
	Actions: See MS 3a-2			
MS 8b-1 Plant deep-rooted riparian vegetation along 23.5 ac of other eroding tributaries and former dam pool sediment.				
Target areas: eroding streams MF, Stow, Silver Springs, Tallmadge, etc.	*Actions: See MS 3b-2*			
Goal MS 8c Reduce causes of streambank erosion by reducing channel loading by 360,980 cu ft in a 3/4 inch storm. ***MS 8c-1 Increase coordination between communities to reduce stormwater effects***				
	Actions: See MS 3d-1			
MS 8c-2 Install biofiltration at developed sites totaling 20,000 square feet and reducing runoff by 3,750 cubic feet in a 3/4-inch storm. Target gorge area, other urban				
	Actions: See MS 3d-2			
MS 8c-3 Restore 10 ac of wetland, reducing channel loading by 6,600 cu ft in a 3/4 in event.				
	Actions: See MS 3b-2			
MS 8c-4 Restore 8 acre-feet of floodplain access, increasing storage volume by 348,480 cu ft.				
	Actions: See MS 3b-3			
MS 8c-5 Install 20,000 square feet of rain gardens, to reducing channel loading by 3750 cu ft in a 3/4 in storm				
	Actions: See MS 3d-5.			
MS 8c-6 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch storm.				
	Actions: See MS 3d-6			
MS 8c-7 Increase stewardship and understanding of watershed protection				
	Actions: See MS 3c-5, 3c-6			
MCR-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year, phosphorous by 25 lb/yr, and sediment by 5 tons/yr				

Table MS-9 Main Stem Habitat Alterations
041100020305, 20203 (part)

Problem Statement MS 9: Habitat Impacts due to Altered Riparian Characteristics

Riparian habitat has been degraded throughout the subwatershed by development, bank erosion/siltation due to overloaded channels, and alteration of watershed features such as riparian zones, floodplains, and wetlands. Mapping indicates alteration of at least 451 acres of wetland (after soils mapping), loss of riparian features (floodplain access, riparian zone) along nearly 11 miles of streams, and alteration of 60-96% of riparian corridor within 75 feet. These figures do not reflect altered pre-existing wetlands or culverted streams in the older urban areas. Further development could encroach on/fragment remaining riparian vegetation, wetlands, or connected habitat complexes, especially where riparian setbacks are lacking. Removal of three dams will restore river habitat, but the newly exposed dam pool sediments will lack forest cover. Removal of the Kelsey Creek dam left 1 acre of sparsely vegetated dam pool sediment. Former dam pool sediments along the river are growing in slowly with woody vegetation.

Goal / *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal MS 9a Restore 3 miles of riverine habitat and associated riparian vegetation				
MS 9a-1 Remove two low-head dams in Cuyahoga Falls		City of Cuyahoga Falls		
	Actions: See MS 1a-1			
MS 9a-2 Coordinate with partners and community to assist as appropriate with removal of Ohio Edison Dam				
	Actions: See MS 1a-2			
Goal MS 9b Improve habitat by restoring 53 acres of altered watershed hydrology/watershed characteristics				
MS 9b-1 Plant 25 ac of deep-rooted native riparian vegetation along former dam pool margins/sediments and unvegetated tributary banks.				
	Actions: See MS 3b-1			
MS 9b-2 Restore/enhance 10 ac of wetland.				
	Actions: See MS 3b-2			
MS 9b-3 Restore 8 acre-feet of floodplain access.				
	Actions: See MS 3b-3			
MS 9b-4 Treat/remove 10 acres of invasive species				
MS 9b-5 Conduct dam removal feasibility for small low-head dams				
Goal MS 9c Protect 40 ac wetlands and beneficial watershed features *target - remaining intact systems, areas providing multiple ecological benefit, habitat connectivity*				
MS 9c-1 Protect 8,000 linear feet of riparian buffer by increasing the use and effectiveness of riparian setbacks.				
	Actions: See MS 3e-1.			
MS 9c-2 Protect/enhance 25 acres of intact wetlands. Target areas: remaining wetlands in NE Tallmadge, upstream end of Kelsey Creek, other remaining wetlands				
	Actions: See MS 3e-2			

Table MS 4.10 Main Stem Recreational Opportunities
041100020305, 20203

<u>Problem Statement MS-10: Recreational Opportunities</u>

The Cuyahoga River is designated a category A recreational water. Recreational opportunities and use are increasing along the river, with the addition of the new canoe livery in Kent. Local communities and MetroParks offer several parks along the river and tributaries, providing an opportunity for stewardship, linked parks, and additional conservation. Cuyahoga River partners are working toward designating the Cuyahoga River a water trail, with maintained access points. The Gorge offers extreme rapids for kayakers, and could grow as a destination with the removal of the two low-head dams and the Ohio Edison dam. Several detriments to recreational use still remain. CSOs in the Gorge present health risks. Debris remains in the river, posing hazards for boating or wading. After heavy rains, high levels of bacteria have been found upstream of the CSO discharge area from an undetermined source. Access for pullouts is limited in the Gorge, and there is limited direct access to the river along much of its length. There is no centralized source of information concerning recreational opportunities along the river and tributaries.

Goal *Objective*		Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal MS 10a Increase safety for recreational users					
MS 10a-1 Conduct 15 river/riverbank clean-ups to remove debris fro			partners (KSU, Kent, Cuy. Falls, WC, Summit Co. etc.)		
	1	Continue coordination with river community partners			
	2	Seek funds (grants, donations, budgets) for refreshments, materials, waste disposal			
	3	Conduct spring (River Day) and fall cleanups on approximately annual basis			
MS 10a-2 Conduct 3 clean-ups at additional tributaries or lakes.					
	1	Outreach with neighborhoods, lake associations			
	2	Seek funds (grants, donations, budgets) for refreshments, materials, waste disposal			
	3	Clean-up events			
MS 10a-3 Monitor the river for e. coli following six rain storms at canoe launch/pull-out areas..					
	1	Coordinate sampling/assessment with local WWTPs			
	2	Monitor following six rain events			
	3	Coordinate results with communities/Ohio EPA.			
	4	Identify likely hot spots or sources			
	4	Develop outreach for website			
Goal MS 10b Increase/improve recreational opportunities related to the Cuyahoga River and Main Stem tributaries.					
MS 10b-1 Construct 3 miles of boardwalk/trail to/along the Cuyahoga River or its tributaries					
MS 10b-3 Plan additional bike-hike/greenway link					
	1	Identify potential locations to connect parks/tributaries			

Table MS 4.10 Main Stem Recreational Opportunities
041100020305, 20203

Goal / *Objective*		Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	2	Hold meetings to determine feasibility			
	3	Submit grant proposal			
	4	Develop conceptual design for links			
MS 10b-3 Increase/improve access points along Cuyahoga River or tributary by 3 publicly accessible location					
	1	Submit grant proposal			
	2	Work with communities and water trail partners to design appropriate access			
	3	Construct access points and related facilities (e.g., parking, signs, etc.) as appropriate			
MS 10b-4 Develop 2 quests or 1 virtual watershed tour					
	1	Determine appropriate River Quest structure (cuyahoga canalway or new one)	WC, partners, volunteers, parks	Permission to develop quests, printing costs	2 quests by 2017 or 1 watershed tour by 2017
	2	Public workshop concerning River quests			1 workshop by 2014
	3	Seek quests from volunteer groups	WC, partners, volunteers, parks	reviewers, outreach	
	4	Review, print, distribute		funding for printing, place on website	
Goal MS 10c: Increase awareness of recreational opportunities, stewardship, and watershed issues.					
MS 10c-1. Economic impact study recreational uses			WC with KSU	outside funding	1 study by 2018
	1	Coordinate with KSU and others on study			
	2	Submit grant proposal			
	3	Conduct study			
	4	Publicize			
MS 10c-2. Increase signage related to watershed at local parks.					
	1	apply for funding			
	2	Design, install signs			
	3	Continued outreach with local communities			
MS 10c-3 Update, increase, and disseminate available information concerning recreational opportunities and care of Cuyahoga River, its tributaries, and watershed.					
	1	Web page of recreational opportunities/access	wc		
	2	Monitor 8 wet-weather events for coliform in river	wc, partner with WWTP		
	3	Other Actions - see MS 3c-9			
MS 10c-4. Increase stewardship activities related to watershed issues					
	1	Annual river/tributary/lake clean-ups			
		Actions - See MS 10a-1, 9a-2			
	2	Additional stewardship activities - see MS 3c-10			

7-Fi Fish Creek
HUC 041100020305 (part)

1 Summary of Conditions
Table Fi 1 summarizes some of the key characteristics of this subwatershed. Table Fi 2 presents a summary of identified impairments, causes, and sources. Figure Fi 1 presents an index map showing the subwatershed and jurisdictions. Figures Fi 2 and 3 have been compiled from mapping in Volume I and show potential areas of concern and resource areas for protection. (Greater detail is shown in the various maps in Vol. I.) Also see photos in Section 4P, Fish Creek.

The primary concerns focus on addressing the effects on water quality and flooding from non-point source pollution and the altered, urbanized landscape – impervious surfaces and altered riparian corridors, channels, floodplains, and wetlands. The problem statements in Tables Fi-4.1 through Fi-4.6) address individual problems related to these broader concerns and may overlap. For instance, urban runoff, septic system failure, and agricultural runoff all contribute to the problems of nitrogen and phosphorous enrichment in Fish Creek and the Cuyahoga River.

Water Quality Assessment and Attainment *(Refer to Problem Statements Fi 1, 2, and 3, Tables Fi 4.1 through 4.3)*

Fish Creek was briefly described in the 2000 TMDL, using data from 1997 and 2000. Fish Creek chemistry was monitored during the 2007 re-assessment of the Middle Cuyahoga River. Upstream of RM 1.3, Fish Creek has been re-designated MWH-C to reflect the channelized nature of the creek and was in attainment of MWH-C standards when assessed. The lower portion of Fish Creek was in non-attainment of WWH standards due to degraded fish populations rather than habitat limitations. Fish Creek has shown slightly elevated levels of phosphorous relative to EOLP targets. Causes and sources contributing to non-attainment in the lower portion of Fish Creek include non-point source pollution from urban and agricultural sources.

With the removal of the Munroe Falls dam, the base level of Fish Creek has dropped; and it remains to be seen if the steeper slope and more rapid flow in the lower portion of the creek will result in improvements to bioassessment scores. However, the highly altered channel, riparian, and watershed conditions in the upper watershed do little to reduce the large loads of incoming pollutants, and may have adverse effects downstream.

Nonpoint source pollution – Nutrients (nitrogen, phosphorous) *(Refer to Problem Statements Fi-1, 2, and 3, Tables Fi 4.1 through 3)*

Fish Creek and the Cuyahoga River are somewhat enriched in nutrients. Limited water chemistry data indicate several instances when state median or criteria values were exceeded for phosphorous or nitrogen. Because higher values often coincide with increased flows (apparently post-storm), runoff is likely a contributing factor.

The STEPL model indicates that the Fish Creek watershed contributes 30,766 pounds per year of nitrogen, 5,810 lb per year of phosphorous, and 895 tons per year of sediment from a combination of urban, rural residential, and agricultural sources, eroding stream banks, and septic systems.

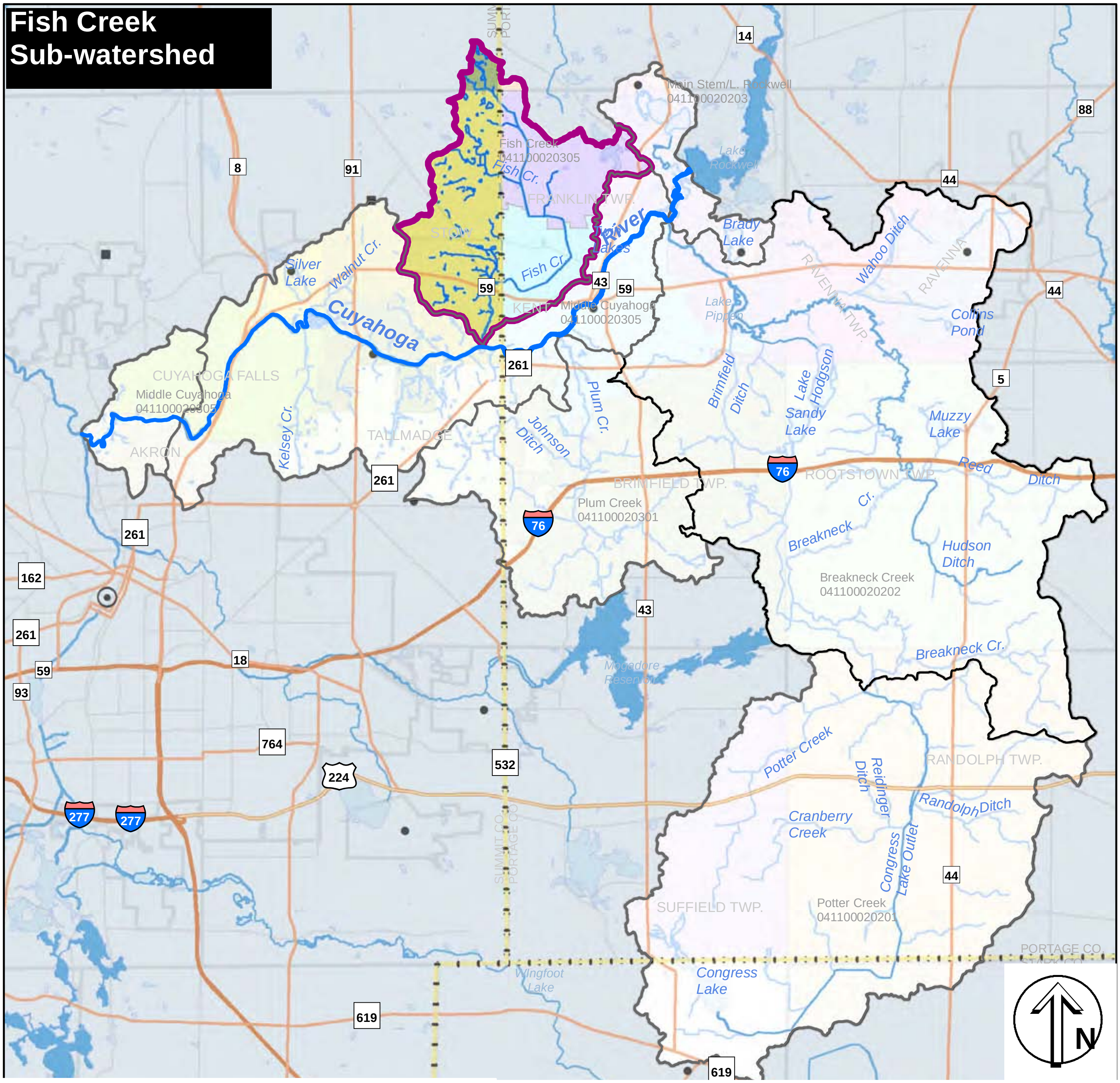


Figure Fi-1
Subwatershed Jurisdictions

0 0.5 1 2 3 4 Miles

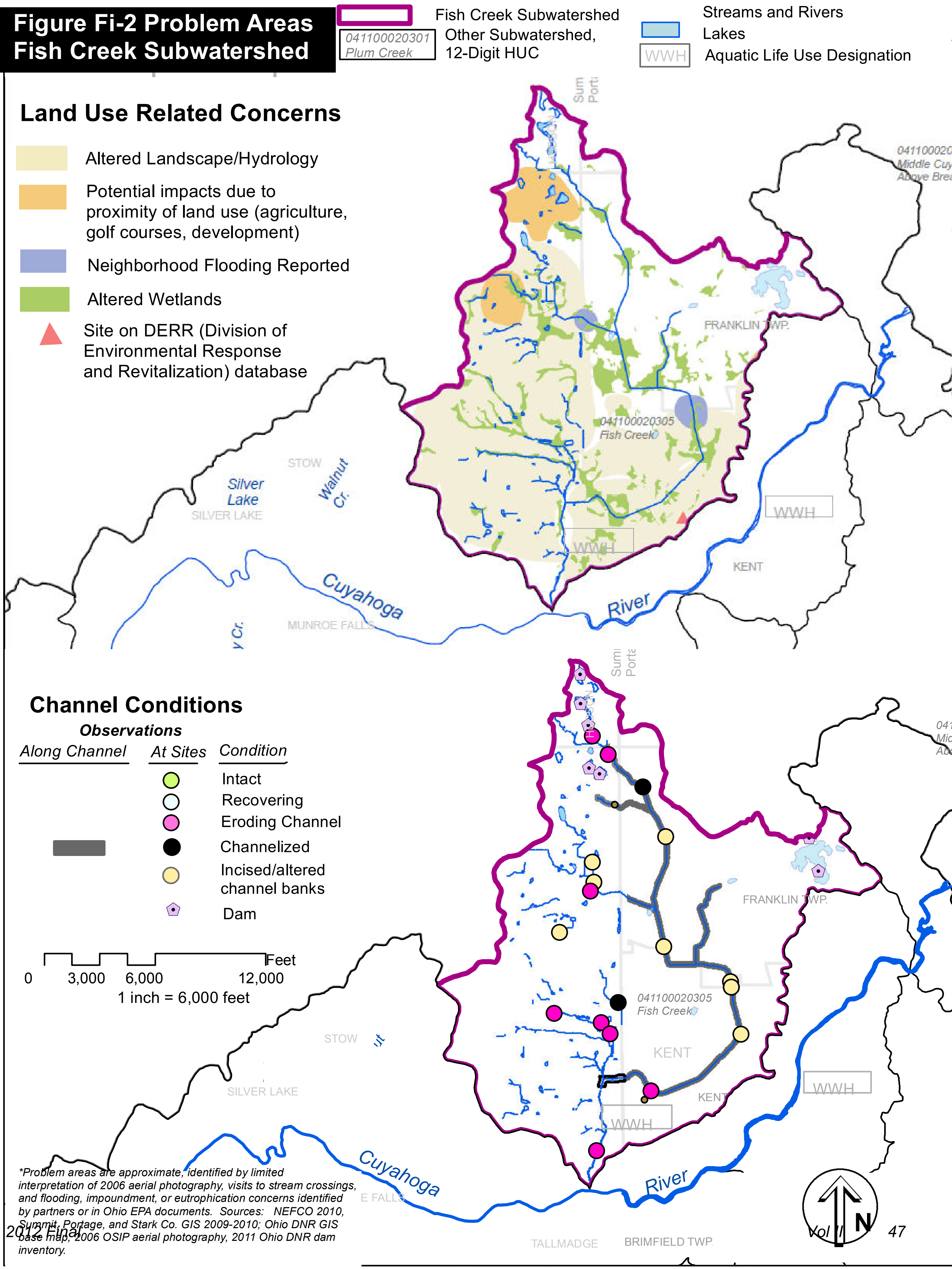
- Streams and Rivers
- Lakes
- Fish Creek Subwatershed *12-Digit Huc: 041100020305 (part)*
- *Fish Creek 041100020305* Other Sub-watersheds
- Counties
- Jurisdictions outside watershed
- Interstate Highways
- State Divided Highways
- State Numbered Rtes
- Local Roads

Subwatershed Local Jurisdictions

- HUDSON
- STOW
- KENT
- FRANKLIN TWP.
- STREETSBORO

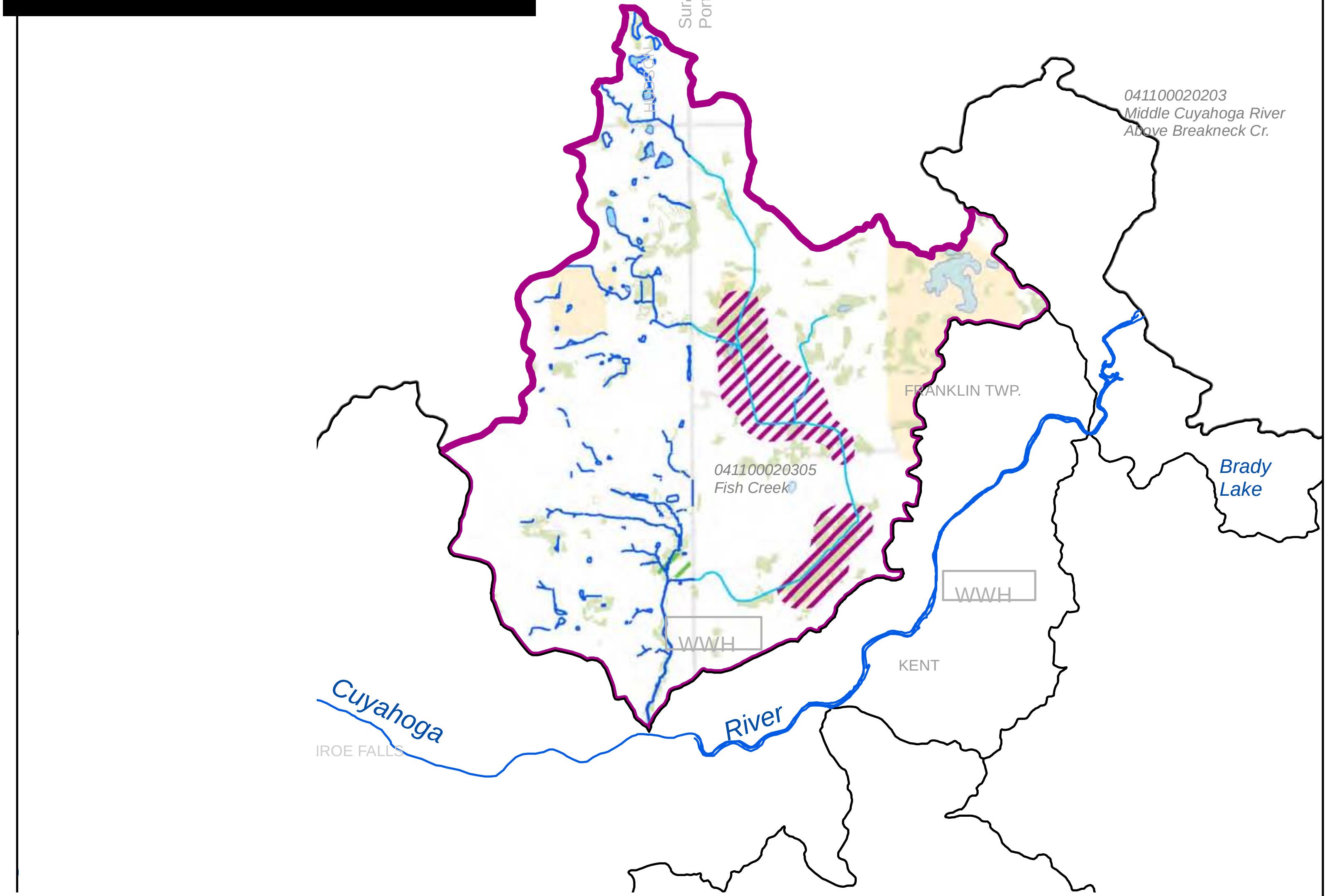
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010

Figure Fi-2 Problem Areas Fish Creek Subwatershed



**Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map; 2006 OSIP aerial photography, 2011 Ohio DNR dam inventory.*

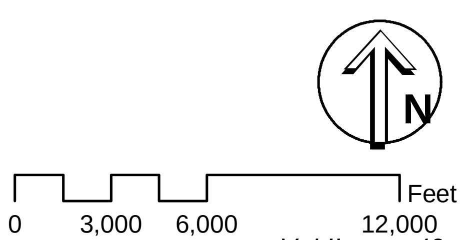
Fi-3 Conservation/Protection Priority Areas Fish Creek Subwatershed



Conservation/Protection Priority Areas

- Riparian Corridor/Wetland
- Wetlands of Additional Importance (e.g., buffering) - enhance/protect
- Restoration/Conservation of Riparian Area/Wetlands
- Mapped Wetlands
- Habitats or Species of Concern - Identified on DNR biodiversity database spanning 30 years; Western Reserve Land Conservancy workshop, 2010.)

- Streams and Rivers
- Lakes
- WWH Aquatic Life Use Designation
- 041100020305 Fish Creek — Subwatershed, 12-Digit HUC
- Local Jurisdictions



Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

Table Fi-1
Summary of Fish Creek Subwatershed Characterisitcs

Concern	Amount/Item	Comments
Water Quality Attainment, latest assessed	Assessed 1997, 2000, 2007. Upstream of RM 1.4, Fish Creek is MWH-C and is in attainment of water quality standards. Downstream of RM 1.3, Fish Creek is WWH, is in non-attainment.	Latest assessment prior to dam removal at Munroe Falls. Change in slope may improve flow in Fish Creek.
Public water supplies	No major public water supplies	
Land Cover acres, %	Developed 4,095 50.2% • *High Density 113 1.2%* • *Moderate Density 366 4.0%* • *Low Density 1,987 42.1%* • *Dev. Open Space 1,629 22.9%* Agricultural 724 7.5% Grassland/scrub-shrub 72 0.8% Woods/wetlands 1,641 19.6%	
Impervious % runoff	20.7% **Excess runoff from 3/4" storm**: 5.5 million gal.	
75 foot buffer	Developed 7,038 ac. 67% *Dev. Open Space 1,802 17%* Agricultural 960 ac. 9% Woods/wetlands 2,077 21%	
Wetlands (ac.)	**Mapped** 745 **Altered:** 737 hydric (hydric inclusions 1,461)	
Likelihood of future development	Within Stow and Kent – limited development on remaining few large parcels. Beyond Kent – potential if annexed	
Channel quality (miles of observed conditions)	**Intact** 1.4 **Altered/channelized** 15.5 **Eroding** 0.1 **Recovering**	
Non-point source load/yr:	**Total N (lb)** 30,766 **Tot. P (lb)** 5,810 **Sediment (tons)** 895	
Septic systems	¼ or more of watershed soils have 2 or more severe limitations for septic systems, indicating high potential for older septic system failure, with > 100 suspected illicit discharging systems in 2011.	
Problem areas	Flooding on Newcomer Rd.., McKinney Ave., excess volume, bank erosion Spaulding. Channelized section embedded.	
Resource areas	Remaining wetlands, woods	
Park/ conserv./inst.	Kent is assembling parcels along Fish Creek. Kent, Portage Co. and Stow have parks. There are numerous open space parcels in subdivisions, and the Stow-MF High School is on a large parcel.	
Riparian setback	Kent	
Recreational opportunities	City of Kent parks and conservation land; Small conservation lands along the tributaries	

Table Fi 2 - Impairments
Fish Creek
Part of HUC 041100020305

Attainment issue/other concern	**Cause**	**Source**	**Other likely sources**
HUC: 041100020305 Cuyahoga River below Breakneck Creek	Habitat alteration Flow alteration Nutrients Organic enrichment Siltation Total Toxics, unknown toxics	Channelization CSO Dam Major municipal point source Natural Septic tanks Sewer line construction Urban runoff/nps	
RM 1.3 to River Non-attainment Fair ranking for fish, macroinvertebrates, habitat not limiting		Unknown (high) Urban runoff (high) NPS from construction, ag Highway maintenance Spills Natural (slight)	Imperviousness: 21% Channelization
UST RM 1.3 MWH-C			
LOCALLY IDENTIFIED CONCERNS			
Flooding along Fish Creek from Johnson Rd. downstream			Urban runoff, loss of flood storage and wetlands, channelization
Bank erosion along Fish Creek in modified section and at river			Urban runoff, loss of flood storage, vertically unstable
Wetland alteration/loss of habitat			Channelization, wetland fill Invasives Urban encroachment

Factors contributing to non-point source pollution include

- *High percent of imperviousness* - 21% in this subwatershed
- *Runoff from development* in Stow and Kent
- *Septic systems* - Approximately one-quarter of the subwatershed presents two or more severe limitations for septic systems and is not served by sewers, indicating the potential for failure of older systems. Of the 232 potential illicit discharges identified in Franklin Township in 2010, it is likely that approximately 100 are in the subwatershed..
- *Channelization and alteration of channels, floodplain access, and wetlands*. Approximately 15.5 miles of remaining stream corridor, 8,000 acres of riparian corridors within 75 feet, and 737 acres of wetland on hydric soils have been channelized or altered in the agricultural and urbanized areas, reducing their ability to absorb, filter, and store storm water, sediment, and the non-point source pollutants entering the streams from the landscape. Observations indicate that much of the riparian area now consists of mown sod. Without stabilizing vegetation, the channels are likely to begin incising, degrading habitat and increasing local and downstream flooding, erosion, and sedimentation. The altered riparian corridor reduces the ability of the landscape to treat and store contaminants and excess water. Fish Creek and its headwaters are largely channelized or altered. The stream network itself has been fragmented through extensive use of culverts.
- *Eroding streambank.* These contribute nitrogen, phosphorous, and sediment, and are often associated with high volumes, lack of floodplain access, and unstable banks. Eroding streambanks have been observed along the lower portion of Fish Creek, especially at Spaulding, and near the confluence with the Cuyahoga River. The channel erosion generally appears to be associated with stormwater volume and lack of floodplain access. Some of the erosion at the lower end of Fish Creek may be related to the lowering of the base level at the Cuyahoga River with the recent dam removal. There may be potential for improving flood storage by reconnecting the channel to portions of the extensive channelized wetlands.
- *Potential for degradation of riparian/wetland features* – Many of the existing wetlands and floodplains flanking Fish Creek have been altered but still provide some treatment and storage of nonpoint source pollution and floodwater. Certain areas appear less altered than others. It is important that the remaining wetlands not be further altered or filled in.

Flooding *(Refer to Problem Statement FI-4, Table Fi 4.4. Note, flooding also addressed under non-point source pollution, due to bank erosion from overloaded channels.*

Flooding problems (where floods interfere with use of structures or roads) have been observed at McKinney Rd. and at Johnson Rd. The heavily altered watershed contributes additional stormwater loading and reduces the ability of the landscape to store or absorb stormwater.

Habitat and Conservation Areas *(Refer to Problem Statement Fi-5 Table Fi 4.5, also problem statements related to non-point source pollution and flooding)*

Approximately 15.5 of Fish Creek and its tributaries has been channelized, including nearly the entire length of Fish Creek in Portage County, removing it from contact with adjacent wetlands and creating a ditch that provides little beneficial watershed functions. Approximately 4,235 acres riparian buffer and 734 acres of wetlands on hydric soils have been altered, degrading habitat and reducing water quality. Remaining intact wetlands and important habitats are at risk of encroachment, fragmentation, degradation, or conversion due to the high degree of development that has been occurring in Fish Creek. As with other subwatersheds, small low-head dams may degrade downstream habitat.

Several areas of important habitats have been identified in this subwatershed. Only a portion of these is held as conservation land, the rest is susceptible to development. The most significant habitat areas are the remaining woods and wetland areas, especially along streams and in larger, connected complexes and corridors. The lower portion of the creek remains a wooded valley. Remaining wetlands have become degraded but nevertheless still provide substantial ecological benefit, and they may represent a good an opportunity for enhancement. There are numerous parcels owned by public or institutional uses. The City of Kent has been acquiring parcels along Fish Creek and its floodplain. These may provide additional restoration opportunities.

This watershed does offer some opportunities for restoration. Substantial areas of altered wetlands in Portage County are no longer used for their original agricultural purpose (muck farming). The City of Kent is assembling open space parcels along Fish Creek that could be used for preservation or restoration. Even in the developed areas, there are small parcels of undeveloped open space along the streams. It may be possible to work with homeowners' associations to restore some of the riparian vegetation or other features in these areas.

Key areas to focus preservation efforts include:

- Remaining intact wetlands along Fish Creek
- Larger intact systems and corridors and habitat areas in close proximity
- Small pocket wetlands in the northeastern portion of the watershed – some of these are associated with species of concern.
- Degraded wetland systems should be targeted for enhancement or restoration, where feasible.
- Floodplain access should be restored along heavily altered (channelized) portions of the creek where feasible without threatening homes.
- The planned conservation/recreation loop centered along Fish Creek should be completed.
- Some stream corridor segments are relatively intact within steeply walled valleys.
- Homeowners Associations own a considerable amount of riparian land, much of which has been altered to sod. These potentially could be restored to native vegetation, enhancing the stream corridors.

Recreational Opportunities *(Refer to Problem Statement Fi-6 Table Fi 4.6)*

There are limited opportunities for access to and recreation along Fish Creek. The City of Kent has been acquiring and developing segments of a planned loop trail centered on Fish Creek and wishes to continue to do so. The Summit County MetroParks bike-hike trail crosses Fish Creek in its steep wooded lower reaches.

2 Problem Statements, Goals, Objectives, and Actions

Table Fi 4.3 summarizes the actions proposed in the subwatershed and their associated pollutant load reductions, listing which problem statements are addressed by these tools, and which tables they can be found in. Tables Fi 4.1 through 6 present the problem statements, goals, objectives, and actions for each problem area. The tables are numbered to reflect each problem statement number, e.g., Table Fi 4.1 corresponds to Problem Statement Fi-1. It should be noted that because many of the objectives address more than one goal, the actions associated with each objective are listed only once, in the first table in which they appear (most frequently, Table Fi 4.1). All other listings of the same objective refer back to the actions at their first occurrence.

Refer to Sections 6 and 7 introduction for a discussion of the format of the problem statements, goals, objectives, actions, and considerations for implementation.

Table Fi 3 Action Item Summary by Subwatershed: Fish Creek

12-digit HUC/ Water Body	Sed	Nutrients	Flooding	Habitat	Recreation	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020305 (part)												
						Riparian Restoration						
Fish Creek	√	√	√	√		Restore Streambank (Bio-Engineering/ re-contouring/ re-grading)*	**3,000**	Linear Feet	$25-200/lf	34	54	20
Fish Creek & tribs	√	√	√	√		Plant Native plants, trees, or shrubs in Riparian Areas	**25**	Acres		25	200	35
Fish Creek & tribs				√		Remove/treat Invasive Species	**40**	Acres				
						Stream Restoration						
Fish Creek	√	√	√	√		Restore Flood Plain	**50**	Acre-foot		22	300	41
Fish Creek & tribs			√			Hydrological study in flood-prone area	**1**	study				
tribs				√		Feasibility Study to remove small dams	**1**	study				
						Wetland Restoration						
Fish Creek	√	√	√	√	√	Reconstruct/reconnect/ restore Wetlands	**100**	Acres	$5k-100k/ac.	100	2800	632
						Home Sewage Treatment Systems						
Fish Creek watershed		√				Obtain correction of failing HSTS	**10**	HSTS			311	122
						Urban runoff and green infrastructure						
Fish Creek watershed	√	√	√			Rain gardens	**6,000**	sq feet	$150,000		0.5	0.1
Fish Creek watershed	√	√	√			Bioinfiltration/ permeable pavement - parking lot retrofit	**10,000**	square feet		0.04	2.2	0.2
Fish Creek watershed	√	√	√			Storm water inventory	**1**	inventory				
Fish Creek watershed	√	√				Stormwater water quality retrofits	**60**	acres treated (50% wq inlet+sand filter, 50% wetland)	$400-17k/ ac	4.5	70	10.2

Table Fi 3 Action Item Summary by Subwatershed: Fish Creek

12-digit HUC/ Water Body	Sed	Nutrients	Flooding	Habitat	Recreation	**Category/**Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Fish Creek watershed	√	√				Retrofit drainage - no-mow/ veg swale/ daylighting	1,000	linear feet		0.1	0.8	0.4
Middle Cuyahoga River	√	√	√			Neighborhood-scale green infrastructure	1		$25-50k design $20k bumpout	5	200	25
						Conservation Easements						
Fish Creek watershed	√	√	√	√	√	Acquire Wetlands/ easements	75	Acres	$5-25k/ac	prevent 75	prevent 2100	prevent 474
Fish Creek watershed	√	√	√	√	√	**Education and Outreach**						
						Develop Brochures/Fact Sheets	10	Brochures/Fact Sheets				
						Websites	1	Website				
						Install Signs	5	Signs	$200-500/ sign			
						Stream Clean-Ups	3	Clean-Ups				
						New lake/stream stewardship groups	1	new group active				
						Conduct Workshops/ training	5	Workshops				
						Develop Manual(s)	1	Manuals				
						Rain barrel workshops	50	rain barrels				
						Develop Newsletters	10	Newsletters				
						Local Policy						
Fish Creek watershed	√	√	√	√		Green code audit/update	2	audits/ updates				
Fish Creek watershed	√	√	√	√		Develop or Customize Adoption of Riparian setback**	1	Jurisdictions		*prevent 14*	*prevent 200*	*prevent 35*
Fish Creek watershed						**Monitoring**						
		√		√		Chemical Sampling	3	Sites				
	√			√		Habitat (QHEI/HHEI) Sampling	5	Sites				
	√	√	√	√	√	Maintain stream database	1	database				

Table Fi 3 Action Item Summary by Subwatershed: Fish Creek

12-digit HUC/ Water Body	*Sed*	*Nutrients*	*Flooding*	*Habitat*	*Recreation*	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
						Recreation						
Fish Creek	√	√	√	√	√	Acquire conservation land for trail loop	**20**	ac				
Fish Creek					√	Construct trail	**3**	mi				
Fish Creek					√	Construct access sites	**1**	site				
Fish Creek watershed					√	Economic benefit study	**1**	study				
Fish Creek watershed					√	Develop quest(s)/ virtual watershed tour	**2 quests/ 1 tour**					
									Total	341	4,049	892

* Streambank erosion is a minor consideration. The primary reasons for restoring streambank are flood management and habitat. Pollutant loading calculated for 200 lf of eroding bank.

**assume 36,000 lf x 30' = 25 ac., treats 7x area

Table Fi 4.1 Fish Creek - Sediment
HUC 041100020305 (part)

Problem Statement Fi-1: Sediment

Siltation has been identified as a cause of non-attainment in the Middle Cuyahoga River. Excess sediment is of concern downstream in the shipping channel and in Lake Erie, because of the nutrients that enter the water with the sediment. The STEP-L model indicates that the watershed contributes 895 tons of sediment per year from runoff and 34 tons per year from eroding banks due to overloaded channels. Alteration of at least 737 acres of wetland, 76% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 15.5 miles of watercourses has reduced the natural sediment storage of the system. Potential loss of riparian vegetation in the undeveloped 30% of the riparian corridor could result in increased loading in the future.

Goal *Objective*		**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Fi-1a Reduce non-point source pollution from runoff to reduce annual loading of sediment by 17.5 tons.					
Fi 1a-1. Plant 25 ac. of deep-rooted riparian vegetation, reducing loading of sediment by 13 tons/yr.					
	1	Submit grant applications e.g., OEEF	WC/SWCDs/partners		
	2	Targeted outreach to public, institutional, and other owners of large properties	WC**/SWCDs/ Communities	Lists of golf courses, lake associations, homeowners' associations; maps of large parcels; printed outreach materials.	Target 1 group every 3 years (3 by 2022); improvements to best management practices or riparian management at one site every 4 years(2 sites by 2020); 2 outreach contacts per year
	3	Outreach to golf course owners encouraging Audubon-certification		labor, printing	
	4	Assist with plantings	SWCDs, master gardeners	native plants/trees and shrubs $500-1,000/ac	25 ac
	5	Construct and install signage	communities, partners, volunteers (scouts?)	$300-500/sign	
	6	Follow-up outreach (individualized guide to riparian zone) and publicize		funding for handouts/brochures	
Fi 1a-2 Retrofit stormwater volume devices for water quality to treat 60 ac of residential use, reducing loading of sediment by 4.5 tons /year.					
	1	Stormwater retrofit inventory		WC/NEFCO with communities	
	2	Submit grant application.			
	3	Design/construct retrofit for existing stormwater (volume) infra-structure to improve water quality	Communities	Varies, depending on treatment provided (e.g., $400/acre treated to $17,000 per acre treated)	Retrofit 3 by 2023 to treat 60 ac res., 1 every 3 years afterward
Fi 1a-3 Retrofit 1,000 lf of drainage with no-mow grass/vegetated swale/daylighting to reduce sediment by 0.2 tons /yr					
	1	Workshop on maintaining ditches/improving drainage for water quality improvements	SWCD/pipe		
	2	Install retrofit/no-mow grass along 1,000 lf			
Fi 1a-4 Facilitate review and update of local codes to include measures for green infrastructure					
	1	Green code audit workshop			
	2	Review codes in two communities for green infrastructure language	partners	volunteers/consultant	
	3	update code language		possibly outside consultant/funding	1 community by 2022

Table Fi 4.1 Fish Creek - Sediment
HUC 041100020305 (part)

Goal Objective		Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Fi 1a-5 Update, increase, and disseminate available information concerning sediment from urban runoff					
	1	Continue to compile, centralize, and make available studies, data, information sources on the watershed, including recreational opportunities, volunteer needs, permitting or regulatory issues; green infrastructure information sources, etc.	WC	Website, technical information and outreach materials	Update and develop pages for website by Dec. 2013, then on-going
	2	Chemical or biological sampling/assessment along streams - volunteer, intern, or class	Community/partner sponsors, Ohio EPA, KSU interns/classes	possibly stipends, analysis, equipment	Sampling at 3 locations by 2022.
	3	Continue to develop stream database			
FI 1a-6 Increase stewardship activities related to non-point source pollution and watershed issues by 21 activities					
	1	Establish clean-up/monitoring efforts at additional tributaries	WC, communities, parks, residents, home-owners' assoc.		1 new tributary or lake monitoring, clean-up (3 cleanups), or other stewardship program by
	2	Distribute 50 rain barrels through workshops	SWCDs/ Communities	Space for workshop; rain barrel kits	2 workshops/50 rain barrels distributed
	3	Survey of yard management practices	WC/partners		
	4	Develop/reproduce informational brochure or website article concerning topics of interest, including reducing runoff, recreational opportunties, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	10 by 2022; 1 each year
	5	Educational outreach workshops on topics of importance, including LID/green infrastructure, restoration, field trips for examples	Partners, WC, communities	Location, speaker, supplies	5 workshops by 2022; 1 every 2 years
	6	Work with schools or city day camps to develop/encourage use of watershed care activities/curricular items	WC, SWCDs, partners, schools		1 educational outreach program/curriculum item by 2018
	7	Watershed "brand," logo, art project	WC, Kent State/ Standing Rock Gallery/River Day communities	Host for project, graphic design capabilities	1 logo or art project by 2015, then 1 every 3 years;
	8	Create social network or google presence	WC		1 by 2014
FI 1a-7 Develop stormwater management design manual for Portage County					
	1	Stormwater management design manual for Portage County	Portage SWCD	In-house task	1 manual by 2014
Fi 1a-8 Facilitate review and update of local codes to include measures for green infrastructure					
	1	Green code audit workshop			
	2	Review codes in two communities for green infrastructure language	partners	volunteers/consultant	
	3	update code language		possibly outside consultant/funding	1 community by 2022
MC-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year, phosphorous by 25 lb/yr, and sediment by 5 tons /yr					
	1	Work with communities to identify suitable target neighborhoods	WC, partners		
	2	Meetings to gauge neighborhood support			2 meetings

Table Fi 4.1 Fish Creek - Sediment
HUC 041100020305 (part)

Goal				
Objective	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
	3 Determine/establish maintenance framework (e.g., easements, homeowner participation)	partner community		
	4 Get grant(s)			
	5 Design/build	outside consultant	Site, outside funding. Design ~$25-50,000; Rain gardens $15-20/sq. foot; Green street bump-outs $20,000 each; per-meable concrete $12-15/ sq. ft	1 project by 2022
	6 Outreach, neighborhood participation			
Goal Fi 1b Restore altered riparian/watershed landscape to reduce sediment in the stream by 122 tons/yr.				
Fi 1b-1. Restore 100 ac of wetland, reducing loading of sediment by 100 tons/year.				
	1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2013, revisit and update if necessary every 3 years
	2 Meetings with landowners to determine interest	WC, partners		2 meetings
	3 Identify wetland restoration site for clearinghouse	WC, Communities, other partners	meetings with landowners; readily available mapping, outside assistance from consultant, possible assistance from Kent State University wetland ecology class	5 concept plans by 2020; 1 every 2 years afterward.
	4 Submit grant application			
	5 Restore/protect/enhance wetlands	Partners	$5,000-$100,000 per acre, design/build consultant, sites -protection by ease- ments would be at the low end of the range	20 ac by 2022; 10 ac every 5 years afterward
Fi 1b-2 Restore 50 acre-ft of floodplain access, to reduce annual sediment loading by 22 tons				
	1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2013, revisit and update if necessary every 3 years
	2 Meet with landowners to determine interest	WC, partners		
	4 Submit grant application			
	5 Restore floodplain access/flood storage			
	6 Public outreach			
Fi 1b-3. Plant 25 ac. of deep-rooted riparian vegetation, reducing loading of sediment by 13 tons/yr.				
Actions: See Fi 1a-1.				
Goal Fi 1c Reduce bank erosion from overloaded channels to reduce sediment loading by 34 tons/yr.				
Fi 1c-1 Stabilize 200 l.f. of 5-foot tall stream bank, reducing sediment loading by 34 tons/yr. *Focus areas, e.g., Spaulding Ave. area*				
	1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement			1 map by 2013, revisit and update if necessary every 3 years
	2 Meet with landowners to determine interest			
	4 Submit grant applications			
	5 Stabillize banks/restore floodplain access			200 lf bank
	6 Public outreach			

Table Fi 4.1 Fish Creek - Sediment
HUC 041100020305 (part)

Goal Objective		Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
FI 1c-2 Install 6,000 square feet of rain gardens, to reducing channel loading by 262 cu ft in a 3/4 in storm					
	1	Identify partners	WC, partners		
	2	Submit grant application	WC/partners		
	3	Workshop/installation	WC/partners		
Fi 1c-3 Install biofiltration in a commercial/institutional site totaling 10,000 square feet and reducing runoff by 1,600 cubic feet in a 3/4-inch storm.					
	1	Identify parcel(s) and landowner(s) for project	partners, WC		
	2	Grants	WC/partners		
	3	Design/construct BMPs	outside consultant		
	4, 5, 6	Green infrastructure workshops, code revision	(see FI 1a-4)		
Fi 1c-4 Restore 50 acres of floodplain access, reducing volume by 2,178,000 cubic feet in a 3/4-inch storm.					
		Actions: See Fi 1a-3			
Fi 1c-5 Restore 100 acres of wetland, reducing volume by 65,000 cubic feet in a 3/4-inch storm.					
		Actions: See Fi 1b-1			
Fi 1c-6 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch storm.					
	1	Submit grant proposal/seek community funding			
	2	Obtain rain barrel materials		barrels, plumbing e.g., $40 per barrel setup	
	4	Workshop			2 workshops
	5	Outreach			
MC 1 Establish 1 neighborhood-scale green infrastructure project as a demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhood is identified, reducing volume of water by 32,670 cu ft in a 1-inch storm.					
Actions - See MC 1 above					
Goal Fi 1d Protect riparian resources, thereby preventing future sediment loading by 89 tons/year					
FI 1d-1 Protect 36,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks, reducing loading of sediment by 14 tons/yr					
	1	Workshops for community officials on developing/enforcing riparian setbacks	Portage County Regional Planning Commission	Workshops would occur during regularly scheduled zoning inspector meetings, etc.	2 workshops by 2015; additional workshops - included in general workshop series
	2	Comment on wetland alteration permit applications concerning impacts to watershed functions/riparian setbacks	WC and partners		on-going
	3	Increase the number of communities using riparian setbacks	WC, communities, Counties	Outreach	1 additional community with riparian setbacks by 2022
	4	Install signage for riparian areas in publicly visible places	Partners	$200-$500 per sign. Outside funding or community sign facility	Signs at 2 locations by 2022; signs at 1 additional location every 5 years afterward
	5	Continued outreach	Partners		brochure, workshops on enforcement, outreach to homeowners etc.
FI 1d-2 Protect 75 acres of wetland/riparian corridor/conservation land through purchase of easement/wetlands, preventing increased loading of sediment by 75 tons/yr					
	1	Mapping			
	2	Contact landowners/partner land trusts			
	3	Submit grant proposal			
	4	Acquire wetlands/easements			

Table Fi 4.2 Fish Creek - Nitrogen
041100020305 (part)

Problem Statement Fi 2: Nitrogen

The 2000 TMDL determined that Fish Creek biological communities are stressed due to urban runoff. Nitrate+nitrogen levels in Fish Creek during/after a rain event in 2007 slightly exceeded state EOLP median values of 0.43 mg/l for WWH streams, with measurements of approx. 0.48 mg/l. Cuyahoga River nitrate+nitrogen levels measured in 2007 frequently the EOLP median (1.0 mg/l) and the state guidelines (1.5 mg/l), ranging from 0.9 mgl/l to 6 mg/l. The STEP-L model indicates that the Fish Creek subwatershed generates 30,766 lb/year from non-point sources, including urban runoff, failing septic systems, and eroding stream banks. Alteration of at least 737 acres of wetland, 76% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 15.5 miles of watercourses has reduced the nitrogen uptake of the system. Potential loss of riparian vegetation in the undeveloped 30% of the riparian corridor could result in increased loading in the future.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Fi 2a Reduce non-point source pollution from urban runoff to reduce annual loading of nitrogen by 273.2 lb			
Fi 2a-1 Plant 25 ac of deep-rooted riparian vegetation, reducing loading of nitrogen by 200 lb/yr *Focus areas: large parcels single ownership, headwaters.*			
Actions - See Fi 1a-1, Table Fi 4.1			
Fi 2a-2 Retrofit stormwater volume devices to treat 60 acres of residential land and improve water quality, reducing loading of nitrogen by 70 lb/yr			
Actions - See Fi 1a-2, Table Fi 4.1			
Fi 2a-3 Retrofit 1,000 lf of drainage with no-mow grass/vegetated swale/daylighting, to reduce annual nitrogen loading by 0.8 lb .			
Actions - See Fi 1a-3, Table Fi 4.1			
FI 2a-4 Install 6,000 sq. ft of rain garden to reduce annual nitrogen loading by 0.5 lb/yr			
Actions - See Fi 1c-2, Table Fi 4.1			
Fi 2a-5 Install 10,000 sq. ft of biofiltration in a developed site to reduce nitrogen loading by 2.2 lb per year			
Actions - See Fi 1c-3, Table Fi 4.1			
Fi 2a-6 Facilitate review and update of 2 local codes to include measures for green infrastructure			
Actions - See Fi 1c-4, Table Fi 4.1			
Fi 2a-7 Update, increase, and disseminate available information concerning phosphorous from urban runoff			
Actions - See Fi 1a-5, Table Fi 4.1			
FI 2a-8 Increase stewardship activities related to non-point source pollution and watershed issues by 21 activities			
Actions - See Fi 1a-6, Table Fi 4.1			
Fi 2a-9 Facilitate review and update of local codes to include measures for green infrastructure			
Actions - See Fi 1a-8, Table Fi 4.1			
FI 2a-10 Develop stormwater management design manual for Portage County			
Actions - See Fi 1a-7, Table Fi 4.1			
MCR 1 Establish 1 neighborhood-scale green infrastructure project as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year			
Actions - See MCR-1, Table Fi 4.1			
Goal Fi 2b Restore altered watershed landscape to reduce nitrogen in the stream by 3,100 lb/yr.			
Fi 2b-1. Restore 100 ac of wetland, reducing loading of nitrogen by 2,800 lb/yr. *Focus areas -altered wetlands in central watershed or headwaters.*			
Actions - See Fi 1b-1, Table Fi 4.1			

Table Fi 4.2 Fish Creek - Nitrogen
041100020305 (part)

Goals / Objectives / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Fi 2b-2 Restore 50 acre-foot of floodplain access/storage, reducing annual nitrogen loading by 300 lb. *Focus areas - areas with modified floodplain access. and at/upstream of flooding problem areas, e.g., upstream of McKinney Ave. neighborhood*			
Actions - See Fi 1b-2, Table Fi 4.1			
Goal Fi 2c Reduce bank erosion from overloaded channels to reduce nitrogen loading by 34 lb/year.			
Fi 2c-1 Stabilize 200 l.f. of 5-foot tall stream bank, reducing nitrogen loading by 34 lb/yr. *Focus areas, e.g., Spaulding Ave. area*			
Actions - See Fi 1c-1, Table Fi 4.1			
Fi 2c-2 Plant 25 ac of deep-rooted riparian vegetation, thereby reducing channel loading by 5,400 cu ft in a 3/4 inch storm .			
Actions - See Fi 1a-1, Table Fi 4.1			
Fi 2c-3 Restore 100 acres of wetland thereby reducing channel loading by 1,300,000 cubic feet of water in a 3/4 inch storm.			
Actions - See Fi 1b-1, Table Fi 4.1			
Fi 2c-4 Increase floodplain storage by 50 acre-ft, thereby reducing stream channel loading by 2,178,000 cubic feet.			
Actions - See Fi 1b-2, Table Fi 4.1			
Fi 2c-5 Construct bioinfiltration or permeable pavement demonstration projects totalling 10,000 square feet, to reduce channel loading by 1600 cu ft in a 3/4 inch storm.			
Actions - See Fi 1c-3, Table Fi 4.1			
Fi 2c-6 Construct 6,000 square feet of rain garden to reduce channel loading by 262 cu ft in a 3/4 inch event.			
Actions - See Fi 1c-2, Table Fi 4.1			
Fi 2c-7 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch or 1-inch storm .			
Actions - See Fi 1c-7, Table Fi 4.1			
Goal Fi 2d Reduce septic system failure to reduce annual loading of nitrogen by 300 lb			
Fi 2d-1 Correct 1 failing HSDS per year, reducing nitrogen loading by 300 lb/yr Focus areas: vicinity of water courses			
1 Inspect systems	PCHD		
2 Correct failing/discharging home sewage treatment systems	Portage County Health District, landowners	Continued inspection and enforcement of illicit discharge regulations. Remedies depend on	10 by 2022; 1 per year afterward
3 Continue to investigate funding sources	PCRPC, PCHD, wc		
4 Outreach:			
Goal Fi 2e Protect beneficial watershed features to prevent future nitrogen loading by 2,300 lb/yr.			
FI 2e-1 Protect 36,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1, reducing loading of nitrogen by 200 lb/yr			
Actions - See Fi 1d-1, Table Fi 4.1			
FI 2e-2 Protect 75 acres of wetlands/riparian corridor/conservation land, preventing increased loading of nitrogen by 2100 lb/yr			
Actions - See Fi 1d-2, Table Fi 4.1			

Table Fi 4.3 Fish Creek - Phosphorous
HUC 041100020305 (part)

Problem Statement Fi 3: Phosphorous

The 2000 TMDL determined that Fish Creek biological communities are stressed due to urban runoff. In approximately half of the reported samples, total phosphorous levels in Fish Creek exceed state/EOLP median values of 0.08 and 0.05 mg/l, respectively, for WWH streams, with measurements in Fish Creek of 0.02 to 1.08 mg/l. The Cuyahoga River has shown signs of slight nutrient enrichment. The STEP-L model indicates that the Fish Creek subwatershed generates 5,810 pounds per year of total phosphorous from non-point sources, including urban runoff, eroding stream banks from overloaded channels, and failing septic systems. Alteration of at least 737 acres of wetland, 76% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 15.5 miles of watercourses has reduced the natural phosphorous removal capacity of the system. Potential loss of riparian vegetation in the undeveloped 30% of the riparian corridor could result in increased loading in the future.

Goal *Objective*	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Fi 3a Reduce non-point source pollution from urban runoff to reduce annual loading of phosphorous by 46 lb.				
Fi 3a-1 Plant 25 ac of deep-rooted riparian vegetation, reducing loading of phosphorous by 35 lb/yr				
	Actions - See Fi 1a-1, Table Fi 4.1			
Fi 3a-2 Retrofit stormwater volume devices to treat 60 acres of developed land and improve water quality, reducing loading of phosphorous by 10.2 lb/yr				
	Actions - See Fi 1a-2, Table Fi 4.1			
Fi 3a-3 Retrofit 1,000 lf of drainage with no-mow grass/vegetated swale/daylighting, reducing loading of phosphorous by 0.4 lb/yr				
	Actions - See Fi 1a-3, Table Fi 4.1			
FI 3a-4 Install 6,000 sq ft of rain garden, to reduce phosphorous loading by 0.1 lb/yr				
	Actions - See Fi 1c-2, Table Fi 4.1			
Fi 3a-5 Install demo project of 10,000 sq. ft. of biofiltration in a commercial/institutional site, to reduce phosphorous loading by 0.3 lb per year				
	Actions - See Fi 1c-3, Table Fi 4.1			
Fi 3a-6 Facilitate review and update of local codes to include measures for green infrastructure				
	Actions - See Fi 1a-4, Table Fi 4.1			
Fi 3a-7 Update, increase, and disseminate available information concerning phosphorous from urban runoff				
	Actions - See Fi 1a-5, Table Fi 4.1			
FI 3a-6 Increase stewardship activities related to non-point source pollution and watershed issues by 21 activities				
	Actions - See Fi 1a-6, Table Fi 4.1			
FI 3a-7 Develop stormwater management design manual for Portage County				
	Actions - See Fi 1a-7, Table Fi 4.1			
MC 1 Establish 1 neighborhood-scale green infrastructure project as a demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of phosphorous by 25 lb/year				
	Actions - See MCR-1, Table Fi 4.1			
Goal Fi 3b Restore altered riparian/watershed landscape to reduce phosphorous in the stream by 673 lb/yr.				
Fi 3b-1. Restore 100 ac of wetland, reducing loading of phosphorous by 632 lb/yr				

Table Fi 4.3 Fish Creek - Phosphorous
HUC 041100020305 (part)

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	Actions - See Fi 1b-1, Table Fi 4.1			
Fi 3b-2 Restore 50 ac-ft of floodplain access/storage, reducing annual phosphorous loading by 41 lb.				
	Actions - See Fi 1b-2, Table Fi 4.1			
Goal Fi 3c Reduce bank erosion from overloaded channels thereby reducing phosphorous loading by 20 lb/year.				
Fi 3c-1 Stabilize 200 l.f. of 5-foot tall eroding stream bank, reducing phosphorous loading by 20 lb/year.				
	Actions - See Fi 1c-1, Table Fi 4.1			
Fi 3c-2 Plant 25 ac of deep-rooted riparian vegetation, thereby reducing channel loading by 5,400 cu ft in a 3/4 inch storm .				
	Actions - See Fi 1a-1, Table Fi 4.1			
Fi 3c-3 Restore 100 acres of wetland, reducing volume by 65,000 cubic feet in a 3/4-inch storm.				
	Actions: See Fi 1b-1, Table Fi 4.1			
Fi 3c-4 Increase floodplain storage by 50 acre-ft, thereby reducing stream channel loading by 2,178,000 cubic feet.				
	Actions - See Fi 1b-2, Table Fi 4.1			
Fi 3c-5 Construct 10,000 sq ft of bioinfiltration or permeable pavement in a developed setting to reduce channel loading by 1,600 cu ft in a 3/4 in storm				
	Actions - See Fi 1c-3, Table Fi 4.1			
Fi 3c-6 Construct 6,000 square feet of rain garden as a demonstration project to reduce channel loading by 262 cu ft in a 3/4 inch event.				
	Actions - See Fi 1c-2, Table Fi 4.1			
Fi 3c-8 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch storm .				
	Actions - See Fi 1c-6, Table Fi 4.1			
Goal Fi 3d Reduce septic system failure to reduce annual loading of phosphorous by 122 lb				
Fi 3d-1 Correct 1 failing HSTS per year, reducing loading of phosphorous by 122 lb/yr				
	Actions - See Fi 2d-1, Table Fi 4.2			
Goal Fi 3e Protect beneficial watershed features to prevent future phosphorous loading by 509 lb/yr.				
FI 3e-1 Protect 36,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1, preventing an additional 35 lb/yr of phosphorous loading.				
	Actions - See Fi 1d-1, Table Fi 4.1			
FI 3e-2 Protect 75 acres of wetlands/riparian corridor/conservation land through acquisition of land/easements, preventing increased loading of phosphorous by 474 lb/yr				
	Actions - See Fi 1d-2, Table Fi 4.1			

Table Fi 4.4 Damaging Floods

HUC 041100020305 (part)

Problem Statement Fi-4: Damaging Floods

Repeated flooding problems (floooding that affects structures or roads) occur along Fish Creek at McKinney Ave., Johnson Road, and along primary headwaters.
The subwatershed is 21% impervious, generating excess runoff. Fish Creek has been straightened - 15.5 miles of the creek is channelized. At least 737 acres of wetlands on hydric soils and 75% of the 75-foot riparian buffer have been altered, and the channelized water courses can no longer access floodplain/wetland. Many of the headwater tributaries have been culverted.
The combination of excess runoff and lost storage/absorption capacity in the watershed contributes to flooding. Continued development in the watershed will contribute further to the flooding problem unless these concerns are addressed.

Goal					
Goal					**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Objective	**Actions**		**Lead/ cooperating organizations**	**Resources needed/cost**	
Goal Fi 4a Reduce stream channel loading by reducing runoff/increasing flood storage by 2,251,945 cubic feet in a 3/4-inch rain event					
Fi 4a-1 Increase infiltration with 25 ac of deep-rooted riparian plantings/native species, reducing runoff by 5,400 cubic feet in a 3/4-inch storm.					
	Actions: see Fi 1a-1 Table Fi 4.1				
Fi 4a-2 Restore 100 acres of wetland, reducing runoff by 65,000 cubic feet in a 3/4-inch storm					
	Actions: see Fi 1a-2 Table Fi 4.1				
Fi 4a-3 Restore 50 acre-foot of floodplain access, reducing volume by 2,178,000 cubic feet in a 1-inch storm.					
	Actions: see Fi 1a-3 Table Fi 4.1				
FI 4a-4 Install 6,000 sq ft of rain garden, reducing stream channel loading by 150 cubic feet in a 3/4-inch storm.					
	Actions: see Fi 1c-2 Table Fi 4.1				
Fi 4a-5 Install 10,000 sq ft of biofiltration/permeable pavement in a developed site to reduce runoff by 3,120 cubic feet in a 3/4-inch storm.					
	Actions: see Fi 1c-3 Table Fi 4.1				
Fi 4a-7 Facilitate installation of 50 rain barrels, thereby reducing stream channel loading by 275 cu ft in a 3/4-inch storm .					
	Actions - See Fi 1c-6, Table Fi 4.1				
Fi 4a-8 Facilitate review and update of local codes to include measures for green infrastructure					
	Actions - See Fi 1a-4, Table Fi 4.1				
Fi 4a-9 Update, increase, and disseminate available information concerning urban runoff					
	Actions - See Fi 1a-5, Table Fi 4.1				
FI 4a-10. Increase stewardship activities related to watershed issues					
	Actions - See Fi 1a-6, Table Fi 4.1				
MC-1 Establish 1 neighborhood-scale green infrastructure project as a demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhood is identified, reducing volume of water by 32,670 cu ft in a 1-inch storm.					
	Actions: See MC-1 Table Fi 4.1				
Goal Fi 4b Reduce flooding in targeted area by improving/restoring function to watershed features					
Fi 4b-1 Restore floodplain/wetland connection in one area of severe flooding, thereby reducing flooding problems					
	1	Conduct neighborhood/community meetings to determine interest			
	2	Apply for funding			

Table Fi 4.4 Damaging Floods
HUC 041100020305 (part)

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	3 Flood reduction/watershed restoration study	outside consultant		
	4 Design-build watershed improvements			
	5 Neighborhood outreach during process	potential for tree planting		
Goal Fi 4c Protect beneficial watershed features to prevent future channel loading by 55,284 cu ft in a 3/4 inch storm.				
FI 4c-1 Protect 36,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks, reducing channel loading by 6,534 cu ft in a 3/4 inch rain event.				
	Actions: See Fi 1d-1 Table Fi 4.1			
FI 4c-2 Protect 75 acres of wetlands/riparian corridor/conservation land through acquisition of land/easements, preventing increased channel loading by 48,750 cu ft/yr				
	Actions - See Fi 1d-2, Table Fi 4.1			

Table Fi 4.5 Fish Creek - Habitat
HUC 041100020305 (part)

Problem Statement Fi-5: Habitat

Fish Creek, its tributaries, and watershed have been substantially altered, degrading habitat. Approx. 15.5 miles of the creek is channelized. At least 737 acres of wetlands on hydric soils and 75% of the 75-foot riparian buffer have been altered. Channelizing the creek has removed it from its adjacent wetlands. Many of the headwater tributaries have been culverted. Remaining wetlands have been degraded by urban encroachment and invasive species. Continued development in the watershed will contribute further to the degradation of the remaining habitat unless these concerns are addressed.

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Fi 5a Restore 22 acres of altered habitat.				
Fi 5a-1 Plant 25 ac. of deep-rooted riparian plantings /native species, improving riparian habitat.				
	Actions: see Fi 1a-1 Table Fi 4.1			
Fi 5a-2 Restore/enhance 100 acres of wetland. Focus areas - e.g., altered wetlands on hydric soils, wetlands along channelized sections, potentially at formerly farmed sites.				
	Actions: see Fi 1a-2 Table Fi 4.1			
Fi 5a-3 Restore 50 acres of floodplain access. Target areas - headwaters, Johnson Rd.-McKinney				
	Actions: see Fi 1a-3 Table Fi 4.1			
Fi 5a-4 Treat/remove invasive species in 40 acres of altered habitat.				
Fi 5a-5 Restore 3,000 lf of streambank/wetland-stream connection				
Fi 5a-6 Conduct feasibility study for removing small low-head dams.				
Goal Fi 5b Protect 255 acres of intact habitat. *Target - intact wetlands, riparian corridor, areas with species of concern, larger intact or connected complexes*				
Fi 5b-1 Protect 36,000 linear feet/ 180 acres of riparian buffer by increasing the number of communities using riparian setbacks.				
	Actions: See Fi 1d-1 Table Fi 4.1			
FI 5b-2 Protect 75 acres of wetlands/riparian corridor/conservation land through acquisition of land or easements.				
	Actions - See Fi 1d-2, Table 6.2-1			
Fi 5b-3 Update, increase, and disseminate available information concerning care of the watershed and habitats.				
	Actions - See Fi 1a-4, Table 6.2-1			
FI 5b-4. Increase stewardship activities related to watershed issues				
	Actions - See Fi 1a-5, Table 6.2-1			
Fi 5b-5. Continue to acquire 25 ac of conservation land in the planned Kent Parks Fish Creek loop.				

Table Fi 4.6 Fish Creek - Recreation

HUC 041100020305 (part)

Problem Statement Fi-6: Recreational Opportunities

There are limited recreational opportunities along or related to Fish Creek. The City of Kent is developing a trail loop along Fish Creek.
Although some Kent parks are located along Fish Creek, the connection to the creek is not highlighted in the parks.

Goal *Objective*	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Fi-6a: Increase recreational opportunities along Fish Creek and in the subwatershed by 3 miles and 1 sites.				
Fi 6a-1 Continue to develop 3 miles of the planned Kent Parks loop and trail centered on Fish Creek				
	1 Submit grant proposal	City of Kent	funding, plans, design - Kent State University students could help with assessments, etc.	
	2 Wetland delineations		Assistance from KSU classes	
	3 Design/build			
	4 signs			
	5 Brochure/outreach			
FI 6a-2. Develop 1 River Quest or virtual watershed tour				
	1 Determine appropriate River Quest structure (cuyahoga canalway or new one)	WC, partners, volunteers, parks	Permission to develop quests, printing costs	2 quests by 2017 or 1 watershed tour by 2017
	2 Public workshop concerning River quests			
	3 Seek quests from volunteer groups			
	4 Review, print, distribute		funding for printing, place on website	
Fi 6a-3 Improve access points at 1 location				
Goal Fi 6b: Increase awareness of recreational opportunities, stewardship, and watershed issues.				
Fi 6b-1. Economic impact study recreational uses		WC with KSU	outside funding	1 study by 2018
	1 Coordinate with KSU and others on study			
	2 Submit grant proposal			
	3 Conduct study			
	4 Publicize			
Fi 6b-2. Increase signage related to Fish Creek at local parks by 6 signs.				
	1 apply for funding			
	2 Design, install signs			
	3 Continued outreach with local communities			
Fi 6b-3 Update, increase, and disseminate available information concerning recreational opportunities and care of Fish Creek, its tributaries, and watershed.				
	1 Web page of recreational opportunities/access	wc		
	2 Other Actions - see Fi 1a-6			
FI 6b-4. Increase stewardship activities related to watershed issues				
	Actions - See Fi 1a-7			
Fi 5b-5. Continue to acquire 25 ac conservation land in the planned Kent Parks Fish Creek loop.				

7 Plum Creek
HUC 041100020301

1 Summary of Existing Conditions

Tables Pl 1 and 2 summarize key characteristics and impairments of this subwatershed. Figure Pl-1 shows the subwatershed and jurisdictions. Figures Pl-2 and 3 show potential areas of concern and resource areas for protection. Greater detail is shown in the various maps in Vol. I.) Also see photos in Section 4P, Plum Creek.

The landscape of the Plum Creek subwatershed is somewhat evenly divided between woods/wetlands/scrub-shrub (28 percent), agriculture (24 percent), and low-moderate intensity development (33 percent, with 11 percent developed open space). Prior to the economic downturn beginning in 2007-2008, several communities in this subwatershed were experiencing rapid development. When new development starts occurring in the region, it is likely that these communities will be the focus of new growth again.

Approximately 12 miles of the streams, primarily headwaters, are channelized. Approximately 4.7 miles of streams in this subwatershed is intact, primarily along the main stem of Plum Creek and flowing through extensive wetland systems. Some of the large wetland complexes contain species of concern. The Tom S. Cooperrider-Kent Bog protects one of the largest tamarack stands in the state, but much of the remaining wetlands are privately owned. The watershed contains three golf courses, one of which occupies much of a five-year time of travel zone of the Portage County public water supply wellfield.

In this subwatershed, priorities include:

- reducing negative effects of potential development,
- protecting key resources (riparian/wetland/habitat corridors, especially along Plum Creek, and the wellfield),
- addressing non-point source pollution from agricultural, construction sources, and septic systems
- improving stream function in channelized areas,
- and protecting the Portage County public water supply.

Several large portions of land are held by a few landowners, suggesting the potential for a coordinated approach to management, restoration, or conservation, with these land owners.

Assessment and Attainment

Plum Creek was assessed at two locations in 2000, with chemical monitoring at both locations in 2007. In 2000, it was in attainment of WWH standards. Based on limited observations, it appears that the sampling location is within an area surrounded by woods, wetlands, and accessible floodplains, and would likely continue to meet WWH standards. Impairments noted include flow/habitat alteration and non-point source pollutants (nutrients and siltation). Sources noted include dams, channelization, urban runoff, and septic systems. The dam at Plum Creek Park has been removed, but 12 miles of the streams remain channelized, mostly along tributaries. In addition to the noted sources of non-point source pollution, erosion from agricultural fields and pastures (with unrestricted livestock access) has also been observed.

With recent development in the area, it is important to continue monitoring water quality of the creek.

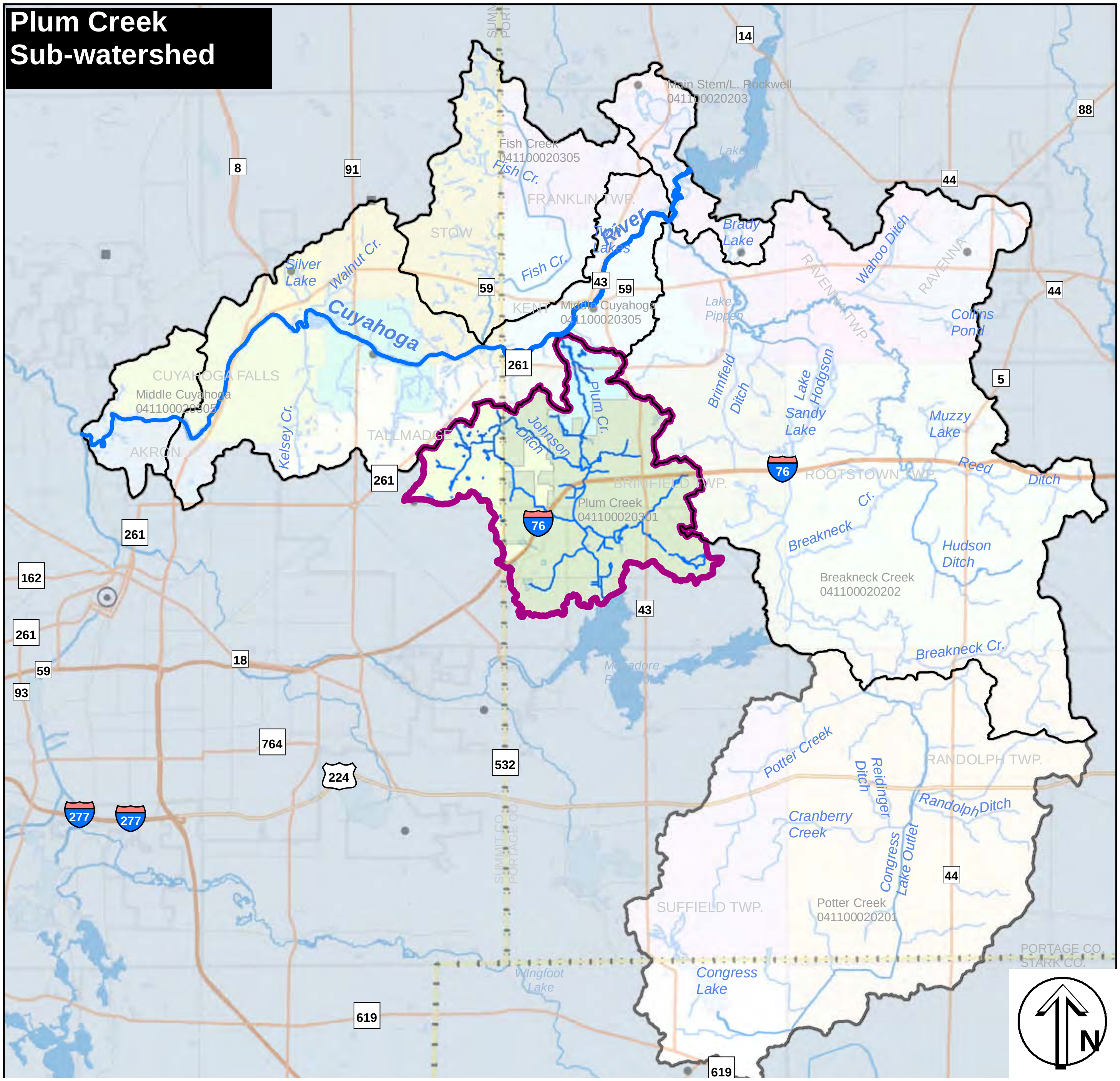


Figure PI-1
Subwatershed Local Jurisdictions

Miles
0 0.5 1 2 3 4

Streams and Rivers
Lakes
Plum Creek Subwatershed
12-Digit Huc: 041100020301
Fish Creek 041100020305 Other Sub-watersheds
Counties
Jurisdictions outside watershed

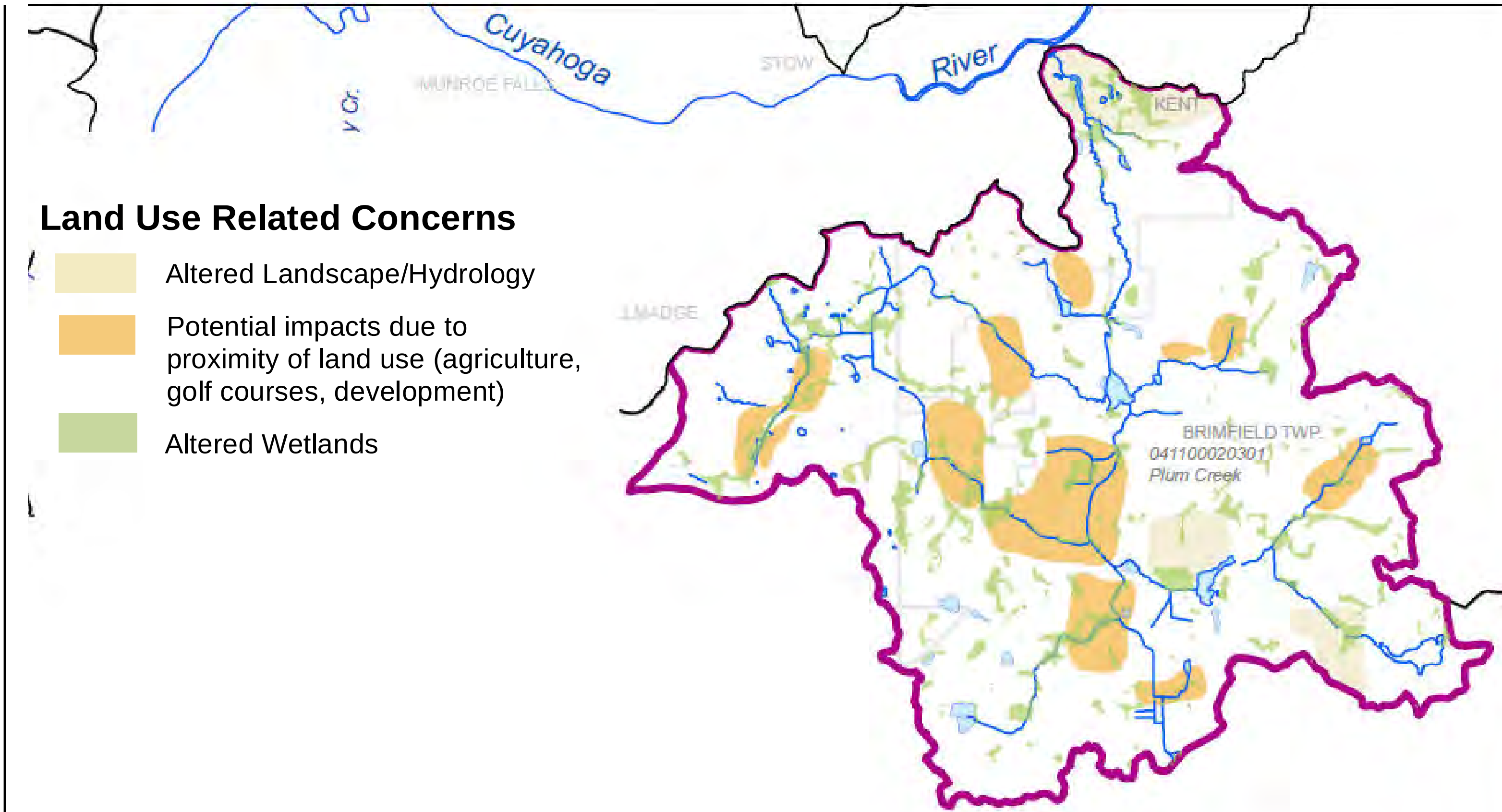
Interstate Highways
State Divided Highways
State Numbered Rtes
Local Roads

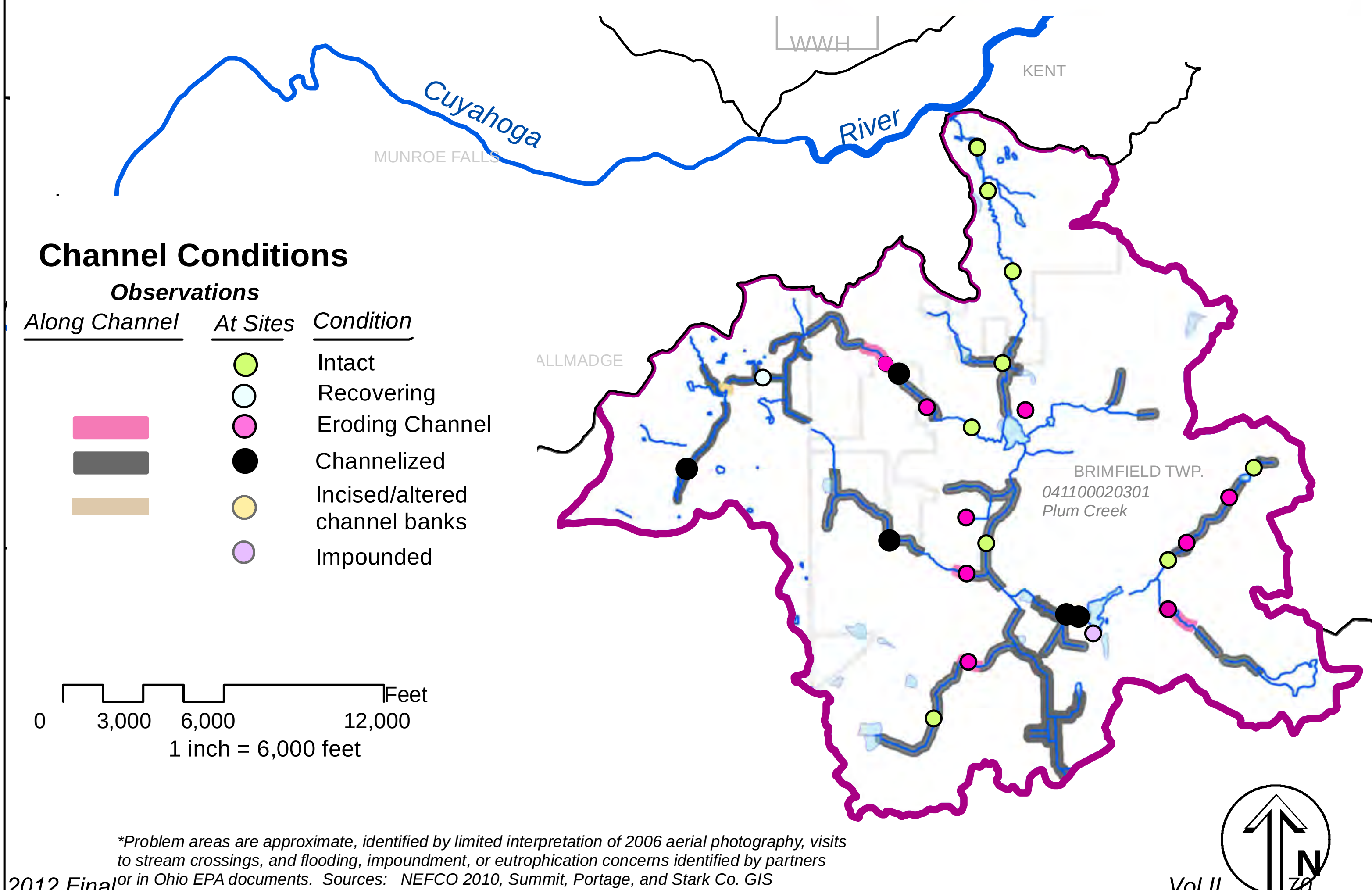
Subwatershed Local Jurisdictions
KENT
TALLMADGE
BRIMFIELD TWP.

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010

Figure PI-2 Problem Areas Plum Creek Subwatershed

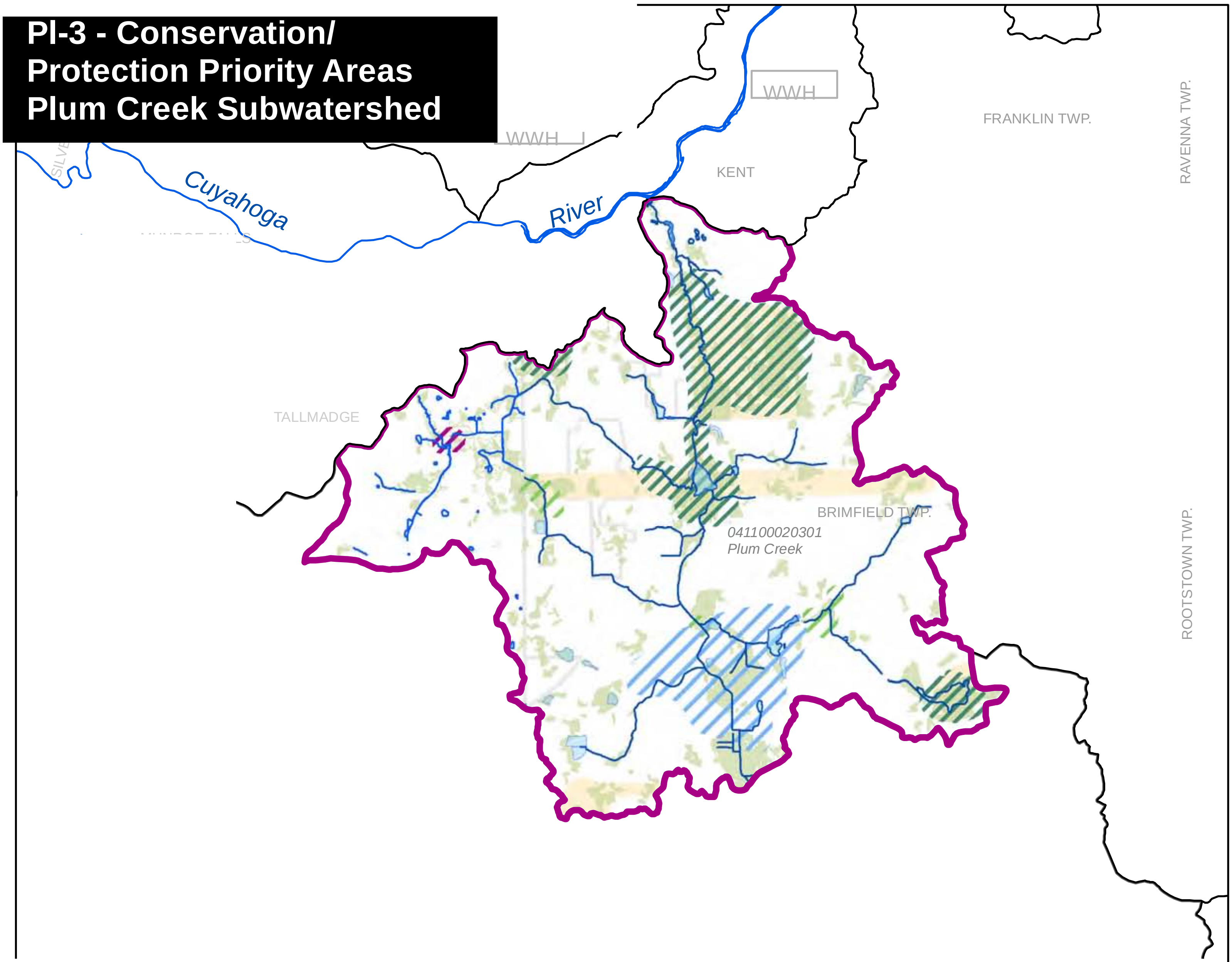
Plum Creek Subwatershed
041100020305 Fish Creek — Other Subwatershed, 12-Digit HUC
Streams and Rivers
Lakes
WWH — Aquatic Life Use Designation





Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography.

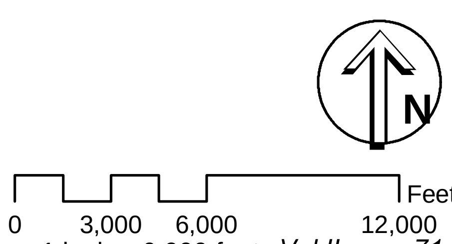
PI-3 - Conservation/ Protection Priority Areas Plum Creek Subwatershed



Conservation/Protection Priority Areas

- Riparian Corridor/Wetland
- Wetlands of Additional Importance (e.g., buffering) - enhance/protect
- Water Supply Protection - Conservation/BMPs/Outreach
- Restoration/Conservation of Riparian Area/Wetlands
- Mapped Wetlands
- Habitats or Species of Concern - Identified on DNR biodiversity database spanning 30 years; Western Reserve Land Conservancy workshop, 2010.)

- Streams and Rivers
- Lakes
- WWH Aquatic Life Use Designation
- 041100020305 Fish Creek — Subwatershed, 12-Digit HUC
- Local Jurisdictions



**Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.*

Table PI-1
Summary of Plum Creek Subwatershed Characterisitcs

Concern	**Amount/Item**	**Comments**
Water Quality Attainment, latest assessed	Plum Creek has been monitored at two locations in 2000 and 2007 and was in attainment of WWH water quality standards in 2000.	The sampling site is in a wetland/ woods complex, likely to continue to attain WWH standards.
Public water supplies	Portage County wellfield	
Land Cover acres, %	Developed 2,884 34.2% • *High Density 121 1.3%* • *Moderate Density 479 5.4%* • *Low Density 1,186 15.9%* • *Dev. Open Space 1,089 11.6%* Agricultural 1,563 24.4% Grassland/scrub-shrub 330 3.5% Woods/wetlands 2,842 24.5%	
Imperv./runoff	11.3% **Additional runoff 3/4" storm**: 13 million gal.	
75 foot buffer	Developed 18% *Dev. Open Space 9%* Agricultural 33% Woods/wetlands 49%	Much of lower Plum Creek and portions of Johnson Ditch are intact.
Wetlands (ac)	**Mapped** 1,388 **Converted** 698 ac. (hydric) 946 ac.(hydric incl.)	
Future development	Brimfield and Rootstown near I-76 were developing rapidly prior to economic downturn that began in 2007-2008.	
Channel quality (miles)	**Intact** 4.7 **Altered/channelized** 12.2 **Eroding** .5 (incl. livestock) **Recovering** 1	2 mi of Plum Creek, portions of Johnson Ditch intact, tribs - altered.
Non-pt source load/yr	**Tot. N** (lb) 30,725 **Tot. P (lb)** 5,799 **Sed**. (tons) 888	
Septic systems	Portions of Brimfield not served by sewers, 2 or more severe limitations	
Problem areas	Sediment erosion from construction and agricultural sites; eroding stream banks; channelization; high development potential	
Resource areas	Portage County wellfield 5 year zone; habitats of concern, wetlands; Plum Creek riparian corridor	
Park/conserv./inst.	Plum Cr. Park, Kent Bog, Brimfield Twp. Park, JayCee Park (Tallmadge)	
Riparian setback	Kent, Tallmadge, and Brimfield	
Recreational opportunities	Plum Creek Park in Kent and restored creek; Howe Ave/Jaycee park, Tallmadge; Kent Bog Nature Preserve; Brimfield Twp Park	

Table PI-2 Summary of Impairments
Plum Creek
HUC 041100020301

	Attainment issue/other concern	**Cause**	**Source**	**Other likely sources**
	HUC: 041100020301 Plum Creek	Direct habitat alteration Flow alteration Nutrients Organic enrichment/DO Siltation Total toxicity Unknown toxicity	Channelization – development Dam construction* Major municipal point source Natural Septic systems Sewer construction Urban runoff	Ag runoff Livestock access Development Impervious surface Construction runoff
			*Plum creek dam has since been removed.	
	Streambank erosion			Excess water, livestock access, lack of riparian veg., lack of floodplain access construction
	Flooding problems?			
	LOCAL CONCERNS			
	Wetland and habitat loss – existing and potential			
	Wellhead protection		Contaminants urban runoff, fracking	

7/15/2012

Non-point Source Pollution – sediment, nitrogen, phosphorous *(See Problem Statements Pl-1, Pl-2, and Pl-3)*

Siltation and nutrients are listed as causes of impairments, with noted sources including septic systems and urban runoff. Erosion from agricultural fields, banks, ditches, and uncontrolled livestock access has been observed. Much of the Plum Creek subwatershed is served by sewers or planned for sewer service. In the remaining areas, minimal areas present two or more severe limitations. The Plum Creek subwatershed is 11 percent impervious, which is near the threshold of degradation. This STEP-L model indicates this subwatershed generates, 30,725 lb/year of nitrogen, 5,739 lb per year of phosphorous and 888 tons per year of sediment through surface runoff, failing septic systems, and bank erosion. Channelization contributes to siltation by allowing sediment to accumulate in the channels. Over 600 acres of wetland have been converted, predominantly along the headwater tributaries, and approximately half of the 75-foot buffer has been altered, reducing pollutant uptake and flood storage, and degrading habitat. Future development will increase the imperviousness, runoff, and alterations.

Public Water Supplies *(See Problem Statement Pl-4)*
Brimfield contains a wellfield and wellhead protection area for the Portage County public water supply. The five-year time-of-travel zone around the Portage County wellfield is largely unprotected and resides within an active golf course, raising the potential for groundwater contamination. Concerns have been raised about the potential for groundwater contamination from “fracking.”

Habitat *(See Problem Statement Pl-5)*
Siltation is degrading habitat in Plum Creek streams. Approximately half of the 75-foot buffer is developed or agricultural, and half is woods/wetlands. As noted above over 600 acres of wetlands have been converted. Development fragments intact habitat. Only about 4.7 miles of the channels in this watershed are intact, predominantly in the lower reaches of Plum Creek. The rest is channelized and/or eroding, primarily along Johnson Ditch and other tributaries.

The City of Kent recently restored a dammed portion of the lower creek in Plum Creek Park to a free-flowing state and reconstructed floodplains and other riparian features. The lower portion of Plum Creek flows through an intact riparian corridor, with fringing wetlands, floodplains, riparian zones, and floodplains. Protecting this remaining corridor is important, as it is maintaining the quality of the creek and helping to mitigate the effects of channelization and alteration upstream. The corridor is connected to a large wetland complex, a small portion of which is protected as the Kent Bog.

There are several parcels currently conserving portions of Plum Creek, its tributaries, and wetlands, including:

- The Cooperrider-Kent Bog Nature Preserve, protecting one of the largest stands of tamarack in Ohio.
- Parcels associated with the Portage County public water supply and Mogadore Reservoir.
- The JayCee/Howe Ave. Park in Tallmadge protects a large, diverse wetland complex on Johnson Ditch (portions of which are culverted upstream of the park)
- The City of Kent owns the Plum Creek Park at the lower end of the creek immediately downstream of the most intact portion of the riparian corridor.
- Brimfield Township Park, much of which is undeveloped, encompasses headwater wetlands.

- The Tallmadge school district owns a substantial parcel downhill from two schools and the City recreation center. The school district recently reconstructed a ditched wetland into a large dry retention basin along this valley to handle stormwater from the new high school and recreation center. The Tallmadge-owned parcels provide an opportunity for additional enhancement or demonstration projects.

The Western Reserve Land Conservancy workshop (described in Section 4a-ii1) identified important areas to protect, including a large area including the protected Kent Bog, the intact Plum Creek corridor, and the lake within the Pleasant Lakes development. The workshop also identified a large wetland complex in the southeastern portion of the watershed as important to protect. These resources are currently intact but could be degraded by development. The ownership of much of the undeveloped land by a few owners presents opportunities to work with landowners to protect and/or restore large portions of the stream network, riparian corridor, wetlands, contiguous habitat, and habitat corridors.

Recreation *(Refer to Problem Statement Pl-6).*

There are limited opportunities for access to Plum Creek or its tributaries.

Direct access to Plum Creek or tributaries is found at JayCee Park in Tallmadge and Plum Creek Park in Kent. The Kent Bog Nature Preserve provides an opportunity for passive recreation in a tamarack bog. Parks located along Plum Creek, its tributaries, and wetlands could become the focus of a virtual watershed tour or other activities that bring the public to watershed features in parks. Additional access for passive recreation could promote stewardship/understanding of the riparian system.

2 Problem Statements, Goals, Objectives, and Actions

Table Pl-1.3 summarizes the actions proposed in the subwatershed and their associated pollutant load reductions, listing which problem statements/goals employ these tools. Tables Pl 4.1 through 4.5 present the problem statements, goals, objectives, and actions for each problem area. The tables are numbered to reflect each problem statement number, e.g., Table Pl 4.1 corresponds to Plum Creek (Pl) Problem Statement 1. It should be noted that because many of the objectives address more than one goal, the actions associated with each objective are listed only once, in the first table in which they appear (most frequently, Table Pl 4.1). All other listings of the same objective refer back to the actions at their first occurrence.

Refer to Sections 6 and 7a for a discussion of the format of the problem statements, goals, objectives, actions, and considerations for implementation.

Table PI-3 Action Item Summary by Subwatershed: Plum Creek

12-digit HUC/ Water Body	Sed	Nutrients	GW contam	Habitat	Recreation	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020301												
						Riparian Restoration						
Plum Cr./tribs	√	√		√		Restore/stabilize eroding Streambank (Bio-Engineering/ re-contouring/ re-grading)	1000	Linear Feet	$25-200/lf	6	12.5	5
Plum Cr./tribs	√	√		√		streambank stabilization - pasture	3000	lf		14	38	10
Plum Cr. Tribs	√	√		√		Plant Native plants, trees, or shrubs in Riparian Areas	8	Acres	$4,000 + labor shrubs	4	67	7
						Stream Restoration						
Plum Cr. Tribs	√	√		√		Restore Flood Plain	10	Acre-foot		4	60	8
						Restore Channel	1000	Linear Feet	$100-200/	20		
						Feasibility study remove small low head	1	study				
						Wetland Restoration						
Plum Cr. Tribs	√	√		√		Reconstruct, Restore, Reconnect Wetlands	25	Acres	$5k-100k/ac.	25	700	158
						Home Sewage Treatment Systems						
Plum Cr.		√				Repair/Replace HSTS	10	HSTS			311	122
						Urban runoff and green infrastructure						
Plum Cr.	√	√				Rain gardens	6000	sq feet			0.5	0.1
Plum Cr.						Parking lot retrofit - bioinfiltration/ permeable pavement	5000	sq ft		0.02	1.1	0.14
Plum Cr. watershed	√	√				Storm water inventory	1	inventory				
Plum Cr.	√	√				Storm water retrofits	60	acres treated	$400-17k/ ac	2.7	30	12
Plum Cr. watershed	√	√				Retrofit drainage No-mow ditch/ veg swale/ daylighting	500	linear feet		0.05	0.4	0.2

Table PI-3 Action Item Summary by Subwatershed: Plum Creek

12-digit HUC/ Water Body	Sed	Nutrients	GW contam	Habitat	Recreation	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Middle Cuyahoga River watershed						Neighborhood-scale green infrastructure	1		$25-50k design $20k bumpout -	5	200	25
	√	√				**Agricultural BMPs**				150	110	6
Plum Creek watershed	√	√				Survey of practices	1	survey				
Plum Cr. and tribs	√	√				Construct 2-Stage Channel/overwide	500	Linear Feet			147	46
Plum Cr. and tribs						Install Grassed Waterways/ vegetated buffer strips	50	Acres treated		72	211	113
Plum Cr. watershed						Cover crops	100	acres		110	256	128
Plum Cr. watershed						Residue applied to fields	50	acres		55	128	64
Plum Cr. and tribs						Livestock Crossings	1	Crossings				
Plum Cr. and tribs	√	√		√		Install Livestock Exclusion Fencing & accompanying watering measures	3,000	Linear Feet	$11,300 + watering	7	56	12
						Conservation Easements						
Plum Creek main and trib	√	√		√	√	Acquire Wetlands/ conservation land/ easements	100	Acres	$5-25k/ac	prevent 100	prevent 2800	prevent 632
	√	√	√	√	√	**Education and Outreach**						
Plum Creek & tribs						Develop Brochures/Fact Sheets	10	Brochures/Fact Sheets				
Plum Creek						Watershed Festivals	2	Festivals				
Plum Creek						Websites	1	Website				
Plum Creek watershed						Install Signs	10	Signs	$200-500/ sign			
Plum Creek						Stream Clean-Ups	5	Clean-Ups				
Plum Creek						New lake/stream stewardship groups	1	new group active				
Plum Creek watershed						Conduct Workshops	5	Workshops				

Table PI-3 Action Item Summary by Subwatershed: Plum Creek

12-digit HUC/ Water Body	Sed	Nutrients	GW contam	Habitat	Recreation	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Plum Creek watershed						Conduct Training		Training Sessions				
Plum Creek watershed						Develop Manual(s)	1	Manuals				
Plum Creek watershed						Rain barrel workshops	50	rain barrels				
Plum Creek watershed						Outreach for golf courses	2	golf courses contacted				
Plum Creek watershed						Develop Newsletters		Newsletters				
						Local Policy						
Plum creek watershed	√	√		√		Green code audit/update Develop or Customize	2	audits/ updates				
						Monitoring						
Plum Creek		√		√		Chemical Sampling	1	Sites				
Plum Creek	√			√		Macroinv./Fish/QHEI Sampling		Sites				
						Recreation						
						Construct trail	1	mile				
Plum Creek					√	Construct access sites	1	site				
Plum Creek watershed					√	Economic benefit study	1	study				
Plum Creek watershed					√	Develop quest(s)/ virtual watershed tour	2 quests/ 1 tour					
Total										474.77	2328.5	716.44

Table Pl 4.1 Plum Creek - Sediment
HUC 041100020301

Plum Creek (Pl) Problem Statement 1: Sediment

Siltation has been identified as a cause of non-attainment. Excess sediment is of concern in the Middle Cuyahoga River, downstream in the shipping channel and in Lake Erie, because of the nutrients that enter the water with the sediment. The STEP-L model indicates that the watershed contributes 888 tons of sediment from runoff and eroding streambanks due to excess storm water, inadequate flood storage, and unrestricted livestock access. Mapping indicates alteration of at least 698 acres of wetland, loss of riparian features (floodplain access, riparian zone) of nearly 12.2 miles of streams, and alteration of approximately 50% of riparian corridor within 75 feet. The loss of beneficial watershed features reduces the flood-storage capacity and vertical stability of watershed tributaries. Potential loss of riparian vegetation with further development could result in increased loading and reduced storage in the future.

Goal *Objective*		**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Pl 1a Reduce streambank erosion, thereby reducing sedimentation by 43 tons per year.					
Pl 1a-1 Stabilize 1,000 lf of eroding tributary banks, improve morphology, and restore vertical stability, in order to reduce sediment loading by 5 tons/year. Target areas: eroding streams					
	1	Identify target areas using mapping			
	2	Work with partners to determine priorities			
	3	submit grant proposal(s)			
	4	Develop restoration strategies			
	5	Submit grant proposal, design/build, coordination, signage,			
	6	Outreach with neighborhoods			
	7	Restoration work - vertical stability, banks, floodplain		$100-250/linear foot plus plantings	
	8	Encourage volunteer assistance with riparian plantings etc.		plants, planting plan	
	9	Install signage - riparian buffer, etc.	Partners, WC, communities	$200-300/sign	
	10	Comment on wetland alteration permit applications concerning impacts to watershed functions/riparian setbacks	WC and partners		on-going
Pl 1a-2 Stabilize 3,000 l.f. of stream bank with livestock access, in order to reduce sediment loading by 38 tons/yr *Focus areas, e.g., Tributaries with livestock access*					
	1	Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
	2	Meet with landowners to determine interest	WC, partners		
	4	Submit grant applications	WC, partners		
	5	Restore floodplain access/flood storage		design-build consultant	
	6	Public outreach			

Table Pl 4.1 Plum Creek - Sediment
HUC 041100020301

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Pl 1b Reduce sediment from urban runoff by 3.7 tons/yr.				
Pl 1b-1 Install 5,000 sq ft green infrastructure retrofit (e.g., bioinfiltration/permeable pavement) in developed area, to reduce sediment loading by 0.02 tons/yr				
Focus areas, e.g., parking lots public facilities				
	1 Submit grant proposal	WC		
	2 Inventory of green infrastructure opportunities	WC, partners, with guidance from outside consultant?	mapping, intern?	1 inventory of top sites
	3 Design/construct green infrastructure	Communities	engineering capability - outside consultant?	Retrofit 1 by 2022 to treat 10 ac institutional.
	4 Green infrastructure codes workshop	WC, partners, CSU, developers	location, materials, fee	1 workshop series by 2015
	5 Evaluate and update local ordinances for opportunties to reduce pavement, improve use of green infrastructure, conservation development, etc. in new/existing development	WC/communities	Volunteers/ interns can assist - outside funding could be used for consultant and/or work-shop - could be done with Portage zoning official meetings	2 code audits by 2017; update 1 code by 2018 (Kent/Portage??)*
	6 Outreach with developers, local officials			
Pl 1b-2 Retrofit stormwater volume devices to improve water quality from 60 acres of residential land, in order to reduce sediment loading by 2.7 tons/yr				
	1 Stormwater retrofit inventory		WC/NEFCO with communities	
	2 Submit grant application			
	3 Design/construct retrofit to improve water quality	Communities	Varies, depending on treatment provided (e.g., $400/acre treated to $17,000 per acre treated)	Retrofit 2 by 2022, 1 every 8 years afterward
Pl 1b-3 Retrofit 500 lf of roadside ditch in no-mow grass/veg swale/daylighiting to reduce sediment loading by 0.5 tons /year.				
	1 Workshop on maintaining ditches/improving drainage for water quality improvements	SWCD	Location, materials	
	2 Install 500 lf of drainage with retrofit			
Pl 1b-4 Install 500 lf of vegetated swale at Plum Creek Park to reduce sediment loading by 0.5 tons/yr.				
Pl 1b-5 Establish two monitoring efforts for QHEI/chemistry along Plum Creek with volunteer, school, or university groups.				
Pl 1b-6 Conduct survey of yard management practices				
Pl 1b-7 Develop stormwater management design manual for Portage County				
	1 Stormwater management design manual for Portage County	Portage SWCD	In-house task	1 manual by 2014
Pl 1b-8 Maintain Stream database				1 database
Pl 1b-9 Facilitate review and update of local codes to include measures for green infrastructure				
	1 Green code audit workshop			

Table Pl 4.1 Plum Creek - Sediment
HUC 041100020301

Goal / *Objective*		Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	2	Review codes in two communities for green infrastructure language	partners	volunteers/consultant	
	3	update code language		possibly outside consultant/funding	1 community by 2022
Pl 1b-10 Conduct workshops on use BMPs at urban sites					
	1	Stormwater management design manual for Portage County	Portage SWCD	In-house task	1 manual by 2015
	2	Workshops for community officials on developing/enforcing riparian setbacks	partners, PIPE		2 workshops by 2015; additional workshops - included in general workshop series
	3	Workshops for community officials on enforcing bmp requirements			
Pl 1b-11 Conduct Education outreach to encourage golf course operators to adopt Audubon Habitat practices					2 contacts
	1	funding			
	2	outreach			
	3	workshops			
	4	assistance			
Pl 1b-12 Conduct public outreach by providing information and studies electronically or in print.					
	1	Continue to compile, centralize, and make available studies, data, information sources on the watershed, including recreational opportunities, volunteer needs, permitting or regulatory issues; green infrastructure information sources, etc.	WC	Website, technical information and outreach materials	Update and develop pages for website by Dec. 2013, then on-going
	2	e-newsletter or article issued 3 times per year	wc	website, share with partners	
	3	Develop/reproduce informational brochure or website article concerning topics of interest, including reducing runoff, recreational oppor-tunties, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	10 by 2022; 1 each year
Pl 1b-13 Conduct 18 outreach/stewardship activities related to non-point source pollution and watershed issues.					
	1	Establish clean-up/monitoring/planting efforts at additional tributaries and lakes	WC, communities, parks, residents, home-owners' associations, lake associations	Funding or donation of trash disposal, refresh-ments, monitoring supplies, crew leaders, volunteers; training for monitoring/planting	1 new tributary or lake monitoring, clean-up, or other stewardship program by 2018
	2	Distribute 50 rain barrels through workshops	SWCDs/ Communities	Space for workshop; rain barrel kits	50 rain barrels distributed
	3	Survey of yard management practices	WC/partners		

Table Pl 4.1 Plum Creek - Sediment
HUC 041100020301

Goal / Objective		Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	4	Develop/reproduce informational brochure or website article concerning topics of interest, including reducing runoff, recreational opportunties, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	10 by 2022; 1 each year
	5	Educational outreach workshops on topics of importance, including LID/green infrastructure, restoration, field trips for examples	Partners, WC, communities	Location, speaker, supplies	5 workshops by 2022; 1 every 2 years (listed under other topics)
	6	Work with schools or city day camps to develop/encourage use of watershed care activities/curricular items	WC, SWCDs, partners, schools		1 educational outreach program/curriculum item by 2018
	7	River Day festivities	Portage Parks, partners		3
	8	Watershed "brand," logo, art project	WC, Kent State/ Standing Rock Gallery/River Day communities	Host for project, graphic design capabilities	1 logo or art project by 2015, then 1 every 3 years;
	9	Create social network or google presence	WC		1 by 2014
MCR-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year, phosphorous by 25 lb/yr, and sediment by 5 tons/yr					
	1	Work with communities to identify suitable target neighborhoods	WC, partners		
	2	Meetings to gauge neighborhood support			
	3	Determine/establish maintenance framework (e.g., easements, homeowner participation)	partner community		
	4	Get grant(s)			
	5	Design/build	outside consultant	Site, outside funding. Design ~$25-50,000; Rain gardens $15-20/sq. foot; Green street bump-outs $20,000 each; per-meable concrete $12-15/ sq. ft	1 project by 2022
	6	Outreach, neighborhood participation			
Goal Pl 1c Reduce sediment loading from agricultural runoff by 244 tons/yr					
Pl 1c-1 Install 3,000 lf of livestock exclusion and accompanying measures to reduce sediment loading by 7 tons per year					
	1	Contact landowners to determine willingness			
	2	Submit proposal for grant funds			
	3	Work with landowners to install measures			
	4	Outreach			
Pl 1c-2 Conduct survey of existing agricultural practices					
	1	Develop survey of existing practices			
	2	Administer survey to willing landowners			
	3	Windshield survey of visible practices			

Table Pl 4.1 Plum Creek - Sediment
HUC 041100020301

Goal *Objective*		Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	4	Tally and summarize survey results			
	5	Outreach with property owners based on results, use results to target practices			
Pl 1c-3 Install grassed waterway/buffer strips to treat 50 ac and reduce sediment by 72 tons /yr.					
Pl 1c-4 Install cover crops to treat 100 ac and reduce sediment by 110 tons/yr					
Pl 1c-5 Increase use of residue on ag fields by an additional 50 acres, reducing sediment loading by 55 tons/yr					
Goal Pl 1d Restore riparian features to reduce sediment loading by 33 tons/yr.					
Pl 1d-1 Plant 8 ac of deep-rooted riparian vegetation, reducing loading of sediment by 4 tons/yr Focus areas: large parcels single ownership, headwaters.					
	1	Submit grant applications e.g., OEEF	WC/SWCDs/partners		
	2	Targeted outreach to public, institutional, and other owners of large properties	WC**/SWCDs/ Communities	Lists of golf courses, lake associations, homeowners' associations; maps of large parcels; printed outreach materials.	Target 1 group every 3 years (3 by 2022); improvements to best management practices or riparian management at one site every 4 years(2 sites by 2020); 2 outreach contacts per year
	3	Outreach to golf course owners encouraging Audubon-certification		labor, printing	
	4	Assist with plantings	SWCDs, master gardeners	native plants/trees and shrubs $250 ($500-1,000 per acre);	
	5	Construct and install signage	communities, partners,	$300-500/sign	
	6	Follow-up outreach (individualized guide to riparian zone) and publicize		funding for handouts/brochures	
Pl 1d-2 Restore 25 ac of wetland, in order to reduce sediment loading by 25 tons/year.					
	1	Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2013, revisit and update if necessary every 3 years
	2	Meet with landowners to determine interest	WC, partners		
	3	Identify wetland restoration site for clearinghouse	WC, Communities, other partners	meetings with landowners; readily available mapping, outside assistance from consultant, possible assistance from Kent State University wetland ecology class	5 concept plans by 2020; 1 every 2 years afterward.
	4	Submit grant application			
	5	Restore/protect/enhance wetlands	Partners	$5,000-$100,000 per acre, design/build consultant, sites -protection by ease- ments would be at the low end of the range	25 acres by 2024

Table Pl 4.1 Plum Creek - Sediment
HUC 041100020301

Goal				
Objective	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Pl 1d-3 Restore 10 acre-ft of floodplain access, in order to store 4 tons of sediment per year.				
	1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
	2 Hold meetings with landowners to determine interest	WC, partners		
	3 Submit grant proposals			
	4 Design & Restore floodplain access/flood storage			
	5 Public outreach			
Goal Pl 1e Reduce causes of streambank erosion by reducing channel loading/increasing flood storage by 98,000 cu ft. in a 3/4 in storm.				
Pl 1e-1 Conduct 6 meetings/workshops among neighboring communities regarding watershed approaches to reducing stormwater effects				
	1 Coordinate with nearby communities/schools to identify areas of concern or opportunity			4 meetings
	3 Coordinated stormwater study on target areas??		outside funding or assistance	
	2 Workshops with public officials to address shared stormwater concerns			2 workshops
Pl 1e-2 Install 5,000 sq ft of permeable pavement/biofiltration in a developed site to reduce runoff by 937 cubic feet in a 3/4-inch storm.				
	Actions: See Pl 1b-1			
Pl 1e-3 Plant 8 ac of deep-rooted riparian vegetation, reducing channel loading by 5,800 cu ft in a 3/4 in storm.				
	Actions: See Pl 1d-1			
Pl 1e-4 Conduct outreach education with 2 golf courses to encourage use of Audubon International techniques.				
	Actions: See Pl 1b-11			
Pl 1e-5 Restore 25 ac of wetland, reducing channel loading by 16,500 cu ft in a 3/4 in event.				
	Actions: See Pl 1d-2			
Pl 1e-6 Restore 10 acre-ft of floodplain access, increasing storage volume by 435,600 cu ft.				
	Actions: See Pl 1d-3			
Pl 1e-7 Install 6,000 square feet of rain gardens, to reducing channel loading by 262 cu ft in a 3/4 in storm				
	1 Identify partners	WC, partners		
	2 Submit grant application	WC/partners		
	3 Workshop/installation	WC/partners		

Table Pl 4.1 Plum Creek - Sediment

HUC 041100020301

Goal				
Objective	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Pl 1e-8 Facilitate review and update of 2 local codes to include measures for green infrastructure				
	Actions: See Pl 1b-9			
Pl 1e-9 Update, increase, and disseminate available information concerning sediment from urban runoff				
	Actions: See Pl 1b-12			
Pl 1e-10 Increase/sponsor 18 stewardship activities related to non-point source pollution and watershed issues.				
	Actions: See Pl 1b-13			
Goal Pl 1-f Protect wetlands and beneficial watershed features to reduce future loading of sediment by 100 tons/yr				
Pl 1f-1 Protect 100 acres of wetlands, through acquisition of land or easements, preventing increased loading of sediment by 100 tons/yr ***Target areas: Plum Cr. Riparian corridor, other remaining wetlands***				
	1 Mapping			
	2 Contact landowners/partner land trusts			
	3 Submit grant proposal			
	4 Acquire wetlands/easements			
Pl 1f-2 Conduct 2 workshops on effectively implementing riparian setbacks				

Table Pl 4.2 Plum Creek Nitrogen
HUC 041100020301

Plum Creek (Pl) Problem Statement 2: Nitrogen

Nutrients are listed as a cause of non-attainment in Plum Creek. While Nitrate+nitrite levels are below state EOLP median for WWH (0.4 mg/l) and state guidelines (1.0 mg/l), measurements generally increased from approximately 0.1 mg/l to 0.2 mg/l from 2000 to 2007, a period of rapid growth in the subwatershed. Middle Cuyahoga nitrate+nitrogen levels measured in 2007 frequently exceed the EOLP median (1.0 mg/l) and the state guidelines (1.5 mg/l), ranging from 0.9 mgl/l to 6 mg/l.

The STEP-L model indicates that the watershed contributes 30,725 lb of nitrogen from runoff, failing septic systems, unrestricted livestock access and eroding streambanks, related to excess stormwater and loss of flood storage. Mapping indicates alteration of at least 698 acres of wetland, loss of riparian features (floodplain access, riparian zone) along nearly 12.2 miles of streams, and alteration of approximately 50% of riparian corridor within 75 feet. Altered riparian features increases streambank erosion and associated nutrient loading, and reduced pollutant uptake. Continued development, increased imperviousness, and altered/degraded watershed features could result in increased loading and reduced storage in the future.

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Pl 2a Reduce streambank erosion, thereby reducing nitrogen loading by 50.5 lb per year.				
Pl 2a-1 Stabilize 1,000 lf of eroding tributary banks, improve morphology, and restore vertical stability, in order to reduce nitrogen loading by 12.5 lb/year.				
	Actions: See Pl 1a-1			
Pl 2a-2 Stabilize 3,000 l.f. of stream bank with livestock access, in order to reduce nitrogen loading by 38 lb/yr				
	Focus areas, e.g., Tributaries with livestock access			
	Actions: See Pl 1a-2			
Goal Pl 2b Reduce nitrogen loading from urban runoff by 15 lb/yr.				
Pl 2b-1 Install 5,000 sq ft green infrastructure retrofit (permeable pavement/bioinfiltration) in developed area, to reduce nitrogen loading by 0.14 lb/yr				
	Focus areas, e.g., parking lots public facilities			
	Actions: See Pl 1b-1			
Pl 2b-2 Install 6,000 square feet of rain gardens, reducing nitrogen loading by 0.5 lb/yr				
	Actions: See Pl 1e-7			
Pl 2b-3 Retrofit stormwater volume devices to improve water quality from 60 acres of residential land, in order to reduce nitrogen loading by 12 lb/yr				
	Actions: See Pl 1b-3			
Pl 2b-4 Plant 500 lf of roadside ditch with no-mow grass to reduce nitrogen loading by 0.2 lb/yr.				
	Actions: See Pl 1b-4			
Pl 2b-5 Install 500 lf of vegetated swale at Plum Creek Park to reduce nitrogen loading by 2 lb/yr.				
Pl 2b-6 Establish two chemical/QHEI monitoring efforts along Plum Creek with volunteer, school, or university groups.				
Pl 2b-7 Conduct survey of yard management practices				
Pl 2b-8 Develop stormwater management design manual for Portage County				
Pl 2b-9 Maintain Stream database				1 database
Pl 2b-10 Conduct outreach education with 4 golf courses to encourage use of Audubon International practices				
Pl 2b-11 Conduct workshops on use BMPs at urban sites				
	Actions: See Pl 1b-7			
Pl 2b-12 Conduct public outreach by providing information and studies electronically or in print.				
	Actions: See Pl 1b-9			

Table Pl 4.2 Plum Creek Nitrogen
HUC 041100020301

Goal				
Objective **Actions**		**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Pl 2b-13 Conduct 18 outreach activities related to non-point source pollution and watershed issues.				
Actions: See Pl 1b-10				
MCR-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year, phosphorous by 25 lb/yr, and sediment by 5 tons/yr				
Goal Pl 2c Reduce nitrogen loading from agricultural runoff by 754 lb/yr				
Pl 2c-1 Install 3000 lf of livestock exclusion and accompanying measures to reduce nitrogen loading by 12 lb per year				
Actions: See Pl 1c-1				
Pl 2c-2 Conduct survey of existing agricultural practices				
Actions: See Pl 1c-2				
Pl 2c-3 Install grassed waterway/buffer strips to treat 50 ac and reduce nitrogen by 211 lb/yr.				
Pl 2c-4 Install cover crops to treat 100 ac and reduce nitrogen by 256 lb/yr				
Pl 2c-5 Increase use of residue on ag fields by an additional 50 acres, reducing nitrogen loading by 128 lb/yr				
Pl 2c-6 Construct 500 lf of 2-stage/overwide ditch along existing ditched channel, to reduce nitrogen loading by 147 lb/yr.				
Goal Pl 2d Reduce nitrogen loading from failing septic systems by 300 lb/yr				
Pl 2d-1 Correct 1 failing HSTS per year, reducing nitrogen loading by 300 lb/yr Focus areas: vicinity of water courses				
	1 Inspect systems	PCHD		
	2 Correct failing/discharging home sewage treatment systems	Portage County Health District, landowners	Continued inspection and enforcement of illicit discharge regulations. Remedies depend on cause of failure and proximity of sewer service.	10 by 2022; 1 per year afterward
	3 Continue to investigate funding sources	PCRPC, PCHD, wc		
	4 Outreach:			
Goal Pl 2e Restore riparian features to reduce nitrogen loading by 827 lb/yr.				
Pl 2e-1 Plant 8 ac of deep-rooted riparian vegetation, reducing loading of nitrogen by 67 lb/yr Focus areas: large parcels single ownership, headwaters.				
Actions: See Pl 1d-1				
Pl 2e-2 Restore 25 ac of wetland, in order to reduce nitrogen loading by 700 lb/year.				
Actions: See Pl 1d-2				
Pl 2e-3 Restore 10 acre-ft of floodplain access, in order to store 60 lb of nitrogen per year.				
Actions: See Pl 1d-3				
Goal Pl 2f Reduce causes of streambank erosion by reducing channel loading/increasing flood storage by 458,962 cu ft. in a 3/4 in storm.				
Pl 2f-1 Increase coordination between communities to reduce stormwater effects				
Actions: See Pl 1e-1				
Pl 2f-2 Install 5,000 sq ft of permeable pavement/biofiltration in a developed site to reduce runoff by 800 cubic feet in a 3/4-inch storm.				
Actions: See Pl 1e-2				
Pl 2f-3 Construct 6,000 sq ft of rain gardens, to reduce runoff by 262 cu ft in a 3/4 in event				

Table Pl 4.2 Plum Creek Nitrogen
HUC 041100020301

Goal / *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
	Actions: See Pl 1e-7			
Pl 2f-4 Plant 8 ac of deep-rooted riparian vegetation, reducing channel loading by 5,800 cu ft in a 3/4 in storm.				
	Actions: See Pl 1d-1			
Pl 2f-5 Restore 25 ac of wetland, reducing channel loading by 16,500 cu ft in a 3/4 in event.				
	Actions: See Pl 1e-6			
Pl 2f-6 Restore 10 acre-ft of floodplain access, increasing storage volume by 435,600 cu ft.				
	Actions: See Pl 2b-3			
Pl 2f-7 Conduct outreach education with 2 golf courses to encourage use of Audubon International techniques.				
	Actions: See Pl 1b-11			
Pl 2f-8 Facilitate review and update of 2 local codes to include measures for green infrastructure				
	Actions: See Pl 1b-9			
Pl 2f-9 Update, increase, and disseminate available information concerning nitrogen from urban runoff				
	Actions: See Pl 1b-12			
Pl 2f-10 Increase/sponsor 18 stewardship activities related to non-point source pollution and watershed issues.				
	Actions: See Pl 1b-13			
Goal Pl 2g Protect wetlands and beneficial watershed features to reduce future loading of nitrogen by 2,800 lb/yr				
Pl 2g-1 Protect 100 acres of wetlands, preventing increased loading of nitrogen by 2,800 lb/yr Target areas: large wetland complexes along Plum Cr. other remaining wetlands, areas containing habitats of concern				
	Actions: See Pl 1f-1			
Pl 2g-2 Conduct 2 workshops on effectively implementing riparian setbacks				
	Actions: See Pl 1f-2			

Table Pl 4.3 Plum Creek Phosphorous

HUC 041100020301

Plum Creek (Pl) Problem Statement 3: Phosphorous

Nutrients are listed as a cause of non-attainment in Plum Creek. Phosphorous (P) levels measured in 2000 and 2007 ranged from 0.027-0.8 mg/l, occasionally exceeding the state median for EOLP headwaters of 0.5 mg/l. The Middle Cuyahoga exhibits signs of slight nutrient enrichment, with large diurnal oxygen swings suggesting increased algal activity. Cuyahoga River Total P levels measured in 2007 ranged from 0.044 to 0.37, occasionally exceeding EOLP targets for medium rivers (0.12 mg/l), especially in wet weather and downstream of Breakneck Cr. The STEP-L model indicates that the Plum Cr. watershed contributes 5,799 lb of phosphorous from runoff, failing septic systems, unrestricted livestock access and eroding streambanks, related to excess stormwater and loss of flood storage. Mapping indicates alteration of at least 698 acres of wetland, loss of riparian features (floodplain access, riparian zone) of 12 miles of streams, and alteration of approximately 50% of riparian corridor within 75 feet. The alteration of watershed features reduces the flood-storage capacity and vertical stability of watershed tributaries. Further development and loss of riparian vegetation could result in increased loading and reduced storage in the future.

Goal / *Objective*	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Pl 3a Reduce streambank erosion, thereby reducing phosphorous associated with sedimentation by 15 lb per year.				
Pl 3a-1 Stabilize 1,000 lf of eroding tributary banks, improve morphology, and restore vertical stability, in order to reduce phosphorous loading by 5 lb/year. Target areas: eroding streams				
	Actions: See Pl 1a-1			
Pl 3a-2 Stabilize 3,000 l.f. of stream bank with livestock access, in order to reduce phosphorous loading by 10 lb/yr *Focus areas, e.g., Tributaries with livestock access*				
	Actions: See Pl 1a-2			
Goal Pl 3b Reduce phosphorous loading from urban runoff by 13.2 lb/yr.				
Pl 3b-1 Install 5,000 sq ft green infrastructure retrofit (permeable pavement) demo project to reduce phosphorous loading by 0.14 lb/yr *Focus areas, e.g., parking lots public facilities*				
	Actions: See Pl 1b-1			
Pl 3b-2 Install 6,000 sq ft of rain garden to reduce phosphorous loading by 0.1 lb/yr				
	Actions: See Pl 2b-2			
Pl 3b-3 Retrofit stormwater volume devices to improve water quality from 60 acres of residential land, in order to reduce phosphorous loading by 12 lb/yr				
	Actions: See Pl 1b-2			
Pl 3b-4 Plant 500 lf of roadside ditch with no-mow grass to reduce phosphorous loading by 0.2 lb/yr.				
	Actions: See Pl 1b-4			
Pl 3b-5 Install 500 lf of vegetated swale at Plum Creek Park to reduce nitrogen loading by 0.8 lb/yr.				
Pl 3b-6 Establish two chemistry/QHEI monitoring efforts along Plum Creek with volunteer, school, or university groups.				
Pl 3b-7 Conduct survey of yard management practices				
Pl 3b-8 Develop stormwater management design manual for Portage County				
Pl 3b-9 Maintain Stream database				1 database
Pl 3b-10 Conduct Education outreach to encourage golf course operators to adopt Audubon Habitat practices				2 contacts

Table Pl 4.3 Plum Creek Phosphorous
HUC 041100020301

Goal / *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Pl 3b-11 Conduct 2 workshops on use of BMPs at urban sites				
	Actions: See Pl 1b-7			
Pl 3b-12 Conduct public outreach by providing information and studies electronically or in print.				
	Actions: See Pl 1b-9			
Pl 3b-13 Conduct 18 outreach activities related to non-point source pollution and watershed issues.				
	Actions: See Pl 1b-10			
MCR-1 Establish 1 neighborhood-scale green infrastructure projects as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year, phosphorous by 25 lb/yr, and sediment by 5 tons/yr				
	Actions: See MCR-1 Problem Statement 1			
Goal Pl 3c Reduce phosphorous loading from agricultural runoff by 353 lb/yr				
Pl 3c-1 Install 3000 lf of livestock exclusion and accompanying measures to reduce phosphorous loading by 12 lb per year				
	Actions: See Pl 1c-1			
Pl 3c-2 Conduct survey of existing agricultural practices				
	Actions: See Pl 1c-2			
Pl 3c-3 Install grassed waterway/buffer strips to treat 50 ac and reduce phosphorous by 113 lb/yr.				
Pl 3c-4 Install cover crops to treat 100 ac and reduce phosphorous by 128 lb/yr				
Pl 2c-5 Increase use of residue on ag fields by an additional 50 acres, reducing nitrogen loading by 64 lb/yr				
Pl 2c-6 Construct 500 lf of 2-stage/overwide ditch along existing ditched channel, to reduce phosphorous loading by 46 lb/yr.				
Goal Pl 3d Reduce septic system failure to reduce annual loading of phosphorous by 122 lb				
Pl 3d-1 Correct 1 failing HSDS per year, reducing nitrogen loading by 122 lb/yr Focus areas: vicinity of water courses				
	Actions: See Pl 2d-1			
Goal Pl 3e Restore riparian features to reduce phosphorous loading by 43 lb/yr.				
Pl 3e-1 Plant 8 ac of deep-rooted riparian vegetation, reducing loading of phosphorous by 12 lb/yr Focus areas: large parcels single ownership, headwaters.				
	Actions: See Pl 1d-1			
Pl 3e-2 Restore 25 ac of wetland, in order to reduce phosphorous loading by 316 lb/year.				
	Actions: See Pl 1d-2			
Pl 3e-3 Restore 10 acre-ft of floodplain access, in order to store 8 lb of phosphorous per year.				
	Actions: See Pl 1d-3			
Goal Pl 3f Reduce causes of streambank erosion by reducing channel loading/increasing flood storage by 458,700 cu ft. in a 3/4 in storm.				
Pl 3f-1 Increase coordination between communities to reduce stormwater effects				
	Actions: See Pl 1e-1			
Pl 3f-2 Install 5,000 sq ft of permeable pavement/biofiltration in a developed site to reduce runoff by 800 cubic feet in a 3/4-inch storm.				
	Actions: See Pl 1e-2			
Pl 3f-3 Construct 6,000 sq ft of rain gardens, to reduce runoff by 262 cu ft in a 3/4 in event				

Table Pl 4.3 Plum Creek Phosphorous
HUC 041100020301

Goal				
Objective	**Actions**	**Lead/ cooperating organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
	Actions: See Pl 1e-7			
Pl 3f-4 Plant 8 ac of deep-rooted riparian vegetation, reducing channel loading by 5,800 cu ft in a 3/4 in storm.				
	Actions: See Pl 1d-1			
Pl 3f-5 Restore 25 ac of wetland, reducing channel loading by 16,500 cu ft in a 3/4 in event.				
	Actions: See Pl 1d-2			
Pl 3f-6 Restore 10 acre-ft of floodplain access, increasing storage volume by 435,600 cu ft.				
	Actions: See Pl 1d-3			
Pl 3f-7 Conduct outreach education with 2 golf courses to encourage use of Audubon International techniques.				
	Actions: See Pl 1b-11			
Pl 3f-8 Facilitate review and update of 2 local codes to include measures for green infrastructure				
	Actions: See Pl 1b-9			
Pl 3f-9 Update, increase, and disseminate available information concerning phosphorous from urban runoff				
	Actions: See Pl 1b-12			
Pl 3f-10 Increase/sponsor 18 stewardship activities related to non-point source pollution and watershed issues.				
	Actions: See Pl 1b-13			
Goal Pl 3-g Protect wetlands to reduce future loading of phosphorous by 632 lb/yr				
Pl 3g-1 Protect 100 acres of wetlands, preventing increased loading of phosphorous by 632 lb/yr Target areas: Plum Creek riparian area, vicinity of Kent Bog				
	Actions: See Pl 1f-1			
Pl 3g-2 Conduct 2 workshops on effectively implementing riparian setbacks				

Table Pl 4.4 Plum Creek - Groundwater Supplies/Contamination
HUC 041100020301

Plum Creek Problem Statement 4, Groundwater/public water supply contamination

The subwatershed contains the Portage County wellfield, both of which is susceptible to contamination from surface spills and leaks to groundwater. The public water supply has a source water protection plan, but the contributing groundwater zone is largely privately owned and susceptible to contamination from uses or spills.

Plum Cr. HUC 041100020301

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Pl 4a Conduct coordination and public outreach to provide information concerning potential risks to groundwater quality and protective measures.			
Pl 4a-1 Develop fact sheet(s) or web page describing how to obtain information concerning oil/gas wells, and the related permitting process, safeguards, and inspections.			
1 Coordinate with state agencies and communities concerning fracking and controls			
2 Coordinate with state agencies to receive notification of drilling permit requests			
3 Outreach to communities and property owners - website, brochures, etc., concerning permitting process, protective measures that can be taken, etc.			
Pl 4a-2 Conduct outreach with community officials and property owners within the 5-year time of travel to provide education concerning reducing groundwater contamination from land use			
1 Coordinate with water suppliers concerning outreach needs			
2 Apply for funding if needed			
3 Develop and disseminate outreach materials - written, website			
Pl 4a-3 Conduct baseline monitoring for groundwater contamination from or near wells			
1 Baseline monitoring for groundwater contamination from or near wells	Portage Water Supply	funding for certain analyses, others in-house?	
Pl 4a-4 Conduct outreach education with 2 golf courses to encourage use of Audubon International techniques.			
Actions: See Pl 1b-11			
Pl 4a-5 Update, increase, and disseminate available information concerning watershed protection			
Actions: See Pl 1a-12			
Pl 4a-6 Increase/sponsor 18 stewardship activities related to non-point source pollution and watershed issues.			
Actions: See Pl 1a-13			

Table Pl 4.5 Plum Creek - Habitat
HUC 41100020301

Plum Creek (Pl) Problem Statement 5: Habitat Loss

Alteration of approximately 700 acres of wetland, 50% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, channel form, floodplain access) along approx. 12 miles of watercourses has degraded riparian and wetland habitat in the subwatershed. Stream channel erosion degrades channel form and causes embedded substrate. The undisturbed riparian corridor and wetlands fringing much of lower Plum Creek have helped maintain the high quality of the creek in spite of agricultural and urban influences. A portion of the Kent bog wetland complex is protected as a nature preserve, but other Brimfield and Kent have wetland and riparian setback ordinances. However, to avoid the risk of encroachment or fragmentation, and conflicts related to private ownership, high value wetland complexes should be protected through easements or purchase.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Pl 5a Restore/improve 93 acres of altered habitat/stream channel morphology.			
Pl 5a-1 Plant 8 ac. of deep-rooted riparian vegetation. Focus areas: large parcels single ownership, headwaters.			
Actions: See Pl 1a-1			
Pl 5a-2 Restore/improve 25 acres of wetland habitat. Focus: *altered wetlands.*			
Actions: SeePl 1b-3			
Pl 5a-3 Restore 10 acre-ft of floodplain access/storage. Focus areas - areas with modified floodplain access.			
Actions: See Pl 1b-2			
Pl 5a-4 Remove/treat 50 acres of invasive species.			
Pl 5a-5 Conduct outreach education with 2 golf courses to encourage use of Audubon International techniques.			
Actions: See Pl 1b-11			
Pl 5a-6 Conduct feasibility study for removing small low-head dams			
Goal Pl 5b Reduce bank erosion from overloaded channels.			
Pl 5b-1 Stabilize 4,000 lf of eroding tributary banks, improve morphology, restore vertical stability, and reduce sedimentation. Target areas: eroding streams			
Actions: See Pl 1a-1			
Pl 5b-2 Increase coordination between communities to reduce stormwater effects			
Actions: See Pl 1e-1			
Pl 5b-3 Install 5,000 sq ft of permeable pavement/biofiltration in a developed site to reduce runoff by 800 cubic feet in a 3/4-inch storm.			
Actions: See Pl 1e-2			
Pl 5b-4 Construct 6,000 sq ft of rain gardens, to reduce runoff by 262 cu ft in a 3/4 in event			
Actions: See Pl 1e-7			
Pl 5b-5 Facilitate review and update of 2 local codes to include measures for green infrastructure			
Actions: See Pl 1b-9			
Goal Pl 5c Protect 50 acres of landscape features to prevent future habitat degradation.			
Pl 5c-1 Protect 50 acres of wetlands through acquisition or easement. *Focus areas: vicinity of Kent Bog, other high-value habitat areas noted in WAP, resources providing multiple ecological functions and habitat connectivity.*			
Actions: See Pl 1f-1			
Pl 5c-2 Update, increase, and disseminate available information concerning watershed habitats			
Actions: See Pl 1b-12			
Pl 5c-3 Increase/sponsor 18 stewardship activities related to stream channel health, non-point source, runoff, erosion, habitats, etc.			
Actions: See Pl 1b-13			

Table Pl 4.6 Plum Creek - Recreation
HUC 041100020305 (part)

Problem Statement Fi-6: Recreational Opportunities

Along Plum Creek and its tributaries are several public and private recreation, institutional, and open space parcels, including JayCee Park, Plum Creek Park, Tallmadge City/Schools parcels two golf courses, and the Portage bike-hike trail. In addition the Tom S. Cooperrider Kent Bog preserve offers passive recreation hiking through a tamarack bog. These provide the opportunity for a watershed-wide system of access or education.

Goal *Objective*	Actions	Lead/ cooperating organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Fi-6a: Increase recreational opportunities along Plum Creek and in the subwatershed by 1 mile/2 access points.				
Fi-6a.1 Expand hiking opportunities along Plum Creek and its tributaries by 1 mile.				
	1 Submit grant proposal	City of Kent	funding, plans, design - Kent State University students could help with assessments, etc.	
	2 Wetland delineations		Assistance from KSU classes	
	3 Design/build			
	4 signs			
	5 Brochure/outreach			
Pl 6a-2. Develop 1 River Quest or virtual watershed tour				
	1 Determine appropriate River Quest structure (cuyahoga canalway or new one)	WC, partners, volunteers, parks	Permission to develop quests, printing costs	2 quests by 2017 or 1 watershed tour by 2017
	2 Public workshop concerning River quests			
	3 Seek quests from volunteer groups			
	4 Review, print, distribute		funding for printing, place on website	
Pl 6a-3 Improve access points at 2 locations				
Goal Pl 6b: Increase awareness of recreational opportunities, stewardship, and watershed issues.				
Pl 6b-1. Economic impact study recreational uses		WC with KSU	outside funding	1 study by 2018
	1 Coordinate with KSU and others on study			
	2 Submit grant proposal			
	3 Conduct study			
	4 Publicize			
Pl 6b-2. Increase signage related to Plum Creek or watershed at local parks/conservation/recreation sites.				
	1 apply for funding			
	2 Design, install signs			8 signs by 2022
	3 Continued outreach with local communities			
Pl 6b-3 Update, increase, and disseminate available information concerning recreational opportunities and care of Plum Creek, its tributaries, and watershed.				
	1 Web page of recreational opportunities/access	wc		
	2 Other Actions - see Pl 1b-12			
Pl 6b-4. Increase stewardship activities related to watershed issues				
	Actions - Pl 1b-13			
Pl 6b-5. Acquire conservation land, targeting important resource protection areas (e.g., wetland complexes in vicinity of Plum Creek/Kent Bog)				
	Actions - See Pl 1f-1			

7 Br Breakneck Creek
HUC 041100020202

1 Summary of Existing Conditions

Table Br 1 summarizes some of the key characteristics of this subwatershed. Table Br 2 presents a summary of identified impairments, causes, and sources. Figure Br 1 shows the subwatershed and jurisdictions. Figures Br 2 and 3 have been compiled from mapping in Volume I and show potential areas of concern and resource areas for protection. (Greater detail is shown in the various maps in Vol. I.) Also see photos in Section 4P, Breakneck Creek.

Key concerns in this subwatershed include:
- addressing the impacts of the urbanized, altered landscape in the north, including heavily altered Wahoo Ditch;
- determining the cause of and addressing nutrient enrichment/algal blooms in Lake Hodgson and nutrient enrichment in Breakneck Creek;
- reducing agricultural sources of non-point source pollution;
- addressing failing septic systems;
- minimizing impacts from development;
- improving hydrology and stream morphology/habitat as possible along channelized streams;
- protecting the Kent wellfield;
- addressing improperly closed dumps/landfills;
- protecting the intact riparian corridor and wetland complexes along Breakneck Creek; and
- improving recreational opportunities.

The problem statements in Tables Br 4.1 through Br 4.8 address individual problems related to these concerns and may overlap. For instance, urban runoff, septic system failure, and agricultural runoff all contribute to the problems of nitrogen and phosphorous enrichment in Breakneck Creek and the Cuyahoga River.

Water Quality Assessment and Attainment *For problem statements/goals/objectives related to contaminants, refer to Problem Statements Br-4 and 8, (Groundwater and Contaminants, Wahoo Ditch and contaminants), Table Br 4.4 and 4.8; for problem statements related to channel morphology refer to tables 4.1-4.3, 4.5 and 4.6.*

Breakneck Creek, a low-gradient, sinuous swamp creek flows through a nearly intact corridor of wetlands, woods, and floodplains. Breakneck Creek was last monitored in 2000 and has been in attainment of water quality standards downstream to Wahoo Ditch. The most recent bioassessment indicated that Breakneck Creek was in partial attainment of WWH below the Ravenna and Franklin Hills wastewater treatment plants and then recovered at the junction with the Cuyahoga River. Noted causes and sources of impairment included organic enrichment/major point sources. However, since the 2000 bioassessment, the wastewater treatment plants have been upgraded. The Ohio EPA has not assessed the effect on biological communities.

Wahoo Ditch does not meet its MWH criteria due to the heavily urbanized nature of the ditch, legacy contamination, and extreme ditchlike morphology. It is a maintained ditch, but there may be potential for restoring some floodplain access.

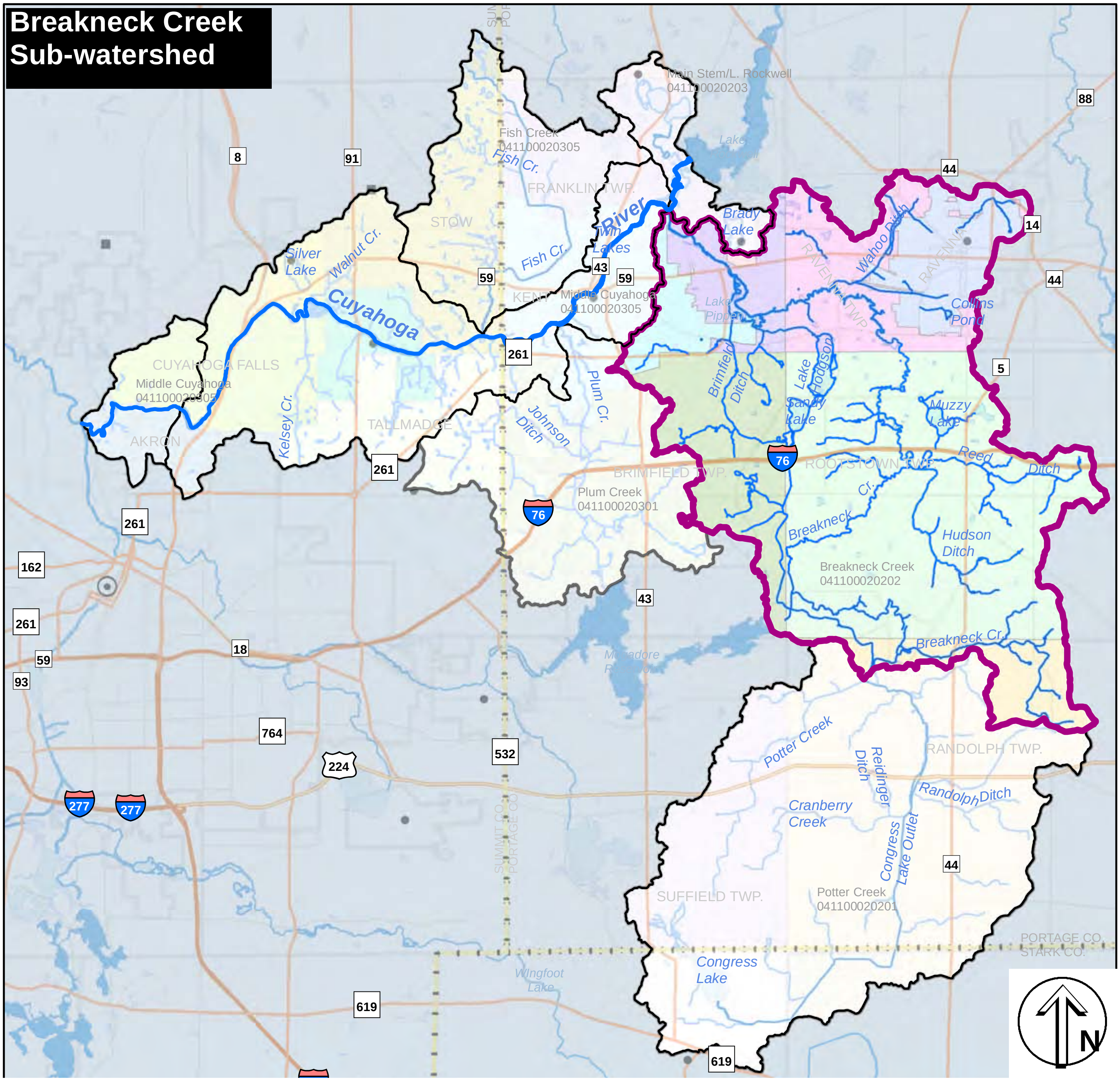


Figure Br-1
Subwatershed Jurisdictions

0 0.5 1 2 3 4 Miles

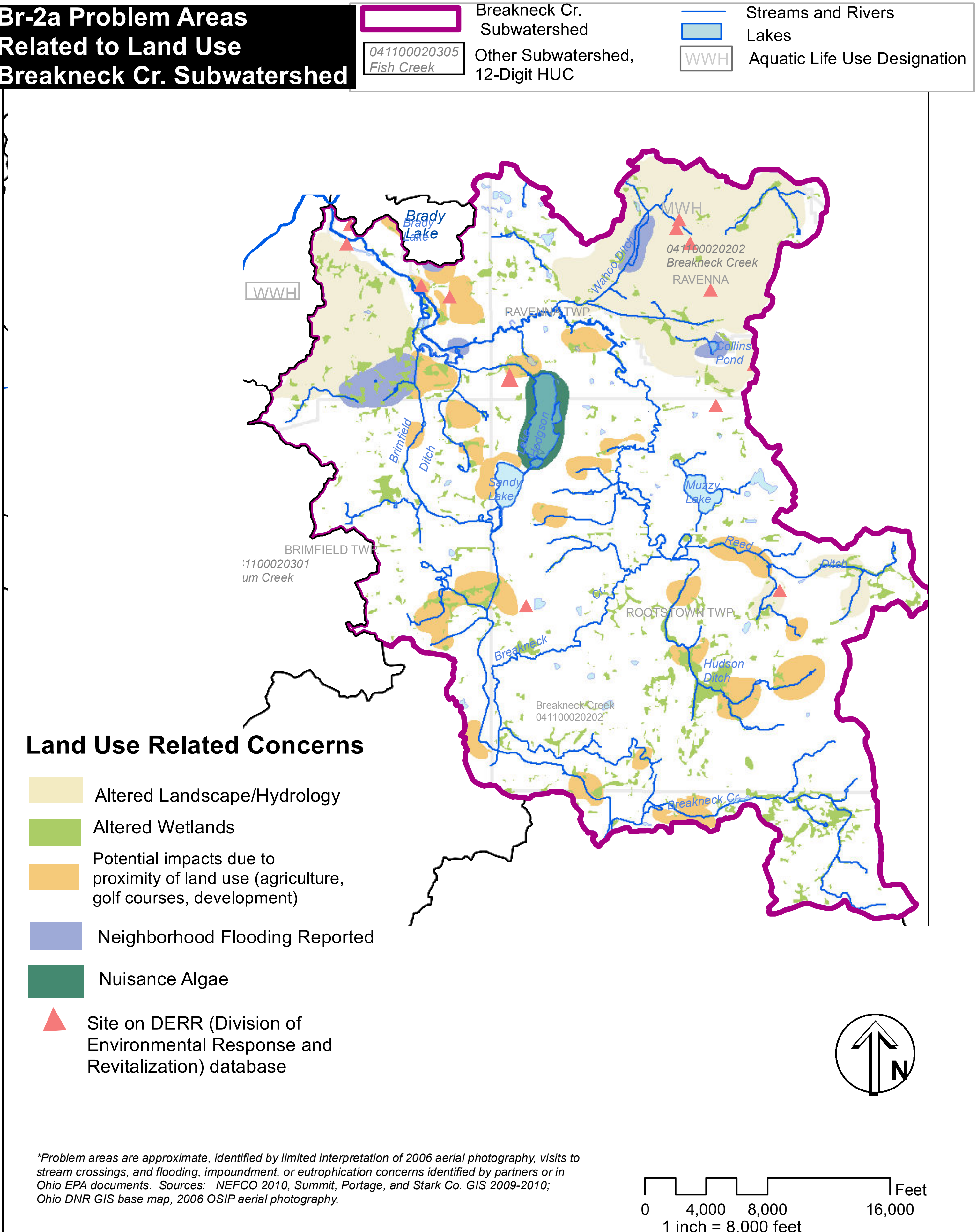
- Streams and Rivers
- Lakes
- Breakneck Cr. Subwatershed *12-Digit HUC: 041100020202*
- *Fish Creek 041100020305* Other Sub-watersheds
- Counties
- Jurisdictions outside watershed
- Interstate Highways
- State Divided Highways
- State Numbered Rtes
- Local Roads

Subwatershed Local Jurisdictions

- BRADY LAKE
- KENT
- FRANKLIN TWP.
- RAVENNA TWP.
- RAVENNA
- BRIMFIELD TWP.
- ROOTSTOWN TWP.
- RANDOLPH TWP.

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010

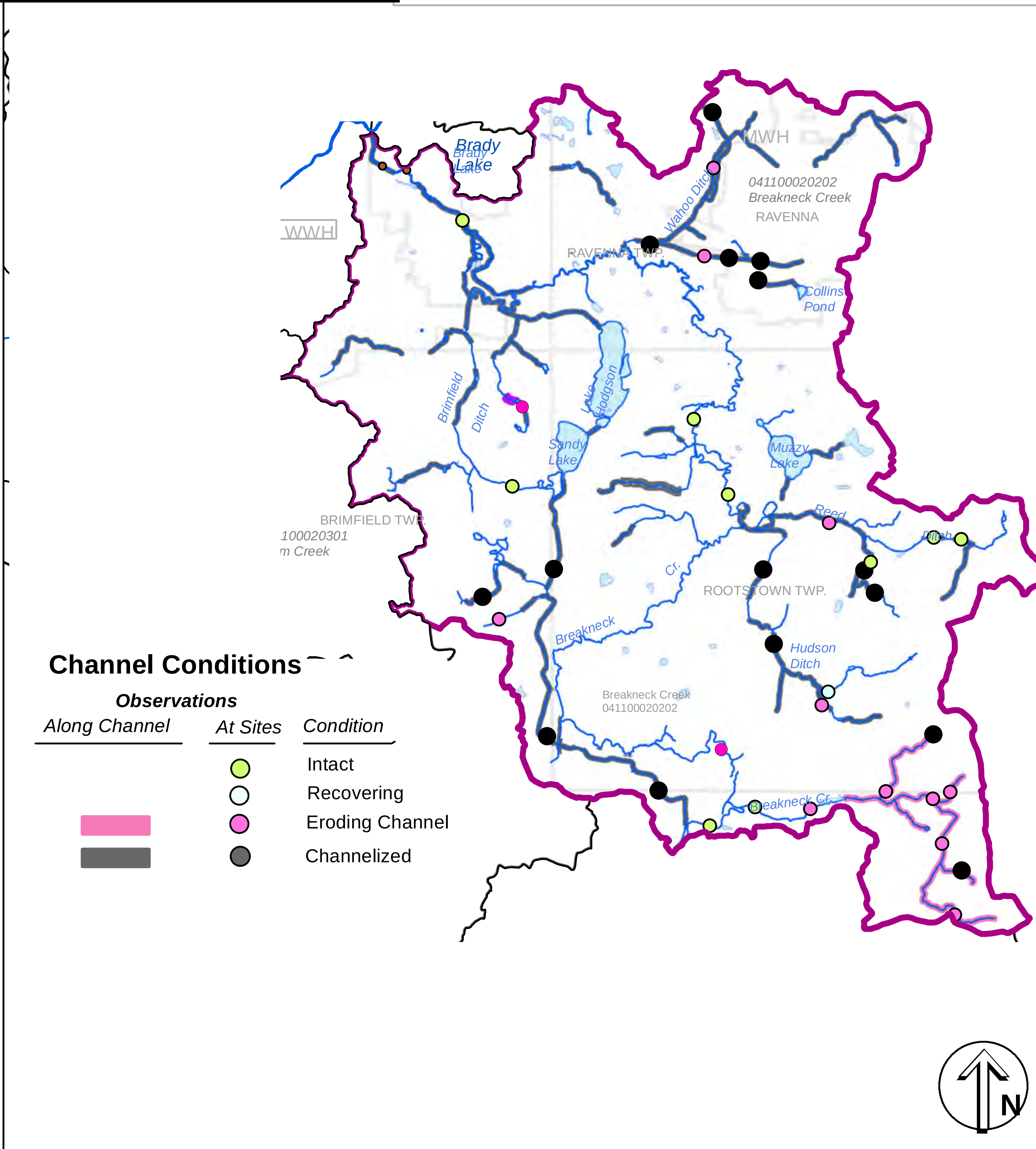
Br-2a Problem Areas Related to Land Use Breakneck Cr. Subwatershed



Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography.

Br-2b Problem Areas Related to Channel Condition Breakneck Cr. Subwatershed

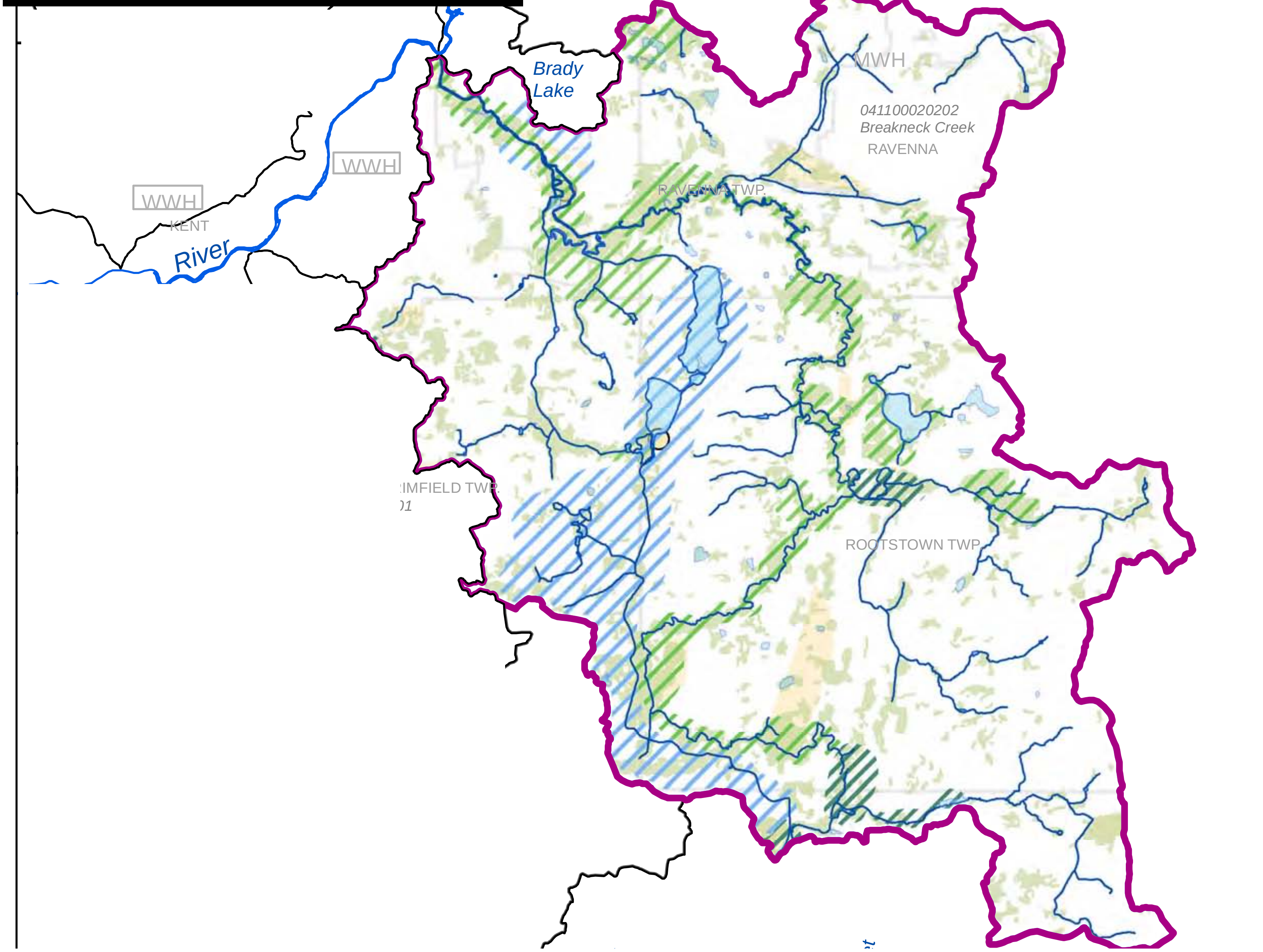
Breakneck Cr. Subwatershed
041100020305 Fish Creek — Other Subwatershed, 12-Digit HUC
Streams and Rivers
Lakes
WWH — Aquatic Life Use Designation



**Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography.*

Feet
0 4,000 8,000 16,000
1 inch = 8,000 feet

Br-3 - Conservation/Protection Priority Areas Breakneck Cr. Subwatershed



Conservation/Protection Priority Areas

- Riparian Corridor/Wetland
- Wetlands of Additional Importance (e.g., buffering) - enhance/protect
- Water Supply Protection - Conservation/BMPs/Outreach
- Mapped Wetlands
- Habitats or Species of Concern Identified on DNR biodiversity database spanning 30 years; Western Reserve Land Conservancy workshop, 2010.)

- Streams and Rivers
- Lakes
- WWH Aquatic Life Use Designation
- 041100020305 Breakneck Creek — Subwatershed, 12-Digit HUC
- Local Jurisdictions

N

0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet

*Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

Table Br 1
Summary of Breakneck Creek Subwatershed Characterisitcs

Concern	Amount/Item	Comments
Water Quality Attainment, latest assessed	Breakneck Cr., monitored until 2000, has generally been in attainment in the upper portions but has been in non-attainment from Wahoo Ditch downstream. The WWTP have been upgraded but there have not been additional bioassessments. Wahoo Ditch consistently is in non-attainment. The Feeder Canal attains MWH standards.	Cause/source: Breakneck Cr. – WWTP (upgraded since latest assessment); Wahoo Ditch – ditchlike conditions, legacy contaminants, channelization; urban influences
Public water supplies	Kent wellfield, recharged by Breakneck Cr.; Lake Hodgson	Taste/odor/algae at L. Hodgson
Land Cover acres, %	Developed 7,975 26.0% • *High Density 406 1.3%* • *Moderate Density 1,760 5.7%* • *Low Density 4,042 13.5%* • *Dev. Open Space 1,767 5.5%* Agricultural 8,316 32.2% Grassland/scrub-shrub 689 2.3% Woods/wetlands 11,183 37.5%	
Impervious/runoff	10.1% **Additional runoff 3/4" storm**: 40 million gal.	
75 foot buffer	Developed 16% *Dev. Open Space 1.7%* Agricultural 33% Woods/wetlands 48%	
Wetlands (ac)	**Mapped Converted** 1,739 ac. (hydric) 6,039 ac.(hydric incl.)	Urban areas may mask earlier wetlands
Development potential	Brimfield, Rootstown near I-76 developed rapidly from 2000-2007 and may do so again.	
Channel quality (miles)	**Intact** 25.3 **Altered/channelized** 47.4 **Eroding** 6.6 **Recovering** 4.7	Much of the intact channel is along Breakneck Creek, but tribs are altered.
Non-pt source load/yr	**Tot. N (lb)** 78,429 **Tot. P (lb)** 16,470 **Sed. (tons)** 2,592	
Septic systems	Approximately half presents 2 or more severe limitations to septic systems and is not served by sewers. In 2010, there were over 600 suspected illicit discharges in subwatershed communities.	
Problem areas	Wahoo Ditch; Lake Hodgson algae; eroding stream banks; unrestricted livestock access;	Upstream influences; streams most intact in woods
Resource areas	Kent wellfield 5 year zone and surface recharge; surface water public water supply and watershed; habitat/species of concern, wetlands	
Park/ conserv./inst.	Acreages to be filled in	
Riparian setback	Cities of Kent and Ravenna	
Recreational oppor.	Breakneck Creek preserve; Ravenna parks;	

Table Br 2 Breakneck Creek Summary of Impairments
HUC 041100020202

Attainment issue/other concern	**Cause**	**Source**	**Other likely sources**
Breakneck Creek – ranges from non-attainment to full attainment	Unknown toxicity (high) Flow alteration (high) Organic enrichment/DO (mod)	Major/minor municipal point source (high) Natural (high)	
Wahoo Ditch – non-attainment MWH-C, poor IBI, ICI	Habitat alterations (high) Organic enrichment (mod) Unknown contaminants	Urban runoff Channelization Sediment PPAH Legacy contaminants Severe ditchlike condition Channelization Major municipal point sources	
Lake Hodgson – high algae counts	Nutrients	Agriculture/ resid. development	
Elevated nutrient levels	Nutrients	Agriculture/ resid. development	
Bank erosion/ sedimentation	Excess water/limited flood storage/loss of vertical stability		Loss of floodplain storage, bank vegetation
LOCAL/Other CONCERNS			
Hommon Ave. Ditch – erosion			Urban runoff, lack of flood storage
Potential loss of wetlands, habitat			
Wellhead protection			Fracking, runoff urban runoff
Flooding: Wahoo Ditch, Collins Pond			Excess storm water, limited flood storage
Protect water supplies			Contamination from fracking, land use
Old Landfills			Ground/surface water contam.

<u>Nonpoint source pollution – Sediment, Nutrients (nitrogen, phosphorous)</u> *(Refer to Problem Statements Br 1, 2 and 3, Tables Br 4.1-4.3)*

Sediment has not specifically been identified as a cause of non-attainment in Breakneck Creek, but it is of concern in the main stem of the Cuyahoga River, and during storm events, suspended solids at the mouth of Breakneck Creek are comparatively high. Portions of headwater streams also show embeddedness. Nutrients, which are a cause of non-attainment, are exported to the river along with sediment.

The lower portion of Breakneck Creek and the Cuyahoga River downstream of Breakneck Creek are somewhat enriched in nutrients. Limited water chemistry data indicate several instances when state median or criteria values were exceeded for phosphorous or nitrogen. Because higher values often coincide with increased flows (apparently post-storm), runoff is likely a contributing factor. The lower, more urbanized, portion of Breakneck Creek exhibits the highest levels of nutrients. Lake Hodgson, which generally receives water from a small area of the Breakneck Creek subwatershed, exhibits elevated chlorophyll and phosphorous levels. The City of Ravenna uses in-lake techniques to reduce the effects of algae in Lake Hodgson, but managing algae will require reduction of nutrients from the watershed as well.

The STEPL model indicates that the Breakneck Creek watershed contributes 78,429 pounds per year of nitrogen, 16,470 pounds per year of phosphorous, and 2,592 tons per year of sediment from a combination of urban, rural residential, and agricultural sources, eroding stream banks, and septic systems. The model assumes that 75 percent of farms use reduced tillage practices.

Factors contributing to non-point source pollution include

- *High percent of imperviousness* in the northern portion of the subwatershed,
- A large portion of agricultural land, especially in the southern portion. Agricultural producers are using various practices (e.g., cover crops, buffers, conservation tillage) to varying and unknown degrees.
- *Runoff from development* in Brimfield and Rootstown,
- *Unrestricted livestock access* at two observed locations
- *Septic systems* - Approximately half of the subwatershed presents two or more severe limitations for septic systems and is not served by sewers, indicating the potential for failure of older systems. Over 600 potential illicit discharges have been identified in subwatershed communities.
- *Channelization and alteration of channels, floodplain access, and wetlands*. Approximately 58 miles of stream corridor, 7,633 acres of riparian corridors within 75 feet, and 1,739 acres of wetland on hydric soils have been channelized or altered in the agricultural and urbanized areas, reducing their ability to absorb, filter, and store storm water, sediment, and the non-point source pollutants entering the streams from the landscape. Breakneck Creek remains largely intact, but much of the tributaries appear channelized.
- *Eroding streambank.* These contribute nitrogen, phosphorous, and sediment, and are often associated with high volumes, lack of floodplain access, and unstable banks from livestock access. Eroding streambanks have been observed at the southeastern Breakneck headwater tributaries (agricultural area), Feeder Canal (rural residential/developing area, affected by volume), Hudson and Reed Ditches (developed area), Breakneck Creek below Hudson and Reed Ditches, and Wahoo Ditch (channelized stream in heavily developed area). Some eroding banks appear to be associated with

livestock access (e.g., Brimfield Ditch at Meloy, Breakneck Creek at Cline), while others (Breakneck headwaters, lower end of Reed Ditch, Wahoo Ditch, Feeder Canal) appear to be related to stormwater volume and lack of floodplain access. There may be potential for improving flood storage through floodplain or wetland restoration along portions of Wahoo Ditch, Hudson/Reed Ditches.

Potential for degradation of riparian/wetland features - The wetlands and floodplains flanking Breakneck Creek appear to be reducing the effects of channel alteration and runoff upstream and maintaining the high quality of Breakneck Creek. Protecting these areas from further encroachment will be one of the most effective ways to reduce future problems related to nutrients and volume/erosion.

Public Water Supplies *(Refer to Problem Statement Br 4 Table Br 4.4)*

The Breakneck Creek subwatershed contains two major public water supplies.:

- The City of Kent's wellfields, recharged in part by Breakneck Creek. Concerns have been raised about potential contamination from hydraulic fracturing ("fracking"), and several inventoried sites (e.g., dumps).
- Lake Hodgson, the City of Ravenna's water supply. Lake Hodgson is generally fed by groundwater and runoff from a small watershed, but occasionally receives water from Congress Lake/ Congress Lake Outlet. The Ravenna public water supply has had taste and odor problems from excessive algal growth due to nutrient enrichment (nitrogen/phosphorous). In managing eutrophic lakes, it is important to reduce both the influx of new nutrients from the watershed and also those resident in the sediments.

Flooding *(Refer to Problem Statement Br 5 Table Br 4.5)*

Reed Ditch, the Feeder Canal, Wahoo Ditch, Collins Pond, and Brimfield Ditch are influenced by runoff from impervious surfaces in developed areas. The watershed as a whole is 10 percent impervious, but the northern, developed portion is between 15 and 20 percent impervious, with Individual areas having a higher percentage of imperviousness. The altered channel form, floodplain access, and wetlands noted above reduce the ability of the landscape to handle storm events, increasing damaging floods:

- Homes near Collins Pond experience flooding. This area is mapped as poorly drained "D" soils and wetlands. The flow from Collins Pond apparently has been culverted and channelized. The City of Ravenna has recently enacted a riparian setback ordinance, which will help prevent further development in this unsuitable area.
- Brimfield Ditch appears to be largely channelized. Repeated flooding problems have occurred near the confluence of Breakneck Creek and Brimfield Ditch.
- Flooding problems have been noted along Wahoo Ditch near Route 59 west of Ravenna, a maintained ditch with no floodplain access in a largely impervious area.
- Flooding has been noted at the Breakneck Creek crossing of Lakewood Road, an area where the channel has been altered.

Habitat and Conservation Areas *(Refer to Problem Statement Br 6 Table Br 4.6, also problem statements related to non-point source pollution and flooding)*

Approximately 54 miles of streams in the subwatershed are either eroding or channelized, degrading habitat by altering the riparian zone, floodplain access, stream channel sinuosity and cross-section, rate of flow, and substrate. Wahoo Ditch is in non-attainment of MWH status due in part to its extreme ditchlike character. Approximately 1,739 acres of wetland on hydric soil and 50% of the 75-foot riparian corridor have been altered, degrading important habitats.

Approximately 28 miles of Breakneck Creek flows through a broad riparian corridor of woods, wetlands, and floodplains, much of which has been identified in the Portage County Watershed Plan and in the Western Reserve Land Conservancy workshop as high value. The wetlands that line the margins of Breakneck Creek likely reduce much of the impacts of the agricultural and channelized lands upstream. Riparian corridors and other high value features outside the incorporated areas are vulnerable to development. Several areas of species of concern are found in the subwatershed, and most remain unprotected.

Alteration of wetlands is regulated under state and federal permitting requirements. Kent, Ravenna, and Brimfield have riparian setback regulations. While these laws offer some protection, this important corridor and other high value resources (e.g., Kent wellfield) could still be vulnerable to impacts from development.

Portage County and local cities, and the Nature Conservancy own several key parcels in this subwatershed, including land around Lake Hodgson and Muzzy Lake. The Sandy Lake Association also holds several parcels adjacent to Sandy Lake for hunting by members. However, large tracts of wetlands and floodplains along Breakneck Creek remain unprotected.

Key areas to focus preservation efforts include:

- Wetland-floodplain systems fringing the length of Breakneck Creek, which extensive, intact habitat corridors and handle and provide treatment for large volumes of water.
- At the confluence of Reed and Hudson ditches – a wetland complex likely mitigates the damaging effects of the combined ditches on the creek.
- A wetland immediately upstream of the confluence of the Breakneck Creek headwaters with Congress Lake Outlet appears to be reducing the effects from the degraded channels upstream, as the channel downstream of the wetland appears intact.
- Wetlands at the upstream end of Sandy Lake may be improving water quality of the Feeder Canal entering the water supply.

Recreational Opportunities *(Refer to Problem Statement Br 7 Table Br 4.7)*

There are limited opportunities for access to and recreation along Breakneck Creek. Portage Park District owns a parcel along the banks of the creek at Lakewood Rd., but this parcel is currently not developed for recreation and offers limited access. The City of Ravenna has developed parks in the watershed. Boating is allowed on Lake Hodgson. Conservation parcels in the subwatershed allow passive recreation (e.g., hiking). The Portage Bike-hike trail crosses Breakneck Creek near its confluence with the Cuyahoga River.

2 Problem Statements, Goals, Objectives, and Actions

Table Br 3 summarizes the actions proposed in the subwatershed and their associated pollutant load reductions, listing which problem statements/goals employ these tools. Tables Br 4.1 through 7 present the problem statements, goals, objectives, and actions for each problem area. The tables are numbered to reflect each problem statement number, e.g., Table Br 4.1 corresponds to Problem Statement Br-1. It should be noted that because many of the objectives address more than one goal, the actions associated with each objective are listed only once, in the first table in which they appear (most frequently, Table Br 4.3). All other listings of the same objective refer back to the actions at their first occurrence.

Refer to Sections 6 and 7 Introduction for a discussion of the format of the problem statements, goals, objectives, actions, and considerations for implementation.

Table Br-3 Action Item Summary by Subwatershed: Breakneck Creek

12-digit HUC/ Water Body	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Contamin. Sites	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020202														
Breakneck Creek								**Brownfields**						
Breakneck Cr./ Wahoo Ditch, tribs			√				√	Conduct brownfields inventory	1	inventory				
Breakneck Cr./ Wahoo Ditch, tribs			√				√	Determine status of listed sites	11	sites				
Breakneck Cr./ Wahoo Ditch, tribs			√				√	Brownfields plan	1	plan				
								Riparian Restoration						
Breakneck Cr. - Wahoo Ditch/ Brimfield Ditch	√	√						Restore Streambank (Bio-Engineering/ re-contouring/ re-grading)	3,000	Linear Fee	$25-200/lf	207	300	112
Breakneck Cr./tribs	√	√		√	√			Plant Native plants, trees, or shrubs in Riparian Areas	12	Acres	$6,000 + labor shrubs	6	93	17
Breakneck Cr. watershed								Remove/treat Invasive Species	50	Acres				
								Stream Restoration						
Breakneck Cr./ Wahoo Ditch/tribs	√	√		√	√			Restore Flood Plain	50	Acre-foot		22	300	41
Breakneck Cr./ Wahoo Ditch/tribs								Restore Channel	5000	Linear Feet	$100-200/lf			
B Creek/ Collins Pd/ Brimfield D./ Wahoo Ditch				√				Hydrological study in flood-prone area	1	study				
								Feasibility study to remove small low-head dams	1					
								Wetland Restoration						
Breakneck Cr. - Reed/ Hudson Ditch/ Feeder Canal	√	√		√	√			Reconstruct, reconect, & Restore Wetlands	80	Acres	$5k-100k/ac.	80	2240	506
								Home Sewage Treatment Systems						

Table Br-3 Action Item Summary by Subwatershed: Breakneck Creek

12-digit HUC/ Water Body	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Contamin. Sites	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Breakneck Cr. Wshed		√						Obtain correction of failing HSTS	30	HSTS			933	366
								Urban runoff and green infrastructure						
Breakneck Cr. Wshed	√	√		√				Rain gardens	20,000	sq feet	$500,000		2.00	0.50
Breakneck Cr. Wshed		√		√				Parking lot retrofit - permeable pavement/ biofilt.	10,000	sq feet	$200,000		2	0.4
Breakneck Cr. Wshed	√	√		√				Storm water inventory	1	inventory				
Breakneck Cr. Wshed	√	√						Storm water retrofits	100	acres treated	$400-17k/ ac	4.5	70.1	10
Breakneck Cr. Wshed	√	√						Retrofit drainage - No-mow ditch/ grassed swale/ daylighting	2,000	linear feet		0.2	1.6	0.8
Any middle cuyahoga watershed								Neighborhood-scale green infrastructure			$25-50k design $20k bumpouts			
Breakneck Cr. Wshed	√	√						**Agricultural BMPs**						
Breakneck Cr. Wshed	√	√						Survey of practices	1	survey				
uncontrolled livestock access along Breakneck Cr and tribs	√	√			√			Install Livestock Exclusion Fencing & accompanying watering measures	3,000	Linear Feet	$11,300 + watering	140	280	140
uncontrolled livestock access along Breakneck Cr and tribs	√	√			√			Install Alternative Water Supplies	1	Supplies				
Breakneck Cr. Ag tribs or ditch	√	√			√			Construct 2-Stage Channel/overwide	1,000	Linear Feet			295	91
Breakneck Cr./ Wahoo Ditch/tribs	√	√						Install Grassed Waterways/ vegetated buffer strips	100	Acres treated		177	466	26
Breakneck Cr. Wshed	√	√						Cover crops	100	acres		101	240	120

Table Br-3 Action Item Summary by Subwatershed: Breakneck Creek

12-digit HUC/ Water Body	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Contamin. Sites	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Breakneck Cr. Wshed	√	√						Residue applied to fields	200	acres		202	480	120
uncontrolled livestock access along Breakneck Cr and tribs	√	√			√			Livestock Crossings	1	Crossings				
								Conservation Easements						
Breakneck Cr. Wshed	√	√		√	√	√		Acquire Wetlands/ easements	100	Acres	$5-25k/ac	prevent 100	prevent 2800	prevent 632
Breakneck Cr. Wshed	√	√	√	√	√	√	√	**Education and Outreach**						
								Brochures/Fact Sheets	10	Brochure				
								Watershed/tributary Festivals	10	Festivals				
								Websites	1	Website				
								Install Signs	24	Signs	200-500			
								Develop Displays		Displays				
								Tours/canoe floats		Tours				
								Stream Clean-Ups	3	Clean-				
								New lake/stream stewardship groups	1	new group				
								Workshops/Training	5	Workshop				
								Develop Manual(s)	1	Manuals				
Breakneck Cr wshed				√				Rain barrel workshops	250	barrels				
								Develop Newsletters	10	Newslette				
								Local Policy						
Breakneck Cr wshed	√	√		√	√			Riparian setback	1	code		prevent 22	prevent 320	prevent 57
Breakneck Cr wshed	√	√		√	√			Green code audit/update	2	audits/ updates				
								Monitoring						
BC wshed - Lake Hodgson/feeder Canal		√						Chemical Sampling	4	Sites				

Table Br-3 Action Item Summary by Subwatershed: Breakneck Creek

12-digit HUC/ Water Body	Sed	Nutrients	GW contam	Flooding	Habitat	Recreation	Contamin. Sites	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Breakneck Cr., tribs								Macroinv./ Fish/ Habitat Sampling		Sites				
Breakneck Cr., tribs								Fish (IBI) Sampling	3	Sites				
Breakneck Cr., tribs								Habitat (QHEI/HHEI) Sampling	3	Sites				
								Recreation						
Breakneck Cr. Wshed								Construct trail	2	miles				
Breakneck Cr.						√		Construct water trail/access sites	1	site				
Breakneck Cr. Wshed						√		Economic benefit study	1	study				
Breakneck Cr. Wshed						√		Develop quest(s)/ virtual watershed tour	3 quests/ 1 tour					
												939.7	5702.7	1550.7

Table Br 4.1 Breakneck Creek - Sediment
HUC 041100020202

Problem Statement Br-2: sediment

While siltation has not been listed as a cause of non-attainment in Breakneck Creek, some tributaries exhibit embeddedness, eroding banks contribute nitrogen and phosphorous, and TSS levels were comparatively high at the mouth of Breakneck Creek during high flow (35 and 47 mg/l July 2007), which affects sediment levels in the Cuyahoga River. Siltation has been identified in the Cuyahoga River as a cause of non-attainment and is of concern in the shipping channel in Cleveland.

The STEP-L model indicates that the watershed generates 78,429 lb/yr of sediment from urban runoff, eroding banks, agricultural runoff, and failing septic systems. systems. Alteration of at least 1,739 acres of wetland, 50% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 54 miles of watercourses has reduced the sediment uptake of the system. Further development and alteration of riparian vegetation could result in increased loading in the future.

Goals / ***Objectives*** / Actions	**Lead/ cooperating Organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Br 1a Reduce non-point source pollution from urban runoff to reduce annual loading of sediment by 11.5 tons.			
Br 1a-1 Plant 12 ac.of deep-rooted riparian vegetation, reducing loading of sediment by 7 tons /yr Focus areas: large parcels single ownership, headwaters.			
1 Submit grant applications e.g., OEEF	WC/SWCDs/partners		
2 Targeted outreach to public, institutional, and other owners of large properties	WC**/SWCDs/ Communities	Lists of golf courses, lake associations, homeowners' associations; maps of large parcels; printed outreach materials.	Target 1 group every 3 years (3 by 2022); improvements to best management practices or riparian management at one site every 4 years(2 sites by 2020); 2 outreach contacts per year
3 Outreach to golf course owners encouraging Audubon-certification		labor, printing	
4 Assist with plantings	SWCDs, master gardeners	native plants/trees and shrubs $500-1,000/ac	
5 Construct and install signage	communities, partners,	$300-500/sign	
6 Follow-up outreach (individualized guide to riparian zone) and publicize		funding for handouts/brochures	
Br 1a-2 Retrofit stormwater volume devices to treat 100 acres of commercial/institutional land and improve water quality, reducing loading of sediment by 4.5 tons/yr			
1 Stormwater retrofit inventory		WC/NEFCO with communities	
2 Submit grant application			
3 Design/construct retrofit for existing stormwater (volume) infra-structure to improve water quality	Communities	Varies, depending on treatment provided (e.g., $400/acre treated to $17,000 per acre treated)	Retrofit 5 by 2022, 1 every 8 years afterward
Br 1a-3 Retrofit 2,000 lf of drainage with no-mow grass, daylighting, or grass swale as a demonstration project, reducing sediment loading by 0.2 tons per year			
1 Workshop on drainage improvements/ditch maintenance for water quality improvements	SWCD	Location, materials	
2 Identify site			
3 Seek funding			
4 Prepare site/install no-mow grass/retrofit			
5 outreach			

Table Br 4.1 Breakneck Creek - Sediment
HUC 041100020202

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Br 1a-4 Review two development codes and update one to encourage use of green infrastructure in new developments.			
1 Submit grant application	WC		
2 Green infrastructure codes workshop	WC, partners, CSU, developers	Funding for outside assistance, location, materials	1 workshop series by 2015
3 Evaluate and update local ordinances for opportunities to reduce pavement, improve use of green infrastructure, conservation development, etc. in new/existing development	WC/communities	Volunteers/ interns can assist - outside funding could be used for consultant and/or work-shop - could be done with Portage zoning official meetings	2 code audits by 2017; update 1 code by 2018 (Kent/Portage??)*
4 Revisions to community development codes to better incorporate green infrastructure		partner communities, possibly funding for outside consultant	update 1 code by 2018
Br 1a-5 Update, increase, and disseminate available information concerning sediment from urban runoff			
1 Continue to compile, centralize, and make available studies, data, information sources on the watershed, including recreational opportunities, volunteer needs, permitting or regulatory issues; green infrastructure information sources, etc.	WC	Website, technical information and outreach materials	Update and develop pages for website by Dec. 2013, then on-going
2 Chemical or biological sampling/assessment along streams - volunteer, intern, or class	Community/partner sponsors, Ohio EPA, KSU interns/classes	possibly funding for stipends, analysis, equipment	Sampling at 1 location every 3 years. 3 sample sets by 2022.
3 Survey of yard management practices	WC/partners		
4 Continue to develop stream database			
5 e-newsletter or article issued 3 times per year	wc	website, share with partners	
6 Develop/reproduce informational brochure or website article concerning topics of interest, including reducing runoff, recreational opportunties, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	10 by 2022; 1 each year
Br 1a-6 Increase/sponsor 25 stewardship activities related to non-point source pollution and watershed issues.			
1 Establish clean-up/monitoring/planting efforts at additional tributaries and lakes	WC, communities, parks, residents, home-owners' associations, lake associations	Funding or donation of trash disposal, refresh-ments, monitoring supplies, crew leaders, volunteers; training for monitoring/planting	1 new tributary or lake monitoring, clean-up, or other stewardship program by 2018
2 Distribute 250 rain barrels through workshops	SWCDs/ Communities	Space for workshop; rain barrel kits	5 workshops/50 rain barrels distributed
3 Survey of yard management practices	WC/partners		

Table Br 4.1 Breakneck Creek - Sediment
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Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
4 Develop/reproduce informational brochure or website article concerning topics of interest, including reducing runoff, recreational opportunties, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	10 by 2022; 1 each year
5 Educational outreach workshops on topics of importance, including LID/green infrastructure, restoration, field trips for examples	Partners, WC, communities	Location, speaker, supplies	5 workshops by 2022; 1 every 2 years
6 Work with schools or city day camps to develop/encourage use of watershed care activities/curricular items	WC, SWCDs, partners, schools		1 educational outreach program/curriculum item by 2018
7 Breakneck Creek Day (others?)	Portage Parks, partners		1 per year
8 Watershed "brand," logo, art project	WC, Kent State/ Standing Rock Gallery/River Day	Host for project, graphic design capabilities	1 logo or art project by 2015, then 1 every 3 years;
9 Create social network or google presence	WC		1 by 2014
Br 1a-7 Develop storm water management design manual for Portage County			
Storm water management design manual	Portage SWCD	In-house task	1 manual by 2014
MCR 1 Establish 1 neighborhood-scale green infrastructure project as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of sediment by 200 lb/year			
1 Work with communities to identify suitable target neighborhoods	WC, partners		
2 Workshops/meetings to gauge neighborhood support			
3 Determine/establish maintenance framework (e.g., easements, homeowner participation)	partner community		
4 Submit grant application			
5 Design/build	outside consultant	Site, outside funding. Design ~$25-50,000; Rain gardens $15-20/sq. foot; Green street bump-outs $20,000 each; per-meable concrete $12-15/ sq. ft	1 project by 2022
6 Outreach, neighborhood participation			

Table Br 4.1 Breakneck Creek - Sediment
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Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Br 1b Reduce bank erosion to reduce sediment loading by 79.5 tons/year.			
Br 1b-1 Stabilize 3,000 l.f. of eroding/incised/channelized bank, reducing sediment loading by 79.5 tons/yr *Focus areas, e.g., eroding stream banks with livestock access, headwaters, Brimfield Ditch, other ditches*			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2013, revisit and update if necessary every 3 years
2 Hold focus meetings to discuss areas of interest, including Wahoo Ditch, Brimfield Ditch, Breakneck headwaters, Feeder Canal	WC, partners		8 meetings to determine focus of restoration efforts along specified (and other) streams
3 Hold meetings with landowners to determine interest	WC, partners		
4 Submit grant applications	WC, partners		
5 Restore floodplain access/flood storage		design-build consultant	
6 Public outreach			
Br 1b-2 Restore 50 acre-feet of floodplain access/storage, reducing channel loading by 2,178,000 cu. Ft.. *Focus areas - areas with modified floodplain access. and at/upstream of flooding problem areas, e.g., Wahoo Ditch, Brimfield Ditch, Feeder Canal, Breakneck headwaters*			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
2 Hold meetings to determine landowner interest	WC, partners		
4 Submit grant application			
5 Restore floodplain access/flood storage	design-build consultant	funding for design-build consultant	
6 Public outreach			
Br 1b-3 Restore 80 acres of wetland thereby increasing storage by 76,000 cubic feet of water in a 3/4 inch storm.			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
2 Hold meetings to determine landowner interest	WC, partners		
3 Identify wetland restoration site for clearinghouse	WC, Communities, other partners	meetings with landowners; readily available mapping, outside assistance from consultant, possible assistance from Kent State University wetland ecology class	5 concept plans by 2020; 1 every 2 years afterward.
4 Submit grant application			
5 Restore/protect/enhance wetlands	Partners	$5,000-$100,000 per acre, design/build consultant, sites -protection by easements would be at the low end of the range	20 ac by 2022; 10 ac every 5 years afterward

Table Br 4.1 Breakneck Creek - Sediment
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Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Br 1b-4 Install 20,000 sq ft of rain garden, reducing channel loading by 3,750 cu ft in a 3/4 inch storm			
1 Identify partners and sites	WC, partners		
2 Submit grant application	WC/partners		
3 Workshop/installation	WC/partners	Small rain gardens: Approx. $500 for materials for 100 rain garden of approx. 100 square feet, with amended soil. Cost depends on whether labor and materials are donated. Larger rain garden projects can be in the thousands or tens of thousands of dollars, depending on the level of engineering.	1 project or 300 square feet by 2022, an additional project in the following 5 years
Br 1b-5 Install 10,000 sq. ft. of biofiltration/permeable pavement in a developed site, reducing channel loading by 1,875 cu ft in a 3/4 in storm			
1 Identify parcel(s) and landowner(s) for project	partners, WC		
2 Grants	WC/partners		
3 Design/construct BMPs	outside consultant		
4, 5, 6 Green infrastructure workshops, code revision	(see Br 1a-4)		
Br 1b-6 Facilitate installation of 250 rain barrels, thereby reducing stream channel loading by 1,376 cu ft in a 3/4-inch storm.			
1 Obtain funding			
2 Obtain rain barrel materials			
4 Workshop		space, rain barrel materials, outreach, staff time	
5 Outreach			
Br 1b-7 Plant 12 ac of deep-rooted riparian vegetation, thereby reducing channel loading by 1,782 cu ft in a 3/4 inch storm .			
Actions: See Br 1a-1			
Goal Br 1c Reduce agricultural runoff to reduce annual loading of sediment by 620 tons			
Br 1c-1 Conduct survey of existing practices			
1 Develop survey of existing practices	WC, KSU?, NRCS		
2 Administer survey to willing landowners			
3 Windshield survey of visible practices			
4 Tally and summarize survey results			
5 Outreach with property owners based on survey			
Br 1c-2 Work with landowners to treat 100 acres of agricultural land with grassed waterways/vegetated filter strips, to reduce annual sediment loading by 177 tons			
1 Identify need and willing landowners			
2 Obtain funding			
3 Design/install			
4 Outreach			

Table Br 4.1 Breakneck Creek - Sediment
HUC 041100020202

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Br 1c-3 Work with landowners to install 100 ac of cover crops, reducing annual sediment loading by 101 tons.			
1 Identify need and willing landowners			
2 Obtain funding			
3 Install			
4 Outreach			
Br 1c-4 Work with landowners to use residue on 200 acres, to reduce annual sediment loading by 202 tons.			
1 Identify need and willing landowners			
2 Obtain funding			
3 Design/install			
4 Outreach			
Br 1c-5 Install 3,000 lf of livestock exclusion and accompanying measures to reduce sediment loading by 140 tons per year			
1 Contact landowners to determine willingness			
2 Submit proposal for grant funds			
3 Work with landowners to install measures			
4 Outreach			
Goal Br 1e Restore riparian features to reduce sedimentation by 108 tons/yr .			
Br 1e-1. Restore 80 ac of wetland, reducing loading of sediment by 80 tons/yr. Focus areas -altered wetlands in central watershed or headwaters.			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2013, revisit and update if necessary every 3 years
2 Hold meetings to determine landowner interest	WC, partners		
3 Identify wetland restoration site for clearinghouse	WC, Communities, other partners	meetings with landowners; readily available mapping, outside assistance from consultant, possible assistance from Kent State University wetland ecology class	5 concept plans by 2020; 1 every 2 years afterward.
4 Submit grant application			
5 Restore/protect/enhance wetlands	Partners	$5,000-$100,000 per acre, design/build consultant, sites -protection by easements would be at the low end of the range	20 ac by 2022; 10 ac every 5 years afterward
Br 1e-2 Restore 50 acre-feet of floodplain access/storage, reducing annual sediment loading by 22 tons/yr. *Focus areas - areas with modified floodplain access. and at/upstream of flooding problem areas, e.g., Brimfield Ditch, Collins Pond, Wahoo Ditch*			
Actions: See Br 1b-2.			
Br 1e-3 Plant 12 ac.of deep-rooted riparian vegetation, reducing loading of sediment by 7 tons /yr Focus areas: large parcels single ownership, headwaters.			
Actions: See Br 1a-1			
Br 1e-4 Restore 3,000 lf of incised/channelized stream			
Actions: See Br 1b-1			

Table Br 4.1 Breakneck Creek - Sediment
HUC 041100020202

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Br 1f Protect landscape features to prevent future sediment loading by 116 tons/yr.			
Br 1f-1 Protect 40,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1, reducing loading of sediment by 16 tons/ yr			
1 Workshops for community officials on developing/enforcing riparian setbacks	Portage County Regional Planning Commission	Workshops would occur during regularly scheduled zoning inspector meetings, etc.	2 workshops by 2015; additional workshops - included in general workshop series
2 Provide written comment on wetland alteration permit applications concerning impacts to watershed functions/riparian setbacks	WC and partners		on-going
3 Increase the number of communities using riparian setbacks	WC, communities, Counties	Outreach	1 additional community with riparian setbacks by 2022
4 Install signage for riparian areas in publicly visible places	Partners	$200-$500 per sign. Outside funding or community sign facility	Signs at 2 locations by 2022; signs at 1 additional location every 5 years afterward
5 Continued outreach	Partners	funding for outreach	brochure, workshops on enforcement, outreach to homeowners etc.
Br 1f-2 Protect 100 acres of wetlands, preventing increased loading of sediment by 100 tons/yr			
1 Identify key areas for protection	Partners - Portage Park District		
2 Contact landowners/partner land trusts			
3 Submit grant proposal			
4 Acquire wetlands/easements			

Table Br 4.2 Breakneck Creek - Nitrogen
HUC 041100020202

Problem Statement Br-2: Nitrogen

Lake Hodgson, in the Breakneck Creek subwatershed, experiences algal blooms from excessive nutrients, with chl-A as high as 23 mg/l during the summer. Nitrogen levels in Breakneck Creek exceed state EOLP median (0.43 mg/l) and guidelines (1 mg/l) for WWH streams of this size, with levels ranging from 0.68 mg/l to 7.43 mg/l in 2007 at Summit Road. Upstream measurements from 2000 occasionally exceeded state median/guidelines, ranging from 0.29-0.64 mg/l. Communities in the northern portion of the subwatershed grew rapidly from 2000-2010, potentially increasing nitrogen loading from measured levels. The Middle Cuyahoga River downstream of Breakneck Cr. shows signs of slight nutrient enrichment, with large diurnal oxygen swings suggesting increased algal activity. Middle Cuyahoga River nitrate+nitrogen levels measured in 2007 frequently exceed the EOLP median (1.0 mg/l) and the state guidelines (1.5 mg/l), ranging from 0.9 mgl/l to 6 mg/l.

The STEP-L model indicates that the watershed generates 78,429 lb/yr of nitrogen from urban runoff, eroding banks, agricultural runoff, and failing septic systems. systems. Alteration of at least 1,739 acres of wetland, 50% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 54 miles of watercourses has reduced the nitrogen uptake of the system. Further development and alteration of riparian vegetation could result in increased loading in the future.

Goals / *Objectives* / Actions	**Lead/ cooperating Organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Br 2a Reduce non-point source pollution from urban runoff to reduce annual loading of nitrogen by 168.6 lb			
Br 2a-1 Plant 12 a c.of deep-rooted riparian vegetation, reducing loading of nitrogen by 93 lb/ yr Focus areas: large parcels single ownership, headwaters.			
Actions: See Br 1a-1			
Br 2a-2 Retrofit stormwater volume devices to treat 100 acres of developed land and improve water quality, reducing loading of nitrogen by 70 lb/yr			
Actions: See Br 1a-2			
Br 2a-3 Retrofit 2,000 lf of drainage with no-mow grass/vegetated swale/daylighting to reduce nitrogen loading by 1.6 lb/yr.			
Actions: See Br 1a-3			
Br 2a-4 Review two development codes and update one to encourage use of green infrastructure in new developments.			
Actions: See Br 1a-4			
Br 2a-5 Install 20,000 sq ft of rain gardens to reduce nitrogen loading by 2 lb/yr			
1 Identify partners	WC, partners		
2 Submit grant application	WC/partners		
3 Workshop/installation	WC/partners	Approx. $500 for materials for 100 rain garden of approx. 100 square feet, with amended soil. Cost depends on whether labor and materials are donated. Larger rain garden projects can be in the thousands or tens of thousands of dollars, depending on the level of engineering.	1 project or 300 square feet by 2022, an additional project in the following 5 years
Br 2a-6 Install 10,000 sq ft of biofiltration in a commercial/institutional site(s), to reduce nitrogen loading by 2 lb per year			
1 Identify parcel(s) and landowner(s) for project	partners, WC		
2 Grants	WC/partners		
3 Design/construct BMPs	outside consultant		
4, 5, 6 Green infrastructure workshops, code revision - see Br 1a-4			

Table Br 4.2 Breakneck Creek - Nitrogen
HUC 041100020202

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Br 2a-7 Develop storm water management design manual for Portage County			
Actions: See Br 1a-7			
Br 2a-8 Update, increase, and disseminate available information concerning nitrogen from urban runoff			
Actions: See Br 1a-5			
Br 2a-9 Increase/sponsor 25 stewardship activities related to non-point source pollution and watershed issues.			
Actions: See Br 1a-6			
MCR 1 Establish 1 neighborhood-scale green infrastructure project as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of nitrogen by 200 lb/year			
Actions: See previous listing, MCR 1			
Goal Br 2b Reduce bank erosion to reduce nitrogen loading by 300 lb/year.			
Br 2b-1 Stabilize 3,000 l.f. to reduce nitrogen loading by 300 lb/yr *Focus areas, e.g., eroding streams with livestock access, headwaters, Brimfield Ditch, other ditches*			
Actions: See Br 1b-1			
Br 2b-2 Restore 50 acre-ft of floodplain access/storage, reducing channel loading by 217,800 cu. Ft.. Focus areas - areas with modified floodplain access. *and at/upstream of flooding problem areas, e.g., Wahoo Ditch, Brimfield Ditch, Feeder Canal, Breakneck headwaters*			
Actions: See Br 1b-2			
Br 2b-3 Restore 80 acres of wetland thereby increasing storage by 76,000 cubic feet of water in a 3/4 inch storm.			
Actions: See Br 1b-3			
Br 2b-4 Construct 20,000 square feet of rain gardens to reduce channel loading by 3,750 cu ft in a 3/4 inch event.			
Actions: See Br 1b-4			
Br 2b-5 Construct 10, 000 sq ft of bioinfiltration/permeable pavement in an institutional/commercial use, thereby reducing channel loading by 1,875 cu ft in a 3/4 inch storm.			
Actions: See Br 1b-5			
Br 2b-6 Facilitate installation of 250 rain barrels, thereby reducing stream channel loading by 1,376 cu ft in a 3/4-inch storm.			
Actions: See Br 1b-6			
Br 2b-7 Plant 12 ac of deep-rooted riparian vegetation, thereby reducing channel loading by 1,782 cu ft in a 3/4 inch storm .			
Actions: See Br 1b-7			
Goal Br 2c Reduce septic system failure to reduce annual loading of nitrogen by 933 lb			
Br 2c-1 Correct 3 failing HSDS per year, reducing nitrogen loading by 933 lb/yr Focus areas: vicinity of water courses			
1 Inspect systems	PCHD		
2 Correct failing/discharging home sewage treatment systems	Portage County Health District, landowners	Continued inspection and enforcement of illicit discharge regulations. Remedies depend on cause of failure and proximity of sewer service.	10 by 2022; 1 per year afterward

Table Br 4.2 Breakneck Creek - Nitrogen
HUC 041100020202

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
3 Continue to investigate funding sources	PCRPC, PCHD, wc		
4 Outreach:			
Goal Br 2d Reduce agricultural runoff to reduce annual loading of nitrogen by 1,466 lb			
Br 2d-1 Conduct 1 approximately year-long nutrient survey along Breakneck Creek, Feeder Canal, Lake Hodgson, Congress Lake Outlet, and Potter Creek.			
Actions: See Br 1c-1			
Br 2d-2 Work with landowners to treat 100 acres of agricultural land with grassed waterways/vegetated filter strips, to reduce annual nitrogen loading by 466 lb			
Actions: See Br 1c-2			
Br 2d-3 Work with landowners to install 100 ac of cover crops, reducing annual nitrogen loading by 240 lb.			
Actions: See Br 1c-3			
Br 2d-4 Work with landowners to use residue on 200 acres, to reduce annual nitrogen loading by 480 lb.			
Actions: See Br 1c-4			
Br 2d-5 Install 3,000 lf of livestock exclusion and accompanying measures to reduce nitrogen loading by 280 lb per year			
Actions: See Br 1c-5			
Goal Br 2e Restore riparian features to reduce nitrogen loading by 2,835 lb/yr.			
Br 2e-1. Restore 80 ac of wetland, reducing loading of nitrogen by 2,240 lb/yr. Focus areas -altered wetlands in central watershed or headwaters.			
Actions: See Br 1b-3			
Br 2e-2 Restore 50 acre-ft of floodplain access/storage, reducing annual nitrogen loading by 300 lb. Focus areas - areas with modified floodplain access. *and at/upstream of flooding problem areas, e.g., Brimfield Ditch, Collins Pond, Wahoo Ditch*			
Actions: See Br 1b-2.			
Br 2e-3 Improve channel morphology, e.g., 2-stage ditch, by 1,000 lf to increase nitrogen uptake by 295 lb/yr. Focus areas: altered headwater channels.			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2013, revisit and update if necessary every 3 years
2 Hold meetings to determine landowner interest	WC, partners		
4 Submit grant application			
5 Construct ditch improvements	design-build consultant	funding for design-build consultant	
6 Public outreach			
Br 2e-4 Restore 3,000 lf of incised/channelized stream, e.g., Wahoo, Brimfield, Hudson ditches; Breakneck headwaters/channel			
Actions: See Br 1b-1			

Table Br 4.2 Breakneck Creek - Nitrogen
HUC 041100020202

Goals / *Objectives* / Actions		Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Br 2f Protect landscape features to prevent future nitrogen loading by 3,020 lb/yr.				
Br 2f-1 Protect 40,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1, reducing loading of nitrogen by 220 lb/yr				
1	Workshops for community officials on developing/enforcing riparian setbacks	Portage County Regional Planning Commission	Workshops would occur during regularly scheduled zoning inspector meetings, etc.	2 workshops by 2015; additional workshops - included in general workshop series
2	Provide written comment on wetland alteration permit applications concerning impacts to watershed functions/riparian setbacks	WC and partners		on-going
3	Increase the number of communities using riparian setbacks	WC, communities, Counties	Outreach	1 additional community with riparian setbacks by 2022
4	Install signage for riparian areas in publicly visible places	Partners	$200-$500 per sign. Outside funding or community sign facility	Signs at 2 locations by 2022; signs at 1 additional location every 5 years afterward
5	Continued outreach	Partners	funding for outreach	brochure, workshops on enforcement, outreach to homeowners etc.
Br 2f-2 Protect 100 acres of wetlands, preventing increased loading of nitrogen by 2,800 lb/yr				
1	Identify key areas for protection	Partners - Portage Park District		
2	Contact landowners/partner land trusts			
3	Submit grant proposal			
4	Acquire wetlands/easements			

Table Br-4.3 Breakneck Creek Phosphorous

HUC 041100020202

Problem Statement Br-3: Phosphorous

Breakneck Creek and the Cuyahoga River downstream of Breakneck are enriched in phosphorous. Lake Hodgson, in the Breakneck Creek subwatershed, experiences algal blooms from excessive nutrients. The STEP-L model indicates that the watershed generates 16,470 lb/yr of phosphorous from urban runoff, eroding banks, agricultural runoff, and failing septic systems. Alteration of at least 1,739 acres of wetland, 50% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 54 miles of watercourses has reduced the phosphorous uptake of the system. Potential loss of additional riparian vegetation through development could increase loading in the future.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Br 3a Reduce non-point source pollution from urban runoff to reduce annual loading of phosphorous by 28.7 lb			
Br 3a-1 Plant 12 ac of deep-rooted riparian vegetation, reducing loading of phosphorous by 17 lb/yr Focus areas: large parcels single ownership, headwaters.			
Actions - See Br 1a-1			
Br 3a-2 Retrofit stormwater volume devices to treat 100 acres of commercial/institutional land and improve water quality, reducing loading of phosphorous by 10 lb/yr			
Actions - See Br 1a-2			
Br 3a-3 Retrofit 1,000 lf of roadside ditch with no-mow grass, vegetated swale, or daylighting to reduce phosphorous loading by 0.8 lb/yr			
Actions - See Br 1a-3			
Br 3a-4 Review two development codes and update one to encourage use of green infrastructure in new developments.			
Actions - See Br 1a-4			
Br 3a-5 Install 20,000 sq ft of rain gardens to reduce phosphorous loading by 0.5 lb/yr			
Actions - See Br 2a-5			
Br 3a-6 Install 10,000 sq ft of biofiltration/permeable pavement, to reduce phosphorous loading from a developed site by 0.4 lb per year			
Actions: see Br 2a-6			
Br 3a-7 Develop storm water management design manual for Portage County			
Actions: See Br 1a-7			
Br 3a-8 Update, increase, and disseminate available information concerning phosphorous from urban runoff			
Actions: see Br 2a-8			
Br 3a-9 Increase/sponsor 25 stewardship activities related to non-point source pollution and watershed issues.			
Actions: see Br 2a-9			
MCR 1 Establish 1 neighborhood-scale green infrastructure project as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing loading of phosphorous by 25 lb/year			
Actions - See TableBr 4.1			
Goal Br 3b Reduce bank erosion from overloaded channels/livestock access to reduce phosphorous loading by 38 lb/year.			
Br 3b-1 Stabilize 3,000 l.f. of eroding streambank to reduce phosphorous loading by 112 lb/yr Focus areas, e.g., headwaters, Brimfield Ditch, other ditches			
Actions: see Br 2b-1			
Br 3b-2 Restore 50 acre-ft of floodplain access/storage, reducing channel loading by 217,800 cu. Ft.. Focus areas - areas with modified floodplain access. *and at/upstream of flooding problem areas, e.g., Wahoo Ditch, Brimfield Ditch, Feeder Canal, Breakneck headwaters*			

Table Br-4.3 Breakneck Creek Phosphorous

HUC 041100020202

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Actions: See Br 1b-2			
Br 3b-3 Restore 80 acres of wetland thereby increasing storage by 76,000 cubic feet of water in a 3/4 inch storm.			
Actions: See Br 1b-3			
Br 3b-4 Construct 20,000 square feet of rain gardens to reduce channel loading by 3,750 cu ft in a 3/4 inch event.			
Actions: See Br 1b-4			
Br 3b-5 Construct 20,000 sq ft of bioinfiltration/permeable pavement in an institutional/commercial use, thereby reducing channel loading by 1,875 cu ft in a 3/4 inch storm.			
Actions: See Br 1b-5			
Br 3b-6 Facilitate installation of 250 rain barrels, thereby reducing stream channel loading by 1,376 cu ft in a 3/4-inch storm.			
Actions: See Br 1b-6			
Br 3b-7 Plant 12 ac of deep-rooted riparian vegetation, thereby reducing channel loading by 1,782 cu ft in a 3/4 inch storm .			
Actions: See Br 1b-7			
Br 3a-8 Review two development codes and update one to encourage use of green infrastructure in new developments.			
Actions: See Br 1a-4			
Br 3a-9 Restore 3,000 lf of incised/channelized stream, e.g., Wahoo, Brimfield, Hudson ditches; Breakneck headwaters/channel			
Actions: See Br 1b-1			
Goal Br 3c Reduce septic system failure to reduce annual loading of phosphorous by 366 lb			
Br 3c-1 Correct 3 failing HSDS per year, reducing phosphorous loading by 366 lb/yr Focus areas: vicinity of water courses			
Actions: See Br 2c-1			
Goal Br 3d Reduce agricultural runoff to reduce annual loading of phosphorous by 526 lb			
Br 3d-1 Conduct 1 approximately year-long nutrient survey along Breakneck Creek, Feeder Canal, Lake Hodgson, Congress Lake Outlet, and Potter Creek.			
Actions: See Br 1c-1			
Br 3d-2 Work with landowners to treat 100 acres of agricultural land with grassed waterways/vegetated filter strips, to reduce annual phosphorous loading by 26 lb			
Actions: See Br 1c-2			
Br 3d-3 Work with landowners to install 100 ac of cover crops, reducing annual phosphorous loading by 120 lb.			
Actions: See Br 1c-3			
Br 3d-4 Work with landowners to use residue on 200 acres, to reduce annual phosphorous loading by 240 lb.			
Actions: See Br 1c-4			
Br 3d-5 Install 3,000 lf of livestock exclusion and accompanying measures to reduce phosphorous loading by 140 lb per year			
Actions: See Br 1c-5			
Goal Br 3e Increase uptake of phosphorous by riparian/in-stream features by 637 lb/yr.			
Br 3e-2 Restore 50 acre-ft of floodplain access/storage, reducing annual phosphorous loading by 41 lb. Focus areas - areas with modified floodplain access. *and at/upstream of flooding problem areas, e.g., Brimfield Ditch, Collins Pond, Wahoo Ditch*			
Actions: see Br 1b-2			

Table Br-4.3 Breakneck Creek Phosphorous

HUC 041100020202

Goals *Objectives* Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Br 3e-2. Restore 80 ac of wetland, reducing loading of phosphorous by 505 lb/yr. Focus areas -altered wetlands in central watershed or headwaters.			
Actions: see Br 1b-3			
Br 3e-3 Improve channel morphology, e.g., 2-stage ditch, by 1,000 lf to treat increase phosphorous uptake by 91 lb/yr			
Actions: see Br 3e-3			
Goal Br 3f Protect landscape features to prevent future phosphorous loading by 711 lb/yr.			
Br 3f-1 Protect 40,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1, reducing loading of phosphorous by 79 lb/yr			
Actions: see Br 2f-1			
Br 3f-2 Protect 100 acres of wetlands, preventing increased loading of phosphorous by 632 lb/yr			
Actions: see Br 2f-2			

Table Br 4.4 Breakneck Creek - Groundwater
HUC 041100020202

Problem Statement Br-4: Groundwater, Public Water Supplies

The subwatershed contains two public water supplies, both of which are susceptible to contamination from surface spills and leaks to groundwater. Both public water supplies have source water protection plans, but their contributing surface and groundwater zones are largely privately owned and susceptible to contamination from uses or spills.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Br 4a Increase community awareness of procedures, protective measures, and groundwater chemistry related to fracking			
Br 4a-1 Monitor groundwater chemistry at 4 sites up-gradient of public water supplies for chemicals associated with fracking			
1 Work with partners to identify sites and chemicals of concern			
2 Develop baseline profile			
3 Monitor 5 times by 2022			
Br 4a-2 Increase awareness of potential hazards and protective measures associated with fracking			
1 Coordinate with state agencies and communities concerning fracking and controls			
2 Coordinate with state agencies to receive notification of drilling permit requests			
3 Outreach to communities and property owners - website, brochures, etc.			
Goal Br 4a Reduce risks of groundwater contamination from land use, spills, or hazardous waste sites.			
Br 1a-1 Inventory brownfield sites in the Breakneck Creek subwatershed, focusing on Ravenna			
1 Submit grant proposal	wc/Portage County		
2 Compile available mapping		mapping, coordinate with city officials	
3 Conduct inventory			1 inventory by 2017
4 Identify likely site(s) for clean-up	County, cities, Ohio EPA, landowners	outside consultant	
Br 1b-1 Initiate clean-up of 1 existing brownfield site, focusing on areas near water supplies or water courses.			
1 Coordinate with state regulators concerning status of DERR-listed sites	WC		
2 Submit grant application	WC/Portage County agencies		
3 Consultant inventory of brownfield sites		outside consultant and funding	1 inventory

Table Br 4.4 Breakneck Creek - Groundwater
HUC 041100020202

Goals / ***Objectives*** / Actions	**Lead/ cooperating Organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
3 Work with property owners and state regulators to identify site and conditions/plans for clean-up			
4 Submit grant application for clean-up funds	WC/Portage County		
5 Clean-up		outside consultant and funding, disposal	clean-up/cap one site
6 Redevelopment		development/use plan	
Br 4b-1 Provide public and agency outreach efforts to assist with implementation of 2 source water protection plans			
1 Coordinate with water suppliers concerning			
2 Apply for funding if needed			
3 Develop and disseminate outreach materials - written, website			
Br 4b-2 Update, increase, and disseminate available information concerning watershed protection			
Actions: See Br 1a-5, Table Br 4.1			
Br 4b-3 Increase/sponsor 25 stewardship activities related to non-point source pollution and watershed issues.			
Actions: See Br 1a-6, Table Br 4.1			

Table Br 4.5 Breakneck Creek - Flooding Problems
HUC 041100020202

Problem Statement Br-5: Flooding Problems

Areas within the subwatershed experience damaging flooding, including Brimfield Ditch near Route 261/Summit Rd., Wahoo Ditch, Breakneck Creek at Lakewood Rd., and Collins Pond. The watershed as a whole is 10% impervious, but the development is concentrated in the northern portion, which is approximately 17% impervious. Throughout the watershed, runoff from a 3/4 inch storm is increased by approx. 500,000 cu ft over an undeveloped watershed. The flood-management capacity along approximately 58 miles of stream channel has been reduced through alteration of watershed features, such as wetlands, riparian corridor, floodplain access, and stream morphology. Additional development or alteration will likely increase the total volume in streams.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Br 5a Address flooding problems in one area by restoring altered watershed hydrology/watershed characteristics			
Br 5a-1 Conduct 1 stormwater management study focusing on flooding problem area to identify potential landscape restoration opportunities that will reduce problem flooding.			
1 Develop detailed maps for areas of interest identifying topography, existing and altered wetlands, drainage, and imperviousness.			
2 Conduct engineering study	Ravenna/Portage County	Outside funding for consultant	
3 Outreach with neighborhoods to discuss feasible approaches			
4 Submit grant proposal	wc/city or county staff		
5 Construct improvements		outside consultant	
Goal Br 5b Reduce runoff throughout the subwatershed by 29,600 cu ft in a 3/4 in storm to reduce flooding potential.			
Br 5b-1 Review two development codes and update one to encourage use of green infrastructure in new developments.			
Actions - SeeBr 2a-4			
Br 5b-2 Construct 20,000 square feet of rain gardens to reduce channel loading by 3,750 cu ft in a 3/4 inch event.			
Actions: See Br 1b-4			
Br 5b-2 Construct 20,000 sq ft of bioinfiltration/permeable pavement in an institutional/commercial use, thereby reducing channel loading by 1,875 cu ft in a 3/4 inch storm.			
Actions: See Br 1b-5			
Br 5b-4 Facilitate installation of 250 rain barrels, thereby reducing stream channel loading by 1,376 cu ft in a 3/4-inch storm.			
Actions: See Br 1b-6			
Br 5b-5 Plant 12 ac of deep-rooted riparian vegetation, thereby reducing channel loading by 1,782 cu ft in a 3/4 inch storm .			
Actions: See Br 1b-7			
Br 5b-6 Update, increase, and disseminate available information concerning reducing runoff			
Actions - See Br 1a-5			
Br 5b-7 Increase stewardship activities related to runoff and watershed issues by 25 events/activities			
Actions - See Br 1a-6			

Table Br 4.5 Breakneck Creek - Flooding Problems

HUC 041100020202

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
MCR 1 Establish 1 neighborhood-scale green infrastructure project as demonstration within the developed areas of one of the Middle Cuyahoga River subwatersheds, where suitable neighborhoods are identified, reducing channel loading by 14,963 cu ft in a 3/4 in storm			
Actions - See Table Br 4.2			
Goal Br 5c Restore/improve altered watershed landscape features throughout watershed to increase flood storage by 295,582 cu ft in a 3/4 in storm.			
Br 5c-1 Restore 50 acre-ft of floodplain access/storage, reducing channel loading by 217,800 cu. Ft.. Focus areas - areas with modified floodplain access. *and at/upstream of flooding problem areas, e.g., Wahoo Ditch, Brimfield Ditch, Feeder Canal, Breakneck headwaters*			
Actions: See Br 1b-2			
Br 5c-3 Restore 80 acres of wetland thereby increasing storage by 76,000 cubic feet of water in a 3/4 inch storm.			
Actions: See Br 1b-3			
Br 5c-3 Improve channel morphology, e.g., 2-stage ditch by 1,000 lf. Storage at higher intensity storms than 3/4 inch would increase.			
Actions - See Br 1b-7			
Br 5c-4 Plant 12 ac of deep-rooted riparian vegetation, thereby reducing channel loading by 1,782 cu ft in a 3/4 inch storm.			
Actions - See Br 1a-1			
Br 5c-5 Restore 3,000 lf of incised/channelized stream, e.g., Wahoo, Brimfield, Hudson ditches; Breakneck headwaters/channel			
Actions: See Br 1b-1			
Goal Br 5d Protect landscape features to prevent future channel loading by 67,760 cu ft in a 3/4 in storm.			
Br 5d-1 Protect 40,000 linear ft of riparian buffer by increasing use of riparian setbacks by 1 community, to reduce channel loading 3,960 cu ft in a 3/4 in storm			
Actions - See Br 2e-1			
Br 5d-2 Protect 100 acres of wetlands through purchase of land/easement, preventing increased channel loading of by 63,800 cu ft in a 3/4 in storm			
Actions - See Br 2e-1			

Table Br 4.6 Habitat
HUC 041100020202

Problem Statement Br-6: Habitat

Alteration of at least 1,739 acres of wetland, 50% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, channel form, floodplain access) along an estimated 54 miles of watercourses has degraded riparian and wetland habitat in the subwatershed. Wahoo Ditch is in non-attainment of MWH status due to its extreme ditchlike nature, with recent QHEI scores of 44.5-55, rating as "poor." Causes/sources of non-attainment include poor habitat due to channelization. The lower portion of Breakneck Creek received QHEI scores of 56.5 and 59, due in part to channelization. Several tributaries have been highly channelized. The undisturbed riparian corridor and wetlands fringing Breakneck Creek have helped maintain high the high quality of the creek in spite of agricultural and urban influences. Remaining wetlands are at risk of degradation/encroachment from development. Three communities do not have riparian setbacks, placing remaining riparian vegetation at risk. The Breakneck riparian corridor and other areas are listed in the Portage County Watershed Plan as priorities for protection, and species of concern are found throughout this watershed..

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Br 6a Restore/improve 21.7 acres of altered habitat/stream channel morphology.			
Br 6a-1 Plant 12 ac. of deep-rooted riparian vegetation. Focus areas: large parcels single ownership, headwaters.			
Actions: See Br 1a-1			
Br 6a-2 Restore/improve 80 acres of wetland habitat. Focus: altered wetlands.			
Actions: See Br 1b-3			
Br 6a-3 Restore 50 acre-ft o f floodplain access/storage. Focus - areas with modified floodplain access. e.g., Wahoo Ditch, Brimfield Ditch, Collins Pond, Wahoo Ditch			
Actions: See Br 1b-2			
Br 6a-4 Improve channel morphology, e.g., 2-stage ditch, by 1,000 lf to increase floodplain access by 10,000 sq. feet.			
Actions: See Br 2e-3			
Br 6a-5 Restore 3,000 lf of incised/channelized stream, e.g., Wahoo, Brimfield, Hudson ditches; Breakneck headwaters/channel			
Actions: See Br 1b-1			
Br 6a-6 Conduct feasibility study for removing small low-head dams.			
Goal Br 6b Reduce bank erosion from overloaded channels.			
Br 6b-1 Restore 50 acre-ft of floodplain access/storage, reducing channel loading by 217,800 cu. Ft.. Focus areas - areas with modified floodplain access. e.g., Wahoo Ditch, Brimfield Ditch, Feeder Canal, Breakneck headwaters			
Actions: See Br 1b-2			
Br 6b-2 Restore 80 acres of wetland thereby increasing storage by 76,000 cubic feet of water in a 3/4 inch storm.			
Actions: See Br 1b-3			
Br 6b-3 Improve channel morphology, e.g., 2-stage ditch by 1,000 lf. Storage at higher intensity storms than 3/4 inch would increase.			
Actions - See Br 1b-7			
Br 6b-4 Plant 12 ac of deep-rooted riparian vegetation, thereby reducing channel loading by 1,782 cu ft in a 3/4 inch storm.			
Actions - See Br 1a-1			
Goal Br 6c Protect 128 acres of landscape features to prevent future habitat degradation.			
Br 6c-1 Protect 40,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1			
Actions: See Br 1f-1			
Br 6c-2 Protect 100 acres of wetlands through acquisition or easement. Focus areas: high value habitat identified in WAP or Portage County Watershed Plan.			
Actions: See Br 1f-2			
Br 6c-3 Update, increase, and disseminate available information concerning watershed habitats			
Actions: See Br 1a-5			
Br 6c-4 Increase/sponsor 25 stewardship activities related to stream channel health, non-point source, runoff, erosion, habitats, etc.			
Actions: See Br 1a-6			

Table Br 4.7 Breakneck Creek - Recreation
HUC 041100020202

Problem Statement Br-7: Recreation

Limited public recreational opportunities exist along Breakneck Creek. Parks districts and communities are actively seeking to increase recreational trails in the vicinity of the creek and Cuyahoga River. The Portage Park District property along Breakneck Creek is not yet open to the public. The Portage Bike/Hike Trail is planned and partially complete.

Goals / ***Objectives*** / Actions	**Lead/ cooperating Organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Br 7a Increase/improve recreational opportunities related to Breakneck Creek and tributaries.			
Br 7a-1 Construct 1 mile of bike/hike trail (e.g., Portage bike-hike greenway).			
1 Submit grant proposal			
2 Develop design			
3 Construct link			
4 Develop and install informational signs			
5 Outreach, pubicity			
Br 7a-2 Increase/improve access points along Breakneck Creek by 1 publicly accessible location			
1 Submit grant proposal			
2 Work with Portage Parks to design access			
3 Construct access points and related facilities (e.g., parking, signs, etc.) as appropriate			
Br 7a-3 Develop 2 quests or 1 virtual watershed tour			
1 Determine appropriate River Quest structure (cuyahoga canalway or new one)	WC, partners, volunteers, parks	Permission to develop quests, printing costs	2 quests by 2017 or 1 watershed tour by 2017
2 Public workshop concerning River quests			
3 Seek quests from volunteer groups			
4 Review, print, distribute		funding for printing, place on website	
Goal Br 7b: Increase awareness of recreational opportunities, stewardship, and watershed issues.			
Br 7b-1. Economic impact study recreational uses	WC with KSU	outside funding	1 study by 2018
1 Coordinate with KSU and others on study			
2 Submit grant proposal			
3 Conduct study			
4 Publicize			
Br 7b-2. Increase signage related to watershed at local parks by 18.			
1 apply for funding			
2 Design, install signs			
3 Continued outreach with local communities			
Br 7b-3 Update, increase, and disseminate available information concerning recreational opportunities and care of Breakneck Creek, its tributaries, and watershed.			
1 Web page of recreational opportunities/access	wc		
2 Other Actions - see Br 2a-5, Table Br 4.1			
Br 7b-4. Increase stewardship activities related to watershed issues			
1 Annual park clean-ups?			
Actions - See Br 2a-6, Table Br 4.1			

Table Br 4.8 Breakneck Creek - Contamination from Brownfields
HUC 041100020202

Problem Statement Br-8: Contaminants from brownfield sites and spills

The Breakneck Creek subwatershed has 11 sites of potential chemical releases, listed on the DERR database or otherwise known. Wahoo Ditch is in non-attainment due in part to legacy contaminants

Goals / ***Objectives*** / Actions	**Lead/ cooperating Organizations**	**Resources needed/cost**	**Amount to complete, time frame** (contingent on funding, resources, landowner willingness)
Goal Br-8a Address contamination at one site along Wahoo Ditch.			
Br 8a-1 Inventory brownfield sites in the Breakneck Creek subwatershed, focusing on Ravenna			
1 Submit grant proposal	wc/Portage County		
2 Compile available mapping		mapping, coordinate with city officials	
3 Conduct inventory			1 inventory by 2017
4 Identify likely site(s) for clean-up	County, cities, Ohio EPA, landowners	outside consultant	
Goal Br 8b Reduce risks of surface or groundwater contamination from toxic releases from 1 existing sites.			
Br 8b-1 Initiate clean-up of 1 existing brownfield site, focusing on areas near water supplies or water courses.			
1 Coordinate with state regulators concerning status of DERR-listed sites	WC		
2 Submit grant application	WC/Portage County agencies		
3 Consultant inventory of brownfield sites		outside consultant and funding	1 inventory
4 Work with property owners and state regulators to identify site and conditions/plans for clean-up			
5 Develop brownfields plan to identify priorities for clean-up	WC/Portage County agencies, cities	outside consultant and funding	1 plan (combine with inventory?)
6 Submit grant application for clean-up funds	WC/Portage County		
7 Clean-up		outside consultant and funding, disposal	clean-up/cap one site
8 Redevelopment		development/use plan	

7 Po Potter Creek
HUC 041100020201

1 Summary of Existing Conditions

Table Po 1 summarizes some of the key characteristics of this subwatershed. Table Po 2 presents a summary of identified impairments, causes, and sources. Figure Po 1 shows the sub-watershed and jurisdictions. Figures Po 2 and 3 have been compiled from mapping in Volume I and show potential areas of concern and resource areas for protection. (Greater detail is shown in the various maps in Vol. I.) Also see photos in Section 4P, Potter Creek.

This subwatershed is 62 percent agricultural, 25 percent woods and wetlands, and the remainder is developed. The riparian landscape is highly altered.

The primary drainage is from Congress Lake through the Congress Lake Outlet, a stream that was channelized during the 1800s canal era and which is maintained as a ditch as part of the Ravenna water supply. Congress Lake Outlet joins with Potter Creek in the lower reaches of the subwatershed. During most of the year, the combined Congress Lake Outlet/Potter Creek flows directly into Breakneck Creek. A control structure at the upper end of the Breakneck Creek watershed (immediately downstream of the Potter Creek subwatershed) allows the City of Ravenna to draw from Congress Lake Outlet via the Feeder Canal to supplement Lake Hodgson water, which is done only occasionally during dry summers. The City has experienced problems with taste, odor, and algae in Lake Hodgson.

Priorities for this subwatershed include reducing non-point source pollution from agricultural land, addressing failing septic systems, protecting remaining large wetland complexes, and as possible improving hydrology and riparian conditions along channelized streams.

The problem statements in Tables Po 4.1 through Po 4.4 address individual problems related to these concerns and may overlap. For instance, agricultural runoff and channelization contribute to the problems of nutrient enrichment and sedimentation.

Water Quality Assessment and Attainment Non-Point Source Pollution *(Refer to Problem Statements Po-1 through Po-3.)*

When Potter Creek was assessed at Trares Road in 2000, the creek was in partial attainment of water quality standards due to siltation and channelization. The 2000 Middle Cuyahoga River TMDL noted that Potter Creek was recovering in locations. Observations suggest that these conditions have not changed and occur throughout the subwatershed.

Nutrients are a concern in this watershed, because Lake Hodgson occasionally draws from Congress Lake Outlet/Potter Creek. Congress Lake, which feeds Congress Lake Outlet, is a hyper-eutrophic kettle lake. However, due to the sporadic influx of water from Congress Lake to Lake Hodgson, the effects of Congress Lake/Congress Lake Outlet/Potter Creek on Lake Hodgson water quality have not been determined.

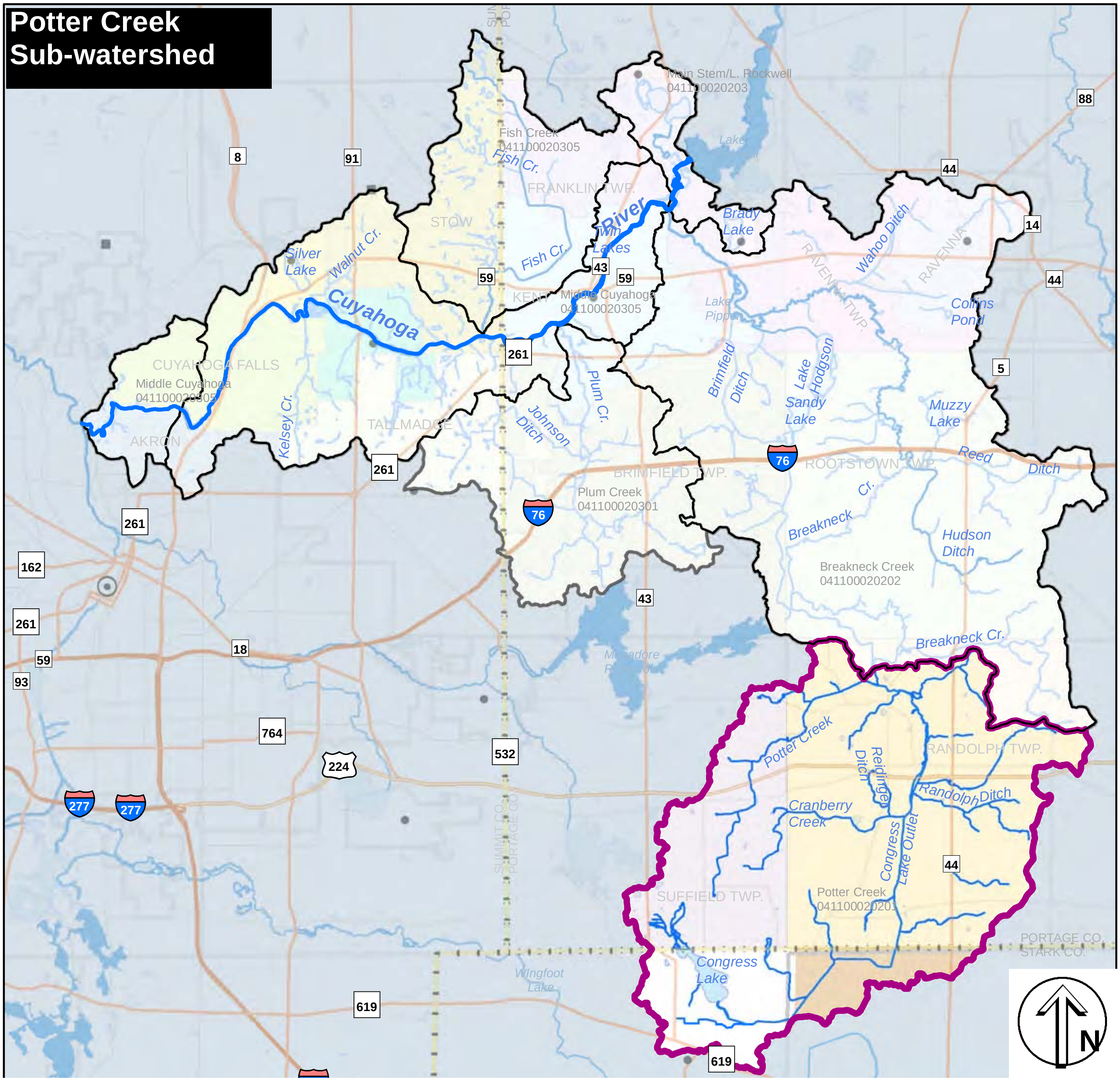


Figure Po-1
Subwatershed Jurisdictions

0 0.5 1 2 3 4 Miles

- Streams and Rivers
- Lakes
- Potter Cr. Subwatershed *12-Digit HUC: 041100020201*
- *Fish Creek 041100020305* Other Sub-watersheds
- Counties
- Jurisdictions outside watershed
- Interstate Highways
- State Divided Highways
- State Numbered Rtes
- Local Roads

Subwatershed Local Jurisdictions

- SUFFIELD TWP.
- RANDOLPH TWP.
- MARLBORO TWP
- LAKE TWP

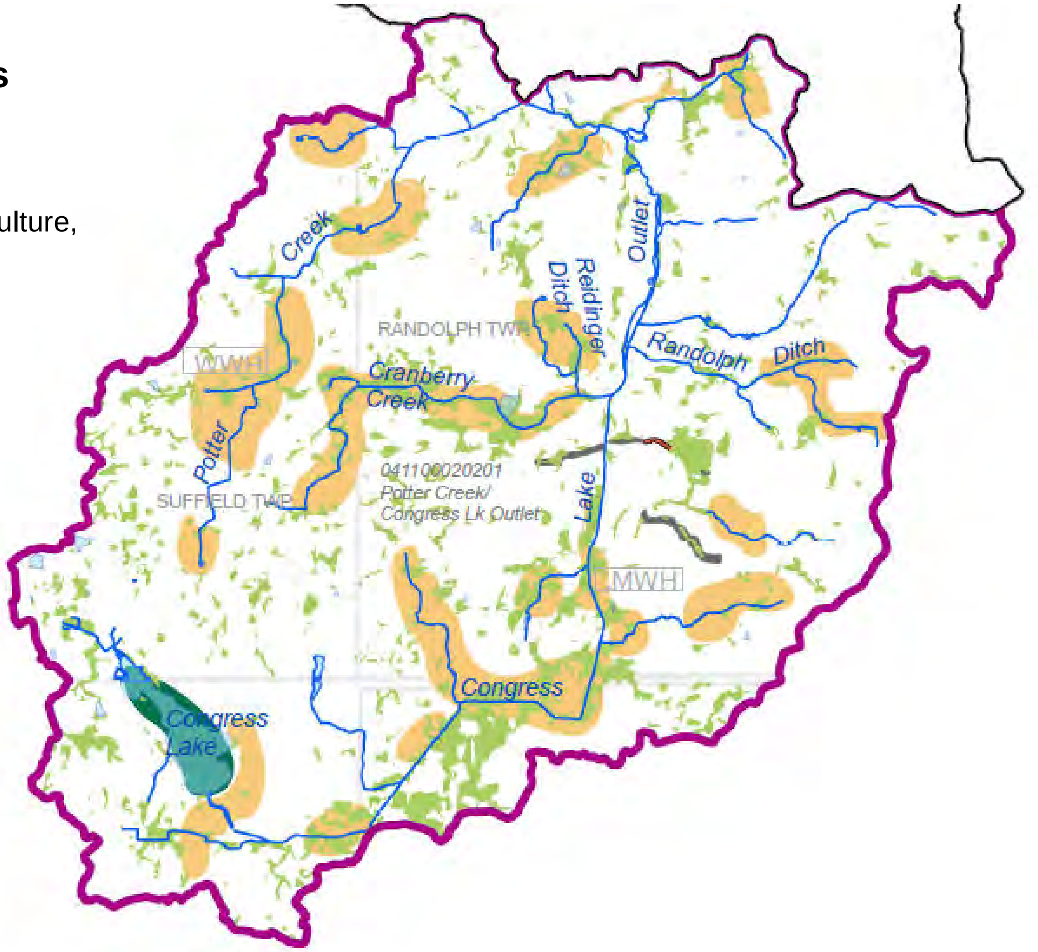
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010

Po-2 Problem Areas
Potter Creek Subwatershed

Potter Creek Subwatershed
041100020305 *Fish Creek* Other Subwatershed, 12-Digit HUC
Streams and Rivers
Lakes
WWH Aquatic Life Use Designation

Land Use Related Concerns

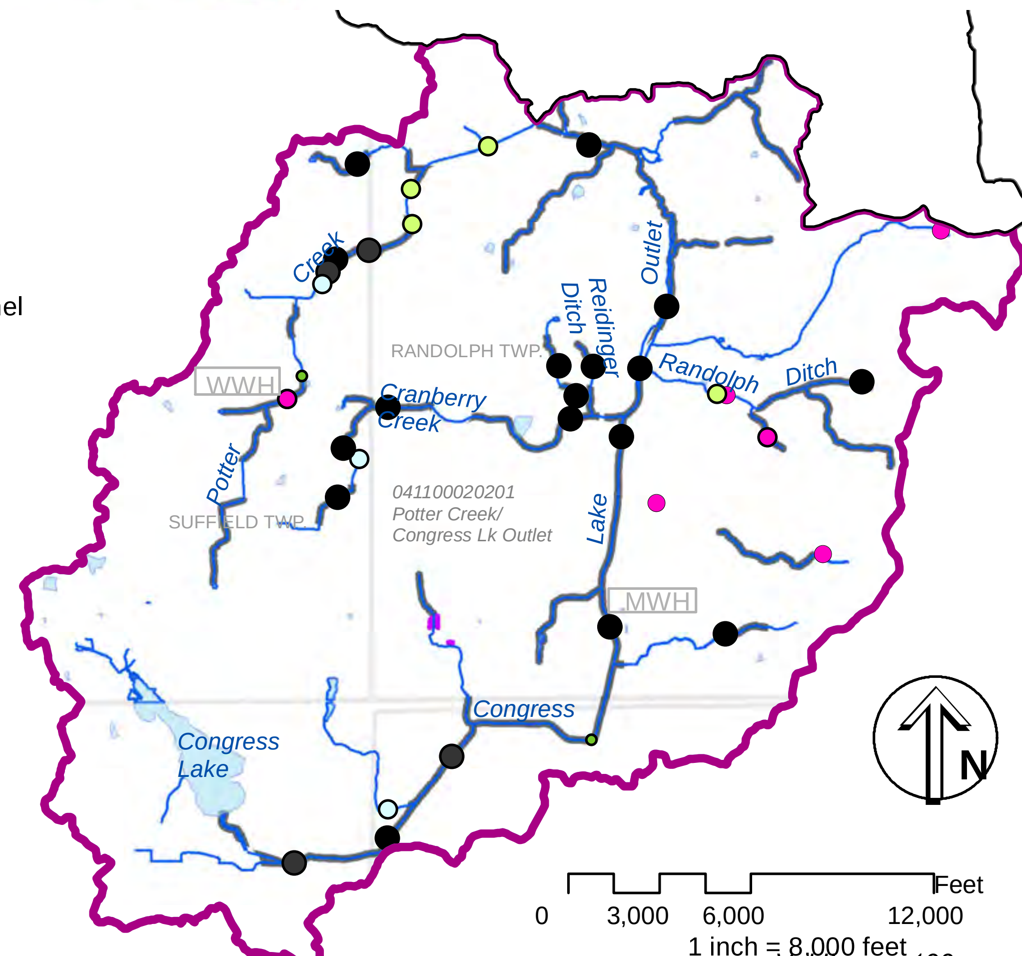
- Potential impacts due to proximity of land use (agriculture, golf courses, development)
- Altered Wetlands
- Nuisance Algae



Channel Conditions

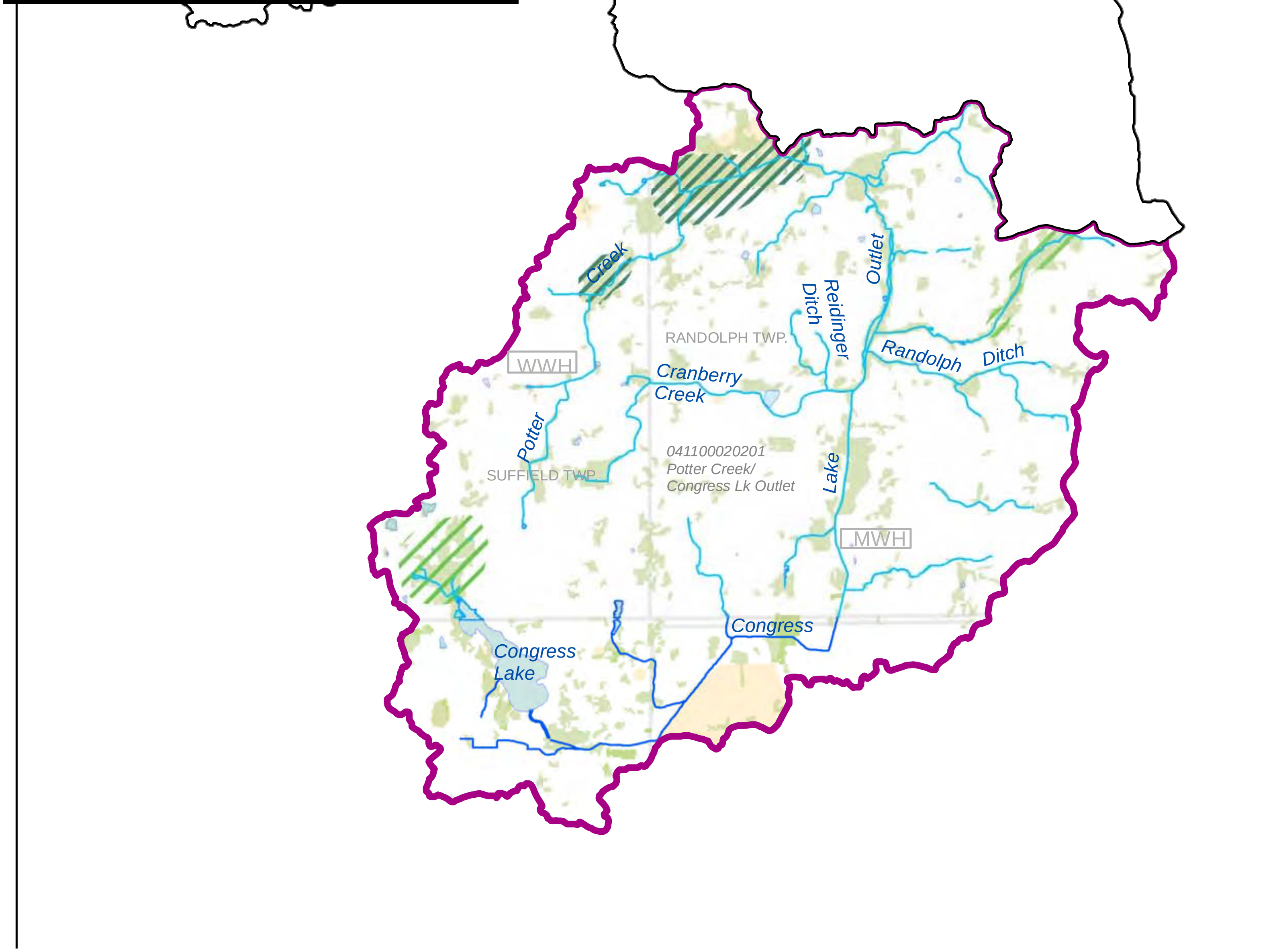
Observations

Along Channel	*At Sites*	*Condition*
		Intact
		Recovering
		Eroding Channel
		Channelized
		Incised/altered channel banks



**Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography.*

Po-3 Conservation/ Protection Priority Areas Potter Creek Subwatershed



Conservation/Protection Priority Areas

- Riparian Corridor/Wetland
- Wetlands of Additional Importance (e.g., buffering) - enhance/protect
- Mapped Wetlands
- Habitats or Species of Concern - Identified on DNR biodiversity database spanning 30 years; Western Reserve Land Conservancy workshop, 2010.)

- Streams and Rivers
- Lakes
- WWH Aquatic Life Use Designation
- 041100020201 Potter Creek — Subwatershed, 12-Digit HUC
- Local Jurisdictions

N

0 4,000 8,000 16,000 Feet

1 inch = 8,000 feet

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

Table Po 1
Summary of Potter Creek Subwatershed Characterisitcs

Concern	Amount/Item	Comments
Water Quality Attain., latest assessed	Potter Creek was in partial attainment of WWH standards in 2000 due to siltation and channelization. Congress Lake experiences harmful algal blooms.	
Public water supplies	Lake Hodgson occasionally draws from Congress Lake Outlet during dry months.	
Land Cover acres, %	Developed 1,810 8.1% • *High Density 82 0.4%* • *Moderate Density 204 0.9%* • *Low Density 986 4.4%* • *Dev. Open Space 538 2.4%* Agricultural 13,439 62.2% Grassland/scrub-shrub 563 2.4% Woods/wetlands 5,665 25.7%	
Impervious/runoff	2.7% **Additional runoff 3/4" storm**: 7.7 million gal.	
75 foot buffer	Developed 3% *Dev. Open space 1.4%* Agricultural 75.5% Woods/wetlands 22.5%	.
Wetlands (ac)	**Mapped** 2,728 **Converted** 2,585 (hydric) (4,819 hydric incl.)	
Likelihood of future development	Access to infrastructure is limited in this sub-watershed, although the Randolph wastewater treatment plant was recently constructed. There are numerous large parcels, and Stark County has experienced recent development in the watershed.	
Channel quality	**Intact** 2.8 **Altered/channelized** 29.5 **Eroding** 2.2 **Recovering** 7.5	
Non-pt source pollution/year	**Tot. N** 63,795 lb **Tot. P** 12,250 lb **Sed**. 2,753 tons/yr	
Septic Systems	Approx. one-third of the subwatershed presents 2 or more severe limitations for septic systems and is not served by sewer. Approx. 300 potential illicit discharges have been identified in subwatershed communities.	
Problem areas	Randolph Ditch, Outlet Cr. are eroding vertically; unrestricted access Randolph Ditch; Cranberry Cr. Incised/channelized, little buffer	
Resource areas	Wetlands, especially large complexes along tribs; bog habitats/species are found in wetlands near Congress Lake	
Park/ conserve./inst.		
Riparian setback	None	
Recreational oppor.	Quail Hollow State Park	

Table Po 2
Summary of Impairments Potter Creek Subwatershed
HUC 041100020201

	Attainment issue/other concern	Cause	Source	Other likely sources
	Partial attainment WWH habitat	sediment	Ag runoff	Streambank erosion
		Habitat, flow alteration	channelization	
	Algal blooms	Nutrients – congress lake	Non-irrigated crop production	Septic system failures
	High algal counts	Nutrients – Lake Hodgson	Non-irrigated crop production	Septic system failures, lake sediments, groundwater, other NPS
	Elevated nutrient levels in river		Non-irrigated crop production	Livestock, septic systems
	Wetland/habitat alteration			

The STEPL model indicates that the watershed contributes 2,753 tons per year of sediment, 63,795 lb/year of nitrogen, and 12,250 lb/year of phosphorous, primarily from agricultural runoff, eroding streambanks, and septic systems. USDA staff indicate that farmers in the watershed are using reduced till and no-till to a large extent (40 percent and 50 percent, respectively, and are using agricultural best management practices (e.g., buffers, filter strips) to varying degrees. It is estimated that 75 percent of the livestock operations allow unrestricted access to the streams.

In much of the watershed, soils present two or more severe limitations for septic systems and are not served by sewer, raising the risks of failure of older septic systems. Portage County inspections have identified approximately 300 potential illicit discharges in subwatershed communities. Septic system failures have been noted in Stark County.

Alteration of wetlands, floodplains, and riparian corridors has reduced the ability of the system to absorb and process nutrients and sediment.

Habitat, Conservation, and Recreation Areas
Approximately 75 percent of the buffer has been altered – converted to agriculture, and is likely associated with alteration or destruction of riparian environments, headwater channels, wetlands, and floodplain access. Over 2,500 acres of wetland have been altered to other uses, and approximately 30 miles of the streams in this subwatershed are channelized, reducing the ability of the channels to store floodwater, deposit

sediment, treat nutrients, and provide habitat. At several locations, including Potter Creek at Saxe Road, stream substrates were embedded with silt and would be unlikely to provide sufficient habitat to meet water quality standards.

With the exception of Quail Hollow State Park and the Breakneck Creek preserve, most conservation areas in this subwatershed are intended for agricultural use. There are several areas of species and habitats of concern that are not protected or held as conservation land, including bog areas near Congress Lake, a large wetland complex at the north end of Potter Creek, and wetlands adjacent to the tributaries. In addition, remaining riparian corridor could be fragmented by use. These areas provide important benefits to the watershed and are susceptible to alteration.

It would be valuable to protect the large wetland complexes and habitat corridors from encroachment or development. Wetlands along the tributaries probably mitigate the effects of the altered landscape upstream and should be protected.

Quail Hollow State Park provides a natural area for passive recreation.

2 Problem Statements, Goals, Objectives, and Actions

Table Po 3 summarizes the actions proposed in the subwatershed and their associated pollutant load reductions, listing which problem statements/goals employ these tools. Tables Po 4.1 through 4 present the problem statements, goals, objectives, and actions for each problem area. The tables are numbered to reflect each problem statement number, e.g., Table Po 4.1 corresponds to Problem Statement Po-1. It should be noted that because many of the objectives address more than one goal, the actions associated with each objective are listed only once, in the first table in which they appear (most frequently, Table Po 4.1). All other listings of the same objective refer back to the actions at their first occurrence.

Refer to Sections 6 and 7 Introduction for a discussion of the format of the problem statements, goals, objectives, actions, and considerations for implementation.

Table Po 3 Action Item Summary by Subwatershed: Potter Creek

12-digit HUC/ Water Body	Sed	Nutrients	Habitat	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
041100020201										
				Riparian Restoration						
Potter Cr./Congress Lake Outlet & tribs	√	√	√	Restore Streambank (Bio-Engineering/ re-contouring/ re-grading)	1,600	Linear Feet	$25-200/lf	110	160	60
Potter Cr./Congress Lake Outlet & tribs	√	√	√	Plant Native plants, trees, or shrubs in Riparian Areas	5	Acres	$2,500 + labor shrubs	2.8	40	7
Potter Cr. Watershed			√	Remove/treat Invasive Species	50	Acres				
				Stream Restoration						
Potter Creek, CLO, tribs	√	√	√	Restore Flood Plain	10	Acre-foot		4.4	60	8
Potter Creek watershed			√	Dam removal feasibility	1	study				
				Wetland Restoration						
Potter Creek CLO, tribs	√	√	√	Reconstruct/reconnect & Restore Wetlands	50	Acres	$5k-100k/ac.	50	1400	316
				Home Sewage Treatment Systems						
		√		Repair/Replace HSTS	15	HSTS			466	183
				Urban runoff and green infrastructure						
Potter Creek watershed	√	√		Rain gardens	1000	sq feet			0.2	0.04
Potter Creek watershed	√	√		Storm water retrofits	20	acres treated	$400-17k/ ac	0.9	10	4
Potter Creek watershed	√	√		No-mow ditch/grassed swale demo	500	linear feet		0.05	0.4	0.2
Middle Cuyahoga River Watershed				Neighborhood-scale green infrastructure	1		$25-50k design	5 tons	200 lb	25 lb
	√	√		**Agricultural BMPs**						
Congress Lake Outlet/ Potter watershed	√	√		Survey of practices	1	survey				
Potter Cr. And tribs	√	√	√	Install Livestock Exclusion Fencing & accompanying watering measures	3,000	Linear Feet	$11,300 + watering	140	280	140

Table Po 3 Action Item Summary by Subwatershed: Potter Creek

12-digit HUC/ Water Body	Sed	Nutrients	Habitat	Category/Practices	Target amount by 2023	Units	Cost	Sed. (tons/ yr)	N (lb/ yr)	P (lb/ yr)
Potter Cr. And tribs	√	√		Install Alternative Water Supplies	1	Supplies				
Potter Cr. And tribs	√	√		Construct 2-Stage Channel/overwide	1,000	Linear Feet			295	91
Potter Cr. And tribs	√	√	√	Install Grassed Waterways/ vegetated buffer strips	100	Acres treated		177	466	26
Potter Cr.watershed	√	√		Cover crops	100	acres		101	240	120
Potter Cr.watershed	√	√		Residue applied to fields	200	acres		202	480	120
Potter Cr.watershed	√	√		Conservation cover	100	acres		101	240	120
Potter Cr.watershed	√	√		Livestock Crossings	1	Crossings				
				Conservation Easements						
Potter Cr.watershed	√	√	√	Acquire riparian buffer/ Wetlands/ easements	50	Acres	$5-25k/ac	prevent 50	prevent 1400	preven t 316
Potter Cr.watershed	√	√	√	**Education and Outreach**						
				Develop Brochures/Fact Sheets	4	Brochures/Fact Sheets				
				Websites	1	Website				
				New lake/stream stewardship groups	1	new group active				
				Conduct Field Days/workshops	3	workshops				
				Develop Manual(s)	1	Manuals				
				Local Policy						
Potter Cr.watershed	√	√	√	Riparian setback	1	jurisdiction		prevent 25	prevent 400	preven t 71
Potter Cr.watershed	√	√	√	Green code audit/ update	1	audits/ updates				
				Monitoring						
Potter Cr. And tribs		√	√	Chemical Sampling	3	Sites				
Potter Cr. And tribs	√		√	Habitat (QHEI/HHEI) Sampling	1	Sites				
								889	4,138	1,195

Table Po 4.1 Potter Creek - Sediment
HUC 041100020201

Potter Creek (Po) Problem Statement 1: Sediment

Potter Creek is listed as partial attainment, due in part to sediment from agricultural runoff. The QHEI indicates the lack of silt-free substrate. The STEP-L model indicates that the watershed generates 2,753 tons of sediment per year, mostly from agricultural runoff but also from eroding banks and urban runoff. Alteration of at least 2,585 acres of wetland, 78% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 31.7 miles of watercourses has reduced the sediment storage of the system. Further alteration of riparian vegetation could result in increased loading in the future.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Po 1a Reduce non-point source pollution from urban runoff to reduce annual loading of sediment by 4.3 tons			
Po 1a-1 Plant 5 ac of deep-rooted riparian vegetation, reducing loading of sediment by 2.8 tons/yr Focus areas: large parcels single ownership, headwaters.			
1 Submit grant applications	WC/SWCDs/partners		
2 Targeted outreach to owners of large properties	WC**/SWCDs/ Communities	Lists of golf courses, lake associations, homeowners' associations; maps of large parcels; printed outreach materials.	Target 1 group every 3 years (3 by 2022); improvements to best management practices or riparian management at one site every 4 years(2 sites by 2020); 2 outreach contacts per year
3 Assist with plantings	SWCDs, master gardeners	native plants/trees and shrubs $250 ($500-1,000 per acre);	
4 Construct and install signage	communities, partners,	$300-500/sign	
5 Follow-up outreach (individualized guide to riparian zone) and publicize		funding for handouts/brochures	
Po 1a-2 Plant 500 lf of roadside ditch with no-mow grass to reduce annual load of sediment by 0.05 tons/yr			
1 Workshop on maintaining ditches for water quality improvements	SWCD	Location, materials	
2 Plant 500 lf of roadside ditch with no-mow grass			
Po 1a-3 Retrofit developed site to treat 20 acres for water quality (e.g., bioinfiltration, green infrastructure, permeable pavement), reducing sediment load by 1.5 tons /year.			
1 Stormwater retrofit inventory		WC/NEFCO with communities	
2 Submit grant application.			
3 Design/construct retrofit for existing stormwater (volume) infra-structure to improve water quality	Communities	Varies, depending on treatment provided (e.g., $400/acre treated to $17,000 per acre treated)	Retrofit 3 by 2023 to treat 60 ac res., 1 every 3 years afterward
Po 1a-4 Install 2,000 square feet of rain gardens, to reducing channel loading by 87 cu ft in a 3/4 in storm			
1 Identify partners	WC, partners		
2 Submit grant application	WC/partners		
3 Workshop/installation	WC/partners		
Po 1a-5 Maintain Stream database			1 database

Table Po 4.1 Potter Creek - Sediment
HUC 041100020201

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Po 1a-6 Conduct public outreach by providing information and studies electronically or in print.			
1 Continue to compile, centralize, and make available studies, data, information sources on the watershed, including recreational opportunities, volunteer needs, permitting or regulatory issues; green infrastructure information sources, etc.	WC	Website, technical information and outreach materials	Update and develop pages for website by Dec. 2013, then on-going
2 e-newsletter or article issued 3 times per year	wc	website, share with partners	
3 Develop/reproduce informational brochure or website article concerning topics of interest, including reducing runoff, recreational opportunties, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	4 by 2022
Po 1a-7 Increase/sponsor 11 outreach/stewardship activities related to non-point source pollution and watershed issues.			
1 Establish clean-up/monitoring/planting efforts at additional tributaries and lakes	WC, communities, parks, residents, home-owners' associations, lake assoc.	Funding or donation of trash disposal, refresh-ments, monitoring supplies, crew leaders, volunteers; training for monitoring/planting	1 new tributary or lake monitoring, clean-up, or other stewardship program by 2018
2 Distribute 50 rain barrels through workshops	SWCDs/ Communities	Space for workshop; rain barrel kits	2 workshops/50 rain barrels distributed
4 Develop/reproduce informational brochure or website article concerning topics of interest, including reducing runoff, recreational opportunties, private wells, septic systems etc.	WC, health depts, SWCDs	technical/outreach materials, possibly printing costs	4 by 2022
5 Educational outreach workshops on topics of importance, including LID/green infrastructure, restoration, field trips for examples	Partners, WC, communities	Location, speaker, supplies	3 workshops by 2022
8 Watershed "brand," logo, art project	WC, Kent State/ Standing Rock Gallery/River Day	Host for project, graphic design capabilities	1 logo or art project by 2015, then 1 every 3 years;
9 Create social network or google presence	WC		1 by 2014
Goal Po 1b Reduce bank erosion to reduce sediment loading by 110 tons/year.			
Po 1b-1 Stabilize 1600 l.f. of eroding stream bank, reducing sediment loading by 110 tons/yr *Focus areas - eroding channels, some with livestock access e.g., Randolph Ditch, eroding Congress Lake Outlet headwaters*			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
2 Hold meetings with landowners to determine interest	WC, partners		
4 Submit grant applications	WC, partners		
5 Restore floodplain access/flood storage		design-build consultant	

Table Po 4.1 Potter Creek - Sediment

HUC 041100020201

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
6 Public outreach			
Po 1b-2 Restore 10 acre-ft of floodplain access/storage, reducing channel loading by 435,600 cu ft. Focus areas - areas with modified floodplain access.			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
2 Hold meetings to determine landowner interest	WC, partners		
4 Submit grant application			
5 Restore floodplain access/flood storage	design-build consultant	funding for design-build consultant	
6 Public outreach			
Po1b-3 Restore 50 acres of wetland thereby increasing storage by 48,500 cubic feet of water in a 3/4 inch storm. Target areas headwaters with altered wetlands.			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2014, revisit and update if necessary every 3 years
2 Hold meetings to determine landowner interest	WC, partners		
3 Identify wetland restoration site for clearinghouse	WC, Communities, other partners	meetings with landowners; readily available mapping, outside assistance from consultant, possible assistance from Kent State University wetland ecology class	5 concept plans by 2020; 1 every 2 years afterward.
4 Submit grant application			
5 Restore/protect/enhance wetlands	Partners	\$5,000-\$100,000 per acre, design/build consultant, sites -protection by easements would be at the low end of the range	20 ac by 2022; 10 ac every 5 years afterward
Goal Po 1c Reduce agricultural runoff to reduce annual loading of sediment by 729 tons			
Po 1c-1 Conduct survey of practices to target application of BMPs			
1 Develop survey of existing practices			
2 Administer survey of existing practices			
3 Outreach with property owners based on survey			
4 Apply for external funding for BMP incentives			
5 Work with landowners and operators to increase use of BMPs based on survey results			
Po 1c-2 Install 3,000 lf of livestock exclusion and accompanying measures (e.g., watering, stream crossing) to reduce sediment loading by 140 tons per year			
1 Contact landowners to determine willingness			
2 Submit proposal for grant funds			
3 Work with landowners to install measures			
4 Outreach			

Table Po 4.1 Potter Creek - Sediment
HUC 041100020201

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Po 1c-3 Install grassed waterway/buffer strips to treat 150 ac and reduce sediment by 236 tons /yr.			
Po 1c-4 Install cover crops on 150 ac and reduce sediment by 151 tons/yr			
Po 1c-5 Increase use of residue on ag fields by an additional 200 acres, reducing sediment loading by 202 tons/yr			
Goal Po 1d Increase sediment uptake in wetlands and floodplains by 54.4 tons/yr.			
Po 1d-1. Restore 50 ac of wetland, increasing storage of sediment by 50 tons/yr. Focus areas -altered riparian wetlands *Target areas: altered riparian wetlands, Cranberry Creek, Potter Creek, headwater tribs, Congress Lake Outlet*			
Actions: See Po 1b-3			
Po 1d-2 Restore 10 acre-ft of floodplain access/storage, reducing sediment loading by 4.4 tons/yr. Focus areas - areas with modified floodplain access.			
Actions: See Po 1b-2			
Goal Po 1e Protect 75 ac wetlands and riparian corridors to prevent future sediment loading by 64 tons/yr.			
Po 1e-1 Protect 25 ac of riparian buffer by increasing the number of communities using riparian setbacks by 1, reducing annual sediment load by 14 tons/yr			
1 Workshops for community officials on developing/enforcing riparian setbacks	Portage County Regional Planning Commission	Workshops would occur during regularly scheduled zoning inspector meetings, etc.	2 workshops by 2015; additional workshops - included in general workshop series
2 Provide written comment on wetland alteration permit applications concerning impacts to watershed functions/riparian setbacks	WC and partners		on-going
3 Increase the number of communities using riparian setbacks	WC, communities, Counties	Outreach	1 additional community with riparian setbacks by 2022
4 Install signage for riparian areas in publicly visible places	Partners	\$200-\$500 per sign. Outside funding or community sign facility	Signs at 2 locations by 2022; signs at 1 additional location every 5 years afterward
5 Continued outreach	Partners	funding for outreach	brochure, workshops on enforcement, outreach to homeowners etc.
Po 1e-2 Protect 50 ac. of riparian buffer/wetland through acquisition of land/easements, preventing increased loading of sediment by 50 tons/yr.			
1 Identify key areas for protection	Partners		
2 Contact landowners/partner land trusts			
3 Submit grant proposal			
4 Acquire wetlands/easements			

Table Po 4.2 Potter Creek - Nitrogen
HUC 041100020201

Potter Creek (Po) Problem Statement 2: Nitrogen

Limited data suggest that Potter Creek is enriched in nutrients relative to state criteria, with nitrate+nitrogen values ranging from 0.473 to 7.32 mg/l in 2000.
Downstream, Breakneck Creek and the Cuyahoga River are enriched in nitrogen. Lake Hodgson, downstream in the Breakneck Creek subwatershed, occasionally draws water from the Congr
due to excessive nutrients. Congress Lake has experienced nuisance algal blooms. The STEP-L model indicates that the watershed generates 63,796 lb/yr of nitrogen from eroding banks, agricultural runoff, and failing septic systems. Alteration of at least 2,585 acres of wetland, 78% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 31.7 miles of watercourses has reduced the nitrogen uptake of the system.
Further alteration of riparian vegetation could result in increased loading in the future.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Po 2a Reduce non-point source pollution from urban runoff to reduce annual loading of nitrogen by 44.5 lb			
Po 2a-1 Plant 5 ac of deep-rooted riparian vegetation, reducing loading of nitrogen by 40 lb/yr Focus areas: large parcels single ownership, headwaters.			
Actions: See Po 1a-1	WC/SWCDs/partners		
Po 2a-2 Plant 500 lf of roadside ditch with no-mow grass to reduce nitrogen loading by 0.4 lb/yr.			
Actions: See Po 1a-2	WC/SWCDs/partners		
Po 2a-3 Retrofit developed site to treat water quality from 20 acres (e.g., stormwater retrofit/green infrastructure), reducing nitrogen loading by 4 lb/yr.			
Actions: See Po 1a-3			
Po 2a-4 Install 2,000 square feet of rain garden, reducing annual nitrogen loading by 0.08 lb/yr.			
Actions: See Po 1a-4	WC/SWCDs/partners		
Po 2a-5 Maintain Stream database			1 database
Po 2a-6 Conduct public outreach by providing information and studies electronically or in print.			
Actions: See Po 1a-6	WC/SWCDs/partners		
Po 2a-7 Increase/sponsor 11 outreach/stewardship activities related to non-point source pollution and watershed issues.			
Actions: See Po 1a-7			
Goal Po 2b Reduce bank erosion to reduce nitrogen loading by 160 lb/year.			
Po 2b-1 Stabilize 1600 l.f. of eroding bank, to reduce nitrogen loading by 160 lb/yr *Focus areas, e.g., eroding streams with livestock access, headwaters, Brimfield Ditch, other ditches*			
Actions: See Po 1b-1			
Po 2b-2 Restore 10 acre-ft of floodplain access/storage, reducing channel loading by 435,600 cu ft. Focus areas - areas with modified floodplain access.			
Actions: See Po 1b-2			
Po 2b-3 Restore 50 acres of wetland thereby increasing storage by 48,500 cubic feet of water in a 3/4 inch storm. Target areas headwaters with altered wetlands.			
Actions: See Po 1b-3			

Table Po 4.2 Potter Creek - Nitrogen
HUC 041100020201

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Po 2c Reduce septic system failure to reduce annual loading of nitrogen by 470 lb			
Po 2c-1 Correct 3 failing HSDS every 2 years, reducing nitrogen loading by 470 lb/yr Focus areas: vicinity of water courses			
1 Inspect systems	PCHD		
2 Correct failing/discharging home sewage treatment systems	Portage County Health District, Stark Co. Health Dist. landowners	Continued inspection and enforcement of illicit discharge regulations. Remedies depend on cause of failure and proximity of sewer service.	10 by 2022; 1 per year afterward
3 Continue to investigate funding sources	PCRPC, PCHD, wc		
4 Outreach:			
Goal Po 2d Reduce agricultural runoff to reduce annual loading of nitrogen by 1,819 lb			
Po 2d-1 Conduct 1 approximately year-long nutrient survey along Breakneck Creek, Feeder Canal, Lake Hodgson, Congress Lake Outlet, and Potter Creek.			
1 Arrange internship with KSU			
2 Determine sampling sites, frequencies			
3 Coordinate lab analysis with Ravenna utilities			
4 Monitor throughout the year			
Po 2d-2 Conduct survey of practices to target application of BMPs			
Actions: See Po 1c-1			
Po 2d-3 Install 3,000 lf of livestock exclusion and accompanying measures (e.g., watering, stream crossing) to reduce nitrogen loading by 280 lb per year			
Actions: See Po 1c-2			
Po 2d-4 Install grassed waterway/buffer strips to treat 150 ac and reduce nitrogen by 699 lb /yr.			
Po 2d-5 Install cover crops on 150 ac and reduce nitrogen by 360 lb/yr			
Po 2d-6 Increase use of residue on ag fields by an additional 200 acres, reducing nitrogenloading by 480 lb/yr			
Goal Po 2e Increase uptake of nitrogen by wetlands and floodplains by 1,755 lb/yr.			
Po 2e-1. Restore 50 ac of wetland, to reduce loading of nitrogen by 1,400 lb/yr. Focus areas -altered riparian wetlands *Target areas: Cranberry Creek, Potter Creek, headwater tribs Congress Lake Outlet*			
Actions: See Po 1b-3.			
Po 2e-2 Restore 10 acre-ft of floodplain access/storage, reducing annual nitrogen loading by 60 lb. Focus areas - areas with modified floodplain access.			
Actions: See Po 1b-2.			
Po 2e-3 Improve channel morphology, e.g., 2-stage ditch, by 1,000 lf to increase nitrogen uptake by 295 lb/yr. Focus areas: altered headwater channels. Cranberry Cr.			
1 Map target areas to investigate for wetland, floodplain, riparian, habitat, or stream corridor restoration/protection/ enhancement	WC, partners	available mapping - compile and build on previous efforts	1 map by 2013, revisit and update if necessary every 3 years
2 Hold meetings to determine landowner interest	WC, partners		
4 Submit grant application			

Table Po 4.2 Potter Creek - Nitrogen
HUC 041100020201

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
5 Construct ditch improvements	design-build consultant	funding for design-build consultant	
6 Public outreach			
Goal Po 2f Protect wetlands and riparian corridors to prevent future nitrogen loading by 1,600 lb/yr.			
Po 2f-1 Protect 36,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1, reducing loading of nitrogen by 200 lb/yr			
Actions: See Po 1e-1.			
Po 2f-2 Protect 50 acres of wetlands/riparian corridor through purchase of land/easements, preventing increased loading of nitrogen by 1,400 lb/yr. Target areas high value wetlands, Potter Cr., Cong. Lk Outlet headwaters			
Actions: See Po 1e-3			

Table Po 4.3 Potter Creek Phosphorous
HUC 041100020201

Potter Creek (Po) Problem Statement 3: Phosphorous

Limited data suggest that Potter Creek is enriched in phosphorous relative to state criteria for WWH headwater streams, ranging from 0.05 to 0.16. The 1997 TSD notes that phosphorous in Potter Creek is high compared to the rest of the Breakneck Creek drainage, likely a result of agriculture. Downstream, Breakneck Creek and the Cuyahoga River are enriched in phosphorous. Lake Hodgson, downstream in the Breakneck Creek subwatershed, occasionally draws water from the Congress Lake Outlet, and experiences nuisance algal blooms due to excessive nutrients. Congress Lake has experienced nuisance algal blooms. The STEP-L model indicates that the watershed generates 12,250 lb/yr of phosphorous from eroding banks, agricultural runoff, and failing septic systems. Alteration of at least 2,585 acres of wetland, 78% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 31.7 miles of watercourses has reduced the nitrogen uptake of the system. Further alteration of riparian vegetation could result in increased loading in the future.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Po 3a Reduce non-point source pollution from urban runoff to reduce annual loading of phosphorous by 11.3 lb			
Po 3a-1 Plant 5 ac of deep-rooted riparian vegetation, reducing loading of phosphorous by 7 lb/yr Focus areas: large parcels single ownership, headwaters.			
Actions: See Po 1a-1	WC/SWCDs/partners		
Po 3a-2 Plant 500 lf of roadside ditch in no-mow grass to reduce phosphorous by 0.2 lb/yr			
Actions: See Po 1a-2	WC/SWCDs/partners		
Po 3a-3 Retrofit developed site to treat water quality from 20 acres (e.g., stormwater retrofit/green infrastructure), reducing phosphorous loading by 4 lb/yr.			
Actions: See Po 1a-3			
Po 3a-4 Install 2,000 square feet of rain garden, reducing annual phosphorous loading by 0.08 lb/yr.			
Actions: See Po 1a-4	WC/SWCDs/partners		
Po 3a-5 Maintain Stream database			1 database
Po 3a-6 Conduct public outreach by providing information and studies electronically or in print.			
Actions: See Po 1a-4	WC/SWCDs/partners		
Po 3a-7 Increase/sponsor 11 outreach/stewardship activities related to non-point source pollution and watershed issues.			
Actions: See Po 1a-5			
Goal Po 3b Reduce bank erosion to reduce phosphorous loading by 60 lb/year.			
Po 3b-1 Stabilize 1600 l.f. of eroding bank, reducing phosphorous loading by 60 lb/yr *Focus areas, e.g., eroding streambanks with livestock access, Congress Lake Outlet headwater tribs, Randolph/other ditches*			
Actions: See Po 1b-1			
Po 3b-2 Restore 10 acre-ft of floodplain access/storage, reducing channel loading by 435,600 cu. Ft.. Focus areas - areas with modified floodplain access.			
Actions: See Po 1b-2			
Po 3b-3 Restore 50 acres of wetland thereby increasing storage by 19,000 cubic feet of water in a 3/4 inch storm. Target areas headwaters with altered wetlands.			
Actions: See Po 1b-3			
Goal Po 3c Reduce septic system failure to reduce annual loading of phosphorous by 183 lb			
Po 3c-1 Correct 3 failing HSTS every 2 years, reducing phosphorous loading by 183 lb/yr Focus areas: vicinity of water courses			

Table Po 4.3 Potter Creek Phosphorous
HUC 041100020201

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Actions: See Po 2c-1			
Po 3c-2 Outreach			
Goal Po 3d Reduce agricultural runoff to reduce annual loading of phosphorous by 599 lb			
Po 3d-1 Conduct 1 approximately year-long nutrient survey along Breakneck Creek, Feeder Canal, Lake Hodgson, Congress Lake Outlet, and Potter Creek.			
Actions: See Po 2d-1			
Po 3d-2 Conduct survey of practices to target application of BMPs			
Actions: See Po 1c-1			
Po 3d-3 Install 3,000 lf of livestock exclusion and accompanying measures (e.g., watering, stream crossing) to reduce phosphorous loading by 140 lb per year			
Actions: See Po 1c-2			
Po 3d-4 Install grassed waterway/buffer strips to treat 150 ac and reduce phosphorous loading by 39 lb /yr.			
Po 3d-5 Install cover crops on 150 ac and reduce sediment by 180 lb/yr			
Po 3d-6 Increase use of residue on ag fields by an additional 200 acres, reducing sediment loading by 240 lb/yr			
Goal Po 3e Increase uptake of phosphorous by wetlands and floodplains by 415 lb/yr.			
Po 3e-1. Restore 50 ac of wetland, reducing loading of phosphorous by 316 lb/yr. Focus areas -altered riparian wetlands *Target areas: Cranberry Creek, Potter Creek, headwater tribs Congress Lake Outlet*			
Actions: See Po 1b-3.			
Po 3e-2 Restore 10 acre-foot of floodplain access/storage, reducing annual phosphorous loading by 8 lb. Focus areas - areas with modified floodplain access.			
Actions: See Po 1b-2.			
Po 3e-3 Improve channel morphology, e.g., 2-stage ditch, by 1,000 lf to increase phosphorous uptake by 91 lb/yr. Focus areas: altered headwater channels. Cranberry Cr.			
Actions: See Po 2e-3.			
Goal Po 3f Protect wetlands and riparian corridors to prevent future phosphorous loading by 352 lb/yr.			
Po 3f-1 Protect 36,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1, reducing loading of phosphorous by 36 lb/yr			
Actions: See Po 1e-1.			
Po 3f-2 Protect 50 acres of wetlands/riparian corridor through acquisition of land/easements, preventing increased loading of phosphorous			
by 316 lb/yr. Target areas high value wetlands, Potter Cr., Cong. Lk Outlet headwaters Actions: See Po 1e-3			

Table Po 4.4 Potter Creek - Habitat
041100020201

Potter Creek (Po) Problem Statement 4: Habitat

The 1997 TSD notes that because Potter Creek was channelized, habitat was characterized by modified attributes and lacked WWH characteristics, scoring 41 on the QHEI.

Much of the Potter Creek subwatershed drainage has been altered by channelization (29 miles). Alteration of at least 2,585 acres of wetland, 78% of vegetated riparian corridor, and loss of riparian features (e.g., riparian zone, floodplain access) along an estimated 31.7 miles of watercourses has degraded habitat. The remaining large wetland complexes and areas containing species of concern are largely unprotected.

Goals / *Objectives* / Actions	Lead/ cooperating Organizations	Resources needed/cost	Amount to complete, time frame (contingent on funding, resources, landowner willingness)
Goal Po 4a Restore 65 ac of riparian habitat and wetlands			
Po 4a-1 Plant 5 ac of deep-rooted riparian vegetation. Focus areas: large parcels single ownership, headwaters.			
Actions: See Po 1a-1	WC/SWCDs/partners		
Po 4a-2. Restore/reconnect 50 ac of wetland. Focus areas -altered riparian wetlands *Target areas: Cranberry Creek, Potter Creek, headwater tribs Congress Lake Outlet*			
Actions: See Po 1b-3.			
Po 4a-3 Restore 10 acre-ft of floodplain access/storage. Focus areas - areas with modified floodplain access.			
Actions: See Po 1b-2.			
Goal Po 4b Improve/restore 1,000 lf of channel habitat			
Po 4b-1 Improve channel morphology, e.g., 2-stage ditch, by 1,000 lf. Focus areas: altered headwater channels, Cranberry Creek			
Actions: See Po 2e-3.			
Po 4b-2 Conduct feasibility study to remove small low-head dams			
Goal Po 4c Protect 75 ac of wetlands/riparian corridors to prevent future degradation. *Target - intact wetlands, riparian corridor, areas with species of concern, large/connected areas of woods/other important habitat*			
Po 4c-1 Protect 36,000 linear feet of riparian buffer by increasing the number of communities using riparian setbacks by 1			
Actions: See Po 1e-1.			
Po 4c-2 Protect 50 acres of wetlands/riparian corridor through property acquisition/easement. Target areas high value wetlands, Potter Cr., Cong. Lk Outlet headwaters			
Actions: See Po 1e-2			

End of Volume

Middle Cuyahoga River Watershed Action Plan
Section 4P
Watershed Photos by Subwatershed

2012 Final

Attachment 4P Organization

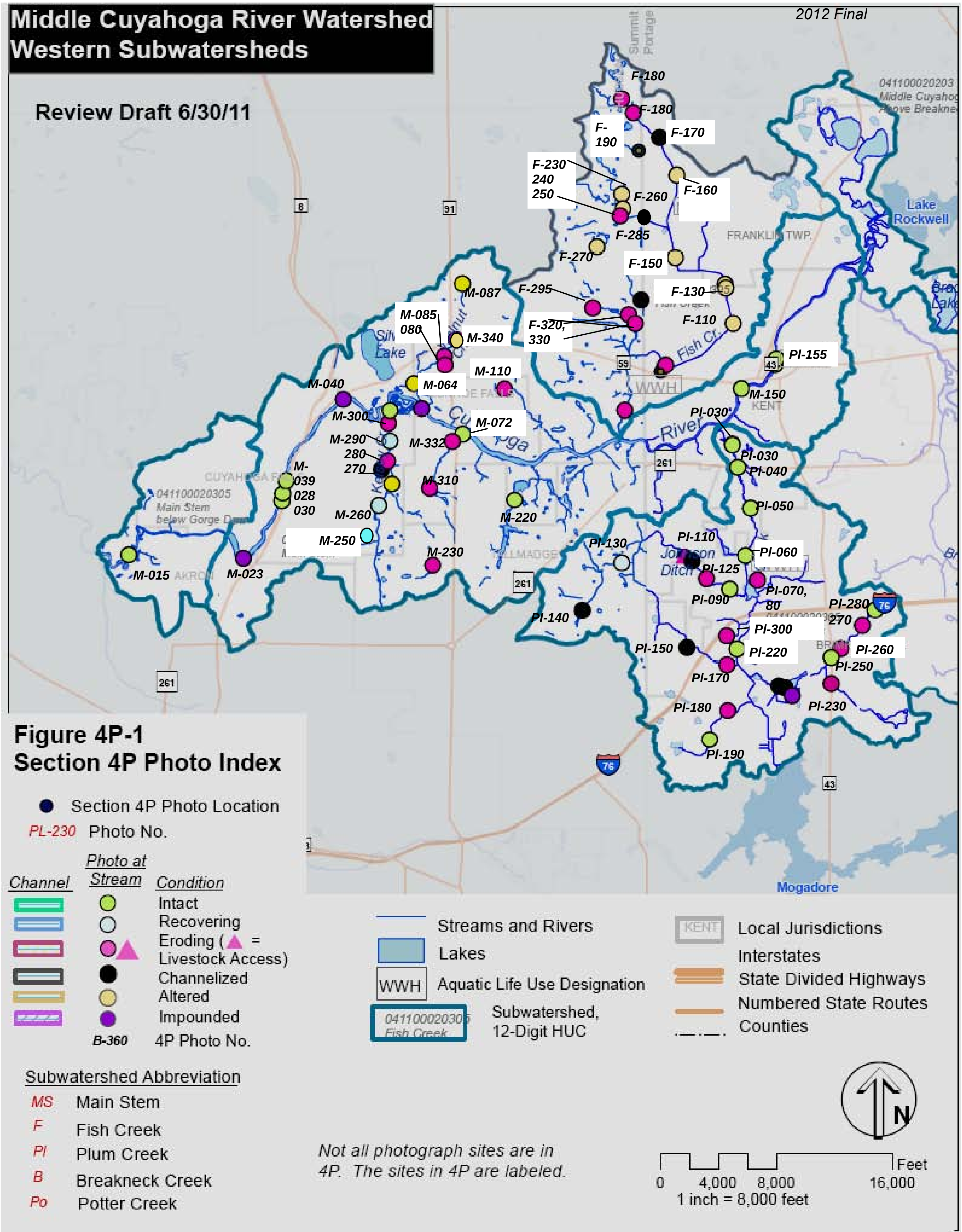
4P is organized by subwatershed:

- M (or MS) is Main Stem;
- F (or FC) is Fish Creek;
- Pl is Plum Creek;
- B (or BC) is Breakneck Creek
- Po is Potter Creek

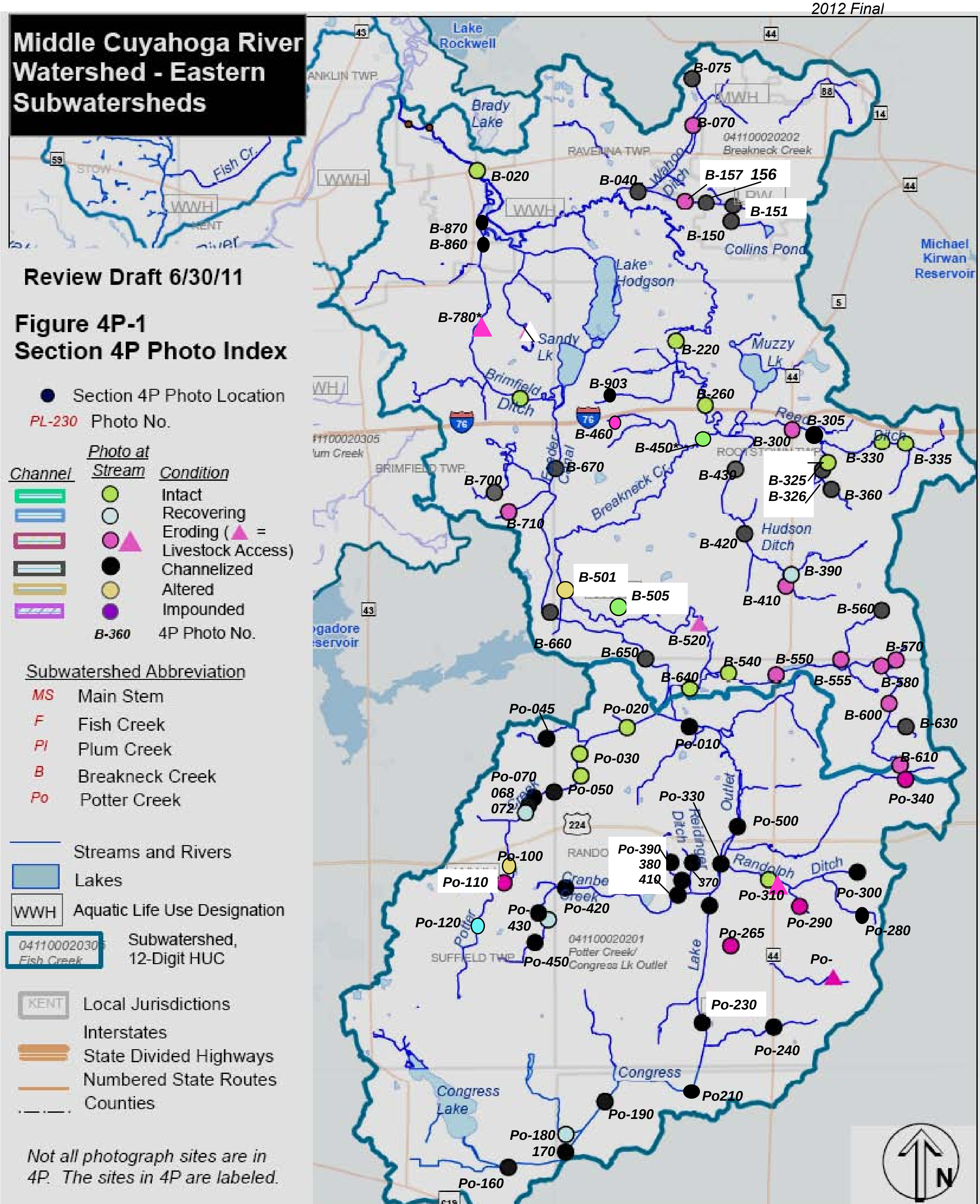
At the beginning of the attachment there is an index map of all the photos and a list and description of the photos, slope, channel condition, and page number by sub-watershed.

The photos are grouped by main stem or tributary and, to the extent possible, are presented from the downstream (receiving) end and working upstream, toward the source.

The photo sites are color coded on the index map to reflect observed conditions.



Middle Cuyahoga River Watershed
Western Subwatersheds
2012 Final
Review Draft 6/30/11
Figure 4P-1
Section 4P Photo Index
Section 4P Photo Location
PL-230 Photo No.
Channel
Photo at Stream
Condition
Intact
Recovering
Eroding (= Livestock Access)
Channelized
Altered
Impounded
B-360 4P Photo No.
Streams and Rivers
Lakes
WWH Aquatic Life Use Designation
041100020305 Fish Creek
Subwatershed, 12-Digit HUC
Local Jurisdictions
Interstates
State Divided Highways
Numbered State Routes
Counties
Subwatershed Abbreviation
MS Main Stem
F Fish Creek
Pl Plum Creek
B Breakneck Creek
Po Potter Creek
Not all photograph sites are in 4P. The sites in 4P are labeled.
0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet
N
Lake Rockwell
FRANKLIN TWP.
KENT
AKRON
Mogadore
Fish Cr.
River
Mogadore



Labeling Errata: In the text, there are multiple references to5B-550. One is B-660 (Old Forge Rd.). Any references to B-790 should read "b-780." References to B-45 should read "B-450."

0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet

Table 4P-1 ms Photo Index Main Stem Subwatershed

4P Photo Number	Page 4P M-	Name	% Slope	Channel Condition	Example_of
MS-015	1	Cuyahoga River	0.28	Intact	Cuyahoga River, intact corridor in Cascade
MS-020	1	Cuyahoga River		Impounded/ intact	Cuyahoga R. Ohio Edison dam and downstream
MS-023	1	Cuyahoga River	0.79	Impounded	Cuy. R. Ohio Edison dam pool impounded
MS-028	1	Cuyahoga River	0.79	Intact	Cuyahoga River in CF Gorge
MS-030	2	Cuyahoga River	0.79	Intact	Cuyahoga River CF Gorge at High Glens
MS-040	2	Cuyahoga River	5.00	Intact	Cuyahoga River expert class rapids
MS-043	2	Cuyahoga River		Impounded	Dams and dam pools, Cuyahoga Falls
MS-057	2	Cuyahoga River	0.09	Impounded	Cuyahoga River dam pool, Cuy. Falls
MS-060	2	Cuyahoga River	0.09	Intact	Cuy. R.- Water Works Pk dam pool but flowing
MS-063	5	Walnut Creek	0.45	Channelized, hardened	Walnut Cr, hardened channel, flooding/bank failure
MS-072	3	Cuyahoga River	0.08	Intact	Cuy R Munroe Falls dam site intact channel
MS-085	5	Walnut Creek	1.60	Eroding	Walnut Creek in park, eroding - runoff vol.
MS-080	5		6.62	Eroding	Walnut Cr. trib, very steep, eroding from runoff
MS-083	1		0.00	Altered, incised	Walnut Cr. headwater urbanized channel
MS-110	6		0.46	Eroding	Eroded headwater trib no buffer
MS-148	3	Cuyahoga River	0.10	Intact	Cuyahoga River intact channel, steep valley, boardwalk Kent
MS-150	3	Cuyahoga River	0.46	Intact,	Cuy R Kent dam site up/downstream
MS-155	3		0.00	Intact	Cuyahoga River near Brady's Leap (rapids)
MS-220	6	Munroe Falls Park tributary	1.18	Intact	Intact stream corridor, Munroe Falls MetroPark
MS-230	4		3.04	Channelized, eroding	Kelsey Cr eroding headwater trib, steep slope, neighborhood runoff
MS-250	4	Kelsey Creek	very low	Intact/ recovering	Low-gradient portion of Kelsey Creek in woods - more intact than other places
MS-260	4	Kelsey Creek	0.50	Recovering	Kelsey Creek - low gradient woods/park
MS-270	4		0.39	Altered, hardened channel	Kelsey Cr. trib - hardened
MS-280	4	Kelsey Creek	0.15	Eroding	Kelsey Cr. eroding/incised in park
MS-290	4	Kelsey Creek	0.23	Recovering	Kelsey Cr. former dam pool
MS-300	4	Kelsey Creek	0.78	Eroding	Kelsey Cr. in Water Works Park - banks eroding
MS-310	6		0.91	Incised	Incised headw trib, slope - 3.4 to 0.9% here
MS-332	6		1.09	Incised	Incised tributary - runoff, steep slopes
MS-340	5			Altered/ culverted	Walnut Creek flowing under building
MS-345	5			Altered/ culverted	Walnut Creek headwater tributary - culverted

Table 4P-1f Photo Index Fish Creek Subwatershed

4P Photo Number	Page 4P f-	Name	% Slope	Channel conditions	Example_of
f-020	1	Fish Creek	0.25	Intact	Fish Cr. intact corridor WWH non att. 2000
f-050	1	Fish Creek		Channelized	Fish Creek at Route 59 channelized narrow
f-070	1	Fish Creek		Channelized	Fish Cr at Sunrise small wooded buffer, flowing
f-080	2	Fish Creek	0.08	Eroding, channelized, embedded	Fish Cr. - lower (Spaulding) - channelized eroding flooding
f-095	7		0.00		Fish Cr. subwatershed pavement runoff
f-110	2	Fish Creek	0.05	Altered wetland, chnanelized	Fish Cr. channelized, altered wetland
f-130	2	Fish Creek	0.05	Channelized	Fish Cr.- McKinney channelized, altered wetland, flooding problems
f-131	2	Fish Creek	0.05	Altered Wetland	Fish Cr. altered wetland upstream of flood probs.
f-150	3	Fish Creek	0.07	Altered wetland, channelized, embedded	Fish Cr. altered wetland, at Johnson limited flood access
f-160	4	Fish Creek	0.47	Altered wetland, channelized	Fish Cr. altered wetland; woods
f-170	4	Fish Creek	0.17	Embedded	Fish Cr. narrow shrub/grass buffer embedded
f-180	4	Fish Creek	0.38	?	Fish Cr. wooded buffer ?intact channel??
f-190	4	Fish Creek	0.77	Incised	Fish Cr. narrow treed buffer, grass, incised?
f-260	5	Fish Creek	0.30	Channelized	Fish Cr. Newcomer Rd., channelized flooded after heavy rain
f-230	6		0.33	Altered Wetland	Fish Cr. Headwaters altered hydrology & wetland in subdiv.
f-240	6		0.52	Altered Wetland	Fish Cr. Headwaters altered hydrology & wetland in subdiv.
f-250	6		0.07	Incising, eroding	F Cr narrow treed buffer eroding bank intact channel
f-270	6		1.03	Altered Wetland	Fish Cr. Headwaters altered hydrology & wetland in subdiv.
f-285	7		0.28	Channelized	Fish Cr. trib - altered channel, grass banks at HS
f-295	7		0.00	Incising, channelizing	Fish Cr. headwaters - storm drain outflow from plaza
f-320	7		1.30	Incising?	F Cr headwater trib in subdiv. grass/shrub banks/buff
f-330	7		0.19	Incising	F Cr headwater trib in subdiv. eroding mown
f-360	7			?Intact?	Fish Creek headwater with narrow buffer

Table 4P-1pl	Index Map Plum Creek Subwatershed				
4P Photo Number	**Page 4P Pl-**	**Name**	**% Slope**	**Channel Condition**	**Example_of**
PL-030	1	Plum Creek	?	Intact - restored	Plum Creek restoration
PL-040	1	Plum Creek	0.56	Intact/starting to erode?	Plum Creek intact corridor
PL-050	1	Plum Creek	0.14	Intact	Plum Creek intact corridor
PL-060	1	Plum Creek	0.52	Intact	Plum Creek in wetlands at Howe by subdiv.
PL-070	1		0.00	Eroding	development and erosion - Pleasant Lakes
PL-080	1	Lake			View of Lake in Pleasant Lakes development, receives water from all ditches
PL-090	2	Johnson Ditch	1.98	Intact	Johnson Ditch intact corridor
PL-100	2	Johnson Ditch		Channelized	Channelized Johnson Ditch, minimal to good buffer
PL-105	2	Johnson Ditch	0.34	Eroding	Johnson Ditch high flow, woods, ag field erosion
PL-110	3	Johnson Ditch	0.34	Channelized - livestock	J Ditch channelized unrestr livestock access
PL-115	2	Johnson Ditch	0.34	Channelized	Johnson Ditch narrow buffer from industrial site
PL-130	3	Johnson Ditch	0.29	Channelized/recovering	J Ditch, JayCee park, in wetl culverted both ends
PL-140	3	Johson Ditch	0.29	Channelized	Johnson Ditch headw in subdiv by det basin
PL-150	4		0.48	Channelized	Johnson Ditch as roadside ditch
PL-170	4		0.27	Eroding	J Ditch s eroding bank by building
PL-180	4		0.48	Incised, eroding	Plum Cr trib eroding stream no buffer golf course
PL-190	4		0.55	Intact	Plum Cr headw trib intact corridor
PL-210	5		0.30	Channelized	Plum Cr trib channelized by subdiv
PL-215	5		0.34	Channelized	Plum Cr headwater - channelized
PL-220	4	Plum Creek	0.44	Intact	Plum Creek intact corridor
PL-225	5		0.00	Impounded	Private impounded lake
PL-230	5		2.48	Eroding, channelized	Plum Cr tributary eroding min-no buffer
PL-250	6		0.41	Intact	Plum Creek trib - Wetland mitigation area
PL-260	6		0.41	Eroding, channelized	Plum Cr. headw trib eroding infrastructure
PL-270	6		0.41	Eroding	Plum Cr trib streambank erosion in development
PL-280	6		0.45	Intact	Plum Cr headw trib intact sm-wide wooded buff
PL-300	4		0.07	Eroding	Plum Cr trib flows through topsoil/mulch piles

Table 4P-1 B Photo Index Breakneck Creek Subwatershed

4P Photo Number	Page 4P b-	Stream Name	% Slope	Channel Condition	Example_of
B-020	1 & 2	Breakneck Creek	0.28	Intact altered buffer	B. Cr. intact channel, narrow wooded buffer, urban
B-045	1	Breakneck Creek		Intact	Breakneck Creek at Rootstown, intact, wetlands, spring floods
B-040	9	Wahoo Ditch	0.13	Channelized	W. Ditch, channelized, overgrown non-attain
B-055	9	Wahoo Ditch		Channelized	Wahoo Ditch
B-070	9	Wahoo Ditch	0.04	Channelized, eroding	W Ditch channelized eroding sod banks, urban/woods, area with flooding problems
B-075	9	Wahoo Ditch	0.22	Channelized	
B-150	10	Hommon Ave. Ditch	0.18	Channelized	Hommon Ave. Ditch LRW narrow channelized gr buffer
B-151	10	Collins Pond Outlet	0.11	Altered/culvered	Altered hydrology culverted channelized
B-156	10	Hommon Ave. Ditch	0.00	Channelized	Hommon Ave. Ditch channelized, grass buffer
B-157	10	Hommon Ave. Ditch	0.00	Channelized, eroding	Hommon Ave. Ditch eroding channelized
B-160	10	Collins Pond Outlet	0.11	Altered/culverted	Collins Pond Outlet/Hommon Ave. Ditch, altered, channelized, culverted
B-170	11	Collins Pond		Altered wetlnad	Vicinity of Collins Pond
B-180	11	Collins Pond		Altered wetland	
B-220	2	Breakneck Creek	0.02	Intact	Breakneck Cr. intact floodplain, flooding
B-260	2	Breakneck Creek	0.03	Altered, eroding grass/no buffer	Altered eroding grass bank/buffer, could be influenced by Hudson/Reed Ditches upstream
B-300	6	Reed Ditch	0.05	Channelized, incised	Reed Ditch channelized incised large volume
B-305	6	Reed Ditch		Channelized	Reed Ditch channelized
B-325	7	Reed Ditch	0.23	Channelized	Reed Ditch s. trib tall grass banks/buffer
B-326	7	Reed Ditch	0.23		Reed Ditch s. trib. wooded buffer
B-330	6	Reed Ditch	0.36	Intact?	R. Ditch small headwater grass/tree buffer good flow
B-335	6	Reed Ditch	0.36	?	R. Ditch small headwater grass/tree buffer
B-360	7	Reed Ditch	1.49	Altered/ channelized	R. Ditch channelized mown swale plus detention basin
B-390	5	Hudson Ditch	0.95	Recovering	Hudson Ditch narrow shrub buffer embedded
B-410	5	Hudson Ditch	0.62	Incised	Incised headwater stream mown grass banks
B-420	5	Hudson Ditch	0.04	Channelized	Hudson Ditch channelized, grass banks

Table 4P-1 B Photo Index Breakneck Creek Subwatershed

4P Photo Number	Page 4P b-	Stream Name	% Slope	Channel Condition	Example_of
B-430	5	Hudson Ditch	0.09	Channelized, incised	Hudson Ditch channelized, embedded, buffer woods/grass
B-460	13			Eroding	Headwater tributary eroding, no buffer
B-501	2	Breakneck Creek	low	?	Breakneck Cr at Old Forge Rd. No buffer.
B-505	13			Intact? No buffer	Headwater tributary at Old Forge no buffer
B-520	2	Breakneck Creek	0.10	Eroding, livestock	Breakneck Cr altered eroded grass bank in livestock yard
B-540	1	Breakneck Creek headwater tribs	0.26	Intact	B Cr intact headwater channel in wetland
B-550	3	Breakneck Creek headwater tribs	0.31	Intact	B Cr Intact weltand below headwater tribs
B-555	3	Breakneck Creek headwater tribs	1.27	Channelized	B Cr headw. tribs channelized eroding grass banks
B-560	3	Breakneck Creek headwater tribs	1.27	Eroding	B Cr headw tribs eroding banks buffer-ag/wet/woods
B-575	3	Breakneck Creek headwater tribs	0.70	Eroding	View of eroding stream in field along Wilkes
B-580	4	Breakneck Creek headwater tribs	2.35	Eroding, channelized	B Cr headw tribs eroding banks volume channelization
B-600	4	Breakneck Creek headwater tribs	0.67	Eroding	B Cr headw trib eroding banks sm. grass/woods buff
B-610	4	Breakneck Creek headwater tribs	0.96	Eroding/incisi ng	B Cr headw trib eroding mown grass banks
B-630	4	Breakneck Creek headwater tribs	1.61	Channelized	B Cr headw trib grass/ag banks/buffer
B-640	1	Breakneck Creek	0.00	Intact buffer - channelized? ?	Congress Lake Outlet/Potter Cr. Upstream of confluence, intact corridor, wetlands
B-650	12	Feeder Canal	0.04	Channelized	Feeder Canal, ditch small treed buffer in res/ag use
B-660	12	Feeder Canal	0.04	Channelized	Feeder Canal mown grass banks/buffer
B-670	12	Feeder Canal	0.13	Channelized	Feeder Canal channelized narrow treed buffer

Table 4P-1 B Photo Index Breakneck Creek Subwatershed

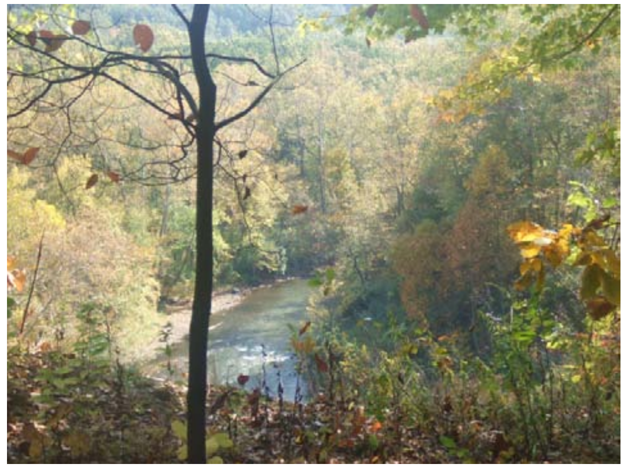
4P Photo Number	Page 4P b-	Stream Name	% Slope	Channel Condition	Example_of
B-700	13	Feeder Canal	0.69	Eroding, altered banks	Feeder Canal headw trib eroding turbid grass banks
B-710	13	Feeder Canal	0.59	Eroding	Feeder Canal headw trib eroding trubid grass banks
B-740	8	Brimfield Ditch	0.27	Intact	Brimfield Ditch intact vegetated buffer
B-780/790	8	Brimfield Ditch		Eroding, channelized, livestock	Brimfield Ditch livestock access channelized no fp
B-860	8	Brimfield Ditch		Channelized	Near water treatment plant - no buffer one side
B-870	8	Brimfield Ditch		channelized	Good buffer
B-903	13			channelized	Headwater tributary channelized, small buffer

Table 4P-1 po Photo Index Potter Creek Subwatershed

4P Photo Number	Page 4P Po-	Name	% Slope	Channel Condition	Example_of
Po-010	4	Congress Lake Outlet	0.14	Channelized	CLO/Potter Creek at Johnnycake Rd. floods, resid. area
Po-020	1	Potter Creek	0.04	Intact channel/ embedded	Potter Cr. lower at confluence of CLO- intact in wetland
Po-030	1	Potter Creek	0.15	Intact	Potter Cr. - lower -Randolph Rd. in wetland
Po-040	1		0.13	Channelized	Potter Cr. trib channelized grass buffer
Po-045	1			Channelized	Potter Cr. Trib channelized no buffer
Po-050	1	Potter Creek	0.15	Intact	Potter Cr. at Trares Rd. in wooded buffer WWH partial
Po-060	1	Potter Creek	0.15	Embedded	Potter Cr. - at Conley Rd. in buffer, embedded, ditch upstream
Po-068	2	Potter Creek	0.16	Channelized	Large, diverse wetland buffer on Potter Creek, contiguous to easement
Po-070	2	Potter Creek	0.16	Channelized/ embedded	Potter Cr. ditch embedded prop. overwide site
Po-072	2	Potter Creek	0.16	Recovering/ intact	Potter Cr. recovered section in woods immediately upstream of demo site
Po-100	2	Potter Creek	0.44	still intact?	Potter Creek at Waterloo Rd. no buffer/treed buffer
Po-110	3	Potter Creek	0.44	Recovering	Potter Cr. at Shaffer, livestock fence, recovering
Po-111	3	Potter Creek	0.44	Eroding incising	Potter Creek bank erosion downstream of fenced cattle yard eroded during floods (2003?)
Po-120	3	Potter Creek			Potter Creek at Steffy Rd. varied buffer
Po-160	5	Congress Lake Outlet	0.12	Channelized embedded weedy	Upper Congress Lake Outlet (CLO) at Swamp Rd. - summer, weedy
Po-170	5	Congress Lake Outlet	0.05	Channelized eutrophic	CLO, upper - algae filled
Po-180	9		0.49	Recovering in channel	CLO tributary - recovering in channel
Po-190	5	Congress Lake Outlet	0.05	Channelized, embedded	CLO - upper, steep sided channel, silted in
Po-210	5		0.16		CLO, upper reaches, narrow channel and buffer
Po-230	5	Congress Lake Outlet	0.07	Channelized	CL0 upper reaches good flow
Po-240	9		0.00	Channelized	Potter Cr/CLO tributary varying grass buffer
Po-250	9		0.70	Eroding, incising, livestock	CLO trib incised unrestricted livestock access
Po-265	9		0.00	Eroding, incising	CLO tributary incised in woods - upstream effects
Po-280	8			Channelized	Randolph Ditch tributary - channelized roadside ditch
Po-290	8	Randolph Ditch	1.17	Eroding, incising	Randolph Ditch trib. some buffer, incised, intact
Po-300	8	Randolph Ditch	0.45	Channelized	Randolph Ditch trib minimal buffer channelized

Table 4P-1 po Photo Index Potter Creek Subwatershed					
4P Photo Number	**Page 4P Po-**	**Name**	**% Slope**	**Channel Condition**	**Example_of**
Po-310	8	Randolph Ditch	0.12	Eroding, livestock	Randolph Ditch unrestricted livestock access
Po-311	8	Randolph Ditch	0.12	Intact	Randolph Ditch downstream of Rte 44 livestock small buf
Po-320	4	Congress Lake Outlet	0.07	Channelized	CLO - wooded buffer
Po-330	4	Congress Lake Outlet	0.11	Channelized	CLO at Alexander Rd., confluence Randolph Ditch grassed/wooded buffer
Po-340	9		0.41	Incising/ Intact/ altered	CLO tributary intact in woods, incised where no buffer
Po-341	9		0.41	Incising/ Intact/ altered	CLO tributary intact in woods, incised where no buffer
Po-370	7	Reidinger Ditch	0.21	Channelized	Reidinger Ditch grass buffer, channelized, tiled
Po-380	7	Reidinger Ditch	0.46	Channelized	Reidinger Ditch, grassed buffer, channelized
Po-390	7	Reidinger Ditch	0.46	Channelized	Reidinger Ditch narrow grass buffer in ag
Po-410	6	Cranberry Creek	0.12	Channelized	Cranberry Cr. tiled ditch small buffer
Po-420	6	Cranberry Creek	0.09	Channelized	Cranberry Creek channelized, small grass buffer
Po-430	6	Cranberry Creek	0.00	Channelized	Cranberry Cr. extensively channelized minimal buffer
Po-440	6	Cranberry Creek	0.28	Recovering	Cranberry Creek minimal buffer from ag recovering
Po-450	6	Cranberry Creek	0.28	Channelized	Cranberry Cr. in residential area min. buffer
Po-500	4	Congress Lake Outlet	0.04	Channelized	CLO lower end - Waterloo Rd., spring floods no flooding; wooded buffer

Middle Cuyahoga River—Lower end to Gorge; Dam Pools—Non-attainment WWH criteria



MS-015 *Cuyahoga River at Cascade MetroPark, Oct., 2010.*

MS-020 *Below and at Ohio Edison Dam; July, 2009.*

MS-023 *Ohio Edison dam pool at Gorge Rd; July, 2009.*

MS 028 *Cuyahoga River in the Gorge between top of the dam pool and Overlook. July, 2009.*

Cuyahoga River Main Stem—Gorge and Low-Head Dam Pools

MS-030 *Gorge up- and downstream of High Glens overlook, Cuyahoga Falls gorge. Low-head dam pools are in far background of left picture. New High Glens Park boardwalk visible in right-hand photo.. Nov., 2009.*

MS 040 *Expert-class rapids at Sheraton below lower-most low-head dam at Broad St., July, 2009.*

MS 043 *View of two remaining low-head dam pools and upper-most dam in Cuyahoga Falls from Cuyahoga Falls riverfront walk. July, 2009.*

MS-057 *Upper dam pool at Oak Park Ave.*

MS-060 *Cuyahoga River at Water Works Park, on a double meander on a low-lying sand/gravel deposit. Park floods during high water. Near public water supply. June, 2011, Mar., 2004.*

2012 Final

Middle Cuyahoga River Restored Section—Munroe Falls to —Kent

MS-072 *View of river and rapids at reconstructed dam abutment at Brust Park where the Munroe Falls dam was removed. May, 2008. Pic. 9192.*

MS-148 *Cuyahoga River boardwalk trail, Kent. Steep-sided valley walls apparent to left. This is a typical view of the Middle Cuyahoga between Munroe Falls and Kent. Mar., 2009.*

MS-150 *Left: View from Main St. bridge looking downstream to Kent dam. River flows through sluiceway, and the historic dam has been retained as a park. Right: View downstream of the park on the dam. June, 2011, Nov. 2010.*

MS-150 *Cuyahoga River upstream of dam and bridge. May, 2010.*

MS-155 *Cuyahoga River near Brady's Leap, Kent. October, 2010*

Kelsey Creek

MS-300. *Kelsey Creek in Water Works Park. The channel is gravelly. Erosion, which may be threatening the bridge, may be due to high volumes. June, 2011.*

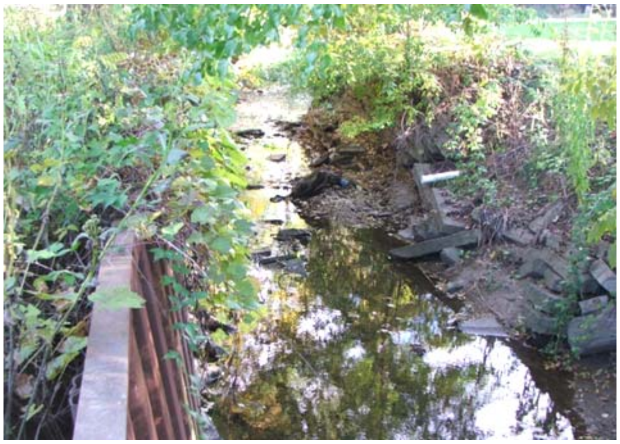
MS-290 *Kelsey Creek, former dam pool. June, 2011.*

MS 280, 270 *Kelsey Creek in Kennedy Park lacks a functional riparian corridor and is eroding its banks, partially due to excess stormwater from altered stream corridors and impervious surfaces in neighborhoods. The sediment and channel erosion degrade the stream habitat. Many streams in the Main Stem subwatershed are altered. Spring, 2011, Summer, 2010.*

MS 250, 260 *Kelsey Creek is generally low-gradient and is most intact within woods.. (Center) Even a low-gradient portion like this through Galt Park is incising, showing evidence of overloading. Summer, 2010.*

MS-230 *Stormwater runoff from a Tallmadge neighborhood contributes to overloading the creek and water quality problems.. This is one of the few steep slopes along Kelsey Cr. Spring, 2004.*

Walnut Creek



MS-063 *Developments on wetlands and floodplains require bulkheads to hold the channels in place. Oct., 2009.*

MS-085 *Walnut Creek in Adell Durbin Park has a wooded buffer but is eroding from excess stormwater. Oct., 2009.*

MS-080 *Steep slopes contribute to the erosive force of the water. Oct., 2009.*

MS 340, 345 *Headwater tributaries to Walnut Creek have been severely altered. Culverted tributaries flow beneath the pavement and sod. The tributary on the right emerges in the background behind the houses. Summer, 2010; Spring, 2011*

Other Main Stem Sub-watershed Tributaries

While a few of the headwater tributaries in the Main Stem subwatershed have intact riparian environments, many have been altered or otherwise affected by excess runoff and steep slopes. Some headwater tributaries became incised at the river when the Munroe Falls dam and river base level were lowered.

MS-110 *Unnamed Tributary, Charring Cross Rd., July, 2010.*

MS-220. *Munroe Falls MetroPark Creek appears to be an intact, high-quality stream with gravel substrate, riparian zone, wooded riparian buffer, variable flow. August, 2010.*

MS-310, 332. *Unnamed tributary that flows past Munroe Falls City Hall. The entire length is incised, apparently overloaded by runoff from neighborhoods and steep slopes.*

Fish Creek—Main Stem WWH (Non-Attainment)


FC-020 *Fish Creek n. of N. River Rd. Nov., 2009, June, 2011*


F-50 *Fish Creek at Rte 59, June, 2011*


F70 Fish Creek at *Sunrise Rd. June, 2011.*

Fish Creek Kent—MWH In Attainment

This portion of Fish Creek is known for flooding problems, receiving excess storm water from upstream.

FC-080 *Fish Creek at Spaulding, spring floods on right. Note proximity of flood waters to buildings and partially submerged utility pole, eroding banks, lack of floodplain access. Nov., 2010, March 2011*

FC-110 *Fish Creek at Fairchild Nov., 2010*

F-130 *McKinney Ave. flooding Mar, 2011*

FC-130 *McKinney Ave. Playground (left) is converted wetland adjacent to Fish Creek; Fish Creek channel (center); channelized wetland upstream of playground/flooding site (right). Nov., 2010.*

Fish Creek at Johnson Rd.

FC-150 *Fish Creek at Johnson Rd. This area provides a clear example of the effect of channelizing Fish Creek through former wetlands. The poorly draining soils pond the water, but the creek has limited access to floodplains, and the flood water is not being stored or treated within the soil and roots of the wetland. Photos taken during July, 2010 (top left), November, 2010 (middle), March floods, 2011(bottom).*

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Fish Creek, Northern Portion

FC-160 *Fish Cr. At Spell Rd. – altered wetland Nov., 2009.*

FC-170 *Fish Creek at Judson Rd., July, 2009.*

FC-180 *Fish Creek by Ravineview, Nov. 2009.*

FC-190 Fish Creek at Barlow Rd. Nov., 2010

Fish Creek Tributary at Newcomer Rd.

FC-260 *Newcomer Rd after heavy rain, April, 2011. There have been reports of this road flooding, and the flattened vegetation suggests possible over-topping of the road. The narrow channelized stream is apparent under the floodwater in the fourth picture. This road receives drainage from several subdivisions on topof the hill to the east, which all have severely altered hydrology.*

Fish Creek Headwaters flowing to Newcomer

This tributary system has been highly altered.

FC-230 *Fish Creek at Rose Mallow Rd., Nov. 2009, July, 2010.*

FC-240 *Fish Creek at Bluestem in altered wetland. Nov., 2009.*

FC-270 *Fish Creek at Wexford Rd. July, 2010.*

FC-250 *Fish Creek headwater at Young Rd., July 2010.*

Lower Fish Creek Headwater Tributaries

These few photos are typical of residential and commercial development in the lower portion of the Fish Creek watershed, both in Stow and Kent. Although some landscape features have been preserved, most of the riparian landscape is highly altered However, there are many homeowners' association parcels and large properties (e.g, the Stow-Munroe falls high school), where willing property owners could improve the riparian landscape or infiltrate stormwater.

F-320, F330 *Remaining stream in developed area, Edgewater neighborhood. In areas like these, enhancing the narrow riparian area with shrubs, tall grasses, or trees, could reduce the risk of erosion. Nov., 2009.*

F-360 *Stream channel off Fish Creek Rd & Greenlawn – some buffer Nov., 2009.*

F-295 *Drainage from a shopping plaza at Graham & Fishcreek is a headwater of Fish Creek Nov. 2010, June, 2011.*

FC-095 *Route 59 (above), Fish Creek Rd., and Graham Rd. in Stow and Kent are heavily developed with commercial uses, roads, and, parking lots, which drain to Fish Cr. Nov., 2010.*

FC-285 *Modified stream channel, Fish Creek tributary at Stow-Munroe Falls High School. July, 2010*

Plum Creek—WWH In Attainment, 2000

Similar to Breakneck Creek, much of the Plum Creek main stem corridor is relatively intact, with wetlands, floodplains, and wooded buffers protecting the stream. However, much of the Plum Creek subwatershed was undergoing rapid development prior to the economic downturn that began in 2007-2008 and is likely to face development pressure again. As with Breakneck Creek, the headwater tributaries are more altered than the main stem.

PI-025*, 030 Plum Creek Park, restored stream; Nov., 2010.*

PI-040 *Plum Creek upstream of Route 261 April, 2011.*

PI-050 *Plum Creek at Sunnybrook Rd.*

PI-060 *Plum Creek at Howe Ave. April, 2011.*

PI-060 *View from railroad tracks across Plum Creek/ wetland to Pleasant Lakes subdivision during flood March, 2009*

PI-070, PI-080 *Pleasant Lakes development, with view of lake. The lake receives water from all Plum Creek tributaries/ditches. March, 2009*

Johnson Ditch

Portions of Johnson Ditch flow through intact stream corridors; others have been altered.

PI-090 *Johnson Ditch at Sunnybrook, March 2009 & May, 2011.*

PI-105 *Johnson Ditch at Mogadore Rd. Roadside ditch carrying sediment to Johnson ditch March, 2009.*

PI-100 *Plum Creek/Johnson Ditch Mogadore Rd March, 2009*

PI-125 *Johnson Ditch crosses industrial property at Howe.*

Johnson Ditch

Pl-110 *Johnson Ditch at Howe Ave. across (upstream) from Crystal Rd., April, 2011*

Pl-130 *Plum Creek/Johnson Ditch @ JayCee Park Howe Ave. in large wetland complex. Upstream ends culverted under park, agricultural land. April, 2011*

Pl-140 *Head of Johnson Ditch below Tallmadge High School with extended detention basin for schools, Recreation Center.*

Plum Creek Tributaries South of Pleasant Lake

Pl-220 *Plum Creek at Tallmadge Rd. east of Sunnybrook Rd. Nov., 2009*

Pl-300 *Plum Creek tributary at I-76 on Sunnybrook*

Pl-170 *Johnson Ditch (south)) at Sunnybrook Note eroding bank by building. Nov., 2009*

Pl 150 *Johnson Ditch (south)) at Tallmadge Rd.*

PL-180 *Plum Creek tributary in golf course on Sunnybrook Rd., near the Portage County wellhead 5-year time of travel zone. Nov., 2009*

Pl-190 *Plum Creek tributary at Old Forge Rd. Nov., 2009*

Plum Creek Southern Tributaries

Pl-210 and 215 *Plum Creek headwater in Lor Run neighborhood, March, 2009.*

Pl-225 *private lake near Irish and Dussell Rds.*

Pl 230 *Southern tributary on SR 43, April, 2011*

Plum Creek Tributaries at Brimfield Center

Pl 250 *Plum Creek northern tributary SR 43, Brimfield Center, restored wetland, Nov. 2009*

Pl-260 *Plum Creek enters Brimfield Center/Tallmadge Rd. from upstream with erosive force.*

Pl 270, 280 *Plum Creek @ Brimfield Crossings pics Nov., 2009*

Breakneck Creek (WWH, generally in attainment)

From its lower (more urbanized) end in Kent to its headwaters, this low-gradient, sinuous "swamp creek" flows through nearly continuous bands of woods, wetlands, and floodplains, which hold back floods, provide habitat and shade, and buffer the creek from impacts. Breakneck Creek begins where its headwater tributaries coalesce and then join with Congress Lake Outlet/Potter Creek (bottom pictures). The tributaries are more altered than the creek.

B-020 *Breakneck Creek at Route 59 very narrow buffer May 2008.*

B-045 *Breakneck at Rootstown Rd. during May high waters, with what appears to be silt in the thalweg, flanked by wetlands May 2011*

B-640 *Congress Lake Outlet/Potter Creek at Johnnycake upstream of confluence, May 2011.*

B-540 *Breakneck Creek at Hartville Rd. – headwater tributaries upstream of Congress Lake Outlet/Potter Creek confluence , May 2011*

Breakneck Creek Wetlands, Floodplains, Riparian Corridor

While most of Breakneck Creek is flanked by wetlands, floodplains and forested riparian buffer (B-220, top left) , at a few areas near road crossings, the wooded riparian environment has been altered.

B-220 *Breakneck Cr. At Sandy Lake Rd. BC 220 Nov., 2009.*

B-020 *Breakneck Creek at Route 59. Very narrow buffer May, 2008.*

B-520 *Breakneck Creek at Old Forge/Kline – Eroded bank from livestock access (fenced chute?), July, 2010.*

B-501 *Breakneck Cr. At Old Forge Rd., Nov., 2009.*

B-260 *At several road crossings, residents near the water have cleared the riparian buffer to the water's edge. In this case, there appears to be a storm pond embankment adjacent to the river, which is eroding. Breakneck Creek at Lynn, downstream of Reed & Hudson Ditches, April, 2011*

Breakneck Creek Headwater Tributaries (upstream of Congress Lake Outlet

B-550 *Breakneck headwaters, mostly incised, flow into a pond and this wetland at Route 44, below which the channel appears to be intact. The downstream effects of the sediment loads have not been determined. April, 2011. Pic 24891.*

B-560 *New Milford Rd. Farm field eroding directly into roadside ditch/headwater tributary. April, 2011. Pic. 24870*

B-555 *Northern headwater tributary at Wilkes. April, 2011. pics 24881, 83*

B-575 *view of incising stream from Wilkes April, 2011. (Misnumbered as 580)*

Breakneck Creek Headwater Tributaries (above Confluence with Congress Lake Outlet

B-580 *Breakneck headwater tributary, Wilkes Rd. (slope 2.3%) Banks are eroding. April, 2011.*

B-580 *Mixed buffer and substrate. July, 2010.*

B-610 *Small tributary, Fairground Rd..*

B-630 *Headwater tributary at New Milford Rd., April, 2011.*

B-600 *Breakneck headwaters at Bassett. Even the portion in the woods is eroding. April, 2011.*

Breakneck Creek—Hudson Ditch

B-430 *Hudson Ditch at Tallmadge Rd. Nov. 2009.*

B-420 *Modified stream channel, Hudson Ditch, Bower Rd. July, 2009.*

B-420 *Hudson Ditch, Bower St. July, 2009.*

B-390 *Hudson Ditch Rte 44 July, 2009.*

B-410 *Modified stream channel, Hudson Ditch, Hartville Rd. Nov. 2009*

Reed Ditch and Eastern tributary

Reed Ditch starts as a small headwater tributary but increases in size to a wide, deeply-incised chasm at its downstream end, due to large volumes of water from the watershed. There appears to be room along Reed Ditch to restore flood storage or other watershed functions.

BC-300 *Reed Ditch at Rte 44 – carries huge volume. June, 2010, pics 5306, 5311*

B-305 *Reed Ditch main stem, neighborhood east of SR 44, June, 2010*

B-330 *Reed ditch eastern end, New Milford Rd, June, 2010.*

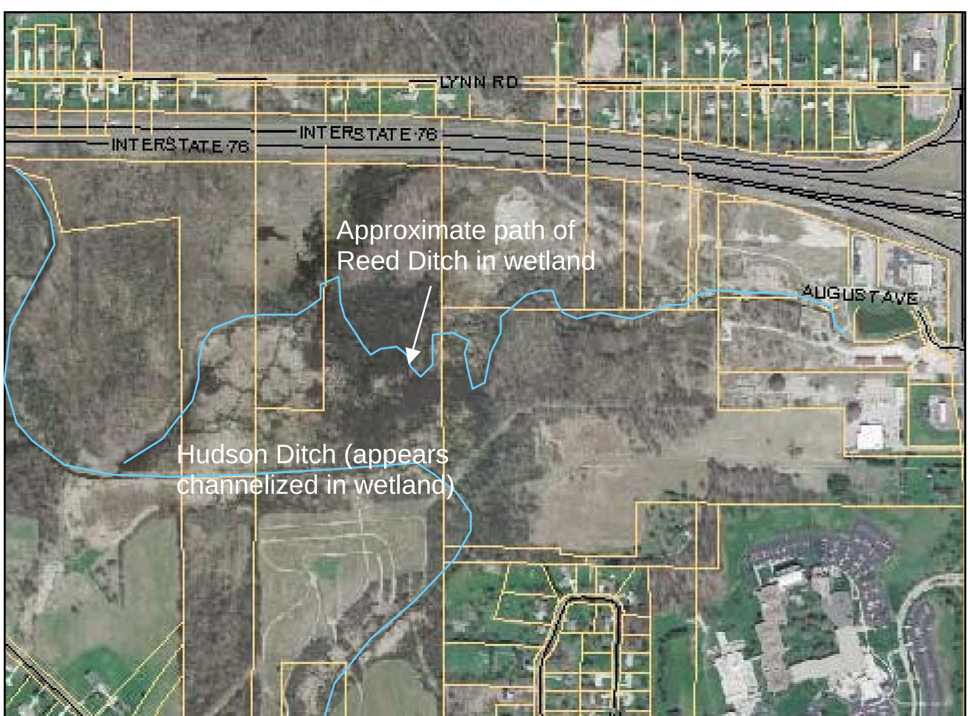
B-335 *Upstream/eastern end Reed Ditch at Haffrick, June 2010*

Reed Ditch—southern tributary

B-325 *Reed Ditch southern tributary. Cemetery east of Rte 44 June, 2010.*

B-326 *Reed ditch same as BC 325 but toward back of the cemetery. June, 2010.*

BC-360 *Reed Ditch s. of Tallmadge Rd. June, 2010.*



Wetland (dark blotchy area) at confluence of Reed and Hudson Ditches. This wetland may be helping buffer the effects of the ditches on Breakneck Creek immediately downstream.

The yellow lines are property lines.

Source: Portage County GIS, 2011, using 2006 aerial photograph.

Brimfield Ditch

BC 870, 860 *Brimfield Ditch North of Summit Road July, 2010*

B-740 *Brimfield Ditch at Sandy Lake Rd. Nov. 2009.*

B-780 *Brimfield Ditch at Meloy. Upper left two photos, November and March, 2009. Right, 2006 aerial photo of Brimfield Ditch, which appears to be channelized, at Meloy Rd..*

Wahoo Ditch—MWH, Not Attaining

BC-040 *Wahoo Ditch at Sandy Lake Rd., Aug., 2009*

B-055 *Wahoo Ditch at Bridge St. & Rte. 59 Feb., 2009 Pics Misnumbered as* ***550*** *.*

B-070 *Wahoo Ditch -Trailer Park - Jones Rd., Feb., 2009.*

B-070 *Wahoo Ditch—Trailer Park, Jones Feb, 2009.*

B-75 *Wahoo Ditch at Wall St. near Infirmary . Feb., 2009.*

Collins Pond Outlet, Hommon Ave. Ditch—LRW

B-150, BC-160 *Collins Pond Outlet at Diamond Rd. May, 2011*

B-151; 156; 157*. Hommon Ave. Ditch—(left) B-151—upstream of Ravenna Wastewater Treatment Plant; (lower left) B-156—downstream of wastewater treatment plant (WWTP in background right); and (below) B-157—where the bank and road appear to be eroding. Note high tension power lines in corridor, which would constrain channel reconstruction. May, 2011. Pics 25226, 30, 31*

Collins Pond and Hommon Ave. Ditch

Collins Pond (highlighted in blue in lower right). Neighbors have noted flooding problems. Collins Pond outlet is culverted west of Diamond St. (see previous page). The pond is surrounded by wetlands and "D" (very poorly draining) soils, see photos below. The pond is also largely surrounded by impervious surfaces, which increases the runoff load to the pond and outlet channel. Hommon Ave. Ditch is in a channel between a road, the wastewater treatment plant, and a high tension utility line. It appears that toward the downstream end of the ditch, the embankment is eroding, threatening the road. The pond in the left center of the picture has increased in size and wetness since the early 1900s. Possible measures to consider, in addition to the City's riparian setback, include setting aside land through easements, reducing or storing runoff from impervious surfaces, daylighting the outlet and restoring some flood storage . Source: Ohio DNR, PCRPC, 2006 Photo.

B-170 *Ponding in poorly draining soils near Collins Pond, Fox Run Rd., Nov. 2009.*

B-180 *View south and west showing wetland, Collins Pond, and houses. Nov., 2009.*

Feeder Canal

B-670 *Feeder Canal at Rootstown April, 2011*

B-670 *(near) Tallmadge Rd. , April, 2011.*

B-660 *Feeder Canal at Old Forge. Algae in April, nearby farms. April, 2011 . (Misnumbered as 550)*

B-650 *Feeder Canal at Saxe Rd. Road ditch drains agricultural and large-lot residential land. April, 2011.*

Other Breakneck Creek & Feeder Canal Headwater Tributaries

B-903 *Breakneck headwater tributary at Lakewood Rd., July, 2010*

B-460 *Breakneck headwater tributary at Lakewood Rd., south of I-76 April, 2011*

B-505. *Headwater tributary on Old Forge Rd. April, 2011.*

B-700, 710 *Feeder Canal Headwater Tributaries Sandy Lake Road, May, 2011.*

Potter Creek—Lower

Po-020 *Potter Creek and substrate in wetland at Ranfield Rd. July, 2010.*

Po-030 *Potter Creek at Randolph Rd. —in wetlands July, 2010.*

Po-040, 45 *Potter Creek tributaries at Randolph Rd., July, 2010*

Po-050 *Potter Cr. At Trares. Site of bio-assessment. Partially attaining WWH criteria. July, 2010*

Po-060 *Potter Creek at Conley— embedded. Spring, 2005.*

Middle Potter Creek—Upstream of Conley Rd.

Po-070 *Potter Creek, site of potential over-wide ditch design to restore flood storage and a narrower, sinuous channel. Site received low QHEI score due to embeddedness, poor channel form, lack of sinuosity and cover. Dec., Oct., 2007.*

Po-072 *Upstream of potential over-wide ditch location, the channel has substantially recovered and received a good QHEI score. Oct. 2007.*

Po-068 *Wetland contiguous to and partially protected through easement. Oct. 2007.*

Po-100 *Potter Creek at Waterloo Rd.. July, 2010.*

Potter Creek—Upper

Po-110 *Potter Creek at Shaffer. Exclusion fence has allowed creek to begin recovering. Blown out stream downstream from flood event. May, 2011.*

Po-120 *Potter Creek at Steffy Rd. July, 2010.*

Congress Lake Outlet

Po-010 *Congress Lake Outlet/Potter Creek at Johnnycake Rd. during spring floods, April, 2011.*

Po-500 *Congress Lake Outlet at Waterloo Rd. during spring floods, April, 2011*

Po-330 *Congress Lake Outlet at Alexander Rd./confluence with Randolph Ditch (coming in from left). April, 2011*

Po-320 *Congress Lake Outlet at Eberly Rd.. Embedded. July 2010*

Congress Lake Outlet—Upper

Po-230 *Congress Lake Outlet at Laubert Rd., July, 2010*

Po-210 *Congress Lake Outlet at Gopp Rd.. July, 2010*

Po-190 *Congress Lake Outlet at Pinedale Rd.. Silted in. July, 2010*

Po-170 *Congress Lake Outlet at Duquette Rd., July, 2010*

Po-160 *Congress Lake Outlet at Swamp Rd.. Weedy. July, 2010.*

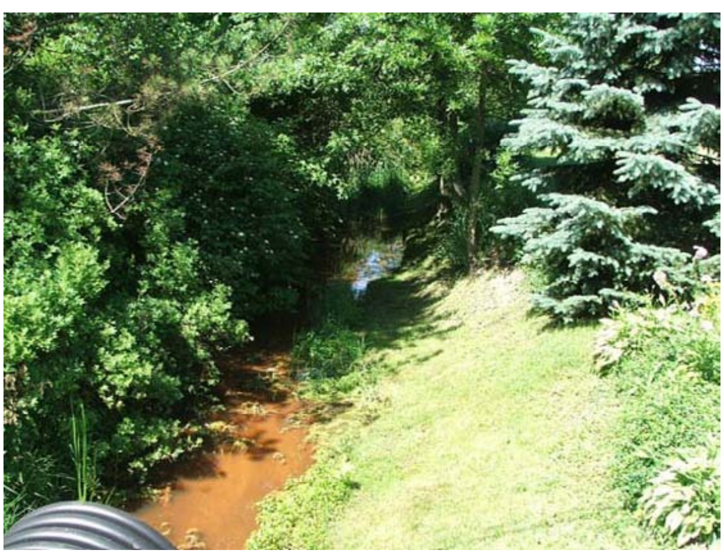
Cranberry Creek

Po-410 *Cranberry Creek at Hartville Rd., Spring, 2011*

Po-420 *Cranberry Creek at Aberagg Rd., June, 2010.*

Po-430 *Cranberry Creek at Shaffer Rd. (west) Spring, 2011*

Po-440 *Cranberry Creek at Shaffer Rd. (east) Spring, 2011*



Po-450 *Cranberry Creek at Griggy Rd. July, 2010*

Redinger Ditch

Po-370 *Reidinger Ditch at Alexander Rd. Grassed buffer. Tile outlets apparent. Spring 2011.*

Po-380 *Reidinger Ditch at Hartville Rd. Grassed buffer. July, 2010.*

Po-390 *Reidinger Ditch at Alexander (w). Typical of tributaries, agricultural use with varying widths of grassed buffer. July, 2010.*

Randolph Ditch

Po-310 *Randolph Ditch at Route 44. Unrestricted livestock access. Downstream appears more intact. May, 2011.*

Po-265 *Congress Lake Outlet tributary at Belding. Spring 2011.*

Po-290 *Randolph Ditch tributary at Eberly (west), spring, 2011*

Po-300 *Randolph Ditch tributary at Matti, Spring, 2011.*

Po-280 *Randolph Ditch tributary at Eberly (eastern). Spring, 2011*

Congress Lake Outlet Tributaries

***Po-340, 341**. Congress Lake Outlet tributary at New Milford Rd. Spring, 2011. Pics. 24907, 908*

***Po-265** Congress Lake Outlet tributary at Belding Rd.. Spring 2011.*

***Po-250** Congress Lake Outlet tributary at A. Horning Rd., Unrestricted livestock access, incised. Spring, 2011.*

***Po-240** Congress Lake Outlet Tributary Route 44 south of Laubert. This is typical of many tributaries, separated from agricultural uses with grass buffers of varying widths. July, 2010*

***Po-180** Congress Lake Outlet tributary at Duquette. Channel is recovering. June, 2010.*

Middle Cuyahoga River Watershed Action Plan
Appendix
TSD and TMDL data

Station	River Mile	Date	Comments	Temp (°C)	pH (s.u.)	D.O.	Cond. (umhos/cm)
BreakneckCk nr Homestead Rd	56.82/14.6	10-Jul-96		18.85	7.86	9.07	526
BreakneckCk nr Homestead Rd	56.82/14.6	20-Jun-96		22.69	7.76	6.44	403
BreakneckCk nr Homestead Rd	56.82/14.6	29-Aug-96		20.83	7.92	8.47	490
BreakneckCr nr Homestead Rd	56.82/14.6	30-Jul-96		19.63	7.85	6.71	684
Breakneck Cr @ Summit Rd	56.82/7.00	04-Sep-96		19.48	7.80	7.43	531
Breakneck Cr @ Summit Rd	56.82/7.00	10-Jul-96		19.63	7.80	7.54	545
Breakneck Cr @ Summit Rd	56.82/7.00	20-Jun-96		22.47	7.63	5.47	351
Breakneck Cr @ Summit Rd	56.82/7.00	29-Aug-96		20.48	7.69	7.19	469
Breakneck Cr @ Summit Rd	56.82/7.00	30-Jul-96		20.25	7.72	6.57	713
Breakneck Ck @ Lakewood Rd	56.82/5.19	04-Sep-96		19.81	7.83	7.04	539
Breakneck Ck @ Lakewood Rd	56.82/5.19	10-Jul-96		19.45	7.84	7.23	563
Breakneck Ck @ Lakewood Rd	56.82/5.19	20-Jun-96		22.25	7.65	5.30	348
Breakneck Ck @ Lakewood Rd	56.82/5.19	29-Aug-96		20.28	7.76	7.62	466
Breakneck Ck @ Lakewood Rd	56.82/5.19	30-Jul-96		20.51	7.76	5.86	727
Breakneck Ck @ Powder Mill	56.82/3.08	04-Sep-96		19.74	7.81	7.76	726
Breakneck Ck @ Powder Mill	56.82/3.08	10-Jul-96		19.18	7.80	8.07	712
Breakneck Ck @ Powder Mill	56.82/3.08	20-Jun-96		21.91	7.68	5.73	385
Breakneck Ck @ Powder Mill	56.82/3.08	29-Aug-96		19.56	7.79	7.71	590
Breakneck Ck @ Powder Mill	56.82/3.08	30-Jul-96		20.10	7.68	5.85	1044
Breakneck Crk @ SR 59	56.82/1.66	04-Sep-96		19.97	7.90	7.65	681
Breakneck Crk @ SR 59	56.82/1.66	10-Jul-96		19.29	7.84	7.46	736
Breakneck Crk @ SR 59	56.82/1.66	20-Jun-96		21.88	7.65	5.97	393
Breakneck Crk @ SR 59	56.82/1.66	29-Aug-96		21.97	7.69	6.33	545
Breakneck Crk @ SR 59	56.82/1.66	30-Jul-96		20.44	7.80	7.0	947
Breakneck Crk near mouth	56.82/0.28	04-Sep-96		19.76	7.92	8.14	649
Breakneck Crk near mouth	56.82/0.28	10-Jul-96		19.35	7.91	8.02	739
Breakneck Crk near mouth	56.82/0.28	20-Jun-96		21.84	7.67	6.05	390
Breakneck Crk near mouth	56.82/0.28	29-Aug-96		20.15	7.89	8.32	592
Breakneck Crk near mouth	56.82/0.28	30-Jul-96		20.42	7.93	8.32	552
Bridge Crk @ Stafford Rd	83.29/11.22	09-Jul-96		20.22	7.61	5.32	366
Bridge Crk @ Stafford Rd	83.29/11.22	16-Sep-96		13.69	7.31	6.04	514
Bridge Crk @ Stafford Rd	83.29/11.22	24-Jul-96		21.0	7.51	6.15	378
Bridge Crk @ Stafford Rd	83.29/11.22	27-Aug-96		21.1	7.86	10.20	390
Bridge Crk @ Stafford Rd	83.29/11.22	27-Jun-96		19.82	7.78	5.88	295

Station	River Mile	Date	Comments	Temp (°C)	pH (s.u.)	D.O.	Cond. (umhos/cm)
Cuy R @ Ravenna Rd	57.67	29-Aug-96		23.86	7.73	5.61	389
Cuy R @ Ravenna Rd	57.67	30-Jul-96		21.43	7.50	5.7	556
Cuy R @ Standing Rock	55.8	04-Sep-96		21.87	7.68	5.50	452
Cuy R @ Standing Rock	*55.8*	*04-Sep-96*	*Dup. samp*	*21.87*	*7.68*	*5.50*	*452*
Cuy R @ Standing Rock	55.8	10-Jul-96		19.62	7.75	6.55	585
Cuy R @ Standing Rock	55.8	20-Jun-96		21.85	7.62	5.66	384
Cuy R @ Standing Rock	55.8	29-Aug-96		21.64	7.75	6.00	460
Cuy R @ Standing Rock	55.8	30-Jul-96		20.75	7.57	6.07	287
Cuy R @ Fuller Park	54.32	04-Sep-96		22.61	7.95	9.01	453
Cuy R @ Fuller Park	54.32	10-Jul-96		20.92	7.89	8.92	602
Cuy R @ Fuller Park	54.32	20-Jun-96		22.05	7.81	8.37	383
Cuy R @ Fuller Park	54.32	29-Aug-96		21.80	7.93	8.40	286
Cuy R @ Fuller Park	54.32	30-Jul-96		21.12	7.81	8.21	715
Cuy R near Middlebury Rd	53.4	04-Sep-96		21.64	7.89	7.89	499
Cuy R near Middlebury Rd	53.4	10-Jul-96		20.82	7.90	8.51	631
Cuy R near Middlebury Rd	53.4	20-Jun-96		22.22	7.77	7.58	346
Cuy R near Middlebury Rd	53.4	29-Aug-96		21.73	7.82	7.22	494
Cuy R near Middlebury Rd	53.4	30-Jul-96		21.00	7.76	6.83	807
Cuy R @ Munroe Falls	50.0	04-Sep-96		23.00	7.91	7.96	595
Cuy R @ Munroe Falls	50.0	10-Jul-96		21.75	8.13	10.51	663
Cuy R @ Munroe Falls	50.0	20-Jun-96		22.33	7.67	6.92	355
Cuy R @ Munroe Falls	50.0	29-Aug-96		21.97	7.69	6.33	545
Cuy R @ Munroe Falls	50.0	30-Jul-96		22.35	7.99	9.19	942
Cuy R @ SR 91	49.78	04-Sep-96		22.77	8.13	9.70	554
Cuy R @ SR 91	49.78	10-Jul-96		22.17	8.24	9.64	333
Cuy R @ SR 91	49.78	20-Jun-96		22.31	7.83	8.48	355
Cuy R @ SR 91	49.78	29-Aug-96		22.15	7.91	8.66	549
Cuy R @ SR 91	49.78	30-Jul-96		22.22	8.07	8.46	819
Cuy R @ Waterworks Park	48.38	04-Sep-96		21.88	7.84	8.38	836
Cuy R @ Waterworks Park	48.38	10-Jul-96		19.86	7.84	10.15	806
Cuy R @ Waterworks Park	48.38	20-Jun-96		22.11	7.85	8.26	379
Cuy R @ Waterworks Park	48.38	29-Aug-96		21.13	7.69	7.64	623
Cuy R @ Waterworks Park	48.38	30-Jul-96		21.86	7.80	6.57	1352
Cuy R near Broad Blvd	46.25	04-Sep-96		22.17	8.21	9.24	766

Station	River Mile	Date	Comments	Temp (°C)	pH (s.u.)	D.O.	Cond. (umhos/cm)
Cuy R near Broad Blvd	46.25	10-Jul-96		21.76	8.36	7.20	826
Cuy R near Broad Blvd	46.25	20-Jun-96		22.41	8.14	8.96	354
Cuy R near Broad Blvd	46.25	29-Aug-96		22.15	8.17	8.82	638
Cuy R near Broad Blvd	46.25	30-Jul-96		22.53	8.31	8.34	1096
Cuy R dst Gorge Dam	43.8	04-Sep-96		22.86	8.56	9.39	721
Cuy R dst Gorge Dam	43.8	10-Jul-96		22.88	8.48	9.72	807
Cuy R dst Gorge Dam	*43.8*	*10-Jul-96*	*Dup. samp*	*22.88*	*8.40*	*9.72*	*807*
Cuy R dst Gorge Dam	43.8	20-Jun-96		22.79	8.18	8.60	352
Cuy R dst Gorge Dam	43.8	29-Aug-96		22.24	8.23	9.43	620
Cuy R dst Gorge Dam	43.8	30-Jul-96	Rain started	22.66	8.13	7.04	926
Cuy R dst Gorge Dam	*43.8*	*30-Jul-96*	*Dup. samp*	*22.66*	*8.13*	*7.04*	*926*
Cuy R @ Cuyahoga St	42.6	04-Sep-96		23.09	8.58	10.23	731
Cuy R @ Cuyahoga St	42.6	10-Jul-96		24.07	8.4	9.98	835
Cuy R @ Cuyahoga St	42.6	20-Jun-96		22.74	8.02	8.57	355
Cuy R @ Cuyahoga St	42.6	29-Aug-96		21.7	8.08	8.77	618
Cuy R @ Cuyahoga St	42.6	30-Jul-96	After rain	21.13	7.62	7.31	496
Cuy R @ Cuyahoga St	42.6	30-Jul-96	Rain	21.18	7.48	6.91	844
Potter Crk @ Trares Rd	56.82 /1.67/10.22	04-Sep-96		17.62	7.74	7.20	500
Potter Crk @ Trares Rd	10.22	10-Jul-96		16.53	7.84	8.49	498
Potter Crk @ Trares Rd	10.22	20-Jun-96		20.40	7.81	7.43	473
Potter Crk @ Trares Rd	10.22	29-Aug-96		18.38	7.76	7.46	518
Potter Crk @ Trares Rd	*10.22*	*29-Aug-96*	*Dup. samp*	*18.38*	*7.75*	*7.43*	*518*
Potter Crk @ Trares Rd	10.22	30-Jul-96		17.81	7.76	6.40	650
Wahoo Ditch @ Lakewood Rd	56.82/4.8 /0.39	04-Sep-96		19.58	7.40	3.94	1104
Wahoo Ditch @ Lakewood Rd	0.39	10-Jul-96		18.25	7.63	8.55	1220
Wahoo Ditch @ Lakewood Rd	0.39	20-Jun-96		20.37	7.88	10.84	998
Wahoo Ditch @ Lakewood Rd	0.39	29-Aug-96		20.33	7.69	8.76	1209
Wahoo Ditch @ Lakewood Rd	0.39	30-Jul-96		19.96	7.48	5.74	1516

Station	Hg		Zn		Hardness as CaCO3	COD		NO2-NO3
Cuy R @ US 422	0.2	K	10	K	116	15		0.17
Cuy R @ Standing Rock	0.2	K	10	K	177	10	K	0.87
Cuy R @ Standing Rock	0.2	K	11		179	10	K	0.83
Cuy R @ Standing Rock	0.2	K	14		246	18		1.16
Cuy R @ Standing Rock	0.2	K	13		163	30		0.62
Cuy R @ Standing Rock	0.2	K	10	K	177	20		0.86
Cuy R @ Standing Rock	0.2	K	12		217	10	K	1.90
Cuy R @ Fuller Park	0.2	K	10	K	174	12		0.73
Cuy R @ Fuller Park	0.2	K	11		243	38		1.50
Cuy R @ Fuller Park	0.2	K	27		160	27		0.74
Cuy R @ Fuller Park	0.2	K	10	K	179	22		0.73
Cuy R @ Fuller Park	0.2	K	10	K	220	15		1.29
Cuy R near Middlebury Rd	0.2	K	10	K	191	27		1.45
Cuy R near Middlebury Rd	0.2	K	10	K	241	10	K	2.13
Cuy R near Middlebury Rd	0.2	K	17		151	32		0.84
Cuy R near Middlebury Rd	0.2	K	10	K	177	20		1.22
Cuy R near Middlebury Rd	0.2		10	K	229	12		2.55
Cuy R @ Munroe Falls	0.2	K	10		200	22		2.17
Cuy R @ Munroe Falls	0.2	K	10	K	233	26		2.38
Cuy R @ Munroe Falls	0.2	K	24		142	30		0.62
Cuy R @ Munroe Falls	0.2	K	10	K	193	21		2.13
Cuy R @ Munroe Falls	0.2	K	11		241	22		3.28
Cuy R @ SR 91	0.2	K	10	K	202	24		2.16
Cuy R @ SR 91	0.2	K	10	K	238	18		2.62
Cuy R @ SR 91	0.2	K	10	K	142	24		0.71
Cuy R @ SR 91	0.2	K	12		193	31		2.14
Cuy R @ SR 91	0.2	K	10	K	236	10	K	3.52
Cuy R @ Waterworks Park	0.2	K	10	K	251	36		2.01
Cuy R @ Waterworks Park	0.2	K	10	K	269	15		1.74
Cuy R @ Waterworks Park	0.2	K	15		151	27		0.66
Cuy R @ Waterworks Park	0.2	K	10		212	20		2.08
Cuy R @ Waterworks Park	0.2	K	13		310	12		2.60
Cuy R near Broad Blvd	0.2	K	10	K	243	15		1.87
Cuy R near Broad Blvd	0.2	K	10	K	271	20		1.49
Cuy R near Broad Blvd	0.2	K	19		140	18		0.65
Cuy R near Broad Blvd	0.2	K	13		210	34		1.88
Cuy R near Broad Blvd	0.2	K	11		247	15		2.28

Station	Hg		Zn		Hardness as CaCO3	COD	NO2-NO3
Cuy R dst Gorge Dam	0.2	K	10		236	18	1.73
Cuy R dst Gorge Dam	0.2	K	10	K	250	26	1.85
Cuy R dst Gorge Dam	*0.2*	*K*	*10*	*K*	*250*	*23*	*1.86*
Cuy R dst Gorge Dam	0.2	K	20		139	27	0.59
Cuy R dst Gorge Dam	0.2	K	10	K	210	22	1.51
Cuy R dst Gorge Dam	0.2	K	10	K	222	28	1.23
Cuy R dst Gorge Dam	*0.2*	*K*	*10*		*217*	*18*	*1.24*
Cuy R @ Cuyahoga St	0.2	K	10		238	12	1.68
Cuy R @ Cuyahoga St	0.2	K	10	K	256	12	1.73
Cuy R @ Cuyahoga St	0.2	K	19		142	21	0.59
Cuy R @ Cuyahoga St	0.2	K	10	K	210	17	1.50
Cuy R @ Cuyahoga St	0.2	K	217		159	103	0.64
Cuy R @ Cuyahoga St	0.2	K	25		224	25	1.03

Station	Hg		Zn		Hardness as CaCO3	COD		NO2-NO3
Breakneck Cr @ Summit Rd	0.2	K	10	K	278	24		0.38
Breakneck Cr @ Summit Rd	0.2	K	10	K	280	12		0.54
Breakneck Cr @ Summit Rd	0.2	K	10	K	165	32		0.88
Breakneck Cr @ Summit Rd	0.2	K	10	K	227	25		0.39
Breakneck Cr @ Summit Rd	0.2	K	10	K	286	10	K	0.21
Breakneck Ck @ Lakewood Rd	0.2	K	10	K	276	21		0.43
Breakneck Ck @ Lakewood Rd	0.2	K	10		297	20		0.49
Breakneck Ck @ Lakewood Rd	0.2	K	10	K	163	38		0.78
Breakneck Ck @ Lakewood Rd	0.2	K	12		224	36		0.39
Breakneck Ck @ Lakewood Rd	0.2	K	10	K	277	10	K	0.22
Breakneck Ck @ Powder Mill	0.2	K	13		269	12		3.95
Breakneck Ck @ Powder Mill	0.2	K	19		288	20		1.99
Breakneck Ck @ Powder Mill	0.2	K	10	K	165	32		0.90
Breakneck Ck @ Powder Mill	0.2	K	13		233	34		2.11
Breakneck Ck @ Powder Mill	0.2	K	12		268	18		2.52
Breakneck Crk @ SR 59	0.2	K	10		264	21		3.89
Breakneck Crk @ SR 59	0.2	K	15		288	20		2.44
Breakneck Crk @ SR 59	0.2	K	10	K	165	35		0.82
Breakneck Crk @ SR 59	0.2	K	10		233	25		2.65
Breakneck Crk @ SR 59	0.2	K	12		266	10	K	4.51
Breakneck Crk near mouth	0.2	K	10	K	261	15		3.22
Breakneck Crk near mouth	0.2	K	10	K	285	18		2.14
Breakneck Crk near mouth	0.2	K	24		165	35		0.71
Breakneck Crk near mouth	0.2	K	28		229	25		2.32
Breakneck Crk near mouth	0.2	K	10	K	263	10	K	3.64
BreakneckCk nr Homestead Rd	0.2	K	11		292	28		0.39
BreakneckCk nr Homestead Rd	0.2	K	10	K	285	12		0.62
BreakneckCk nr Homestead Rd	0.2	K	13		203	38		1.05
BreakneckCk nr Homestead Rd	0.2	K	10	K	238	36		0.39
BreakneckCk nr Homestead Rd	0.2	K	12		292	18		0.20
Potter Crk @ Trares Rd	0.2	K	10	K	273	15		0.42
Potter Crk @ Trares Rd	0.2	K	10	K	274	10	K	0.57
Potter Crk @ Trares Rd	0.2	K	10	K	246	28		0.81
Potter Crk @ Trares Rd	0.2	K	10	K	260	20		0.48
Potter Crk @ Trares Rd	*0.2*	*K*	*10*	*K*	*269*	*11*		*0.52*
Potter Crk @ Trares Rd	0.2	K	10	K	283	10	K	0.51
Wahoo Ditch @ Lakewood Rd	0.2	K	25		262	15		9.07
Wahoo Ditch @ Lakewood Rd	0.2	K	41		269	32		4.81
Wahoo Ditch @ Lakewood Rd	0.2	K	23		246	32		4.06
Wahoo Ditch @ Lakewood Rd	0.2	K	22		257	28		11.5
Wahoo Ditch @ Lakewood Rd	0.2	K	25		255	26		4.72

Station	NH3-N		TKN		Total-P		TDS	TSS		FC Bacteria
Cuy R @ Standing Rock	0.08		0.5		0.05	K	310	5	K	33
Cuy R @ Standing Rock	*0.05*		*0.5*		*0.05*	*K*	*306*	*5*	*K*	*33*
Cuy R @ Standing Rock	0.06		0.5		0.07		404	6		230
Cuy R @ Standing Rock	0.14		0.8		0.12		272	14		180
Cuy R @ Standing Rock	0.05		0.4		0.07		324	5		40
Cuy R @ Standing Rock	0.07		0.6		0.11		390	7		220
Cuy R @ Fuller Park	0.05	K	0.4		0.08		300	5	K	30
Cuy R @ Fuller Park	0.05	K	0.4		0.09		396	7		180
Cuy R @ Fuller Park	0.12		0.8		0.10		272	8		280
Cuy R @ Fuller Park	0.05		0.4		0.09		328	5		150
Cuy R @ Fuller Park	0.05	K	0.5		0.10		384	5		440
Cuy R near Middlebury Rd	0.05	K	0.5		0.05	K	322	5	K	60
Cuy R near Middlebury Rd	0.05	K	0.4		0.11		420	6		140
Cuy R near Middlebury Rd	0.11		0.8		0.26		262	10		300
Cuy R near Middlebury Rd	0.08		0.4		0.10		328	7		370
Cuy R near Middlebury Rd	0.05		0.6		0.10		430	6		1000
Cuy R @ Munroe Falls	0.06		0.6		0.08		380	5	K	
Cuy R @ Munroe Falls	0.05	K	0.8		0.07		435	11		10
Cuy R @ Munroe Falls	0.15		0.9		0.12		242	12		250
Cuy R @ Munroe Falls	0.12		0.5		0.08		374	8		
Cuy R @ Munroe Falls	0.05	K	0.8		0.09		486	6		
Cuy R @ SR 91	0.05	K	0.5		0.11		384	7		30
Cuy R @ SR 91	0.05	K	0.6		0.08		434	11		40
Cuy R @ SR 91	0.13		0.8		0.10		242	11		340
Cuy R @ SR 91	0.14		0.4		0.08		376	9		10
Cuy R @ SR 91	0.05		0.7		0.10		486	6		40
Cuy R @ Waterworks Park	0.05	K	0.6		0.07		540	9		
Cuy R @ Waterworks Park	0.05	K	0.17		0.07		492	12		
Cuy R @ Waterworks Park	0.14		0.8		0.05		260	12		
Cuy R @ Waterworks Park	0.09		0.2		0.09		433	10		
Cuy R @ Waterworks Park	0.05	K	0.7		0.07		630	5		
Cuy R near Broad Blvd	0.05	K	0.8		0.06		494	10		100
Cuy R near Broad Blvd	0.05	K	0.7		0.05		530	13		60
Cuy R near Broad Blvd	0.11		0.6		0.05	K	252	14		260
Cuy R near Broad Blvd	0.08		0.2	K	0.10		428	14		90
Cuy R near Broad Blvd	0.08		0.9		0.07		534	9		120
Cuy R dst Gorge Dam	0.05	K	0.8		0.05		448	6		
Cuy R dst Gorge Dam	0.06		0.8		0.05	K	520	7		
Cuy R dst Gorge Dam	*0.06*		*0.8*		*0.05*	*K*	*514*	*7*		
Cuy R dst Gorge Dam	0.11		0.7		0.08		230	14		360
Cuy R dst Gorge Dam	0.05	K	0.2		0.06		420	6		
Cuy R dst Gorge Dam	0.13		0.7		0.06		456	5		
Cuy R dst Gorge Dam	*0.12*		*0.7*		*0.06*	*466*	*5*			

Station	NH3-N		TKN	Total-P		TDS	TSS	FC Bacteria
Cuy R dst Gorge Dam	0.06		0.8	0.05	K	520	7	
Cuy R dst Gorge Dam	*0.06*		*0.8*	*0.05*	*K*	*514*	*7*	
Cuy R dst Gorge Dam	0.11		0.7	0.08		230	14	360
Cuy R dst Gorge Dam	0.05	K	0.2	0.06		420	6	
Cuy R dst Gorge Dam	0.13		0.7	0.06		456	5	
Cuy R dst Gorge Dam	*0.12*		*0.7*	*0.06*		*466*	*5*	
Cuy R @ Cuyahoga St	0.05	K	0.7	0.05	K	456	5	280
Cuy R @ Cuyahoga St	0.05		0.7	.05	K	512	8	
Cuy R @ Cuyahoga St	0.11		0.7	0.06		248	19	360
Cuy R @ Cuyahoga St	0.05	K	0.2	0.07		420	9	90
Cuy R @ Cuyahoga St	0.79		1.6	0.68		254	342	200000
Cuy R @ Cuyahoga St	0.17		0.7	0.20		432	61	2100

Station	NH3-N		TKN		Total-P		TDS	TSS		FC Bacteria
Breakneck Cr @ Summit Rd	0.05	K	0.4		0.05		406	9		
Breakneck Cr @ Summit Rd	0.05	K	0.2	K	0.12		386	8		
Breakneck Cr @ Summit Rd	0.09		0.9		0.17		262	6		
Breakneck Cr @ Summit Rd	0.05	K	0.4		0.10		362	9		
Breakneck Cr @ Summit Rd	0.05	K	0.3		0.07		420	5	K	
Breakneck Ck @ Lakewood Rd	0.05	K	0.5				406	8		190
Breakneck Ck @ Lakewood Rd	0.05	K	0.2	K	0.23		406	15		
Breakneck Ck @ Lakewood Rd	0.09		0.9		0.14		264	7		
Breakneck Ck @ Lakewood Rd	0.05	K	0.5		0.08		360	14		14
Breakneck Ck @ Lakewood Rd	0.05	K	0.3		0.09		393	13		
Breakneck Ck @ Powder Mill	0.05	K	0.5		0.08		524	5	K	130
Breakneck Ck @ Powder Mill	0.15		0.5		0.07		498	6		
Breakneck Ck @ Powder Mill	0.16		1.0		0.11		280	14		
Breakneck Ck @ Powder Mill	0.05	K	0.6		0.10		434	5		130
Breakneck Ck @ Powder Mill	0.67		1.2		0.15		548	5	K	
Breakneck Crk @ SR 59	0.05	K	0.6		0.08		476	5	K	
Breakneck Crk @ SR 59	0.05	K	0.4		0.08		508	6		
Breakneck Crk @ SR 59	0.15		0.9		0.15		284	12		
Breakneck Crk @ SR 59	0.05	K	0.5		0.12		456	5	K	
Breakneck Crk @ SR 59	0.05	K	0.6		0.14		500	5	K	
Breakneck Crk near mouth	0.05	K	0.3		0.12		464	5	K	
Breakneck Crk near mouth	0.05	K	0.4		0.08		510	5	K	
Breakneck Crk near mouth	0.15		0.9		0.17		288	11		
Breakneck Crk near mouth	0.05	K	0.5		0.11		444	5		
Breakneck Crk near mouth	0.05	K	0.4		0.14		474	5	K	
BreakneckCk nr Homestead Rd	0.06		0.4		0.06		416	14		
BreakneckCk nr Homestead Rd	0.05		0.2		0.11		387	9		
BreakneckCk nr Homestead Rd	0.11		0.9		0.28		308	22		
BreakneckCk nr Homestead Rd	0.06		0.5		0.11		382	9		
BreakneckCk nr Homestead Rd	0.05	K	0.3		0.05		412	9		
Potter Crk @ Trares Rd	0.16		0.4		0.07		380	17		
Potter Crk @ Trares Rd	0.12				0.05	K	392	7		
Potter Crk @ Trares Rd	0.23		1.0		0.42		356	6		
Potter Crk @ Trares Rd	0.16		0.4		0.08		398	5		
Potter Crk @ Trares Rd	*0.17*		*0.4*		*0.06*		*408*	*5*	*K*	
Potter Crk @ Trares Rd	0.23		0.4		0.11		364	6		
Wahoo Ditch @ Lakewood Rd	0.19		0.9		0.12		790	5	K	140
Wahoo Ditch @ Lakewood Rd	1.42		2.5		0.26		864	5	K	15
Wahoo Ditch @ Lakewood Rd	0.48		1.9		0.66		724	5	K	
Wahoo Ditch @ Lakewood Rd	0.06		0.4		0.18		844	5	K	180
Wahoo Ditch @ Lakewood Rd	2.54		3.5		0.31		794	5	K	
[illegible]	[illegible]	K	[illegible]		[illegible]	K	[illegible]	[illegible]		[illegible]

Appendix Table . Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characterstics for fish sampling sites in the Cuyahoga River basin study area, 1996.

Key
QHEI
Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence														
			No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	Total WWH Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	Total H.I. MWH Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
57.5	56.5	3.00	■					■			■		3	●					1		♦		♦	♦	♦			♦	♦		♦	7	0.50	2.25
56.0	67.5	4.61	■	■				■		■	■		5			●			1		♦		♦	♦	♦			♦			♦	6	0.33	1.33
54.2	70.0	6.12	■	■		■		■			■		5	●					1		♦			♦	♦			♦	♦	♦		6	0.33	1.33
53.4	64.0	6.12	■	■				■			■		4						0		♦			♦	♦			♦	♦		♦	6	0.20	1.40
52.0	54.0	0.10	■					■			■		3						0		♦			♦	♦			♦	♦		♦	6	0.25	1.75
51.0	48.5	0.10	■								■		2	●		●			2		♦			♦	♦			♦	♦		♦	6	1.00	3.00
48.7	56.0	1.00	■	■				■			■		4			●			1		♦			♦	♦			♦	♦		♦	6	0.40	1.60
48.0	46.5	0.10	■					■			■		3	●		●			2		♦			♦	♦			♦	♦		♦	6	0.75	2.25
46.0	67.0	0.10	■			■	■	■	■	■	■		7						0					♦	♦				♦	♦		4	0.13	0.63
44.0	76.0	62.50	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
42.8	82.0	8.62	■	■		■	■	■	■	■	■		9						0											♦		1	0.10	0.20
(19-028) Breakneck Creek																																		
Year: 96																																		
9.5	67.5	1.77	■			■	■	■		■	■		6	●					1		♦							♦	♦		♦	4	0.29	0.86
6.8	66.5	1.27	■	■			■	■		■	■		6		●				1		♦			♦	♦			♦			♦	5	0.29	1.00
5.2	86.5	5.21	■	■		■	■	■	■		■	■	8						0		♦								♦			2	0.11	0.33
3.1	56.5	5.21						■	■		■		3	●					1	♦	♦			♦	♦				♦		♦	6	0.50	2.00
1.7	59.0	3.48						■			■		2	●					1	♦	♦			♦	♦			♦	♦		♦	7	0.67	3.00
0.2	69.0	3.48	■	■		■	■	■	■		■		7						0		♦								♦	♦		3	0.13	0.50
(19-029) Potter Creek																																		
Year: 96																																		
1.5	41.0	10.00						■			■		2	●	●				2	♦	♦			♦	♦			♦	♦		♦	7	1.00	3.33

Key
QHEI
Components

Wahoo Ditch
Year: 2009

WWH Attributes

River Mile	QHEI	Habitat Rating	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth >40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**
2.6	**44.5**	Fair											0
2.5	**46.0**	Fair		■			■						2
2.2	**55.0**	Good		■		■	■	■			■		5

MWH Attributes

High Influence

River Mile	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/ No Cover	Max. Depth <40 cm (WD,HW sites)	**Total High Influence Attributes**
2.6			◆	◆	◆	3
2.5			◆	◆	◆	3
2.2			◆			1

Moderate Influence

River Mile	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total Moderate Influence Attributes**	**(MWH H.I.+1)/ (WWH+1) Ratio**	**(MWH M.I.+1)/ (WWH+1) Ratio**
2.6	●				●				●	●	●		5	4.00	9.00
2.5	●	●			●				●	●	●		6	1.33	3.33
2.2	●	●			●				●	●	●		6	0.33	1.33

Source: Ohio EPA, 2009. Wahoo Ditch Bioassessment.

Appendix Table . IBI metric scores from fish sampling sites in the Cuyahoga River basin study area, 1996.

				Number of					Percent of Individuals									
River Mile	Type	Date	Drainage area (sq mi)	Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)		IBI	Modified Iwb
Cuyahoga River - (19001)																		
Year: 1996																		
75.80	D	07/15/1996	151	14(3)	4(5)	2(1)	0(1)	2(1)	40(5)	35(3)	13(5)	15.7(5)	71(5)	0.0(5)	81(1)	*	40	7.4
75.80	D	08/14/1996	151	15(3)	3(3)	3(3)	0(1)	3(3)	58(5)	25(3)	22(3)	14.0(5)	64(5)	2.4(1)	153(1)		36	7.8
64.50	D	07/15/1996	177	17(3)	3(3)	2(1)	1(1)	4(3)	51(5)	6(5)	4(5)	13.5(5)	78(5)	0.0(5)	156(1)	*	42	7.6
64.50	D	08/14/1996	177	14(3)	1(1)	2(1)	1(1)	3(3)	41(5)	5(5)	3(5)	11.8(5)	83(5)	1.8(1)	158(1)	*	36	7.3
57.50	D	07/15/1996	208	14(3)	5(5)	2(1)	0(1)	3(3)	38(5)	41(1)	1(5)	13.7(5)	82(5)	1.4(3)	65(1)	*	38	6.8
57.50	D	08/14/1996	208	8(1)	3(3)	0(1)	0(1)	1(1)	20(3)	46(1)	0(5)	22.9(5)	71(5)	2.9(5)	29(1)	*	32	4.4
56.00	D	07/16/1996	291	12(3)	5(5)	1(1)	0(1)	1(1)	16(1)	31(3)	7(5)	29.3(5)	55(5)	0.0(5)	60(1)	*	36	6.9
56.00	D	08/14/1996	291	12(3)	4(5)	0(1)	0(1)	2(1)	7(1)	24(3)	0(5)	23.9(5)	57(5)	4.3(3)	53(1)	*	34	6.5
44.00	E	08/27/1996	337	12(3)	0(1)	2(1)	0(1)	3(1)	48(5)	15(5)	11(5)	6.9(5)	54(3)	0.0(5)	222(3)		38	7.5
44.00	D	07/23/1996	337	14(3)	1(1)	2(1)	0(1)	2(1)	15(1)	4(5)	4(5)	1.2(3)	15(1)	0.0(5)	1484(5)		32	7.7
42.80	D	07/30/1996	340	15(3)	1(1)	2(1)	0(1)	4(3)	37(5)	4(5)	3(5)	0.3(1)	37(3)	0.0(5)	1682(5)		38	7.4
42.80	D	08/27/1996	340	13(3)	1(1)	2(1)	0(1)	4(3)	68(5)	7(5)	3(5)	0.5(1)	69(5)	0.0(5)	300(3)		38	6.3
54.20	A	07/16/1996	293	17(3)	5(5)	3(3)	1(1)	19(3)	57(5)	44(1)	43(1)	5(1)	34(3)	6.3(1)	136(1)		28	7.5
54.20	A	08/15/1996	293	15(3)	6(5)	3(3)	0(1)	13(1)	44(3)	42(1)	41(1)	11(5)	36(3)	8.2(1)	154(1)		28	7.6
53.40	A	07/16/1996	307	13(3)	5(5)	2(1)	0(1)	1(1)	6(1)	18(3)	14(5)	20(5)	46(3)	2.7(3)	184(1)		32	6.7
53.40	A	08/15/1996	307	13(3)	4(5)	2(1)	0(1)	1(1)	13(1)	26(3)	23(3)	13(5)	46(3)	2.4(3)	122(1)	*	30	6.7
52.00	A	07/23/1996	309	14(3)	6(5)	1(1)	0(1)	0(1)	5(1)	16(3)	14(5)	36(5)	41(3)	4.5(1)	184(1)		30	7.3
52.00	A	08/15/1996	309	12(3)	5(5)	2(1)	0(1)	3(1)	7(1)	15(3)	14(5)	29(5)	45(3)	3.6(1)	188(1)		30	7.6
51.00	A	07/16/1996	322	10(3)	5(5)	1(1)	0(1)	0(1)	10(1)	24(3)	21(3)	15(5)	52(3)	11.9(1)	102(1)	*	28	6.3
51.00	A	08/15/1996	322	8(1)	4(5)	1(1)	0(1)	0(1)	3(1)	11(5)	11(5)	16(5)	41(3)	2.9(3)	124(1)	*	32	6.1
48.70	A	07/16/1996	327	14(3)	5(5)	2(1)	0(1)	4(1)	8(1)	34(1)	34(1)	15(5)	48(3)	7.0(1)	172(1)		24	7.1
48.70	A	08/15/1996	327	15(3)	5(5)	2(1)	0(1)	3(1)	13(1)	38(1)	36(1)	18(5)	46(3)	0.0(5)	110(1)	*	28	7.1
48.00	A	08/15/1996	331	14(3)	5(5)	2(1)	0(1)	2(1)	11(1)	31(1)	31(1)	16(5)	48(3)	3.4(1)	122(1)	*	24	6.9
48.00	A	07/23/1996	331	11(3)	4(5)	1(1)	0(1)	0(1)	14(1)	41(1)	40(1)	17(5)	40(3)	3.2(1)	112(1)	*	24	6.4

▲ - IBI is low end adjusted.
* - < 200 Total individuals in sample
** - < 50 Total individuals in sample

Breakneck Creek - (19028)																	
Year: 1996																	
3.10	D	08/01/1996	22	14(3)	3(3)	2(3)	0(1)	4(5)	29(3)	39(3)	14(5)	32.7(5)	51(3)	0.0(5)	45(1) *	40	5.4
3.10	D	10/09/1996	22	10(3)	2(3)	2(3)	0(1)	3(3)	18(3)	65(1)	1(5)	7.0(5)	90(5)	1.4(3)	38(1) *	36	4.7
1.70	D	08/01/1996	22	8(1)	2(3)	1(1)	0(1)	2(3)	31(1)	66(1)	28(1)	28.1(1)	44(1)	3.1(1)	17(1) * *	16	5.0
1.70	D	10/09/1996	22	6(1)	2(3)	1(1)	0(1)	1(1)	13(1)	45(1)	0(1)	41.9(1)	58(1)	0.0(1)	26(1) * *	14	4.3
0.20	D	08/02/1996	79	15(3)	2(3)	2(3)	2(1)	4(3)	36(3)	8(5)	3(5)	28.8(5)	62(5)	0.0(5)	101(1) *	42	7.4
0.20	D	10/09/1996	79	15(3)	2(3)	2(3)	1(1)	5(5)	61(5)	16(5)	9(5)	12.6(5)	78(5)	0.0(5)	110(1) *	46	6.9
Bridge Creek - (19035)																	
Year: 1996																	
0.50	E	08/08/1996	37	11(3)	3(3)	1(1)	0(1)	2(1)	18(1)	45(3)	34(3)	3.6(3)	61(5)	0.0(5)	62(1) *	30	5.9
West Branch Cuyahoga - (19036)																	
Year: 1996																	
0.90	D	08/02/1996	35	17(3)	2(3)	3(3)	1(1)	5(5)	76(5)	7(5)	5(5)	9.4(5)	85(5)	0.0(5)	458(3)	48	7.0

ario Lake Plain - WWH Use Designation (Existing)

530	13.41	67.5	NA	46	V. Good
86	6.38	66.5	NA	30*	Fair
171	5.74	86.5	NA	40	Good
90	5.05	56.5	5.1*	38	Poor/Good
47	5.85	59.5	4.6*	15*	Poor/V. Poor
120	4.00	69.0	7.2*	44	Fair/Good

ario Lake Plain - WWH Use Designation (Existing)

128	4.85	--	7.1*	44	Fair/Good
133	3.04	--	6.3*	40	Fair/Good
162	9.69	--	7.2*	42	Fair/Good

oregion Biocriteria: Erie-Ontario Lake Plain

IBI			MIwb		
WWH	EWH	MWHc	WWH	EWH	MWHc
40	50	24	NA	NA	NA
38	50	24	7.9	9.4	5.6

headwater streams with drainage areas < 20 mi2.
from biocriteria (<4 IBI units or <0.5 MIwb units).
applicable biocriteria (>4 IBI units or >0.5 MIwb units). Underlined
Very Poor range.

End of Volume