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Ohio Environmental Protection Agency

Total Maximum Daily Loads for the Salt Creek Watershed (Muskingum River Basin)

Final Report
April 18, 2011

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Photo caption: Salt Creek downstream of the U.S. Route 40 bridge. August 2008.

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Acronyms and Abbreviations

ALU	aquatic life use
AU	assessment unit
AWS	agricultural water supply
BMP	best management practices
BNA	base neutral and acid extractable compounds
BW	bathing water
CAFO	confined animal feeding operation
CFR	Code of Federal Regulations
cfs	cubic feet per second
Corps	United States Army Corps of Engineers
CREP	Conservation Reserve Enhancement Program (USDA program)
CRP	Conservation Reserve Program (USDA program)
CSO	combined sewer overflow
CSP	Conservation Security Program (USDA program)
CWA	Clean Water Act
CWH	coldwater habitat
D.O.	dissolved oxygen
DNAP	Division of Natural Areas and Preserves (part of ODNR)
DOW	Division of Wildlife (part of ODNR)
DSW	Division of Surface Water (part of Ohio EPA)
DSWC	Division of Soil and Water Conservation (part of ODNR)
ECBP	Eastern Corn Belt Plains (ecoregion)
EPA	Environmental Protection Agency, see U.S. EPA
EQIP	Environmental Quality Incentive Plan (USDA program)
EWH	exceptional warmwater habitat
FCA	fish consumption advisory
FFY	federal fiscal year (October 1 to September 30)
FSA	Farm Service Agency
FWPCA	Federal Water Pollution Control Act
gpd	gallons per day
GRP	Grassland Reserve Program (USDA program)
HELP	Huron Erie Lake Plain (ecoregion)
HU	hydrologic unit
HUC	hydrologic unit code
I/I	infiltration and inflow
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IR	Integrated Report
IWS	industrial water supply
kg	kilogram
L	liter
LA	load allocation
LaMP	Lakewide Management Plan
LEC	(Ohio) Lake Erie Commission
LEL	lowest effect level
LEPF	Lake Erie Protection Fund (LEC program)
LRAU	large river assessment unit
LRW	limited resource water

LTCP	long-term control plan
mg	milligram
MGD	million gallons per day
MHP	mobile home park
MIwb	Modified Index of well being
mi^2	square miles
ml	milliliter
MOR	monthly operating report
MPN	most probable number
MS4	municipal separate storm sewer system
MWH	modified warmwater habitat
n	number (of data points in a grouping)
NHD	National Hydrography Dataset
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resource Conservation Service
OAC	Ohio Administrative Code
ODA	Ohio Department of Agriculture
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OEPA	Ohio Environmental Protection Agency
Ohio EPA	Ohio Environmental Protection Agency (preferred nomenclature)
ORC	Ohio Revised Code
ORSANCO	Ohio River Valley Water Sanitation Commission
OSC	on-site coordinator
OSUE	Ohio State University Extension
OWDA	Ohio Water Development Authority
OWRC	Ohio Water Resources Council
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCR	primary contact recreation
PEC	probable effect concentration
PDWS	public drinking water supply
PEC	probable effect concentration
ppb	parts per billion
PS	point source
PTI	permit to install
PTO	permit to operate
PWS	public water supply
QA	quality assurance
QC	quality control
QHEI	qualitative habitat evaluation index
RM	river mile
SCR	secondary contact recreation
SDWA	Safe Drinking Water Act
SEL	severe effect level
SFY	state fiscal year (July 1 to June 30)
SMP	sludge management plan
sq mi	square miles

SRW	state resource water
SSH	seasonal salmonid habitat
SSM	single-sample maximum
SSO	sanitary sewer overflow
STORET	STOrage and RETrieval (a U.S. EPA water quality database)
SWIMS	Surface Water Information Management System
SWCD	Soil and Water Conservation District
TEC	threshold effect concentration
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TOC	total organic carbon
TSS	total suspended solids
ug	microgram
µg	microgram
U.S. EPA	United States Environmental Protection Agency
UAA	use attainability analysis
USACOE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	volatile organic compound
WAU	watershed assessment unit
WHIP	Wildlife Habitat Incentives Program (USDA program)
WLA	wasteload allocation
WPCLF	Water Pollution Control Loan Fund
WQ	water quality
WQS	water quality standards
WRP	Wetland Reserve Program (USDA program)
WRRSP	Water Resource Restoration Sponsor Program (Ohio EPA program)
WTP	water treatment plant
WWH	warmwater habitat
WWTP	wastewater treatment plant

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Project leaders	Dan Imhoff and Scott Foster
Biological monitoring	Ed Moore and Brian Alsdorf
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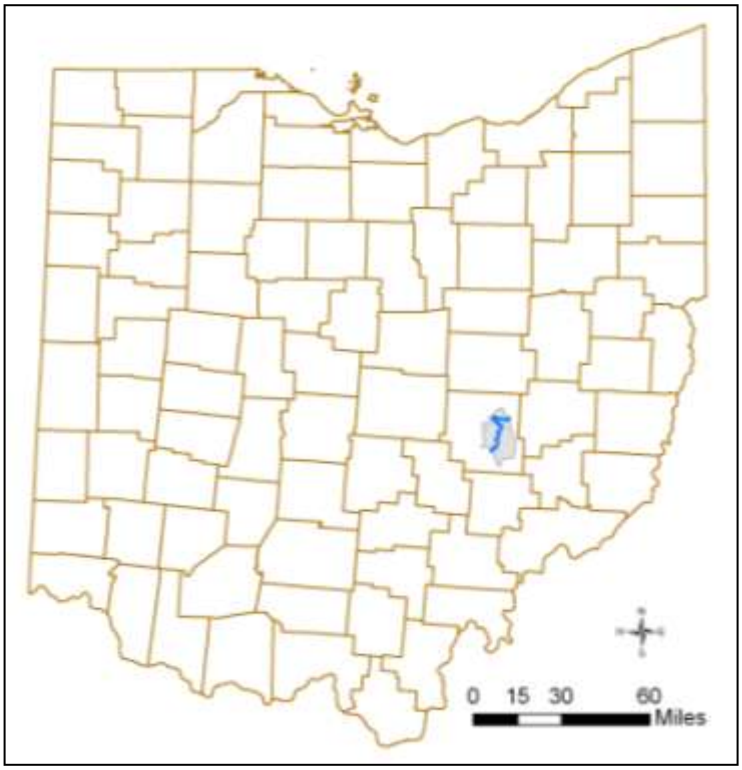
The Ohio EPA appreciates the cooperation of the property owners who allowed Ohio EPA personnel access to the project area.

Executive Summary



The Salt Creek watershed is located in southeast Ohio extending from northeastern Muskingum County to southwest of Zanesville. This 145 square mile watershed area is home to more than 12,000 people and encompasses all or part of three municipalities in Muskingum County. The watershed is primarily forest (52%) and pasture (30%), with nearly eight percent being developed.

In 2008, Ohio EPA sampled twenty-three sites on streams in this watershed. Data collected related to water and sediment quality, aquatic biological communities, and habitat. Ohio's water quality standards were compared with these data to determine if quality criteria for various designated beneficial uses are being met.

Overall the watershed met criteria for the recreation use at 13% of sites, at 100% for aquatic life uses and at 100% for the public drinking water supply use. The cause of impairment is bacteria. Probable sources of bacteria include agricultural practices such as improper manure management; unrestricted cattle access to streams; and failing home sewage treatment systems.

A total maximum daily load (TMDL) has been developed for bacteria, which has impaired recreation uses and precluded attainment of applicable water quality standards. The TMDL is described in this report.

The needed load reductions ranged from 0 to 99% for bacteria. Sources of the pollutants that have been allocated the most significant reductions include nonpoint sources (i.e., agricultural practices and failing home sewage treatment systems).

Nonpoint sources of bacteria should be addressed by increasing riparian vegetation; establishing fencing along streambanks to keep livestock away from streams combined with installing alternative water supplies; installing roofs over or repairing manure storage facilities; and inspecting home sewage treatment systems for failure and repairing or replacing those that are failing.

1 INTRODUCTION

The Salt Creek watershed is located in southeastern Ohio and drains into the Muskingum River south of Zanesville. Ohio EPA completed a comprehensive biological, physical and chemical survey of the streams in the watershed in 2008. Aquatic life uses were fully supported in the watershed, but recreation use was not supported because of bacterial contamination that was widespread in the watershed. Bacteria likely came from failing home sewage treatment systems, agricultural land uses and runoff across farm fields where manure had been spread.

1.1 The Clean Water Act Requirement to Address Impaired Waters

The Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize waters for which technology-based limits alone do not ensure attainment of water quality standards. Lists of these impaired waters (the Section 303(d) lists) are made available to the public for comment, then submitted to the U.S. Environmental Protection Agency (U.S. EPA) for approval in even-numbered years. Further, the CWA and U.S. EPA regulations require that total maximum daily loads (TMDLs) be developed for all waters on the Section 303(d) lists. The Ohio EPA identified the Salt Creek watershed (assessment units 05040004 06 01, 06 02, 06 03, 06 04, 06 05 and 06 06) as impaired on the 2010 303(d) list (Ohio EPA 2010a; available at http://www.epa.ohio.gov/dsw/tmdl/2010IntReport/2010OhioIntegratedReport.aspx).

In the simplest terms, a TMDL can be thought of as a cleanup plan for a watershed that is not meeting water quality standards. A TMDL is defined as a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and an allocation of that quantity among the sources of the pollutant. Ultimately, the goal of Ohio's TMDL process is full attainment of water quality standards (WQS), which would subsequently lead to the removal of the waterbodies from the 303(d) list. Figure 1-1 shows the phases of TMDL development in Ohio.

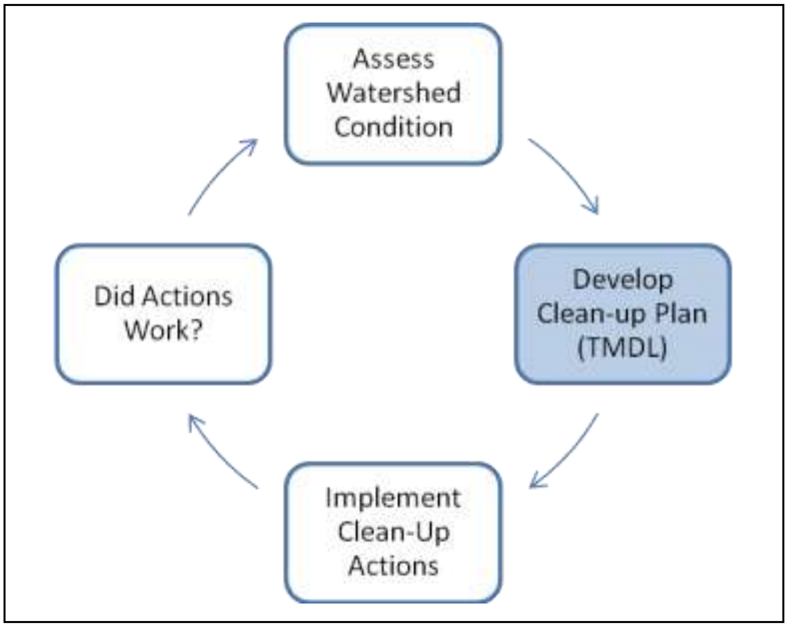


Figure 1-1. Overview of the TMDL project process.

Table 1-1 summarizes how the impairments identified in the Salt Creek watershed are addressed in this TMDL report.

Table 1-1. Summary of impairments in the Salt Creek watershed and methods used to address impairments.

Assessment Unit (05040004)	Narrative Description	Causes of Impairment (Beneficial use in parentheses)	Action Taken
06 01 *Priority points: 4*	Little Salt Creek	No impairment (ALU[1])	No action necessary
		Bacteria (RU[2])	TMDL for bacteria
06 02 *Priority points: 3*	Headwaters Salt Creek	No impairment (ALU[1])	No action necessary
		Bacteria (RU[2])	TMDL for bacteria
06 03 *Priority points: 4*	Buffalo Fork	No impairment (ALU[1])	No action necessary
		Bacteria (RU[2])	TMDL for bacteria
06 04 *Priority points: 1*	Boggs Creek	No impairment (ALU[1])	No action necessary
		Bacteria (RU[2])	TMDL for bacteria
06 05 *Priority points: 4*	Manns Fork Salt Creek	No impairment (ALU[1])	No action necessary
		Bacteria (RU[2])	TMDL for bacteria
		No impairment (PDWSU[3])	No action necessary
06 06 *Priority points: 4*	Mouth Salt Creek	No impairment (ALU[1])	No action necessary
		Bacteria (RU[2])	TMDL for bacteria

[1] ALU = aquatic life use
[2] RU = recreation use
[3] PDWSU = public drinking water supply use

1.2 Public Involvement

Public involvement is fundamental to the success of water restoration projects, including TMDL efforts. From the beginning, Ohio EPA has invited participation in all aspects of the TMDL program. The Ohio EPA convened an external advisory group in 1998 to assist the Agency with the development of the TMDL program in Ohio. The advisory group issued a report in July 2000 to the Director of Ohio EPA on their findings and recommendations. The Salt Creek watershed TMDL project has been completed using the process endorsed by the advisory group.

Prior to the 2008 sampling, a meeting was held with the Muskingum County Soil and Water Conservation District (SWCD). The SWCD helped to identify locations for sampling during the field survey. An on-site meeting was held with the Muskingum County Engineer on May 27, 2009 to evaluate storm water impacts and improvements that can be made to developments in the headwaters of Salt Creek. A meeting and presentation were held at the Muskingum County Health Department office on April 12, 2010 to talk about the unsanitary conditions found throughout the watershed. The Health Department agreed to prioritize funding to the areas identified as impaired.

Consistent with Ohio's current continuous planning process (CPP), the draft TMDL report was available for public comment from March 11 through April 11, 2011. A copy of the draft report was posted on Ohio EPA's web page (http://www.epa.ohio.gov/dsw/tmdl/index.aspx). No public comments were received.

Continued public involvement is essential to the success of any TMDL project. Ohio EPA will continue to support the implementation process and will facilitate, to the fullest extent possible, restoration actions that are acceptable to the communities and stakeholders in the study area and to Ohio EPA.

1.3 Organization of Report

Chapter 2 gives an overview of water quality standards applicable in the watershed. Chapter 3 gives an overview of the water quality conditions in the watershed. Chapter 4 briefly discusses the methods used to calculate load reductions. Chapter 5 provides the load reduction results. Chapter 6 discusses suggested restoration methods to improve water quality.

More detailed information on selected topics is contained in appendices. Appendix A lists the permitted facilities in the watershed. Appendix B summarizes the findings of the watershed survey. Appendix C is a primer on Ohio's water quality standards. Appendix D contains details of the loading analysis. Appendix E discusses programs and actions available to improve water quality.

2 CHARACTERISTICS AND EXPECTATIONS OF THE WATERSHED

The Salt Creek watershed is located entirely within Muskingum County in southeastern Ohio. Salt Creek discharges into the Muskingum River at river mile 67.03, is 27.1 miles long and drains 145 square miles. Fourteen streams within the Salt Creek watershed were sampled in 2008, including Salt Creek, Prairie Fork, Georges Run, Frog Run, Little Salt Creek, White Eyes Creek, Pleasant Run, Buffalo Fork, Williams Fork, Boggs Creek, Indian Run, Manns Fork, Kent Run, and an unnamed tributary to Manns Fork at river mile (RM) 2.3.

2.1 Watershed Characteristics

The following subsections provide an overview of the characteristics of the Salt Creek watershed.

2.1.1 Population and Distribution

The population of Muskingum County, which contains the entire Salt Creek watershed, is projected to grow by 4% from 2010 to 2020 (ODD 2003). Figure 2-1 shows the population density from the 2000 United States Census.

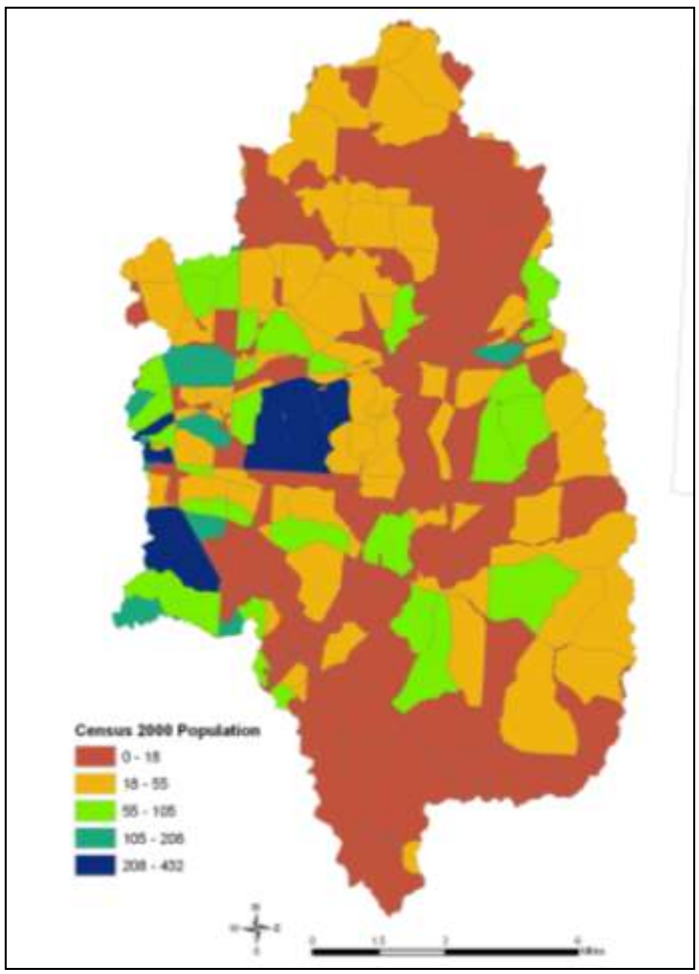


Figure 2-1. Population density blocks (number of people) from the 2000 United States Census.

2.1.2 Land Use

The southern and eastern portions of the Salt Creek watershed are dominated by forest, whereas the northern and western portions have a greater concentration of pasture and crop land, though there is still a large proportion of forest. The only urbanized areas are in the western portion of the watershed. Figure 2-3 shows the various land uses within the Salt Creek watershed.

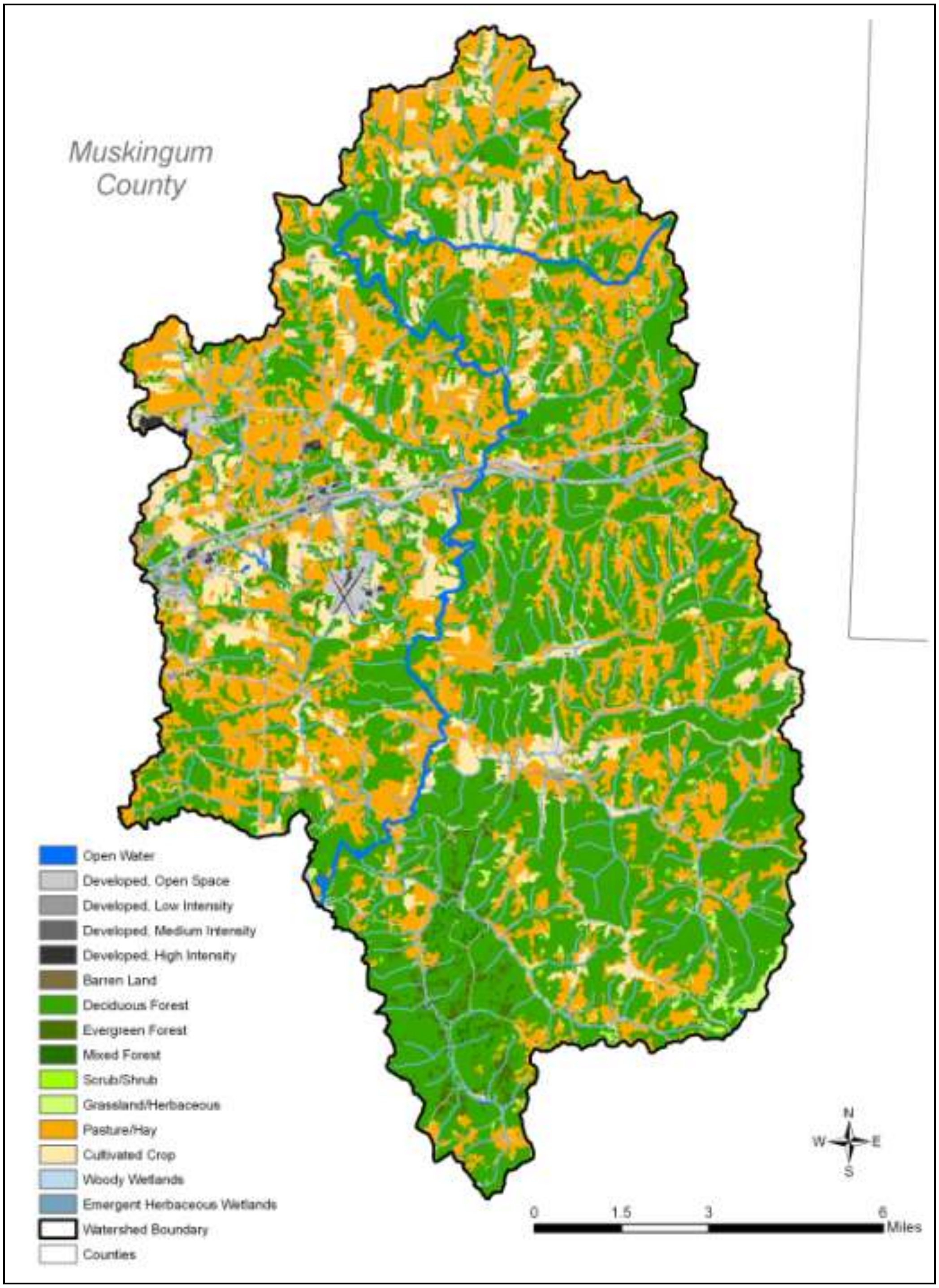


Figure 2-3. Land use in the Salt Creek watershed.

2.1.3 Point Source Discharges

Industrial and municipal point sources include wastewater treatment plants and factories. Wastewater treatment plants can contribute to bacteria, nutrient enrichment, siltation, and flow alteration problems. Industrial point sources, such as factories, sometimes discharge water that is excessively warm or cold, changing the temperature of the stream. Point sources may contain other pollutants such as chemicals, metals and silt.

NPDES dischargers are entities that possess a permit through the National Pollutant Discharge Elimination System (NPDES). NPDES permits limit the quantity of pollutants discharged and impose monitoring requirements. NPDES permits are designed to protect public health and the aquatic environment by helping to ensure compliance with state and federal regulations. NPDES entities generally discharge wastewater continuously. They primarily affect water quality under average- to low-flow conditions because the potential for dilution is lower. NPDES dischargers located near the origin of a stream or on a small tributary are more likely to cause severe water quality problems because their effluent can dominate the natural stream flow. Appendix A lists the NPDES permittees in the Salt Creek watershed.

There are two individual municipal wastewater treatment permittees in the watershed (an Ohio Department of Transportation rest stop and an Ohio Department of Natural Resources State Park wastewater treatment plant). There are three individual industrial NPDES permits. There are two general small sanitary NPDES permits. Four of the permits are located in the northern portion of the watershed; two are in the western portion; and one is in the southern portion.

MS4s carry storm water from “separate storm sewer systems” directly to bodies of water. Separate storm sewer systems include ditches, curbs, gutters, storm sewers, and other conveyances of runoff. These systems do not connect to wastewater collection systems or treatment plants. Storm water can transport oil, grease, pesticides, herbicides, dirt and grit that have the potential to reduce water quality.

U.S. EPA’s storm water program requires municipalities to obtain storm water permits and addressed storm water in two phases: Phase I covered large (serving populations > 250,000) and medium (100,000 to 250,000) MS4s and Phase II addressed small (< 100,000) MS4s. There is one Phase II MS4 located partially within the Salt Creek watershed (City of Zanesville).

2.1.4 Public Drinking Water Supplies

Some communities supply public drinking water from ground water (underground aquifers). Other communities supply public drinking water by withdrawing water from surface waters, including lakes and streams. A surface water public drinking water supply for Blue Rock State Park is located in the Salt Creek watershed. More details are available in Appendix B.

2.2 Water Quality Standards

TMDLs are required when a waterbody fails to meet water quality standards (WQS). Every state must adopt WQS to protect, maintain, and improve the quality of the nation's surface waters. WQS represent a level of water quality that will support the Clean Water Act goal of swimmable and fishable waters. Ohio's WQS, set forth in Chapter 3745-1 of the Ohio Administrative Code (OAC), include three major components: beneficial use designations, criteria and antidegradation provisions. Where criteria have not been developed, the State can develop project-specific targets.

Beneficial use designations describe the existing or potential uses of a waterbody, such as public water supply; protection and propagation of aquatic life; and recreation in and on the water. Ohio EPA assigns beneficial use designations to each waterbody in the state. Use designations are defined in paragraph (B) of rule 3745-1-07 of the OAC and are assigned in rules 3745-1-08 to 3745-1-32. Attainment of uses is based on specific numeric and narrative criteria.

Numeric criteria are estimations of chemical concentrations, degree of aquatic life toxicity, and physical conditions allowable in a waterbody without adversely impacting its beneficial uses. Statewide narrative "*free from*" criteria are presented within Chapter 3745-1-04 of the OAC. Narrative *free froms* are general water quality criteria that apply to all surface waters in the State of Ohio. In general, the narrative *free from* criteria strive to achieve "*no toxics in toxic amounts*" and state that all waters should be free from: sludge, floating debris, oil and scum, color and odor, producing materials, substances that are harmful to humans, animals or aquatic life, and nutrients that may cause algal blooms. Ohio EPA developed its strategy based on an evaluation of the potential for significant toxic impacts within the receiving waters. Very important components of this evaluation are the biological survey program and the biological criteria used to judge aquatic life use attainment.

Antidegradation provisions describe the conditions under which water quality may be lowered in surface waters. Water quality may not be lowered below criteria protective of existing beneficial uses unless lower quality is deemed necessary to allow important economic or social development. Antidegradation provisions are in Sections 3745-1-05 and 3745-1-54 of the OAC.

The following sub-sections describe the applicable water quality standards for the Salt Creek watershed. Further details can be found in Appendix C.

2.2.1 Aquatic Life Use

Ohio's WQS have seven subcategories of aquatic life uses (see http://www.epa.ohio.gov/portals/35/rules/01-07.pdf). The WQS rule contains a narrative for each aquatic life use and the three most commonly assigned aquatic life uses have quantitative, numeric biological criteria that express the minimum acceptable level of biological performance based on three separate biological indices. The indices measure the health of aquatic communities of both fish and insects. Figure 2-4 shows the applicable aquatic life use designations in the watershed. All aquatic life uses were fully supported in the watershed.

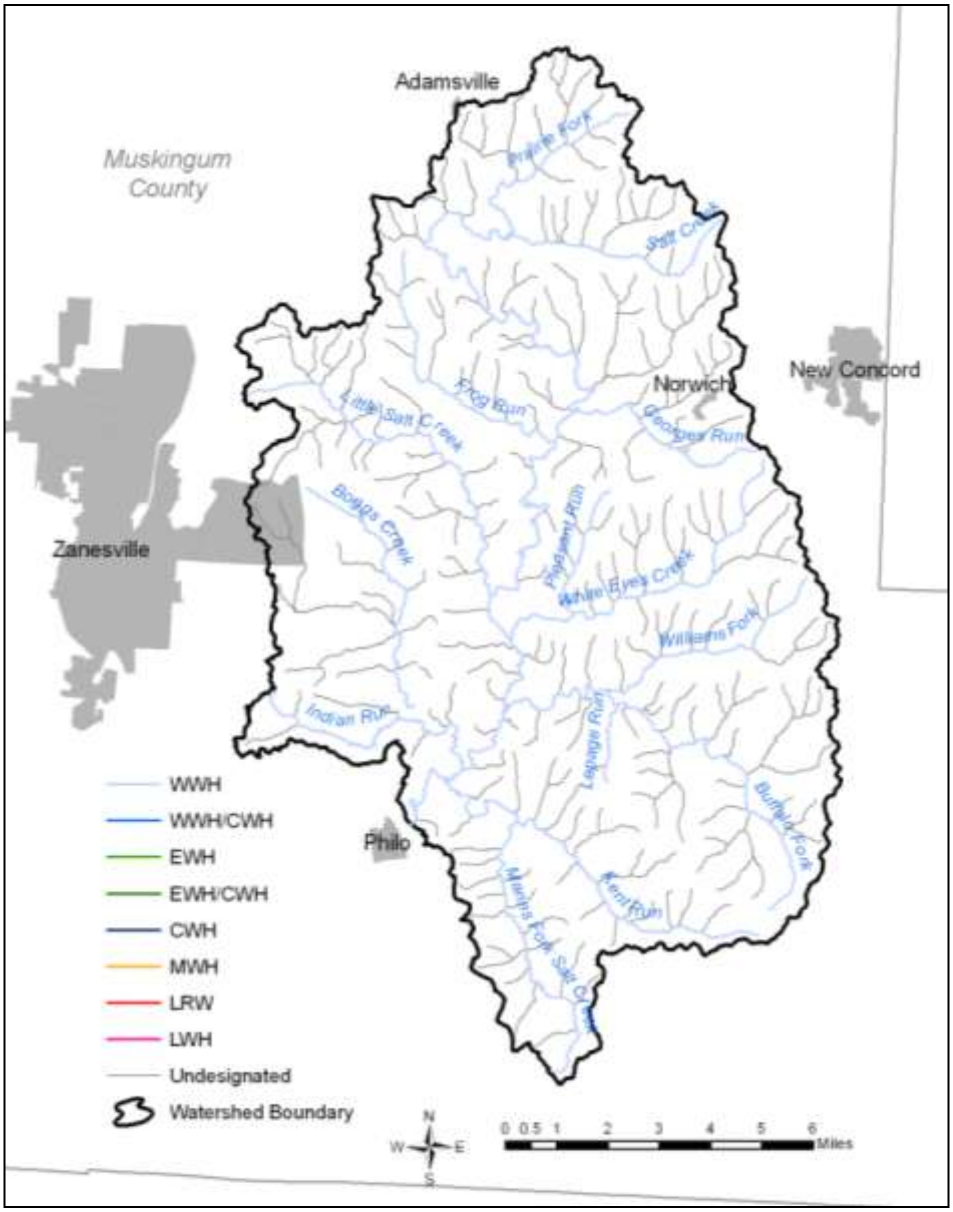


Figure 2-4. Aquatic life use designations in the Salt Creek watershed.

2.2.2 Recreation Use

Ohio's WQS have three subcategories of recreation uses (bathing waters, primary contact and secondary contact). Within primary contact there are three classes of streams (A, B and C) that describe the general frequency with which the stream is used for recreation. The WQS rule contains a description of each recreation use and all primary contact recreation classes have numeric criteria that are associated with a statistically-based risk level. Figure 2-5 shows the recreation use designations applicable in the Salt Creek watershed and the nearest primary contact recreation class A waters.

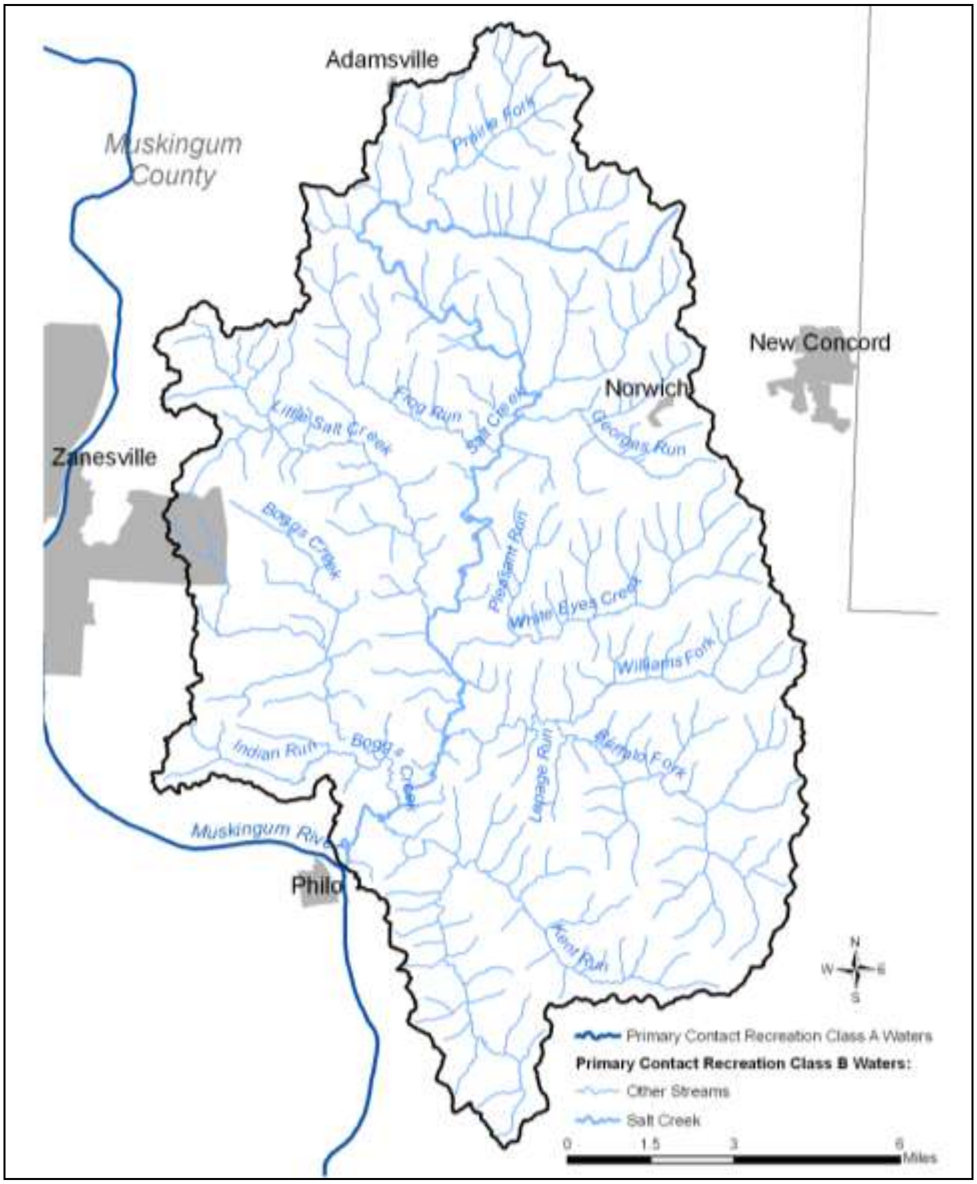


Figure 2-5. Recreation use designations in the Salt Creek watershed.

Table 2-1 displays the criteria for the various recreation use designations (from Table 7-13 of OAC 3745-1-07).

Table 2-1. Recreation use criteria for Ohio.

Recreation Use	*E. coli* (colony counts per 100 ml)	
	Seasonal Geometric Mean	Single Sample Maximum[1]
Bathing water	126	235[2]
Class A primary contact recreation	126	298
Class B primary contact recreation	161	523
Class C primary contact recreation	206	940
Secondary contact recreation	1030	1030

[1] Except as noted in footnote 2, these criteria shall not be exceeded in more than ten per cent of the samples taken during any thirty-day period.
[2] This criterion shall be used for the issuance of beach and bathing water advisories.

2.2.3 Public Drinking Water Supply Use

The public drinking water supply use includes surface waters from which public drinking water is supplied. This beneficial use provides an opportunity to strengthen the connection between Clean Water Act and Safe Drinking Water Act (SDWA) activities by employing the authority of the CWA to meet SDWA objectives of source water protection and reduced risk to human health. Criteria associated with this use designation apply within five hundred yards of surface water intakes.

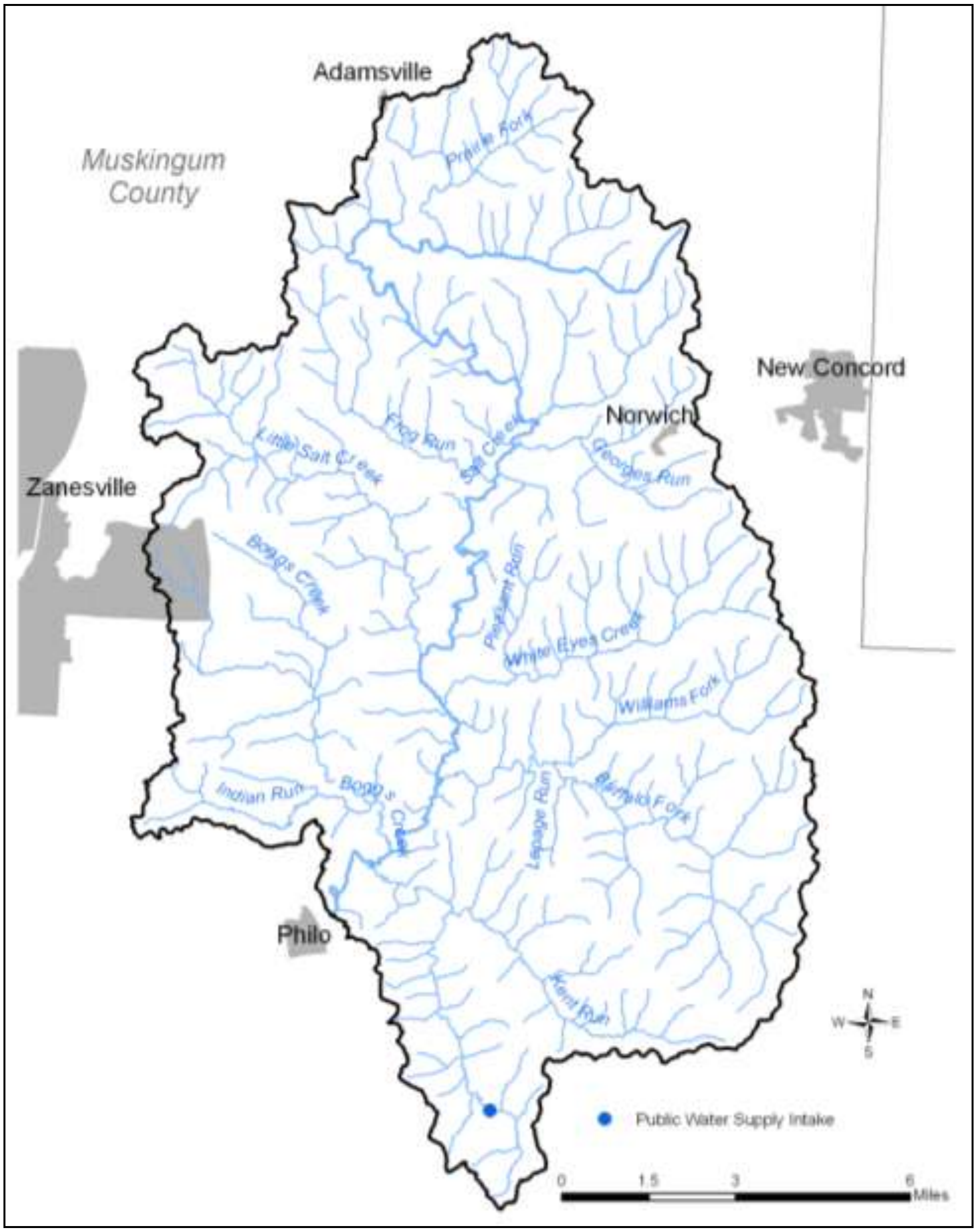


Figure 2-6. Location of the public water supply intake in the Salt Creek watershed.

The location of the public drinking water supply is shown in Figure 2-6. The public drinking water supply use was fully supported according to the 2010 Ohio Integrated Report (Ohio EPA 2010a).

2.2.4 Human Health (Fish Contaminants) Use

Ohio has adopted human health WQS criteria to protect the public from adverse impacts, both carcinogenic and non-carcinogenic, caused by exposure via drinking water (applicable at public water supply intakes) and by exposure in the contaminated flesh of sport fish (applicable in all surface waters). The latter criterion, called the non-drinking water human health criterion, ensures that levels of a chemical in water do not bioaccumulate in fish to levels harmful to people who catch and eat the fish. Ohio measures contaminants in fish tissue and uses the data in two comparisons: (1) to determine if the human health criteria are being violated, thus identifying the water for restoration through a TMDL or other action, or (2) to determine the quantity of sport fish that may be safely consumed. The first comparison can result in the water being identified as impaired on the 303(d) list; the second can result in the issuance of a sport fish consumption advisory.

There were no data to analyze support of the human health use in the 2010 Ohio Integrated Report (Ohio 2010a) for five out of six assessment units (see http://wwwapp.epa.ohio.gov/dsw/ir2010/subwatershed.php?id=0504000406). There were some data in the sixth assessment unit, but they were insufficient to determine support of the use.

The Salt Creek watershed is included in the statewide fish advisory for mercury. Additional advisories specific to the Salt Creek watershed do not exist. Information regarding fish consumption advisories can be found at: http://www.epa.ohio.gov/dsw/fishadvisory/index.aspx.

3 WATER QUALITY CONDITIONS IN THE WATERSHED

Ohio uses the fish and aquatic insects that live in streams to assess the health of Ohio's flowing waters. Aquatic animals are generally the most sensitive indicators of pollution because they inhabit the water all of the time. A healthy stream community is also associated with high quality recreational opportunities (e.g., fishing and boating).

In addition to biological data, Ohio EPA collects information on the chemical quality of the water, sediment, and wastewater discharges; data on the contaminants in fish flesh; and physical information about streams. Taken together, this information identifies the factors that limit the health of aquatic life and that constitute threats to human health.

Ohio EPA performed a comprehensive water quality study in the Salt Creek watershed in 2008. Twenty-one sites were studied for biological health, twenty-two sites for water chemistry, twenty-three sites for recreation use, and three sites for human health (fish contaminants) use. Sites were scattered throughout the watershed. Please refer to Appendix B for more detail.

Based on 2008 sampling, aquatic life uses were fully supported across the watershed except for two sites. Kent Run and Little Salt Creek (at RM 5.6) were re-sampled in 2009 after habitat impairment issues were resolved. After 2009 sampling, aquatic life uses were determined to be fully supported. Therefore, no TMDL is necessary for aquatic life use. Non-support of recreation use was widespread (20 of 23 sites were impaired). Unimpaired sites were located in the southern portion of the watershed. Probable sources included agricultural land practices such as inadequate manure management; unrestricted cattle access to streams; and sewage discharges in unsewered areas with inadequate or failing home sewage treatment systems (HSTS).

The Salt Creek watershed TMDL includes six smaller watersheds that are nested (Figure 3-1). This chapter discusses conditions in the watershed.

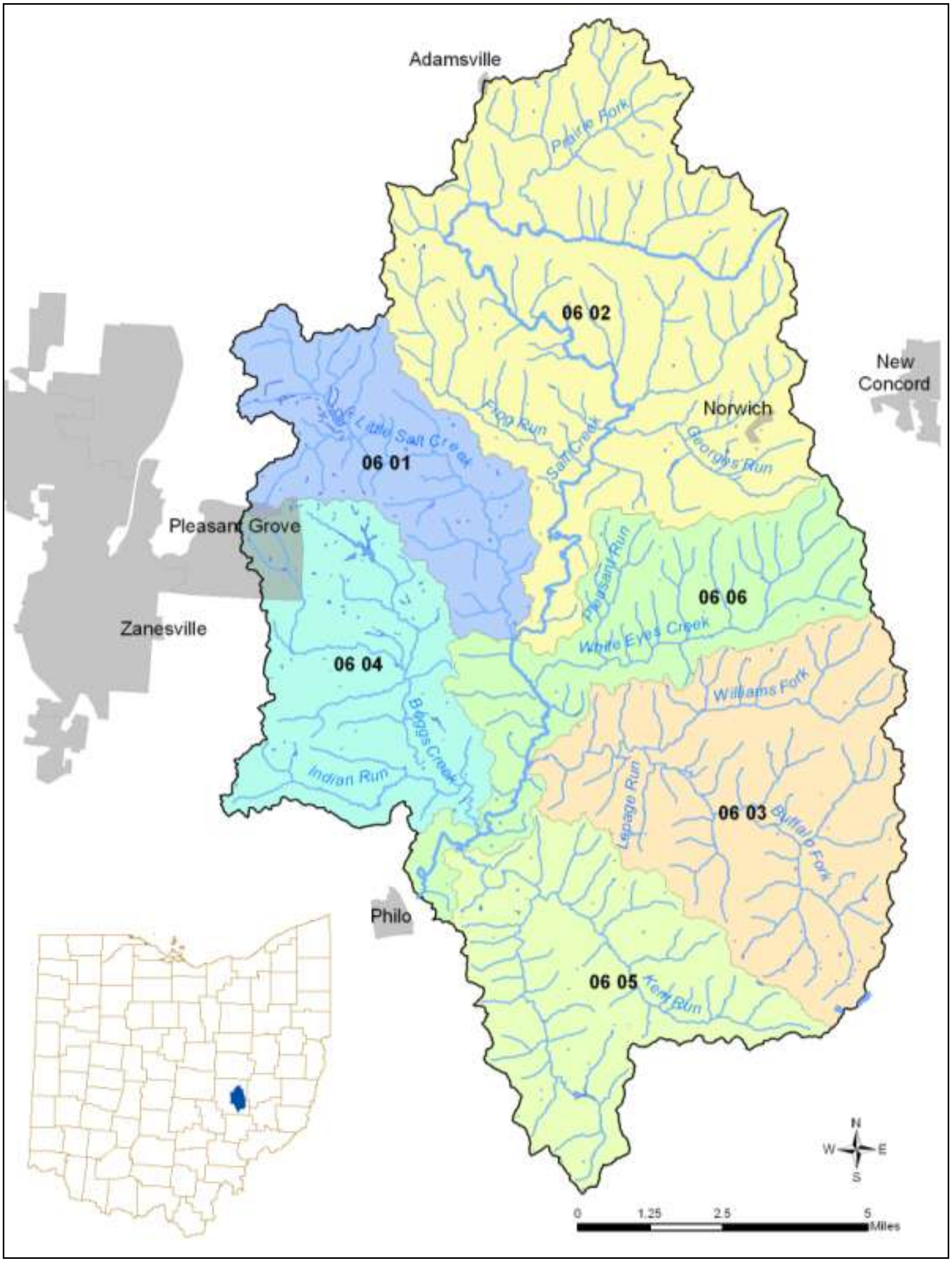


Figure 3-1. Map of the Salt Creek watershed, including nested subwatersheds.

3.1 Salt Creek (05040004 06)

The Salt Creek watershed drains 145 square miles (see Figure 3-2). It consists of six nested subwatersheds (12-digit assessment units). The main tributaries to Salt Creek include Manns Fork, Kent Run, Boggs Creek, Buffalo Fork, White Eyes Creek, Little Salt Creek, Frog Run, Georges Run and Prairie Fork. As stated above, there is no aquatic life use impairment. Recreation use impairment, caused by bacteria, is primarily associated with agricultural land practices such as inadequate manure management; unrestricted cattle access to streams; and sewage discharges in unsewered areas with inadequate or failing HSTS.

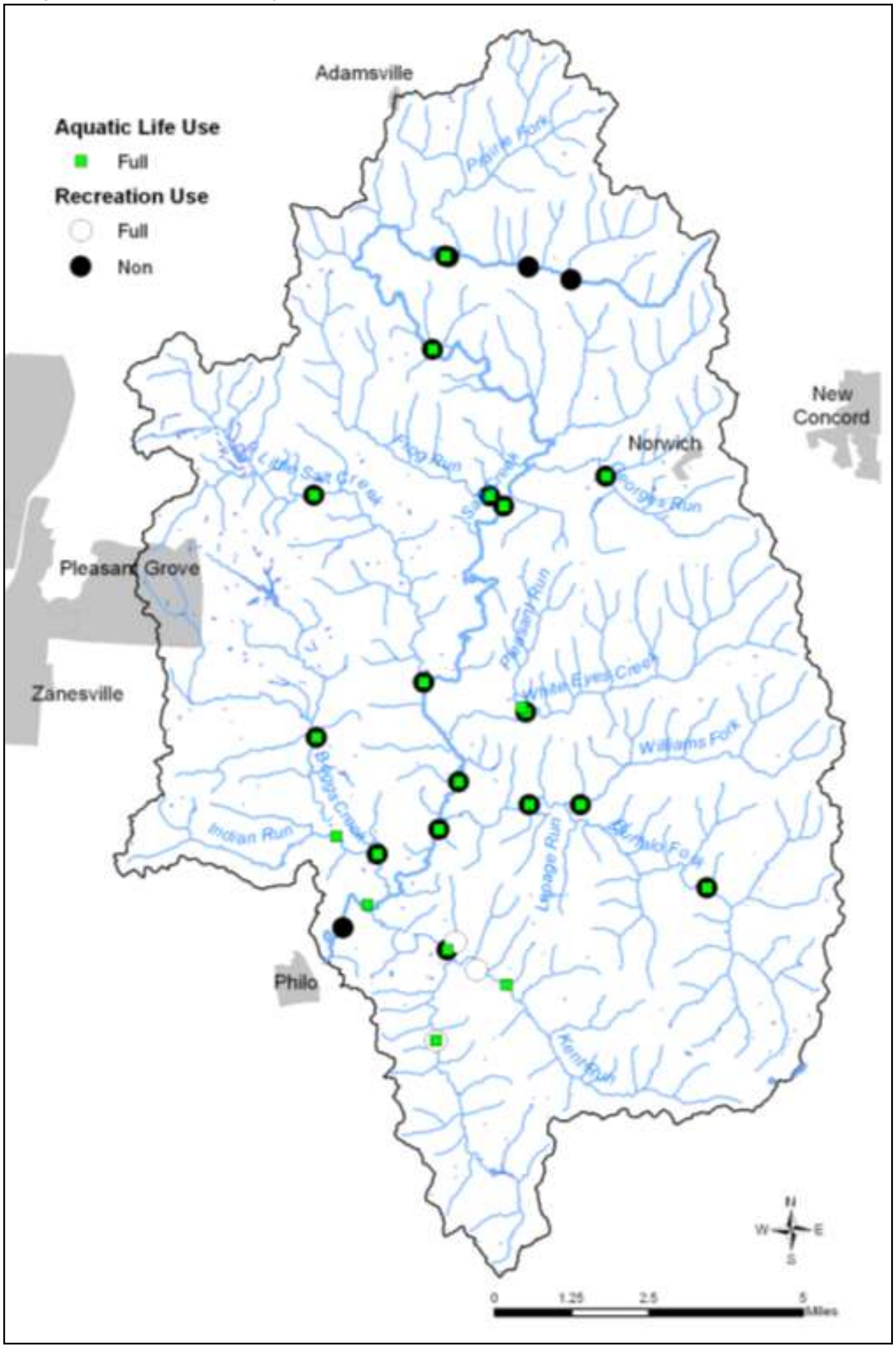


Figure 3-2. Attainment results for the Salt Creek watershed.

In most cases, excess bacteria are associated with land uses in the watershed (see Appendix C for further information). Figure 3-3 shows land use within the Salt Creek watershed. Generally speaking, pasture and forest land are scattered throughout the watershed as the two most dominant land use types. However, there is a distinctly larger predominance of forest land in the southern half of the watershed than in the northern; the opposite is true for pasture land. Cultivated crops are also more dominant in the northern half of the watershed, as is developed land.

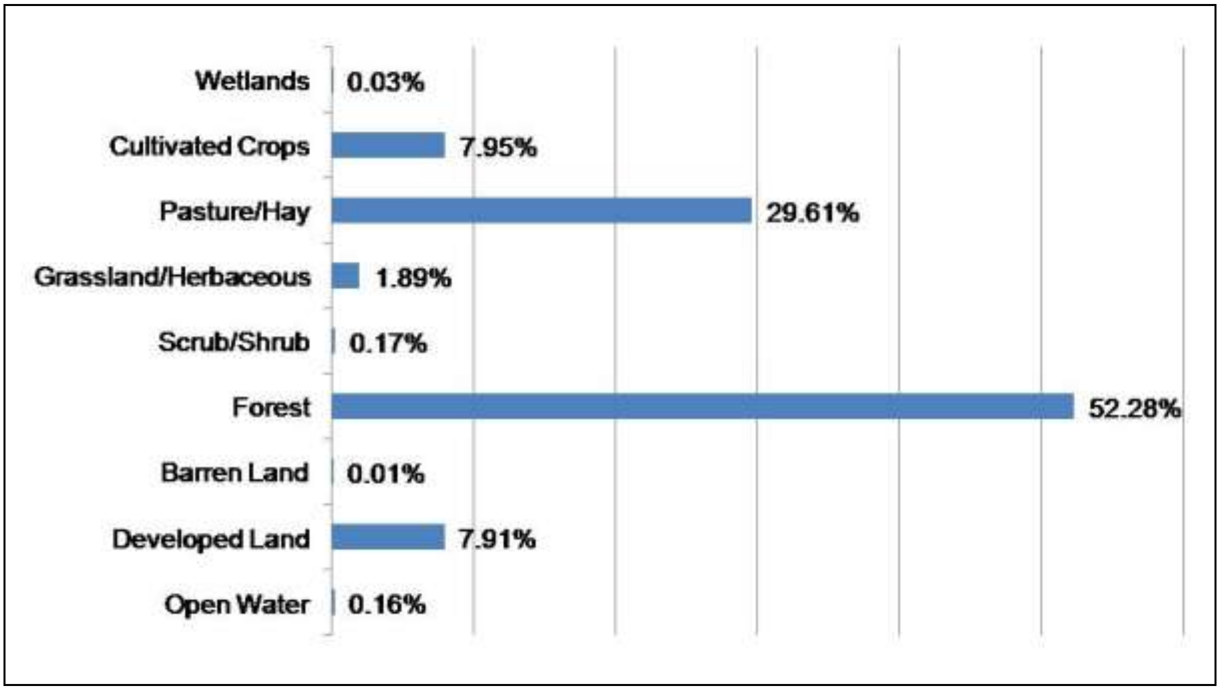


Figure 3-3. Land use in the Salt Creek watershed.

Three probable sources of *E. coli* were identified in the watershed: agricultural land use practices (e.g., poor manure management); unrestricted cattle access to the streams; and failing home sewage treatment systems (HSTSs). Agricultural practices were listed as a probable cause at every impaired site (Ohio EPA 2010b). Twelve of twenty impaired sites listed agricultural practices and failing HSTSs as probable sources. Two of twenty impaired sites listed agricultural practices and unrestricted cattle access as probable sources of *E. coli*. One site listed all three as probable sources.

A geographic distribution of *E. coli* shows that larger geometric means were present in the northern half of the watershed than in the southern half. Figure 3-4 shows geometric mean results for *E. coli* in the watershed.

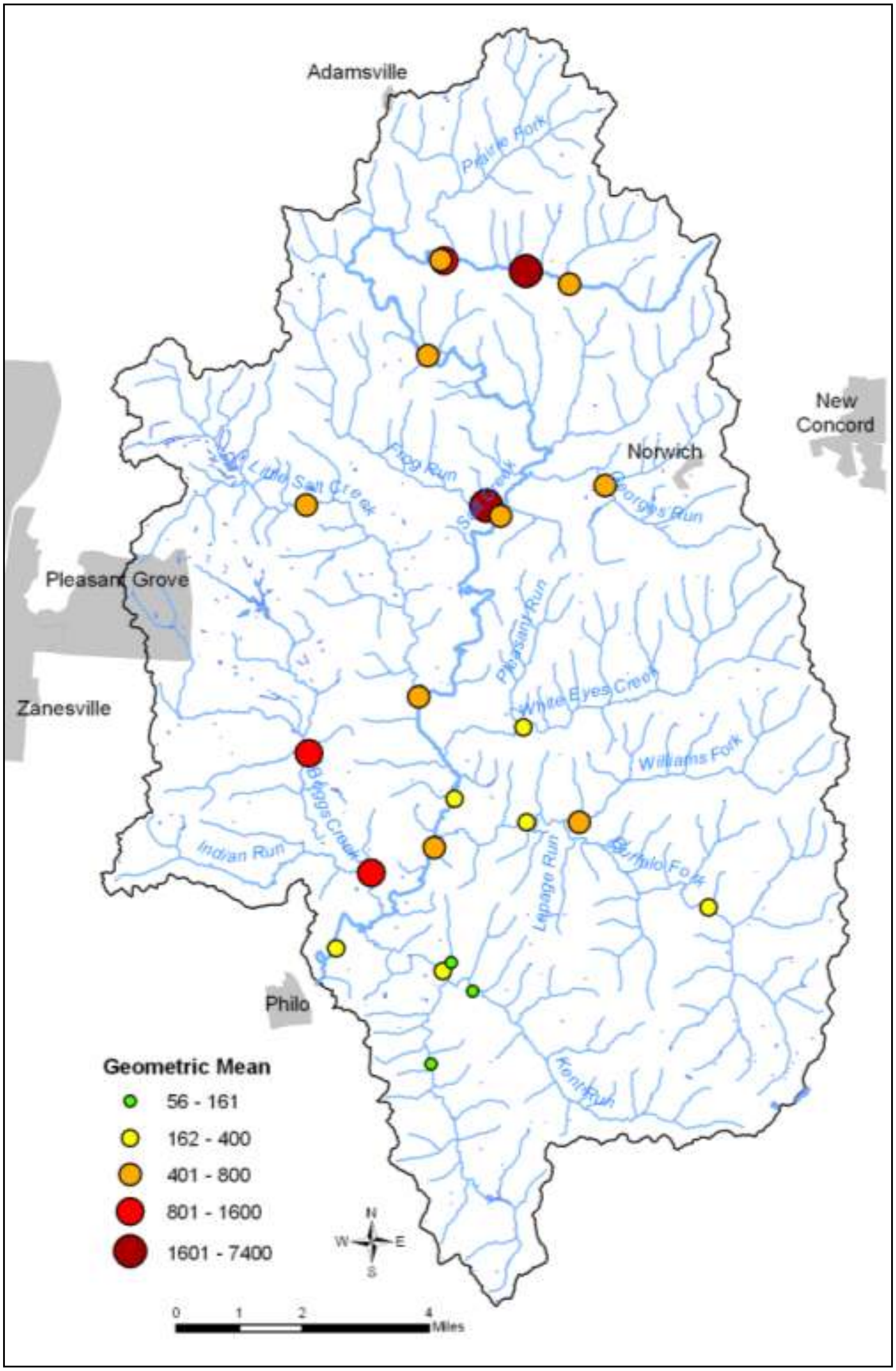


Figure 3-4. *Escherichia coli* geometric mean results for the Salt Creek watershed.

Table 3-1 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Table 3-1. Number of impaired sites, organized by use and nested subwatershed, in the Salt Creek watershed.

Nested Subwatershed (05040004)		Aquatic Life Use	Recreation Use[3]	Public Drinking Water Supply Use	Human Health Use[1]
06 01	# impaired sites (non/partial)	0/0	4	N/A	No data
	Index score[2]	100	55	N/A	N/A
06 02	# impaired sites (non/partial)	0/0	9	N/A	No data
	Index score	100	40	N/A	N/A
06 03	# impaired sites (non/partial)	0/0	6	N/A	No data
	Index score	100	63	N/A	N/A
06 04	# impaired sites (non/partial)	0/0	3	N/A	No data
	Index score[2]	100	15	N/A	N/A
06 05	# impaired sites (non/partial)	0/0	3	0/0	0[4]
	Index score	100	71	N/A	N/A
06 06	# impaired sites (non/partial)	0/0	8	N/A	No data
	Index score	100	70	N/A	N/A

1 Impairments to the human health use are not being addressed in this TMDL.
2 The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.
3 Several sites were sampled in 2004 rather than 2008. They were included in the Ohio 2010 Integrated Report assessment but were not included in the *Biological and Water Quality Study of Salt Creek and Selected Tributaries* (Ohio EPA 2010b).
4 While some data were collected for fish tissue analysis in Cutler Lake, there were insufficient samples to determine site attainment.

Within the Salt Creek study area, good to excellent stream habitat was recorded at 17 sites (81%) and fair habitat was noted at 3 locations (14%). One site (Indian Run) scored in the poor range. The average QHEI score for all sites combined was 67.0, consistent with good overall habitat quality. Many of the stream sites were predominated by high quality substrates, including gravel, sand, and cobble. Three stream sites (Boggs Creek at mouth, Williams Creek and Indian Run) were predominated by bedrock substrate. Moderate to extensive embeddedness of the bottom substrates occurred at 16 of the 21 fish sites (76%). Sand dominated the embedded material throughout the study area. Embeddedness is the degree that cobble, gravel, and boulder substrates are surrounded, compacted, or covered by fine sand and silt. Extensive embeddedness is detrimental to bottom spawning fish and can impair macroinvertebrate communities.

The upper portion of Salt Creek has more agricultural land than forested areas. Many of the stream reaches monitored had little or no riparian corridor remaining. Cattle access to the streams was observed at numerous sites. Indian Run flows through an open pasture and had black manure pooled in the stream along with the lowest habitat score in the watershed. The upper portion of Little Salt Creek had storm water runoff via newly cleared (now impervious) acreage, causing flashy flows with erosion, sedimentation and embedded conditions from the Eastpointe Business Park. The sedimentation affected the fish community in 2008. Storm water controls are now in place and the fish community improved in 2009. The lower portion of Salt Creek has more wooded areas, but agriculture dominates the wide stream valleys. Kent Run’s streambed was actively mined for gravel during the 2008 sampling season, which had a negative impact on the macroinvertebrate community. The landowner said he removed sand and gravel sporadically (once or twice a year) and would cease his in-stream mining. In 2009 the macroinvertebrate community had recovered and Kent Run is now recommended EWH. Further details about habitat are available in Appendix C.

4 METHODS TO CALCULATE LOAD REDUCTIONS

Aquatic life use was fully supported in the Salt Creek watershed (Muskingum River basin) according to Ohio EPA's 2008 field survey (Ohio EPA 2010). Recreation use, however, was not supported in multiple assessment units in which at least one site's geometric mean did not attain the water quality standards criteria. Twenty-three sites were sampled to determine recreation use support.

A study was carried out to develop an *E. coli* total maximum daily load (TMDL) as required by Section 303(d) of the Clean Water Act. The TMDL report defines in-stream bacterial conditions, potential sources, bacteria targets and needed reductions and recommends implementation strategies. Appendix D gives details about the loading analysis that was completed.

Of the 20 sites found to be in recreation use non-attainment during the summer of 2008, a subset of nine representative sampling locations was established on six different streams within the watershed, and these sites were used for further study of the causes of recreation use non-attainment. These nine sites included four sites on the mainstem of Salt Creek and five sites on the tributaries showing impairment that have the largest flow contribution to Salt Creek.

Table 4-1 indicates how the applicable cause of impairment is addressed in each of the assessment units.

Table 4-1. Summary of causes of impairment and actions taken to address them in assessment units within the Salt Creek watershed.

Causes of Impairment	Watershed Assessment Units					
	05040004 06					
	01	02	03	04	05	06
Recreation Use						
E. coli	D	D	D	D	D	D

D – direct Means that TMDLs are calculated for this parameter

In order to determine the magnitude of bacteria impairment and differentiate between types of bacteria sources contributing to impairment, load duration curves (LDCs) were calculated for analyzed sites following the methods described in U.S. EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs* (U.S. EPA 2007). Further details on modeling methods and analyses are available in Appendix D.

4.1 Load Duration Curves

Load duration curves (LDCs) can assist in distinguishing between point and nonpoint sources that contribute to *E. coli* loading by highlighting the flow conditions under which impairment occurs. Load duration curves plot the concentration of a given pollutant according to the flow at which the sample was collected. The acceptable load, based on water quality standards, varies according to flow. Hence, exceedances of the allowable load at any particular flow indicate times at which excessive loads are entering the stream. Because of this relationship to flow, load duration curves can assist in distinguishing between sources of load exceedances. For example, at lower flows when there is little precipitation creating runoff, there is little to no in-stream flow to dilute *E. coli* entering the stream from external sources. Because of this, any *E. coli* contributions to the stream during low flows are likely from point sources. Examples of bacteria point sources include combined sewer overflows (CSOs), municipal separate storm sewer systems (MS4s) or wastewater treatment plants. High bacteria levels under low flow conditions may also indicate direct nonpoint sources, such as concentrated cattle grazing in the stream channel, leaking sewer lines, or failing home sewage treatment systems.

Under higher flow conditions, point sources are typically diluted by in-stream flow. Therefore, high *E. coli* loading is likely caused by precipitation washoff or erosion of contaminated land surfaces. Some typical nonpoint sources of *E. coli* include manure spreading and washoff from livestock feeding operations.

When high *E. coli* loads exist under mid-range flow conditions, or high loads occur under all conditions, they can be attributed to a mixture of point and nonpoint sources. Site investigation using digital mapping, aerial photography or an on-the-ground visit can help conservation staff develop priorities for implementation based on the LDC evidence for either point or nonpoint sources of *E. coli*.

It is important to note that the load duration curve method does not enable one to attribute impairment to any one particular source; instead it is a tool used to determine the flow conditions under which impairment occurs and the probable types of sources contributing to that impairment.

An outline of LDC development specific to the Salt Creek watershed is as follows:

1. An historical daily flow record was obtained for the USGS Gage 03149500 “Salt Creek near Chandlersville, OH” for the period of record containing November 1, 2000 through March 31, 2009. Dates outside of the recreation season (May 1 through October 31) were excluded from the record. This flow record was then ordered and ranked to determine, for each daily flow, the percentage of the period of record when that flow was equaled or exceeded. This flow exceedance range constitutes the x-axis in a graphical LDC plot.
2. In-stream bacteria loads were determined for each sampling event using stream sample bacteria concentration in conjunction with calculated instantaneous flow data for each sampling location. At the appropriate flow exceedance, the corresponding *E. coli* concentration for a stream sample was plotted as a point on the y-axis of the LDC. In order to determine instantaneous flow at the time of each sampling event, the following steps were taken:
    a. Hourly flow data for each sampling date were obtained from USGS 03149500 “Salt Creek near Chandlersville, OH”.
    b. Sampling locations with larger drainage areas, similar to the USGS gage site, were assigned scaled hourly flows based on the ratio of each sampling location’s drainage area compared to that of the gage site.
    c. Six flow measurements were made at a smaller, tributary sampling location (*Buffalo Fork at Okey Rd.*) and plotted in a regression against the corresponding USGS gage flow. This relationship was used to generate hourly flows at *Buffalo Fork at Okey Rd*.

   d. Sampling locations with smaller drainage areas were assigned scaled hourly flows based on the ratio of each sampling location's drainage area compared to that of *Buffalo Fork ay Okey Rd*.
3. Target *E. coli* loads were calculated by applying the applicable *E. coli* WQS concentration value at each flow exceedance value for the entire flow duration interval.
4. A margin of safety was calculated to account for unknown variability.
5. An allowance for future growth, based upon population growth projections, was factored into any needed load reductions.
6. The LDCs were divided into five hydrologic regimes and within each regime the total required nonpoint load reduction percentage is calculated by incorporating the margin of safety and allowance for future growth into the target load and determining the difference between this target and the existing load in each flow regime.

A "TMDL table" is associated with each LDC, detailing the information that is graphically presented in the LDC figure. Each table contains the following information for each hydrologic regime:

- number of samples
- median sample *E. coli* load
- total maximum daily load (TMDL)
- total wasteload allocation (WLA) and individual WLAs, including MS4
- nonpoint source load allocation (LA)
- margin of safety (MOS) load
- allowance for future growth (AFG) load
- nonpoint source (%) load reduction required.

4.1.1 Target and Existing Deviation

For a given impaired site, each hydrologic condition (high flows, moist conditions, mid-range conditions, dry conditions or low flows) was assigned a target bacteria loading rate (cfu/day) by multiplying the class B *E. coli* water quality standard, 161 cfu/100 ml, by the median flow of each hydrologic class at that site and a constant, used to convert cubic feet per second to milliliters per day: $T = Q_m * S * C$; where T = target bacteria load, Q_m = median flow for a specific hydrologic class, S = water quality standard, 161 cfu/100 ml and C = a unit conversion constant (cubic feet per second to milliliters per day). Median observed bacteria loads in each hydrologic condition were compared to the median target value in that condition, after incorporating a margin of safety and allowance for future growth, in order to quantify needed reductions.

To use a hypothetical example, assume the median flow under 'dry weather' at the site *Green River at Horse Camp,* a class B river, is 50 cfs, the margin of safety is 40% and the allowance for future growth is 4%. The target bacteria load would be determined as follows:

(i) $50 \text{ (cfs)} * (1 – (0.4 + 0.04) *161 \text{ (cfu/100 ml)} * C = 1.26 \times 10^{11} \text{ (cfu/day)}$

The actual bacteria load would then be calculated by substituting the target concentration with the median observed concentration over the same hydrologic range. In this case let it be 200 (cfu/100 ml).

(ii) $50 \text{ (cfs)} * 200 \text{ (cfu/100 ml)} * C = 2.45 \times 10^{11} \text{ (cfu/day)}$

Finally, if the observed load is larger than the target load, the total nonpoint load reduction is expressed as a percentage:

(iii) $(2.45 \times 10^{11}$ (cfu/day) – 1.26×10^{11} (cfu/day)) / 2.45×10^{11} (cfu/day)* 100%
= 49% total nonpoint load reduction

4.1.2 Downstream Class A Recreation Use Protection

In order to protect downstream class A recreation use attainment, any facilities within 5 river miles upstream of a class A receiving water are also held to the more-protective class A WQS. Salt Creek flows into the Muskingum River south of Zanesville at the town of Philo. The entire length of the Muskingum River is designated as class A PCR in OAC Rule 3745-1-24; for class A streams 126 cfu/100 ml is the *E. coli* WQS. There are no NPDES permitted facilities within five miles of the Muskingum River.

4.1.3 Wasteload Allocation

There are two individual NPDES permitted sanitary dischargers in the Salt Creek basin. Each of these dischargers is assigned a wasteload allocation (WLA) based upon the design flow of the treatment facility and the water quality standard applicable to its receiving water. Because a given facility operates at most times at some fraction of its design flow, the WLA for each facility includes an amount of reserve capacity up to the design flow of the facility.

The wasteload allocation for each of these facilities is included for all nested, downstream LDCs within the watershed. For example, the ODOT Rest Stop 5-20 WLA is included in the LDC for the most immediate downstream sampling location, *Salt Creek at US-40 (RM 12.91)*, as well as the two other downstream sampling locations, *Salt Creek at SR-146 (RM 5.6)* and *Salt Creek adjacent Manns Fork Road (RM 1.1)*.

Blue Rock State Park (Ohio EPA Permit # 0PP00088*AD)
Located at 7924 Cutler Lake Road, the facilities consist of two primitive campground areas as well as a beach house facility located near Cutler Lake with full restroom facilities. The sanitary wastewater generated at the beach house receives treatment from an extended aeration wastewater treatment plant with an average daily design flow of 3,000 gallons per day (0.003 MGD). The treated effluent undergoes primary settling and secondary treatment prior to being disinfected and discharged to Manns Fork downstream of the lake spillway.

ODOT Rest Stop Facility 5-20 (Ohio EPA Permit # 0PP00052*CD)
Located along the westbound lane of Interstate 70 approximately four miles west of Norwich, the rest stop consists of two full service restrooms which discharge sanitary wastewater to an extended aeration package plant with an average daily design flow of 10,000 gallons per day (0.01 MGD). The sanitary waste receives primary, secondary and tertiary treatment through an initial trash trap, aeration basins with clarifiers and surface sand filters. Following the tertiary treatment from the sand filters the treated effluent is disinfected in the months of May through October with ultraviolet radiation and discharged to Frog Run.

Municipal Separate Storm Sewer System
Allocations for the one Phase II MS4 in the Salt Creek watershed were determined based on the area of the MS4 draining to each assessment location. Townships, municipalities, and urbanized areas as documented in geographic information system (GIS) files within the Salt Creek watershed were used to determine the total regulated area for each MS4. These areas were then used to estimate WLAs based on the proportion of the upstream drainage area

located within the MS4 boundaries. Storm water runoff was assumed to occur only during high flows, wet weather and normal flow conditions.

4.1.4 Load Allocation

The load duration curve method was selected to assign in-stream bacteria loads at a given site to one or several potential bacteria sources (see U.S. EPA 2007). In a load duration curve, patterns of bacteria impairment can be examined and addressed relative to the flow conditions under which they occur which allows a set of potential bacteria sources specific to a given site to be highlighted. Under the highest flow conditions, point sources are likely to be masked by in-stream dilution; therefore high bacteria measurements in these conditions are associated with precipitation washoff or erosion of contaminated land surfaces. Impairments under mid-range flows can be caused by a mixture of point and nonpoint sources. Under the lowest flow conditions, recreation use impairments are generally attributable to sources not associated with runoff events, such as a failing HSTS or in-stream livestock.

Each sampling location was visited under a range of different flow conditions approximately 11 different times during the recreation seasons of 2008 and 2009. Additionally, during sampling events in the watershed, Ohio EPA made observations regarding the land use (i.e., housing density and location of livestock farms) proximal to each sampling location to outline potential sources of bacteria.

Daily loading of bacteria was calculated for each site utilizing *E. coli* stream sample data. Existing in-stream loads, target loads and load duration curves were calculated from the collected data. Using these data and notes about land use, recommendations regarding sources and potential implementation were developed.

4.1.5 Margin of Safety

The Clean Water Act requires that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

An implicit MOS is incorporated in various ways, including in the derivation of the *E. coli* water quality criterion and in not considering the die-off of pathogens as part of the TMDL calculations. The implicit MOS is also enhanced by the use of the geometric mean target (which is a seasonal target) to calculate daily loads. In addition, an explicit MOS has been applied as part of all of the bacteria TMDLs by reserving 20% of the allowable load because of the broad fluctuation of *E. coli* concentrations that occurs in nature and the relatively low numbers of data points available for this analysis. The explicit MOS in each allocation is shown in the TMDL allocation tables throughout Section 5.

4.1.6 Critical Conditions

Critical conditions for in-stream bacteria vary by source and can occur across the hydrograph, from washoff of land-deposited bacteria under moist conditions to in-stream livestock and failing home sewage treatment systems (HSTSs) in low flow conditions. Nonpoint sources to which bacteria loads are allocated in the Salt Creek basin include livestock, both manure washoff and in-stream animals, and failing HSTSs.

4.1.7 Allowance for Future Growth

The population of Muskingum County, which contains the entire Salt Creek watershed, is projected to grow by 4% from 2010 to 2020 (ODD 2003). In order to ensure recreation use attainment over the next ten years of population growth, an allowance for future growth (AFG) of 4% of the assimilative capacity was reserved from each TMDL.

5 LOAD REDUCTION RESULTS

Several analyses were completed to address the causes of impairment. Results are summarized in this chapter and organized by assessment unit. Further details are available in Appendix D.

5.1 Little Salt Creek (05040004 06 01)

A load duration curve was created for Little Salt Creek near the mouth. In general, larger bacteria reductions were shown to be necessary at higher flows. No data were collected in the low flow range.

Table 5-1. TMDL table for site on Little Salt Creek near the mouth at County Road 5.

Flow regime TMDL analysis ***E. coli* (billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	1	6	4	N/A
Median sample load	4,364	504	37	6.50	N/A
TMDL	365	32.25	9.76	5.11	4.73
WLA: Zanesville MS4	13.96	1.25	0.36	0	0
LA	265	24	7	3.89	3.59
MOS: 20%	72	6	2	1.02	0.95
AFG: 4%	14	1	0.4	0.20	0.19
Nonpoint (LA) % load reduction required	**92%**	**94%**	**74%**	**21%**	N/A

Values were adjusted for rounding.

5.2 Headwaters Salt Creek (05040004 06 02)

Load duration curves were created for three sites in this assessment unit: Salt Creek at river mile (RM) 12.9; Salt Creek at RM 18.3; and Georges Run at RM 1.6. Bacteria reductions were shown to be necessary at all flow regimes in which data were available. However, in general reductions were larger at higher flows.

Table 5-2. TMDL table for site on Salt Creek downstream of Frog Run at U.S. Route 40.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	1	5	4	N/A
Median sample load	84,698	773	78	13.31	N/A
TMDL	1,554.061	121.061	21.961	2.761	0.401
WLA: ODOT Rest Area 5-20	0.061	0.061	0.061	0.061	0.061
LA	1,181	92	17	2.04	0.24
MOS: 20%	311	24	4	0.55	0.08
AFG: 4%	62	5	0.9	0.11	0.02
Nonpoint (LA) % load reduction required	**98%**	**84%**	**72%**	**79%**	N/A

Values were adjusted for rounding.

Table 5-3. TMDL table for site on Salt Creek at Norfield Road.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	1	6	4	N/A
Median sample load	14,480	922	36	22.61	N/A
TMDL	578	52	14.6	8.27	7.48
WLA	0	0	0	0	0
LA	439	40	11	6.29	5.68
MOS: 20%	116	10	3	1.65	1.50
AFG: 4%	23	2	0.6	0.33	0.30
Nonpoint (LA) % load reduction required	**96%**	**94%**	**59%**	**63%**	N/A

Values were adjusted for rounding.

Table 5-4. TMDL table for site on Georges Run adjacent to U.S. Route 40.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	N/A	3	1	N/A
Median sample load	400	N/A	22	7.42	N/A
TMDL	136	13	3.8	1.97	1.58
WLA	0	0	0	0	0
LA	104	10	3	1.50	1.20
MOS: 20%	27	2	0.7	0.39	0.32
AFG: 4%	5	0.5	0.1	0.08	0.06
Nonpoint (LA) % load reduction required	**66%**	N/A	**83%**	**73%**	N/A

Values were adjusted for rounding.

5.3 Buffalo Fork (05040004 06 03)

A load duration curve was created for Buffalo Fork at RM 2.1. No data were available for the low flow regime. No reductions were necessary at dry weather conditions. Larger reductions were necessary at high flows and wet weather conditions than at normal range flows.

Table 5-5. TMDL table for site on Buffalo Fork at Okey Road.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	1	6	4	N/A
Median sample load	3,956	2,597	47	2.56	N/A
TMDL	640	57	17	9.06	8.27
WLA	0	0	0	0	0
LA	486	44	13	6.89	6.29
MOS: 20%	128	11	3	1.81	1.65
AFG: 4%	26	2	0.7	0.36	0.33
Nonpoint (LA) % load reduction required	**84%**	**98%**	**64%**	**0%**	N/A

Values were adjusted for rounding.

5.4 Boggs Creek (05040004 06 04)

A load duration curve was created for Boggs Creek at RM 0.9. No data were available for the low flow regime. No reductions were necessary at dry weather conditions. Large reductions were necessary at high, wet weather and normal range flows.

Table 5-6. TMDL table for site on Boggs Creek at Salt Creek Drive.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	1	4	2	N/A
Median sample load	6,980	978	118	5.16	N/A
TMDL	439.35	40.15	11.45	6.30	5.51
WLA: Zanesville MS4	35.35	3.15	0.95	0	0
LA	298	27	8	4.79	4.19
MOS: 20%	88	8	2	1.26	1.10
AFG: 4%	18	2	0.5	0.25	0.22
Nonpoint (LA) % load reduction required	**94%**	**96%**	**90%**	**0%**	N/A

Values were adjusted for rounding.

5.5 Manns Fork Salt Creek (05040004 06 05)

A load duration curve was created for Salt Creek at RM 1.1. No data were available for the low flow regime. Larger reductions were necessary at high and normal flows than at dry weather and wet weather conditions.

Table 5-7. TMDL table for site on Salt Creek adjacent to Manns Fork Road.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	1	5	4	N/A
Median sample load	63,611	343	143	10.60	N/A
TMDL	4,101.639	319.119	59.089	7.089	1.239
WLA: total	0.639	0.119	0.089	0.079	0.079
WLA: Zanesville MS4	0.56	0.04	0.01	0	0
WLA: ODOT Rest Area 5-20	0.061	0.061	0.061	0.061	0.061
WLA: Blue Rock State Park	0.018	0.018	0.018	0.018	0.018
LA	3,117	242	45	5.31	0.86
MOS: 20%	820	64	12	1.42	0.25
AFG: 4%	164	13	2	0.28	0.05
Nonpoint (LA) % load reduction required	**94%**	**7%**	**59%**	**33%**	N/A

Values were adjusted for rounding.

5.6 Mouth Salt Creek (05040004 06 06)

Load duration curves were created for Salt Creek at RM 5.6 and White Eyes Creek at RM 1.7. No data were available for low flow conditions on either stream. On Salt Creek, larger reductions were necessary at high flows than dry weather or normal flows. No reductions were necessary in wet weather conditions. On White Eyes Creek, large reductions were necessary at high flows but no reductions were necessary at wet weather, normal or dry weather flows.

Table 5-8. TMDL table for site on Salt Creek at State Route 146.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	1	5	4	N/A
Median sample load	33,209	179	75	5.54	N/A
TMDL	2,735.221	214.071	40.063	4.731	0.791
WLA: total	0.221	0.071	0.063	0.061	0.061
WLA: Zanesville MS4	0.16	0.01	0.002	0	0
WLA: ODOT Rest Area 5-20	0.061	0.061	0.061	0.061	0.061
LA	2,079	162	30	3.53	0.54
MOS: 20%	547	43	8	0.95	0.16
AFG: 4%	109	9	2	0.19	0.03
Nonpoint (LA) % load reduction required	**92%**	**0%**	**47%**	**15%**	N/A

Values were adjusted for rounding.

Table 5-9. TMDL table for site on White Eyes Creek at Okey Road.

Flow regime TMDL analysis ***E. coli*** **(billion bacteria/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Duration interval	0-5%	5-40%	40-80%	80-95%	95-100%
Samples per regime	1	1	6	1	N/A
Median sample load	1,843	9	6	2.15	N/A
TMDL	231	20	6.0	3.15	2.76
WLA	0	0	0	0	0
LA	176	15	4.4	2.39	2.10
MOS: 20%	46	4	1.3	0.63	0.55
AFG: 4%	9	1	0.3	0.13	0.11
Nonpoint (LA) % load reduction required	**87%**	**0%**	**0%**	**0%**	N/A

Values were adjusted for rounding.

6 WATER QUALITY IMPROVEMENT STRATEGY

Based on 2008 sampling, aquatic life uses were fully supported across the watershed except for two sites. Kent Run and Little Salt Creek (at RM 5.6) were re-sampled in 2009 after habitat impairment issues were resolved. After 2009 sampling, aquatic life uses were determined to be fully supported. Therefore, no TMDL was developed for aquatic life use. Non-support of recreation use was widespread (20 of 23 sites were impaired). Unimpaired sites were located in the southern portion of the watershed. Probable sources included agricultural land practices such as inadequate manure management; unrestricted cattle access to streams; and sewage discharges in unsewered areas with inadequate or failing home sewage treatment systems.

In general, improvements in operation, maintenance and the periodic inspection of home sewage treatment systems as well as the elimination of unrestricted cattle access to streams by fencing to keep cattle out of streams are recommended watershed management options for reducing bacteria inputs to the Salt Creek watershed. Livestock exclusion fencing is often paired with the providing of alternative water supplies and sometimes with stream crossings between pastures. Further details about individual practices can be found in Appendix E. Probable sources (Ohio EPA 2010b) at each impaired site are shown in Table 6-1 and addressed in more detail below.

Table 6-1. Probable sources of bacteria at impaired sites in the Salt Creek watershed.

Location	RM	Probable Sources[1]
Salt Creek	25.7	Agricultural practices, unrestricted cattle access
Salt Creek	24.95	Agricultural practices, unrestricted cattle access
Salt Creek	23.43	Agricultural practices
Salt Creek	18.3	Agricultural practices
Salt Creek	12.91	Agricultural practices, failing HSTSs
Salt Creek	5.6	Agricultural practices, failing HSTSs
Salt Creek	1.1	Agricultural practices, failing HSTSs
Prairie Fork	0.1	Agricultural practices
Georges Run	1.63	Agricultural practices
Frog Run	0.36	Agricultural practices
Little Salt Creek	5.08	Agricultural practices, failing HSTSs
Little Salt Creek	0.11	Agricultural practices, failing HSTSs
White Eyes Creek	1.67	Agricultural practices, failing HSTSs
Buffalo Fork	6.55	Agricultural practices, failing HSTSs
Buffalo Fork	2.13	Agricultural practices, failing HSTSs
Buffalo Fork	0.7	Agricultural practices, failing HSTSs
Williams Fork	0.2	Agricultural practices, failing HSTSs
Boggs Creek	4.04	Agricultural practices, unrestricted cattle access, failing HSTSs
Boggs Creek	0.9	Agricultural practices, failing HSTSs
Manns Fork	2.31	Agricultural practices, failing HSTSs

1 HSTS stands for home sewage treatment system.

The headwaters of the Salt Creek watershed (Salt Creek at Norfield Road) are dominated by pasture, hay and row crop land-use along with large forested areas. This site exceeded target loadings in all hydrologic conditions that were sampled. Cattle have been observed in the streams in this area on numerous occasions during the recreational season, a source of high *E. coli* loading under most flow regimes. Establishing fencing along streambanks to keep livestock out of streams would be the most direct method of reducing bacteria from this source. Lowland flood plain areas, where row crops are cultivated, have reduced wooded or vegetated riparian zones along the stream bank. Pasture runoff and application of manure to harvested crop fields in the late summer are a likely cause of elevated in-stream bacteria levels during that time of year. Increasing the riparian vegetation in this area, particularly woody vegetation, would help buffer pollutant loading during precipitation or storm events. The watershed action plan (WAP) also recommends building roofs over or repairing manure storage facilities.

The middle segment of Salt Creek and all of Little Salt Creek fall along the Interstate 70 corridor where there is the highest amount of development, consisting mainly of light industry and residential developments. Sites that were sampled downstream of these more developed areas of the watershed (Little Salt Creek at County Road 5, Salt Creek downstream of Frog Run at U.S. Route 40, Georges Run adjacent to U.S. Route 40, Salt Creek at State Route 146) need significant reductions in *E. coli* loading across a wider range of flow conditions. At the time of this report, only Zanesville Municipal Airport and the Eastpointe Business Park, along State Route 40, are served by sanitary sewers. The areas along I-70 and County Road 52 had sewers installed in 2010 and citizens are currently tying into the system; this may help address some of the *E. coli* loading problems under drier conditions in the abovementioned tributaries. The WAP recommends installation of livestock exclusion fencing where appropriate combined with the installation of alternative water supplies and stream crossings between pastures; and installation of riparian vegetation to filter runoff from fields.

In rural tributaries such as Boggs Creek and Buffalo and Williams Forks (represented by Boggs Creek at Salt Creek Drive and Buffalo Fork at Okey Road), overland washoff appears to be the foremost mechanism for bacteria entering the stream because load reductions are needed primarily under elevated flow conditions. Increasing the riparian vegetation, particularly trees and other woody vegetation, will help to slow down water and filter it before it enters streams. The WAP also suggests building roofs over or repairing manure storage facilities (in Buffalo Fork and Boggs Creek) and building stream crossings for livestock (in Boggs Creek) when exclusion fencing is used.

In Manns Fork, the WAP recommends installation of livestock exclusion fencing where appropriate combined with the installation of alternative water supplies.

The downstream-most site on Salt Creek, near the confluence with the Muskingum, Salt Creek adjacent Manns Fork Road exhibits the cumulative effect of watershed land use on *E. coli* loading, with load reductions required across all flow regimes and a wide range of upstream sources of bacteria. White Eyes Creek at Okey Road has a similar pattern of load reduction needs, though to a lesser degree, but in this case upstream land use indicates that HSTS inspection at near-field residences should be addressed as a first step to reduce *E. coli* loading. The WAP also recommends livestock exclusion fencing combined with the building of alternative water supplies; building roofs over or repairing manure storage facilities; riparian vegetation enhancement; and stream crossing construction where exclusion fencing is used.

In all cases, the WAP recommends proper maintenance, and in some cases replacement, of failing home sewage treatment systems.

6.1 Regulatory Recommendations

Recommendations for NPDES permits are summarized by discharger and nested subwatershed in Table 6-2. Any suggestions in permit limits reflect calculated TMDLs. Ohio EPA will work with permit holders to accomplish any needed reductions in loadings. Effluent limits for *E. coli* for any NPDES-regulated facility not specifically mentioned in this report will be equivalent to WQS.

Table 6-2. Recommended implementation actions through the NPDES program for *E. coli*.

Nested Sub-watershed (05040004)	Entity	Ohio EPA Permit #	Receiving Stream	Design Flow[1]	Wasteload Allocation (load)[2]	Wasteload Allocation (concen-tration)	Recommended Permit Conditions[3]
06 02	ODOT Rest Area 5-20[4]	0PP00052 *DD	Frog Run	0.010	0.061	161 cfu/ 100 ml	Average weekly limit of 362 cfu/100 ml Average monthly limit of 161 cfu/100 ml
06 05	ODNR Blue Rock State Park	0PP00088 *AD	Manns Fork	0.003	0.018	161 cfu/ 100 ml	Average weekly limit of 362 cfu/100 ml Average monthly limit of 161 cfu/100 ml

[1] Design flows are shown in millions of gallons per day.
[2] Wasteload allocation load is shown in billions of organisms per day.
[3] "cfu" indicates colony forming units
[4] The ODOT Rest Area 5-20 permit currently contains the recommended limits.

6.2 Reasonable Assurances

The recommendations made in this TMDL report will be carried out if the appropriate entities work to implement them. In particular, activities that do not fall under regulatory authority require that there be a committed effort by state and local agencies, governments, and private groups to carry out and/or facilitate such actions. The availability of adequate resources is also imperative for successful implementation. Ultimately, nonpoint source reductions occur when individual landowners decide to change their land management in order to improve the stream.

When a TMDL is developed for waters impaired by point sources only, the issuance of a NPDES permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with the assumptions and requirements of any available wasteload allocation in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, U.S. EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. To this end, Appendix E discusses organizations and programs that have an important role or can provide assistance for meeting the goals and recommendations of this TMDL. Efforts specific to this watershed are described in this section.

6.2.1 Local Watershed Groups

A watershed group was organized out of the Muskingum County Soil and Water Conservation District (SWCD) office in 2002 when the SWCD hired a water quality technician. The initial goal of the group was to determine base line water quality data for the watershed. In order to determine bacteria levels in the watershed, the coordinator sampled 26 sites for fecal coliform in 2003 and 31 sites for fecal coliform and *E. coli* in 2004. The group wrote a watershed management plan that was endorsed by Ohio in 2005. The state-endorsed watershed management plan is available at: ftp://ohiodnr.com/Soil_&_Water_Conservation/WatershedActionPlans/EndorsedPlans/Salt%20Creek.pdf.

6.2.2 Other Sources of Funding and Special Projects

The Muskingum County Soil and Water Conservation District received a Section 319 grant in 2006 in order to finance a variety of agricultural best management practices to reduce sedimentation, bacteria and nutrient runoff.

6.2.3 Past and Ongoing Water Resource Evaluation

Ohio EPA's monitoring in 2008 was the first time that Ohio EPA surveyed the watershed. Bacteria monitoring was completed in 2004 by the Muskingum County SWCD to establish base line data for writing the watershed action plan.

Early communications should take place between the Ohio EPA and any potential collaborators to discuss research interests and objectives. Areas of overlap should be identified and ways to make all parties' research efforts more efficient discussed. Ultimately, important questions can be addressed by working collectively and through pooling resources, knowledge and data.

6.2.4 Potential and Future Evaluation

The watershed coordinator, operating out of the Muskingum County SWCD, applied to and has become a level 2 qualified data collector in Ohio EPA's Volunteer Monitoring Program in the area of chemical water quality assessment. She could, in the future, collect water chemistry data in the watershed.

6.2.5 Revision to the Improvement Strategy

The Salt Creek watershed would benefit from an adaptive management approach to restoring water quality. An adaptive management approach allows for changes in the management strategy if environmental indicators suggest that the current strategy is inadequate or ineffective. Adaptive management is recognized as a viable strategy for managing natural resources (Baydack *et al.* 1999).

If chemical water quality does not show improvement and/or water bodies are still not attaining water quality standards after the improvement strategy has been carried out, then a TMDL revision would be initiated. Ohio EPA would initiate the revision if no other parties wish to do so.

7 REFERENCES

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