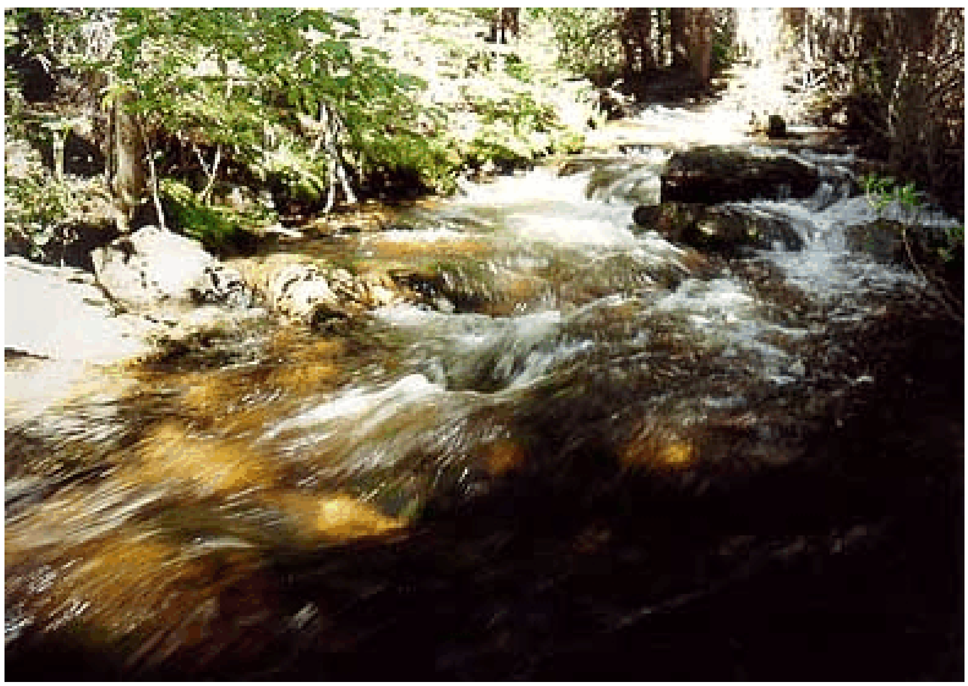
State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Little Beaver Creek Watershed



Final Report
August 17, 2005

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FIGURES

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ACRONYMS AND ABBREVIATIONS

AL	Aquatic life
AU	Assessment unit
cfs	Cubic feet per second
DO	Dissolved oxygen
EPA	Environmental Protection Agency
GIS	Geographic information system
GWLF	Generalized Watershed Loading Functions
IBI	Index of Biological Integrity
ICI	Invertebrate Community Index
L	Liter
LA	Load allocations
MIwb	Modified Index of Well-being
MOS	Margin of safety
MOU	Memorandum of Understanding
mg	Milligram
NN	Nitrate+nitrite
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
QHEI	Quality Habitat Evaluation Index
STORET	EPA Storage and Retrieval System
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total suspended solids
WLA	Wasteload allocation
WQS	Water quality standard
WWH	Warmwater habitat
WWTP	Wastewater treatment plant

1.0 INTRODUCTION

The 1972 Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize waters for which technology-based treatment limits alone do not ensure attainment of water quality standards. The Section 303(d) list of impaired waters is made available to the public and submitted to the U.S. Environmental Protection Agency (USEPA) in every even-numbered year (with the exception that 40 CFR 130.7(d) did not require a 303(d) list submittal in the year 2000).

The Ohio Environmental Protection Agency (Ohio EPA) identified the Little Beaver Creek watershed in northeastern Ohio as a priority impaired water on the 1998, 2002 and 2004 303(d) lists (Ohio EPA, 1998; 2002;2004). The Clean Water Act and USEPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all waters on the Section 303(d) lists. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. The process of formulating TMDLs for specific pollutants is therefore a method by which impaired water body segments are identified and restoration solutions are developed. Ultimately, the goal of Ohio's TMDL process is full attainment of biological and chemical water quality standards and, subsequently, delisting of waterbodies from the 303(d) list.

Ohio EPA has found that developing TMDLs on a watershed basis (as opposed to solely focusing on impaired segments within a watershed) is an effective approach toward the goal of full attainment of water quality standards in all Ohio waters. Ohio EPA lists impaired waters by sub-watershed, defined by the hydrologic unit boundaries represented by an eleven-digit Hydrologic Unit Code (HUC11). A HUC11 sub-watershed, or Assessment Unit (AU), is listed as impaired if only one of the waterbodies within its boundaries was not fully attaining water quality standards.

The 2002 and 2004 listing information for the Little Beaver Creek watershed is shown in Table 1-1 and Table 1-2. The tables indicate that a variety of causes of impairment impact the Little Beaver Creek watershed, including organic enrichment/dissolved oxygen (DO), siltation, habitat alteration, nutrients, and salinity/total dissolved solids/chlorides. A summary of the impairments addressed by the TMDLs in this report is shown in Table 1-3 and Figure 1-1. More than twenty TMDLs or de-listing recommendations are included in this report. All of the named tributaries in the Little Beaver Creek watershed are shown in Figure 1-2.

During the development of TMDLs for the Little Beaver Creek watershed, close examination of existing data revealed more impairment causes than previously included on the 2002 or 2004 303(d) lists. TMDLs to address this new analysis are included in this document. The next 303(d) list, to be included in the 2006 Integrated Report due to U.S. EPA on April 1, 2006, will include these new observations.

This report serves to document the Little Beaver Creek TMDL process and provide for tangible actions to restore and maintain this watershed. The main objectives of the report are to describe the water quality conditions of the Little Beaver Creek watershed and its tributaries and to quantitatively assess the factors affecting non or partial attainment of water quality standards. The report is organized in sections forming the progression of the TMDL process.

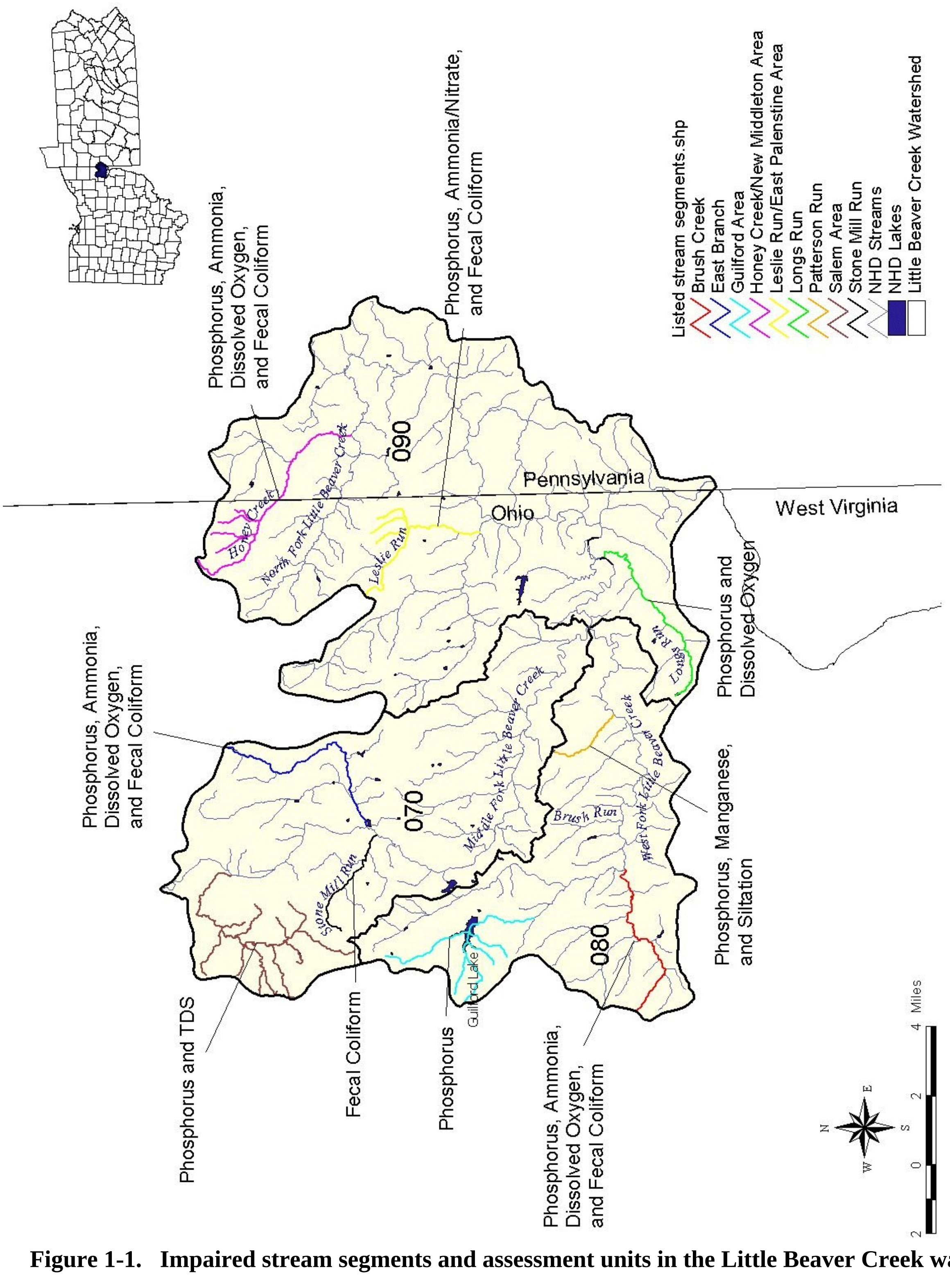


Figure 1-1. Impaired stream segments and assessment units in the Little Beaver Creek watershed.

Table 1-1. Ohio 2002 Section 303(d) listing information within the Little Beaver Creek watershed.

AU	Description	Priority	High Magnitude Causes	Sources
05030101 070	Middle Fork Little Beaver Creek	12	Cause unknown, Pesticides, Unionized Ammonia, Nutrients, Siltation, Organic Enrichment/DO, Salinity/TDS/Chlorides, Other Habitat Alterations, Oil and Grease, Natural Limits (Wetlands)	Source Unknown, Contaminated Sediments, Major Municipal Point Source, Removal of Riparian Vegetation, Confined Animal Feeding Operations (NPS), Pasture Land Onsite Wastewater Systems (Septic Tanks), Urban Runoff/Storm Sewers (NPS) Nonirrigated Crop Production, Surface Mining, Channelization
05030101 080	West Fork Little Beaver Creek	4	Cause Unknown, Siltation, Flow Alteration, Natural Limits (Wetlands)	Pasture Land, Channelization (Agricultural and Developmental), Upstream Impoundment, Removal of Riparian, Natural Source, Source Unknown
05030101 090	Little Beaver Creek	4	Unionized Ammonia, Nutrients, Siltation Organic Enrichment/DO, Flow Alteration, Other Habitat Alterations, Pathogens, Natural Limits (Wetlands)	Major Industrial Point Source, Combined Sewer Overflows, Pasture Land, Surface Mining, Subsurface Mining, Channelization, Removal of Riparian Vegetation Natural

Note: AU = Assessment Unit

Table 1-2. Ohio 2004 Section 303(d) listing information for the Little Beaver Creek watershed.

AU	Description	Priority	High Magnitude Causes	Sources
05030101 070	Middle Fork Little Beaver Creek	8	Cause Unknown, Pesticides, Unionized Ammonia, Nutrients Siltation, Organic Enrichment/DO, Salinity/TDS/Chlorides, Other Habitat Alterations, Oil and Grease, Natural Limits (Wetlands)	Source Unknown, Contaminated Sediments, Major Municipal Point Source, Removal of Riparian Vegetation, Confined Animal Feeding Operations (NPS), Pasture Land, Onsite Wastewater Systems (Septic Tanks), Urban Runoff/Storm Sewers (NPS), Nonirrigated Crop Production, Surface Mining, Channelization
05030101 080	West Fork Little Beaver Creek	4	Cause Unknown, Siltation, Flow Alteration, Natural Limits (Wetlands)	Pasture Land, Channelization (Agricultural and Developmental), Upstream Impoundment, Removal of Riparian Vegetation, Natural Source, Source Unknown
05030101 090	Little Beaver Creek	4	Unionized Ammonia, Nutrients, Siltation, Organic Enrichment/DO, Flow Alteration, Other Habitat Alterations, Pathogens, Natural Limits (Wetlands)	Major Industrial Point Source, Combined Sewer Overflows, Pasture Land, Surface Mining Subsurface Mining, Channelization, Removal of Riparian Vegetation, Natural

Note: AU = Assessment Unit

Table 1-3. Little Beaver Creek impairments addressed by the TMDLs in this report.

AU/ Stream Segment	Water Quality Parameter						
	Phosphorus	**Ammonia**	**DO**	**Fecal Coliform**	**TDS**	**Siltation**	**Manganese**
Middle Fork Little Beaver Creek 070							
Salem Area	TMDL				DL		
Stone Mill Run				Sample			
East Branch	TMDL	DL	TMDL	DL			
Middle Fork						TMDL	
West Fork Little Beaver Creek 080							
Guilford Area	TMDL						
Patterson Run						TMDL	DL
Brush Creek		TMDL	TMDL	TMDL		TMDL	
West Fork						TMDL	
Little Beaver Creek 090, including North Fork							
Longs Run	TMDL		TMDL				
Leslie Run	TMDL	TMDL		DL			
Honey Creek	TMDL	TMDL	TMDL	DL			
Little Beaver Creek						TMDL	

Notes:
AU = Assessment Unit
TMDL = TMDL Developed
DL = Recommend De-listing (TMDL not necessary), or potential impairment examined and found to not meet listing threshold.
DO = dissolved oxygen
TDS = total dissolved solids
Sample = additional data needed

Impairment causes addressed by TMDLs for water quality parameters:
Phosphorus: nutrients, organic enrichment/ DO
Ammonia: unionized ammonia
DO: organic enrichment/ DO
Fecal coliform: pathogens
TDS: habitat alteration, siltation, salinity/TDS/chlorides
Siltation: siltation, habitat alteration, flow alteration, nutrients

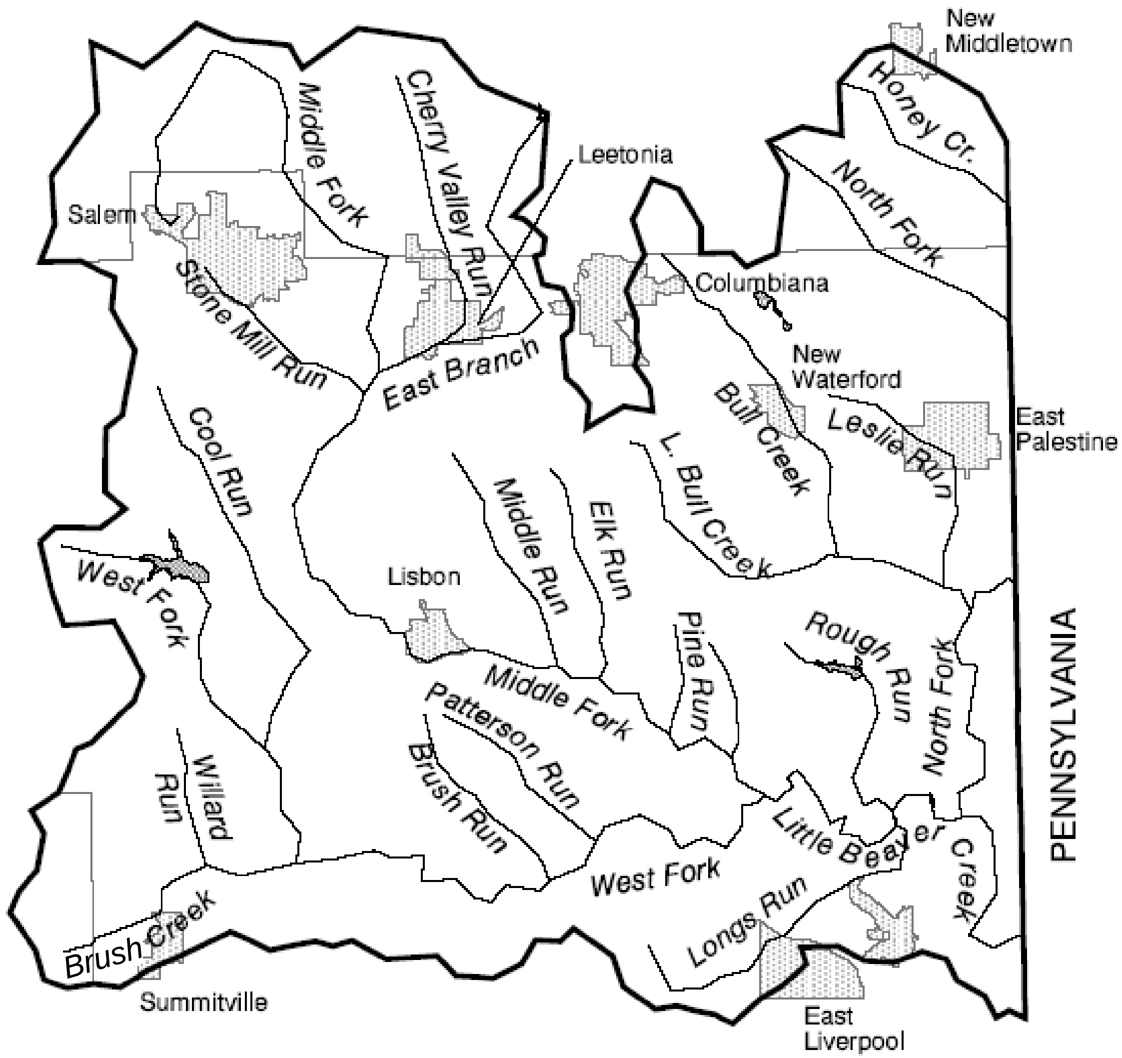


Figure 1-2. Named Ohio tributaries in the Little Beaver Creek watershed.

2.0 IDENTIFICATION OF WATERBODY, POLLUTANT OF CONCERN, POLLUTANT SOURCES, AND PRIORITY RANKING

This section of the document provides brief background information on Little Beaver Creek and its tributaries, the watershed, the pollutants of concern, and the priority ranking for TMDL development.

2.1 Identification of Waterbody and Description of the Watershed

The Little Beaver Creek watershed is located in northeastern Ohio and western Pennsylvania (Figure 2-1). The basin occupies portions of Columbiana, Carroll, and Mahoning counties in Ohio; and Lawrence and Beaver counties in Pennsylvania. It has a total drainage area of approximately 510 square miles, of which 408 are in Ohio.

The Little Beaver Creek watershed is characterized by deep valleys, wooded slopes, and occasional rock outcroppings. The creek is boulder-strewn, consisting of fast-flowing rapids and riffles, quiet pools and clear, swiftly flowing tributaries. In addition to a diverse macroinvertebrate population, the watershed supports 63 species of fish, 49 mammal species, 140 types of birds and 46 species of reptiles and amphibians. Ohio's largest population of endangered Hellbender salamanders resides in Little Beaver Creek (Ohio DNR, 2004).

The Little Beaver Creek stream network is composed of three major branches: North Fork, Middle Fork, and West Fork. The mainstem of Little Beaver Creek begins at the confluence of the Middle Fork and the West Fork in St. Clair Township at river mile (RM) 16.3. It then flows in a southeasterly direction into Pennsylvania, and joins the Ohio River near Smith's Ferry. The mainstem has a length of 14.8 miles in Ohio and 1.5 miles in Pennsylvania, with an average gradient of 10.5 feet per mile. The drainage area for the mainstem segment is 67.9 square miles.

The North Fork of Little Beaver Creek rises in Springfield Township in Mahoning County and flows southeastwardly into Pennsylvania, then returns to Ohio at RM 7.75 near Negley. It empties into the mainstem of Little Beaver Creek in St. Clair Township about eight miles downstream from the confluence of the West Fork and the Middle Fork. The North Fork has a length of 34.2 miles and a gradient of approximately 13.9 feet per mile. It drains a total area of 183.1 square miles, with 76.1 square miles in Pennsylvania.

The West Fork of Little Beaver Creek rises in the southern part of Butler Township of Columbiana County, flows southerly where it is impounded by Guilford Lake. Downstream from the lake it merges with Brush Creek east of Summitville, where it turns sharply and flows in a due easterly direction until it unites with the Middle Fork to form the mainstem of Little Beaver Creek within the boundary of the Little Beaver Creek State Park. The West Fork has a length of 25.2 miles and an average gradient of 21 feet per mile. The total drainage area is 111.7 square miles, all in Ohio.

The Middle Fork of Little Beaver Creek rises southwest of Salem and flows in a northerly direction into Mahoning County, then turns sharply and flows in a southeasterly direction to Lisbon, then southeast to St. Clair Township where it joins the West Fork to form the Little Beaver Creek mainstem. The East Branch of the Middle Fork of Little Beaver Creek empties into the Middle Fork near Leetonia. The Middle Fork of Little Beaver Creek has a length of 40.6 miles and an average slope of 11.8 feet per mile. It drains a total area of 147.4 square miles, all in Ohio.

The surficial geology of the Little Beaver Creek basin has been greatly influenced by the advance of two continental glaciers, the first formed by the Illinoian ice sheet, and more recently the Wisconsin advance. The Wisconsin stage began its retreat from Ohio about 14,000 years ago. The melt waters formed the present drainage patterns of the Middle and North Forks of the Little Beaver Creek. The northern region of the Little Beaver Creek basin was covered by ice which blanketed the area with layers of till, sand, clay, and gravel. The glacial action abraded once rugged hills and filled valleys, resulting in a relatively flat plain that is today covered with fertile soils. The middle section of the basin was crossed by end moraine of the Illinoian glacier advance. This narrow area displays greater and more varied relief than the northern region, and soils are moderately fertile on higher lands.

The southern portions of the Little Beaver Creek basin are unglaciated, and the topography is hilly and rugged. Most of the West Fork of Little Beaver Creek watershed is located within this unglaciated region of Ohio. The bedrock geology consists of alternating layers of sandstone, shale, limestone, clay and coal which were deposited during the Pennsylvanian period. These strata have been classified into four rock formations: the Pottsville, Allegheny, Conemaugh, and Monogahela. Coal beds are prevalent in all of these formations. The highest elevation is found in Madison Township at 1447 feet above sea level.

Portions of the Little Beaver Creek basin were designated State Wild and Scenic River under Section 1501 of the Ohio Revised Code (effective on January 15, 1974). In 1975 select river sections were also designated National Scenic River, thus making Little Beaver Creek the only major river in Ohio to have dual State Wild and Scenic and National Scenic River designations. A total of 36 river miles are designated under the State and Federal Wild and Scenic River rules as listed in Table 2-1 and shown in Figure 2-2.

More detailed information about the current condition of streams in the Little Beaver Creek watershed is included in Appendix B.

Table 2-1. State and Federal Wild and Scenic River designated areas for the Little Beaver Creek watershed.

State Designation	***Wild segments*** - West Fork from 1/4 mile downstream from Twp. Rd. 914 to confluence with Middle Fork. North Fork from Twp-. Rd. 952 to confluence with Little Beaver Creek. Little Beaver Creek from confluence of West and Middle Forks downstream to 3/4 mile north of Grimm's Bridge. Effective: January 15, 1974. ***Scenic segments*** - North Fork from Ohio-Pennsylvania line downstream to Jackman Road. Middle Fork from Elkton Rd. (Twp. Rd. 901) downstream to confluence with West Fork. Little Beaver Creek from 3/4 mile north of Grimm's Bridge downstream to the Ohio-Pennsylvania line. Effective: January 15, 1974. Miles with State designation is approximately: Wild-20 miles, Scenic-16 miles
National Designation	In October, 1975, Little Beaver Creek was designated a National Scenic River. Designated sections include the Little Beaver Creek main stem, from confluence of West Fork with Middle Fork near Williamsport to mouth; North Fork from confluence of Brush Run and North Fork to confluence of North Fork with main stem at Fredericktown; Middle Fork from vicinity of Co. Rd. 901 (Elkton Road) bridge crossing to confluence of Middle Fork with West Fork near Williamsport; West Fork from vicinity of Co. Rd. 914 (Y-Camp Road) bridge crossing east to confluence of West Fork with Middle Fork near Williamsport. Miles with National designation is approximately: Scenic-33 miles.

Flow characteristics within the basin have been monitored at a variety of locations by the United States Geological Survey (USGS). However, only one long-term monitoring station has been established by the USGS near East Liverpool, Ohio. This station is located on the Little Beaver Creek mainstem about 4 miles upstream from the mouth. The minimum daily flow recorded at this station over a 82 year monitoring period is 12.0 cfs, while the critical 7Q10 and 30Q10 low flows during this monitoring period are 20 and 28 cfs, respectively.

General land use and land cover data for the Little Beaver Creek watershed were extracted from the Multi-Resolution Land Characterization (MRLC) database for the state of Ohio (MRLC, 1992) and are shown in Figure 2-2. This database was derived from satellite imagery taken during the early 1990s and is the most current detailed land use data known to be available for the watershed. Each 98-foot by 98-foot pixel contained within the satellite image is classified according to its reflective characteristics. A complete description of the MRLC land cover categories is given in Appendix A. Table 2-2 summarizes land cover in the watershed and shows that deciduous forest and pasture/hay are the dominant land uses.

Table 2-2. Land use within the Little Beaver Creek watershed.

Land Use Code	Land Use	Acres	% of Total
11	Open Water	3,795	1.2
21	Low Intensity Residential	9,732	3.0
22	High Intensity Residential	599	0.2
23	Commercial/industrial/transportation	2,496	0.8
32	Quarries/strip Mines/gravel Pits	1,508	0.5
33	Transitional	263	0.1
41	Deciduous Forest	137,189	42.5
42	Evergreen Forest	7,077	2.2
43	Mixed Forest	7,271	2.3
81	Pasture/hay	108,768	33.7
82	Row Crops	42,792	13.2
85	Urban/recreational Grasses	110	0.0
91	Woody Wetlands	806	0.3
92	Herbaceous Wetlands	754	0.2
	Total	**323,160**	**100**

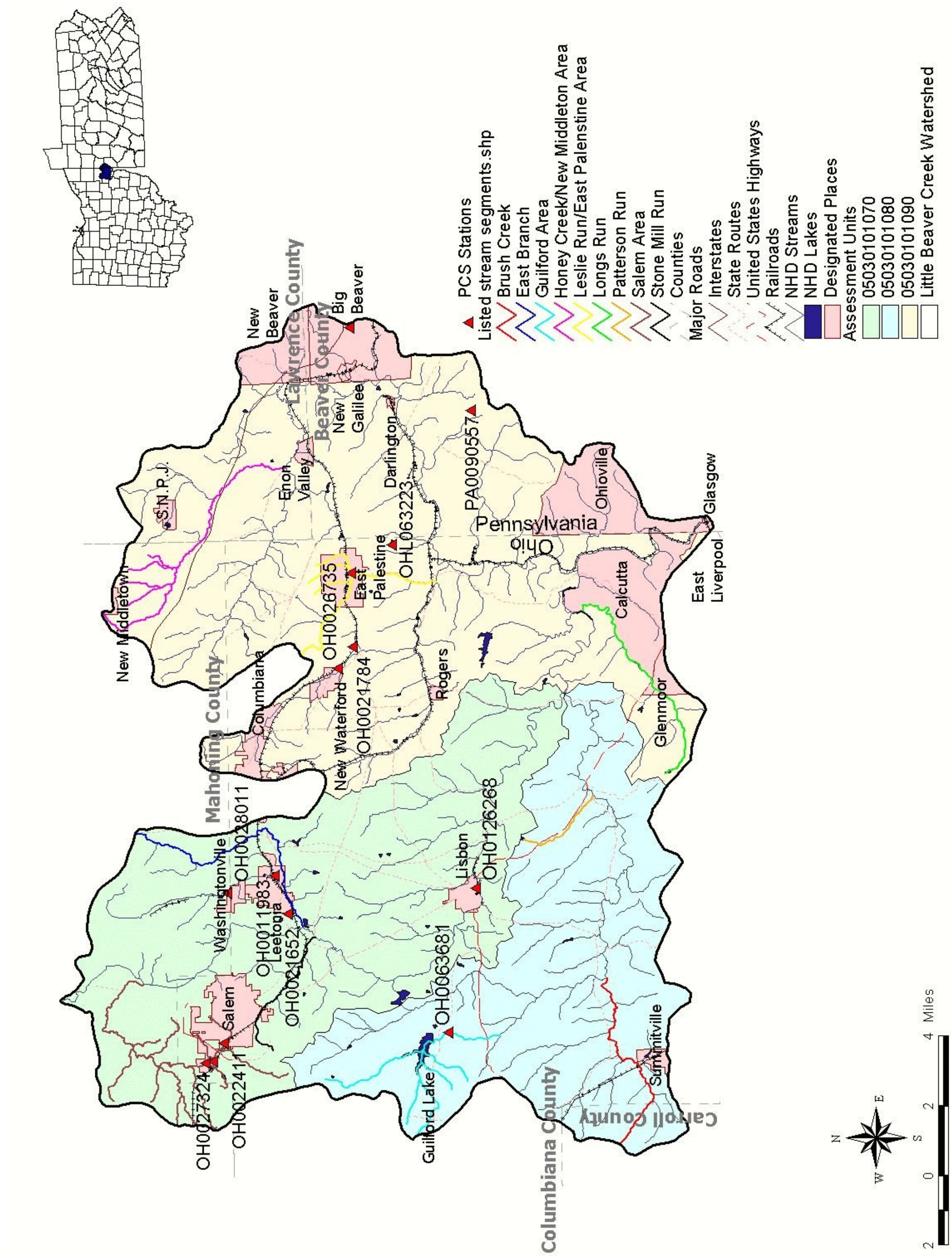


Figure 2-1. The Little Beaver Creek watershed.

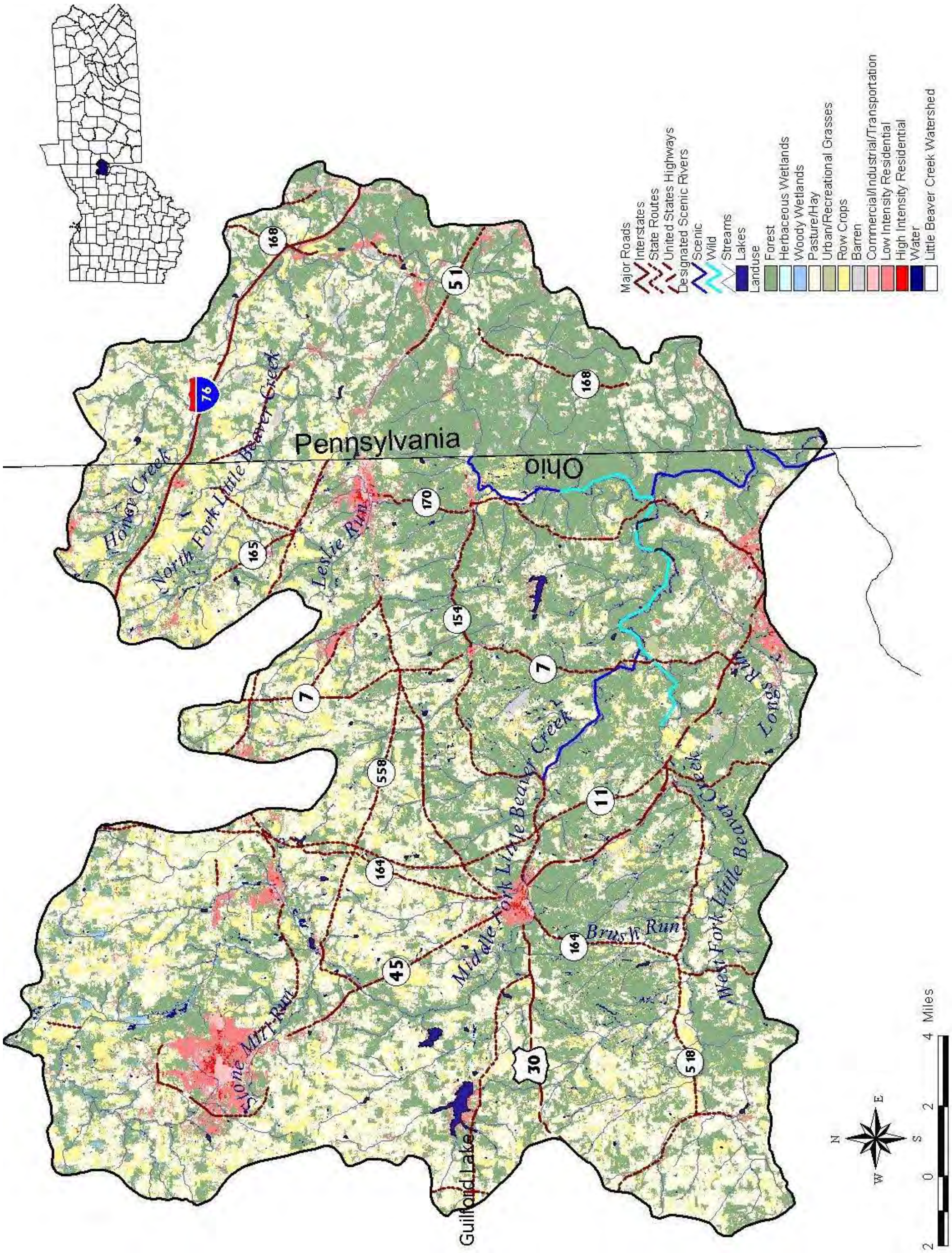


Figure 2-2. Land use and scenic river status within the Little Beaver Creek watershed.

2.2 Previous Studies

Two comprehensive surveys of the Little Beaver Creek watershed were conducted by Ohio EPA in 1985 and 1999. Biological and chemical samples were collected at a large number of stations throughout the Little Beaver Creek basin, including all major tributaries (e.g., North Fork, West Fork, Middle Fork). This sampling effort was mostly targeted at stream locations upstream and downstream from National Pollutant Discharge Elimination System (NPDES) permitted dischargers, although impacts from potential nonpoint sources of pollutants were assessed from tributary samples. No survey findings documents were published for either the 1985 or 1999 surveys. However, raw chemical, biological, and physical habitat data are available via STORET (US EPA chemical database), FINS (Ohio EPA fish database), and MIDGES (benthic macroinvertebrate database). A number of summary tables also are available, including a biological attainment table that compiles the results of the 1985 and 1999 biological surveys (Appendix B). The TMDL recommendations provided in this report are based on the results of the 1999 Ohio EPA survey of the Little Beaver Creek basin, monthly data collected from the Little Beaver Creek mainstem at Grimms Bridge Road since 1999, and sampling conducted by wastewater treatment plants since 1998. Data from the 1985 Ohio EPA survey are used exclusively to document historical trends over time in chemical and biological water quality, and not to develop TMDL loading limits.

Based on the results of the 1985 survey, a fish tissue and sediment organic chemical evaluation report for the Middle Fork of Little Beaver Creek was completed (Estenik, 1988). In addition, a number of studies have been conducted on the levels of mirex in sediment and fish tissue from the Middle Fork of Little Beaver Creek for the USEPA superfund project for the Nease Chemical Company in Salem. The Ohio Department of Health has issued a contact and fish consumption advisory downstream from the Nease company for a distance extending well over 20 miles downstream. The chemical of concern in this advisory is the pesticide mirex.

Prior to 1985, the Ohio EPA completed a large number of Wasteload Allocation and Water Quality Management Plan reports as required by Section 208 of the Clean Water Act. These reports were published between 1974 and 1979 and represent a good source of historical information including geology, hydrology, water quality, land use, and status of point and nonpoint sources of pollutant loadings within the Little Beaver Creek basin. In 1979, the Ohio Department of Natural Resources, Scenic River Program, published the Little Beaver Creek Wild-Scenic River Assistance Manual. This report summarizes the various sections of the Little Beaver Creek basin that have been designated as either a Wild or Scenic River under the Ohio Scenic Rivers Act of 1974.

2.3 Pollutants of Concern

The TMDLs presented in this report address the sediment, manganese, total dissolved solids, fecal coliform, and nutrient-related impairments in the Little Beaver Creek watershed. The specific nutrients addressed are ammonia and total phosphorus. It is acknowledged that riparian habitat conditions in some parts of the watershed contribute to the biological impairments, but no “habitat” TMDL is presented in this report. Instead, improving habitat conditions in the relevant streams should be an important part of the implementation activities that result from this TMDL.

2.4 Pollutant Sources

A variety of nonpoint sources contribute pollutant loadings to the Little Beaver Creek watershed. Agricultural activities such as row crop farming practices are sources of sediment and nutrients. Residential land uses also contribute these pollutants due to storm water runoff and failing septic systems. Patterson Run is also impacted by high manganese levels from nearby mining operations. The magnitude of loadings from these various nonpoint sources were estimated for each subwatershed using the GWLF model, as explained below in Section 4.1.

There are no current stormwater Phase II cities in the Little Beaver Creek watershed, although Ohio EPA is now reviewing whether the City of Salem should be designated a Phase II community under Appendix 7 wording of the Phase II NPDES stormwater regulations.

There are also no Ohio EPA regulated confined animal feeding operations (CAFOs) within the watershed. Regulated CAFOs are those with greater than 1,000 animal units.

The only combined sewer overflow (CSO) community in the watershed is the City of Lisbon and the city is working with Ohio EPA to prepare a long-term control plan.

There are sixteen National Pollutant Discharge Elimination System (NPDES) permitted facilities with design flows greater than 16,000 gallons per day in the Little Beaver Creek watershed. All of these facilities are presented in Table 2-3 and the larger wastewater treatment plants are shown in Figure 2-1. There are also some smaller facilities under NPDES permit as well as numerous on-lot dissipation systems approved by Ohio EPA.

Table 2-3. Wastewater Treatment Plants in the Little Beaver Creek Watershed.

OEPA NPDES ID	USEPA NPDES ID	Facility Name	Design Flow (million gallons per day)	Receiving Stream
3BP00017	OH0021652	Leetonia STP	0.340	East Branch
3BP00059	OH0026735	New Waterford WWTP	0.130	Bull Creek
3PD00027	OH0027324	Salem STP	4.000	Middle Fork Little Beaver Creek
3PK00016	OH0122084	Columbiana County Elkton WWTP	1.143	Middle Fork Little Beaver Creek
3PH00043	OH0063681	Guilford Lake WWTP	0.400	West Fork Little Beaver Creek
3PB00051	OH0028011	Village of Washingtonville	0.120	Cherry Valley Run
3PB00042	OHL021784	City of East Palestine	1.400	Leslie Run
3PH00016	OH0037273	New Middletown WWTP	0.550	Honey Creek
3PT00059	N/A	Crestview Schools	0.030	Little Bull Creek
3PV00018	N/A	Colonial Villa Mobile Home Park	0.0475	Middle Fork Little Beaver Creek
3PR00346	N/A	Chaparral Family Campground	0.035	Tributary to Middle Fork Little Beaver Creek
3PV00107	N/A	Breezeway Mobile Manor	0.020	Little Beaver Creek
3PV00024	N/A	Echo Dell Mobile Home Park	0.025	Little Beaver Creek
3PT00096	N/A	Beaver Local High School	0.016	West Fork Little Beaver Creek
3PR00352	N/A	Stoneridge Terrace	0.0175	Cold Run
N/A	PA0090557	Extendicare Health Facilities Inc.	N/A	Tributary of Painters Run

2.5 Priority Ranking

The priority ranking of the waters in the Little Beaver Creek watershed are summarized in Table 1-1 and Table 1-2. The priorities assigned by Ohio EPA vary between 4 and 12.

3.0 DESCRIPTION OF WATER QUALITY STANDARDS, NUMERIC WATER QUALITY TARGETS, AND EXISTING WATER QUALITY

The purpose of developing a TMDL is to identify the pollutant loading that a waterbody can receive and still achieve water quality standards. Under the Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the Clean Water Act's goal of "swimmable/fishable" waters. Water quality standards consist of three components: designated uses, numeric or narrative criteria, and an antidegradation policy. Ohio's water quality standards are summarized in Table 3-1 and explained in greater detail below.

Table 3-1. Ohio water quality standards.

Component	Description
Designated Use	Designated use reflects how the water can potentially be used by humans and how well it supports a biological community.
Numeric Criteria	Chemical criteria represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Biological criteria indicate the health of the in-stream biological community by using one of three indices: • Index of Biotic Integrity (IBI) (measures fish health). • Modified Index of well being (MIwb) (measures fish health). • Invertebrate Community Index (ICI) (measures the health of the macroinvertebrate community).
Narrative Criteria	These are the general water quality criteria that apply to all surface waters. These criteria state that all waters must be free from sludge; floating debris; oil and scum; color- and odor-producing materials; substances that are harmful to human, animal or aquatic life; and nutrients in concentrations that may cause algal blooms.
Antidegradation Policy	This policy establishes situations under which Ohio EPA may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to <http://www.epa.state.oh.us/dsw/wqs/wqs.html> for more information.

3.1 Biocriteria

The Ohio water quality standards (Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the narrative goals specified by each use designation. Use designations consist of two broad groups: aquatic and nonaquatic life. In applications of the Ohio water quality standards to the management of water resource issues in rivers and streams, the aquatic life use criteria frequently control the resulting protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting aquatic life generally results in water quality suitable for all uses.

Little Beaver Creek and the lowermost portions of the Middle and West Forks are designated as exceptional warmwater habitat (EWH) streams. Other streams in the watershed are designated as warmwater habitat (WWH) streams (Ohio Administrative Code Chapter 3745-1-15). WWH is the use designation that defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams and represents the principal restoration target for the majority of water resource management efforts in the state. EWH waters are capable of supporting and maintaining an exceptional or unusual community of warmwater aquatic organisms. Based on the results of the Ohio EPA 1999 survey, a number of tributaries that are currently designated WWH have been shown to attain either the Coldwater Habitat or EWH aquatic life uses, or both. A request is pending to have the aquatic life designations for these tributaries upgraded.

Although the entire Little Beaver Creek basin lies within the Allegheny Plateau physiographic province, it is located within two ecoregions, the Eastern Ontario Lake Plain (EOLP) and the Western Allegheny Plateau (WAP). The ecoregion divide follows closely the southern advance of the terminal moraines of the Illinoian ice sheet. The Ohio EPA has developed separate water quality standards to protect the aquatic life designations for each of these ecoregions, which are summarized in Table 3-2.

Table 3-2. Biological criteria for the protection of aquatic life that apply within the Little Beaver Creek watershed.

Index Sampling site Ecoregion	Modified Warmwater Habitat Channel Modif.	 Mine Affected	 Impounded	Warmwater Habitat	Exceptional Warmwater Habitat
(A) Index of biotic integrity (fish-IBI)					
(1) Wading sites					
EOLP	24	–	–	38	50
WAP	24	24	–	44	50
(2) Boat sites					
EOLP	24	–	30	40	48
WAP	24	24	30	40	48
(3) Headwater sites					
EOLP	24	–	–	40	50
WAP	24	24	–	44	50
(B) Modified index of well-being (fish-MIwb)					
(1) Wading sites					
EOLP	6.2	–	–	7.9	9.4
WAP	6.2	5.5	–	8.4	9.4
(2) Boat sites					
EOLP	5.8	–	6.6	8.7	9.6
WAP	5.8	5.4	6.6	8.6	9.6
(C) Invertebrate community index (macroinvertebrates)					
EOLP	22	–	–	34	46
WAP	22	30	–	36	46

3.2 Numeric Water Quality Targets

The ultimate goals of this TMDL are to attain the appropriate biocriteria to achieve support of the aquatic life designated uses and the fecal coliform criteria to achieve support of the recreational use. Targets have been established to link water chemistry to the biocriteria, recognizing that other important factors such as habitat and flow conditions also affect the attainment of biocriteria. The purpose of the modeling effort conducted for this TMDL was to evaluate load reductions that are required to meet the chemical water quality targets. It is important to note that the modeling effort did not produce output that can be directly compared to the biocriteria. The assumption is that management efforts to address water chemistry, in combination with other activities to improve habitat and flow conditions, will result in the attainment of the biocriteria.

3.2.1 Total Phosphorus

The term nutrients refers to the various forms of nitrogen and phosphorus found in a waterbody. Both nitrogen and phosphorus are necessary for aquatic life, and both elements are needed at some level in a waterbody to sustain life. The natural amount of nutrients in a waterbody varies depending on the type of system. A pristine mountain spring might have little to almost no nutrients, whereas a lowland, mature stream flowing through wetland areas might have naturally high nutrient concentrations. Streams draining larger areas are also expected to have higher nutrient concentrations.

Various forms of nitrogen and phosphorus can exist at one time in a waterbody, although not all forms can be used by aquatic life. Common phosphorus sampling parameters are total phosphorus (TP), dissolved phosphorus, and orthophosphate. Common nitrogen sampling parameters are total nitrogen (TN), nitrite (NO2), nitrate (NO3), nitrate+nitrite (NN), total Kjeldahl nitrogen (TKN), and ammonia (NH3). Concentrations are measured in the lab and are typically reported in milligrams per liter.

Nutrients generally do not pose a direct threat to the designated uses of a waterbody. However, excess nutrients can cause an undesirable abundance of plant and algae growth and this process is called eutrophication. One possible effect is low dissolved oxygen concentrations caused by excessive plant respiration and/or decay. Aquatic organisms need oxygen to live and they can experience lowered reproduction rates and mortality with lowered dissolved oxygen concentrations. Excessive plant growth caused by eutrophication can also increase the pH of water due to alteration of the carbonic acid-carbonate balance. Because plants and algae provide food and habitat to animals, changing the relative abundance of these primary producers can affect the composition and diversity of the animal community, resulting in loss of biotic integrity as measured by Ohio EPA using the fish IBI and benthic macroinvertebrate ICI. Eutrophication also interferes with recreational and aesthetic enjoyment of water resources, and may impart taste and odor to public drinking waters. The negative economic implications of cultural eutrophication caused by release of excessive nutrients to waters can be significant for many communities (USDA, 1999).

It should be noted that the impact of nutrients can be moderated by riparian habitat conditions. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the detention, removal, and assimilation of nutrients from or by the water column. Therefore a stream with good riparian habitat is better able to moderate the impacts of high nutrient loads than is a stream with poor habitat. High nutrient concentrations in the Little Beaver Creek watershed can therefore be compounded where the natural habitat of the streams has been altered.

Excessive algal growth in most Ohio watersheds is limited by phosphorus rather than nitrogen. Monthly average TP targets have therefore been identified for the Little Beaver Creek watershed based on the Ohio EPA technical guidance manual *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999). TP target values, given in Table 3-3, are based upon a water’s aquatic life designation and drainage area. These targets are to be applied as a monthly average applied year-round.

Table 3-3. Statewide total phosphorus targets (mg/L) for Ohio rivers and streams.

Watershed Size	Aquatic Life Designations		
	WWH	EWH	MWH
Headwaters (drainage area < 20 mi^2)	0.08 (West Fork Little Beaver Creek (Guilford Area), Patterson Run, Long's Run, Leslie Run	0.05	0.34
Wadeable rivers (20 mi^2 < drainage area < 200 mi^2)	0.10 Middle Fork Little Beaver Creek (Salem Area), East Branch, Honey Creek, Brush Creek	0.05	0.28
Small rivers (200 mi^2 < drainage area < 1,000 mi^2)	0.17	0.1	0.25
Large rivers (drainage area > 1,000 mi^2)	0.3	0.15	0.32

WWH = Warmwater Habitat; EWH = Exceptional Warmwater Habitat; MWH = Modified Warmwater Habitat.
Source: Ohio EPA, 1999.

3.2.2 Organic Enrichment/Dissolved Oxygen

Several streams in the Little Beaver Creek watershed are listed as being impaired due to organic enrichment/low dissolved oxygen concentrations. These streams are the East Branch of Middle Fork Little Beaver Creek, the upstream segment of the Brush Creek, Longs Run, and Honey Creek (Figure 1-1). These impairments are believed to largely result from elevated nutrient concentrations contributing to excessive algal growth and therefore large swings in dissolved oxygen concentrations. Therefore, the organic enrichment/low dissolved oxygen TMDLs are dependent on the development of the TP TMDLs. Attaining the TP target should result in attaining the dissolved oxygen standard because of the relationship between TP, excessive algal growth, and dissolved oxygen. Ohio's water quality standards for dissolved oxygen are summarized in Table 3-4.

Table 3-4. Ohio's numeric criteria for dissolved oxygen.

Type	Aquatic Life Designations	
	WWH (mg/L)	EWH (mg/L)
Outside Mixing Zone Minimum (OMZM)	4.0	5.0
Outside Mixing Zone Average (OMZA) (24-hour)	5.0	6.0

3.2.3 Ammonia

Ohio has established both maximum (Outside Mixing Zone Maximum) and average (Outside Mixing Zone Average) numeric criteria for ammonia which vary according to temperature, pH, and season. Because of limitations with the available data and the modeling approaches used for this study, only the monthly average targets were used to develop allowable loadings. It is believed that achieving the monthly average ammonia criteria will allow water quality standards to be met.

Both the cold (December through February) and warm (March through November) season ammonia criteria were reviewed in conjunction with typical Little Beaver Creek pH values (6.7 to 8.8) to determine an appropriate TMDL target for the Little Beaver Creek watershed. The cold season targets were found to range between 0.4 mg/L and 13 mg/L and the warm season targets ranged from 0.2 mg/L to 2.3 mg/L. The more stringent warm season criterion (0.2 mg/L) was selected as the monthly target for all listed stream segments in the Little Beaver Creek watershed. This target is to be applied as a monthly average.

3.2.4 Fecal Coliform

Table 3-5 summarizes Ohio's water quality standards for fecal coliform and *E. coli* for primary contact recreation, bathing waters, and secondary contact. Only the primary contact use designation applies to the impaired waters in the Little Beaver Creek watershed. Ohio's water quality standards to support recreational uses are found at OAC 3745-1-07(B)(4) and apply during the period May 1 to October 15.

Table 3-5 shows that the primary contact *E. coli* criteria of 126/100 mL is identical to the bathing water *E. coli* criteria as a geometric mean. However, this is not the case for fecal coliforms. While the primary contact fecal coliform criteria is 1,000/100 mL, the bathing water fecal coliform criteria is 200/100 mL. For this reason, *E. coli* is not used by itself to determine if there is a violation of the primary contact recreation criteria because Ohio EPA's regulations state that:

> *"For each designation at least one of the two bacteriological standards (fecal coliform or* E. coli*) must be met (OAC 3745-1-07, Table 7-13."*

Therefore, when both fecal coliform and *E. coli* data are available from the same sample, if at least one of the two standards is met, there is not a human health violation. If only one of the two bacteria groups are available to determine violations of recreational standards, then fecal coliform should be used, not *E. coli*, because it is very rare that a fecal coliform count of 1,000/100 mL would violate the criteria and *E. coli* would not violate the 126/100 mL criteria. For this reason, and because many more fecal coliform data are available than *E. coli*, the TMDL for the Little Beaver Creek watershed is based on meeting the primary contact fecal coliform standard. Both the geometric mean and instantaneous portions of the standard are used to assess compliance with the standard.

Table 3-5. Fecal coliform and *E. coli* standards for Ohio.
Standards only apply for the period May 1 through October 15.

	Bathing Waters		Primary Contact		Secondary Contact
Parameter	**Geometric Mean[1]**	**Instantaneous[2]**	**Geometric Mean[1]**	**Instantaneous[2]**	**Instantaneous[2]**
Fecal Coliform	200/100 mL	400/100 mL	1,000/100 mL	2,000/100 mL	5,000/100 mL
E. coli	126/100 mL	235/100 mL	126/100 mL	298/100 mL	576/100 mL

[1] Geometric mean fecal coliform content should not exceed this standard based on not less than five samples within a thirty-day period.
[2] Fecal coliform content should not exceed this standard in more than ten percent of the samples taken in any thirty-day period.

3.2.5 Manganese

Neither Ohio nor USEPA has established aquatic life criteria for manganese. A target of 1,000 µg/L was therefore chosen based on best professional judgment. This value is the same as that used to develop numerous manganese TMDLs in mining affected watersheds in West Virginia, the Duck Creek TMDLs in Ohio, and it is believed to be protective of aquatic life. Among the considerations that were made in choosing this value is the fact that manganese has been reported to kill fish in 8 to 18 hours at concentrations of 2,200 to 4,100 µg/L (River Assessment Monitoring Project, 2003). Other studies recommend manganese targets ranging from 790 µg/L to 1,040 µg/L (Government of British Columbia, 2001).

3.2.6 Siltation

Excess total suspended solids (TSS) in a stream can pose a threat to aquatic organisms. Turbid waters created by excess TSS concentrations reduce light penetration, which can adversely affect aquatic organisms. Also, TSS can interfere with fish feeding patterns because of the turbidity. Prolonged periods of very high TSS concentrations can be fatal to aquatic organisms (Newcombe and Jensen, 1996). As TSS settles to the bottom of a stream, critical habitats such as spawning sites and macroinvertebrate habitats can be covered in sediment. This is referred to as siltation. Excess sediment in a stream bottom can reduce dissolved oxygen concentrations in stream bottom substrates, and it can reduce the quality and quantity of habitats for aquatic organisms. For these reasons, excessive TSS can result in non-attainment of biocriteria and impairment of the designated use.

Erosion and overland flow contribute some natural TSS to most streams. In watersheds with highly erodible soils and steep slopes, natural TSS concentrations can be very high. Excess TSS in overland flow can occur when poor land use and land cover practices are in place. This potentially includes grazing, row crops, construction activities, road runoff, and mining. Grazing and other practices that can degrade stream channels are other possible sources of TSS.

TSS is also a concern because of its ability to transport TP to a waterbody. When anthropogenic sources of phosphorus are delivered to a stream the ratio of dissolved phosphorus immediately available to algae may be high relative to particulate forms of phosphorus (e.g., attached to soil particles; Robinson et al. 1992). Total phosphorus (TP; the form measured in this study) consists of both dissolved phosphorus (DP), which is mostly orthophosphate, and particulate phosphorus (PP), including both inorganic and organic forms (Sharpley et al., 1994). Runoff from conventional tillage is generally dominated by PP; however, the proportion of TP as DP increases where erosion is comparatively low such as with no-till fields or pasture (Sharpley et al., 1994). Streams with low gradients and a morphology that enhances deposition of sediments in the low flow channel (e.g., channelized streams) may continually release dissolved phosphorus from sediments.

Ohio EPA does not have numeric targets for TSS and no statewide recommendations have been published. The reference stream approach is often used in such instances to identify site-specific targets for the development of a TMDL. With the reference stream approach, TSS concentrations in a similar, but unimpaired, watershed are evaluated and used as the basis for meeting water quality standards. No appropriate reference stream for Little Beaver Creek has been identified.

Due to the lack of reference streams in the Little Beaver Creek watershed, the approach for this TMDL was to evaluate the existing TSS data within the Little Beaver Creek watershed and select the lowest quartile as the target condition (USEPA, 2000). A TSS concentration distribution was determined for subwatersheds of similar size using observed values. Then, the lowest 25th percentile of the distribution yielded a concentration as the target or threshold point. The lowest 25th percentile is interpreted as the least contaminated 25 percent of all the observed values. The 25th percentile methodology results in a target that is within the range of natural conditions within the watershed, and is believed to be protective of the aquatic community.

The 25th percentile for smaller tributaries within Little Beaver Creek is 7.25 mg/L. The 25th percentile for larger streams (i.e., Middle Fork Little Beaver Creek, West Fork Little Beaver Creek, North Fork Little Beaver Creek, and the Little Beaver Creek mainstem) is 6 mg/L.

The TSS target is meant to be expressed as a maximum monthly average. That is, the average of all TSS samples taken within a particular month at a certain site should not exceed 7.25 mg/L. Ideally, sampling should occur during low, average, and high flows so that the flow condition does not bias the results (e.g., samples taken only during high flows would be more likely to result in an exceedance of the target). Up to 10 percent of the monthly values should be allowed to exceed the targets as specified in EPA's Consolidated Assessment and Listing Methodology (USEPA, 2002).

The TSS target is also subject to modification as new data are generated and the application of additional siltation metrics (e.g., percent fine sediments) should continue to be explored.

3.2.7 Total Dissolved Solids

As water flows through a system, particles of soil, rock, and other materials accumulate in the water. The materials dissolve (or dissociate) in the water to form cations (positively charged ions) and anions (negatively charged ions). The term salinity refers to the total amount of dissolved cations and anions in water. Major ions in water are generally sodium, calcium, magnesium, potassium, chloride, sulfate, and bicarbonate. Metals (e.g., copper, lead, and zinc) and other trace elements (e.g., fluoride, boron, and arsenic) are usually only minor components of the total salinity. Salinity is determined by measuring the conductance of water, which is the opposite of resistance. This is done by sending an electrical current through the water and measuring the electrical conductivity (EC).

The sum of all of the dissolved substances in water is called total dissolved solids (TDS), and is measured in milligrams per liter (mg/L). TDS is a laboratory measurement and cannot be determined in the field. Pure distilled water has a TDS of zero. TDS concentrations in rainfall and snowfall vary, and generally range from zero to 10 milligrams per liter.

The salinity of a waterbody is important to many aquatic organisms because it regulates the flow of water into an out of an organism's cells (osmosis). Increases or decreases in salinity can cause a shift in the composition of the natural aquatic community. Highly saline waters can adversely affect crop production depending on the amount of water applied and the salt tolerance of the crop. Livestock can also be adversely affected by high salinity values.

Natural sources, such as geology and soils, contribute to the salinity of a stream. Watersheds that have easily erodible soils, or parent materials with high salt concentrations, have streams and lakes that have naturally high salinity. However, there are also several potential anthropogenic sources of salinity. Anthropogenic sources of salinity can occur from disturbed land, road salting, and agricultural runoff.

Ohio’s statewide water quality criteria for the protection of aquatic life (OAC Chapter 3745-1-07; Table 7-1) specifies that the applicable criterion for TDS is 1,500 mg/L. This is a concentration meant to apply as an outside the mixing zone average (OMZA).

3.3 Existing Water Quality

This section summarizes the available water quality data for the Little Beaver Creek watershed. Available water quality data are summarized according to parameter, and summary statistical tables are provided for each listed stream segment.

3.3.1 Total Phosphorus

A summary of all available TP data collected in listed stream segments in the Little Beaver Creek watershed is given in Table 3-6 and Table 3-7. These data were compared to the suggested TP target values for aquatic use designation and watershed area discussed previously. Tables 3-6 and 3-7 indicate that a significant percentage of recent observations have exceeded the applicable targets in all listed streams.

Table 3-6. Total Phosphorus Data Summary for Little Beaver Creek WWH Headwater Streams (Target Value of 0.08 mg/L).

Stream Segment	# Obs	Avg (mg/L)	Median (mg/L)	Min (mg/L)	Max (mg/L)	Std Dev	% XS (All Data)	% XS (Recent Data)[1]	Start Date	End Date
West Fork Little Beaver Creek (Guilford Area)	28	0.41	0.16	0	1.81	0.63	39%	18%	5/25/77	8/24/99
Leslie Run/ East Palestine Area	68	0.56	0.43	0	4.36	0.87	54%	16%	4/24/73	9/8/99
Longs Run	15	0.18	0.14	0	1.10	0.27	40%	40%	7/20/99	9/8/99
Patterson Run	5	0.09	0.05	0	0.19	0.06	40%	40%	3/2/77	8/23/99

Notes: Recent data includes those collected after 12/31/97; % XS = Percentage Exceeding

Table 3-7. Total Phosphorus Data Summary for Little Beaver Creek WWH Wadeable Streams (Target Value of 0.10 mg/L).

Stream Segment	# Obs	Avg (mg/L)	Median (mg/L)	Min (mg/L)	Max (mg/L)	Std Dev	% XS (All Data)	% XS (Recent Data)[1]	Start Date	End Date
Brush Creek	4	0.17	0.17	0.06	0.22	0.07	75%	75%	7/8/99	8/3/99
East Branch	20	0.81	0.16	0	6.39	1.61	40%	25%	4/25/73	9/8/99
Honey Creek/New Middletown Area	22	1.79	0.79	0	18.50	3.89	82%	64%	11/17/82	9/8/99
Middle Fork Little Beaver Creek (Salem Area)	146	4.37	2.64	0	20.00	4.93	85%	97%	4/25/73	8/24/99

Notes: Recent data includes those collected after 12/31/97; % XS = Percentage Exceeding

3.3.2 Ammonia

Table 3-8 presents a summary of all available ammonia data collected in listed stream segments in the Little Beaver Creek watershed. The table shows that a significant number of historic and recent observations in all four streams have exceeded the target value. It should be noted that the high ammonia values for East Branch are believed to be due to a spill that occurred during the 1999 sampling. Because this was a one-time event, and other samples are below water quality standards, no TMDL is being proposed.

Table 3-8. Ammonia Data Summary for Little Beaver Creek Streams.

Stream Segment	Count	Avg (mg/L)	Median (mg/L)	Min (mg/L)	Max (mg/L)	Std Dev	% XS (All Data)	% XS (Recent Data)	Start Date	End Date
Brush Creek	4	0.17	0.13	0.085	0.313	0.10	25%	25%	7/8/99	8/3/99
East Branch	20	3.91	0.17	0.1	50.60	11.4	35%	40%	4/23/73	9/7/99
Honey Creek	22	2.38	0.45	0.1	20.00	5.49	45%	39%	11/16/82	9/7/99
Leslie Run	93	3.78	0.45	0	59.50	10.1	46%	21%	4/23/73	9/7/99

Notes: Recent data includes those collected after 12/31/97; % XS = Percentage Exceeding

3.3.3 Siltation

A summary of the available TSS data for the siltation impaired streams is given in Table 3-9. The table shows that 75 percent of the recent TSS samples collected in Patterson Run exceed the target concentration of 7.25 mg/L. However, only five samples have been collected.

Table 3-9. Total Suspended Solids Data Summary for Little Beaver Creek Streams.

Stream Segment	# Obs	Avg (mg/L)	Median (mg/L)	Min (mg/L)	Max (mg/L)	St Dev	% XS (All Data)	% XS (Recent Data)	Start Date	End Date
Patterson Run	5	8.80	9.00	5.0	12	2.59	80%	75%	3/2/77	8/23/99
Middle Fork Little Beaver Creek	176	16.5	11.0	5.0	119	16.8	80%	83%	4/25/73	8/24/99
West Fork Little Beaver Creek	113	14.8	10.0	5.0	171	19.3	77%	26%	4/24/73	8/24/99
Little Beaver Creek Mainstem	132	26.8	6.0	0	1,030	96.0	50%	38%	10/23/69	7/21/03
Brush Creek	5	39.60	15.5	9	126	49.1	100%	100%	7/8/99	8/24/99

Notes: Recent data includes those collected after 12/31/97; % XS = Percentage Exceeding

3.3.4 Fecal Coliform

A summary of the fecal coliform data collected in the listed streams in the Little Beaver Creek watershed is presented in Table 3-10. The data were compared to the 2,000/100 mL instantaneous standard because insufficient data were available to make a direct comparison to the geometric mean component of the standard that requires five samples in a 30-day period. Note that recent samples in Stone Mill Run did not exceed the standard.

Table 3-10. Fecal Coliform Data Summary for Little Beaver Creek Streams.

Stream Segment	# Obs	Avg (#/100 mL)	Geomean (#/mL)	Min (#/100 mL)	Max (#/ 100 mL)	Std Dev	% XS (All Data)	% XS (Recent Data)	Start Date	End Date
Brush Creek	3	59,900	39,699	8,700	160,000	86,697	100%	100%	7/8/99	8/24/99
East Branch of Middle Fork Little Beaver Creek	34	3,510	276	8	72000	13,082	15%	8%	4/25/73	8/19/03
Honey Creek	7	820	673	240	1700	458	0%	0%	8/5/99	9/8/99
Leslie Run	90	684	274	15	16000	1758	9%	4%	4/24/73	10/1/03
Stone Mill Run	7	2834	617	100	13000	4846	29%	0%	4/25/73	8/23/99

Notes: Recent data includes those collected after 12/31/97**;** % XS = Percentage Exceeding

3.3.5 Manganese

Limited manganese data are available for Patterson Run (Table 3-11). However, all five samples that have been collected were below the proposed target of 1,000 mg/L. The average value is approximately 300 μg/L and the maximum observed value is 387 μg/L . No manganese TMDL for Patterson was therefore developed.

Table 3-11. Manganese Data Summary for Patterson Run.

Stream Segment	# Obs	Avg (μg/L)	Median (μg/L)	Min (μg/L)	Max (μg/L)	Std Dev	% XS (All Data)	% XS (Recent Data)	Start Date	End Date
Patterson Run	5	294.4	342	120	387	107.65	0%	0%	3/2/77	8/24/99

Notes: Recent data includes those collected after 12/31/97**;** % XS = Percentage Exceeding

3.3.6 Total Dissolved Solids

The TDS data for the Middle Fork Little Beaver Creek (Salem area) are summarized in Table 3-12. They indicate that 23 percent of recent samples exceed the water quality standard of 1,500 mg/L. However, all of the recent exceedances were observed during July and August 1999 and were associated with effluent from the Salem WWTP that often exceeded the water quality standard of 1,500 mg/L. Following the 1999 sampling, Ohio EPA notified the Salem WWTP of the problem and the company responsible drastically reduced its salt loadings to the plant. Effluent concentrations from the plant for the period 2002 to 2004 are now estimated to be 760 mg/L (see Section 5.3 for more details) and instream TDS concentrations are assumed to be less than 1,500 mg/L.

Since the current discharge from the Salem WWTP is now well below 1,500 mg/L, no TMDL is necessary for the Middle Fork Little Beaver Creek (Salem area). Instead, future monitoring is recommended to ensure that in-stream TDS concentrations remain below 1,500 mg/L.

Table 3-12. Summary of Middle Fork Little Beaver Creek (Salem Area) TDS data.

Stream Segment	# Obs	Avg (mg/L)	Median (mg/L)	Min (mg/L)	Max (mg/L)	St Dev	% XS (All Data)	% XS (Recent Data)	Start Date	End Date
Middle Fork Little Beaver Creek (Salem Area)	129	785.6	342	35.9	2070	415.3	6%	23%	4/25/73	8/24/99

Notes: Recent data includes those collected after 12/31/97; % XS = Percentage Exceeding

4.0 TECHNICAL APPROACH

The cause-and-effect relationship between pollutant sources (stressor indicators), receiving water chemistry (exposure indicators), and biology was completed using a modeling approach in which pollutant loads from the watershed are transported to the waterbody and then downstream. The linkage between water chemistry and biology is established through the adoption of nutrient, sediment, manganese, and TDS targets associated with the desired biocriteria. The fecal coliform data are directly linked to the recreational use.

Several factors were considered in choosing a methodology by which to estimate pollutant loadings. These included identifying the various types of sources (e.g., point, nonpoint, natural), the relative location of each of the sources with respect to the impaired waterbody, the transport mechanisms of concern (e.g., direct discharge, storm-event runoff), and the time scale of loading to the waterbody (i.e., duration and frequency of loading to the receiving waters). Other factors included the available data with which to setup and calibrate a model, and the resources available to the project.

Water quality data collected on the 303(d) listed stream segments in the Little Beaver Creek watershed are limited. Furthermore, only a single USGS stream flow gage (03109500) with continuous flow is located in the watershed, very near the watershed outlet. These data limitations posed a limitation to using a sophisticated modeling approach which would have required long-term stream flow and water quality information for model calibration and verification. With an understanding of these limitations, sources of phosphorus, ammonia, and total suspended solids were determined by a modeling approach using the Generalized Watershed Loading Functions (GWLF) model. The GWLF model is described in the following section.

4.1 The Generalized Watershed Loading Functions (GWLF) Model

The GWLF model simulates the hydrologic cycle in a watershed, predicting streamflow based on precipitation, evapotranspiration, land uses, and soil characteristics (Haith, et al., 1992). Loading functions are used along with the hydrologic cycle to predict sediment and nutrient loads from surface runoff, groundwater, point sources, and septic systems. In addition the simulation provides monthly streamflow, soil erosion, and sediment yield. The model has been validated for an 330 square mile watershed in upstate New York and has been used to develop a significant number of TMDLs nationwide.

GWLF requires daily precipitation and temperature data, runoff sources, and transport and chemical parameters. Transport parameters include areas, runoff curve numbers, and the erosion product K*LS*C*P for each runoff source. Required watershed transport parameters are groundwater recession and seepage coefficients, the available water capacity of the unsaturated zone, the sediment delivery ratio and monthly values for evapotranspiration cover factors, average daylight hours, growing season indicators and rainfall erosivity coefficients. Initial values must also be specified for unsaturated and shallow saturated zones, snow cover and 5-day antecedent rain fall plus snowmelt.

Input nutrient data for rural source areas are dissolved nitrogen and phosphorus concentrations in runoff and solid-phase nutrient concentrations in sediment. If manure is spread during winter months on any rural area, dissolved concentrations in runoff are also specified for each manured areas. Daily nutrient accumulation rates are required for each urban land use. Septic systems require estimates of the per capita nutrient load in septic system effluent and per capita nutrient losses due to plant uptake, as well as the number of people served by each type of system. Point sources of nitrogen and phosphorus are assumed to be in dissolved form and must be specified for each month. The remaining nutrient data are dissolved nitrogen and phosphorus concentrations in groundwater. Data for transport and nutrient parameters are available from various literature sources, as well as from the GWLF User's Guide.

The application of GWLF in Little Beaver Creek required that the model be set up for the entire watershed, as combined stream flow and water quality data were available only for the USGS station 03109500, located near the watershed outlet. Station 03109500 was used to calibrate GWLF to observed stream flow and water quality information. The calibrated GWLF model was then applied to individual subbasins (e.g., Leslie Run, Honey Creek) within the watershed to more directly address the impaired segments. A full discussion of the input variables used to model Little Beaver Creek is provided in Appendix C.

4.2 Load Duration Curve

The GWLF model does not include options for simulating fecal coliform loads. Load reductions for fecal coliform were therefore determined through the use of load duration curves. This approach involves calculating the desired loadings over the range of flow conditions expected to occur in the impaired stream. This can be accomplished in the following steps:

1. A flow duration curve for the site of interest is developed by generating a flow frequency table and plotting the data points. Because stream flow in the Little Beaver Creek watershed is only monitored daily at one location (near the watershed outlet), stream flows at this gage were multiplied by the fraction of watershed area represented by the site of interest. For example, if a certain stream drains 10 percent of the area drained by the USGS gage, the flows were estimated to be 10 percent of the flows observed at the gage. A major assumption of this approach is therefore that streamflow at any point in the watershed is linearly related to the upstream contributing area and to the flows measured at the stream gage.

2. The flow curve is translated into a load duration (TMDL) curve. To accomplish this, the flow value is multiplied by the water quality standard and by a conversion factor. The resulting points are graphed.

3. A water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected. Then, the load is plotted on the TMDL graph. Only recent samples (those collected after 12/31/1997) were used during the development of the fecal coliform load duration curves.

4. Points plotting above the curve represent deviations from the water quality standard and the permissible loading function. Those plotting below the curve represent compliance with standards and represent adequate quality support for the appropriate designated use.

5. The area beneath the TMDL curve is the loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards.

This approach helps to identify the issues surrounding the impairment and to roughly differentiate between sources. Loads which plot above the curve in the low flow regime are likely indicative of constant discharge sources. Those plotting above the curve over the range of 10 to 70 percent exceedance likely reflect wet weather contributions. Some combination of the two source categories lies in the transition zone of 70 to 85 percent exceedance. Those plotting above the curve at exceedances less than 10 percent or more than 99 percent reflect extreme hydrologic conditions of flood or drought.

4.3 GWLF Strengths and Weaknesses

There are several strengths associated with using GWLF to determine the loading capacity of the Little Beaver Creek watershed. These strengths of GWLF include:
- the ability to model most constituents of concern (TP, TN, and sediments)
- the capability to model runoff and water quality from both urban and rural land uses
- the ability to model septic system failure and point source pollutants
- model output is given on a monthly and annual basis which allows for direct comparison to most of the water quality targets

There are also several weaknesses associated with using GWLF, such as:

- inability to directly model ammonia, total dissolved solids, manganese, and fecal coliform
- simplification of instream transport processes
- model output is given only on a monthly time step

To evaluate allowable loadings of ammonia, statistical relationships between ammonia and parameters simulated by GWLF were evaluated. To estimate ammonia loadings to the Little Beaver Creek watershed, observed ammonia concentrations were correlated with total and dissolved nitrogen parameters. The best correlation was found to be between ammonia and total nitrogen (r-squared = 0.45). The results of these analyses are graphically presented in Appendix D.

4.4 Load Duration Curve Strengths and Weaknesses

There are several strengths associated with using the load duration curve approach to determine the fecal coliform loading capacity in the Little Beaver Creek watershed. These include the following:

- assuming appropriate data are available, the approach accurately identifies existing and allowable pollutant loads
- the approach provides insight into critical conditions
- the approach is relatively easy to apply

There are several weaknesses associated with the application of load duration curves, which include:

- load duration curves provide little information on pollutant sources
- use of load duration curves do not allow for the simulation of “what if” scenarios, such as the implementation of BMPs
- load duration curves do not allow for a direct comparison to monthly average water quality standards

4.5 Critical Conditions

The calculation of TMDLs must consider the critical condition, or those circumstances under which the aquatic system is under the most stress. The condition can vary by parameter. For the Little Beaver Creek analysis, the conditions were determined as described below.

Critical conditions for the nutrient and organic enrichment/dissolved oxygen impairments are during the late summer when low stream flows and abundant sunshine are most likely to lead to excessive plant growths. However, loadings throughout the year potentially contribute to high nutrient concentrations during the critical period because of desorption from the sediment. The nutrient targets therefore apply throughout the year.

Critical conditions for the sediment impairments are not as straightforward. Loadings are highest during wet weather events which lead to sheet erosion and scouring of the streambank. The impacts of excessive siltation and turbidity can occur at various times, however, such as during the late summer when they might contribute to depleted dissolved oxygen concentrations or during the early spring when they might affect fish spawning. The TSS targets therefore apply year-round.

Critical conditions for fecal coliform are during wet weather periods when loadings from nonpoint sources are elevated. Additionally, the fecal coliform standard only applies during the recreation season (May 1 to October 15).

5.0 ALLOCATIONS

TMDLs are composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, a TMDL is defined by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

To develop TMDLs for the Little Beaver Creek watershed the following approach was taken:

- Simulate current conditions
- Assess source loading alternatives so that the TMDL water quality targets are met
- Determine the TMDL and source allocations

Load allocations (LAs) are identified for nonpoint source and natural background loading of pollutants in support of final TMDL allocations that will lead to attainment of water quality standards. Allocation analysis was performed by applying the model to identify the assimilative capacity of the receiving water and determine how the allowable loading capacity could be allocated among the various sources. Loads were reduced until the target water quality concentrations were met for all months. Percent reductions for point and nonpoint sources were then calculated by comparing the existing loads to the new TMDL loads:

$$Percent\ \mathrm{Re}duction = \frac{TMDLLoad - CurrentLoad}{CurrentLoad}$$

The results are presented in Sections 5.1 through 5.3. The allocation analysis includes the loading capacity (or TMDL), load allocation, and wasteload allocation. The allocation also considers critical conditions and seasonal variation of the loading characteristics, hydrologic variability of the stream flow, and the stream’s assimilative capacity.

The load allocations will be used to develop nonpoint source reduction plans based on meeting the relevant load reduction targets. The ultimate goal is to improve the IBI, MIwb, and ICI scores, as well as to meet the fecal coliform numeric criteria, so that Little Beaver Creek can be removed from the impaired waters list.

5.1 Total Phosphorus TMDLs

Eight segments in the Little Beaver Creek watershed were listed as impaired due to nutrients. A summary of the total phosphorus (TP) TMDLs for these segments is presented in Table 5-1.

Significant reductions are needed for the Middle Fork Little Beaver Creek (Salem Area) due to existing wasteloads from the Salem WWTP. Existing loads from the WWTP are estimated to be more than 98 percent of the existing total load and will need to be significantly reduced to achieve the 0.10 mg/L instream TP target. The TMDL is therefore based on a 50 percent reduction to controllable nonpoint sources (e.g., row crop agriculture and storm water runoff from residential and commercial lands), a 100 percent reduction from failing septic systems, and a 95 percent reduction in loads from the Salem WWTP. It is recommended that future monitoring be conducted to ensure that the reduced TP concentrations, coupled with efforts to improve habitat, result in the biocriteria being met.

The TMDL for the East Branch represents moderate (13 percent) reductions from nonpoint sources and a 69 percent combined reduction in TP loads for the Leetonia and Washingtonville WWTPs. Controllable nonpoint sources in this subwatershed include pasture/hay, row crop agriculture, septic systems, and storm water runoff from low intensity residential lands.

The TMDL for the West Fork Little Beaver Creek (Guilford area) represents a 44 percent reduction from controllable nonpoint sources (e.g., row crop agriculture and storm water runoff from residential lands), a 100 percent reduction from failing septic systems, and a 61 percent reduction in loads from the Guilford WWTP. The GWLF model suggests that the Guilford WWTP is the most significant source of TP, even though this plant already discharges TP at concentrations of approximately 1 mg/L. It is recommended that future monitoring be conducted to ensure that the reduced TP concentrations, coupled with efforts to improve habitat, result in the biocriteria being met.

The results of the GWLF model indicate that a TP TMDLs is not needed for Patterson Run or Brush Creek. Limited TP data are available for both of these streams to determine whether GWLF is or is not underpredicting current conditions. Certain sources, such as instream cattle that have been observed in Brush Creek, might not be fully accounted for in the model.

The GWLF model indicates that the 0.08 mg/L TP target can be met for Long's Run with moderate (10 percent) reductions from nonpoint sources. Grazing cattle are estimated to be the major source of TP.

The TMDL for Leslie Run represents a 40 percent reduction to controllable nonpoint sources (e.g., row crop agriculture and storm water runoff from residential lands), a 100 percent reduction from failing septic systems, and a 48 percent reduction in loads from the East Palestine WWTP. The GWLF model suggests that the East Palestine WWTP is the most significant source of TP, even though this plant already discharges TP at concentrations of approximately 1 mg/L. It is recommended that future monitoring be conducted to ensure that the reduced TP concentrations, coupled with efforts to improve habitat, result in the biocriteria being met.

The TMDL for Honey Creek represents a 44 percent reduction to controllable nonpoint sources (e.g., row crop agriculture and storm water runoff from residential lands), a 100 percent reduction from failing septic systems, and a 63 percent reduction in loads from the New Middleton WWTP. Future monitoring is also recommended for Honey Creek.

Table 5-1. Total Phosphorus TMDL Annual Allocation Summary Table for the Little Beaver Creek Watershed.

Stream Segment	Existing NPS Load (kg/yr)	Existing Point Source Load (kg/yr)	Existing Total Load (kg/yr)	LA (kg/yr)	WLA (kg/yr)	Total Allocation (kg/yr)	NPS Reduction (Percent)	PS Reduction (Percent)
Middle Fork Little Beaver Creek								
Salem Area	790	52290	53080	445	2800	3245	44%	95%
East Branch	950	2070	3020	830	650	1480	13%	69%
West Fork Little Beaver Creek								
Guilford Area	410	710	1120	230	280	765	44%	61%
Patterson Run	215	na	215	215	na	215	0%	na
Brush Creek	980	na	980	980	na	980	0%	na
Little Beaver Creek, Including North Fork								
Long's Run	390	na	390	350	na	350	10%	na
Leslie Run	350	1880	2230	210	980	1190	40%	48%
Honey Creek	780	1010	1790	440	380	820	44%	63%

Notes: na = Not Applicable; LA = Load Allocation; WLA = Wasteload Allocation

5.2 Ammonia TMDLs

Four segments in the Little Beaver Creek watershed were listed as impaired due to ammonia. However, the East Branch listing appears to be due to a one-time spill event that occurred in 1999 and therefore no TMDL is being proposed. A summary of the ammonia TMDLs for the other three segments is presented in Table 5-2. The major sources of ammonia in Leslie Run and Honey Creek are point sources with some additional impacts due to nonpoint sources. Ammonia concentrations in Honey Creek are also likely made worse due to the presence of wetlands downstream since wetlands typically release ammonia during the spring and winter (Horne, 1995). TMDL allocations have been determined based on reducing both point and nonpoint sources such that the water quality targets are met. Because of GWLF's limitations with regard to modeling ammonia, final ammonia permit limits for the NPDES facilities should be determined using standard wasteload allocation procedures as outlined in Ohio Administrative Code 3745-2-05. The major sources of ammonia in Brush Creek are cattle and septic systems. Implementation activities should focus on reducing loads from these two sources.

Table 5-2. Ammonia TMDL Annual Allocation Summary for the Little Beaver Creek Watershed.

Stream Segment	Existing NPS Load (kg/yr)	Existing Point Source Load (kg/yr)	Existing Total Load (kg/yr)	LA (kg/yr)	WLA (kg/yr)	Total Allocation (kg/yr)	NPS Reduction (Percent)	PS Reduction (Percent)
West Fork Little Beaver Creek								
Brush Creek	5,100	na	5,101	2,980	na	2,980	42%	na
Little Beaver Creek, Including North Fork								
Leslie Run	2,120	3,785	5,906	490	560	1,050	77%	85%
Honey Creek	5,115	1,385	6,500	2,360	690	3,050	54%	50%

Notes: na = Not Applicable; LA = Load Allocation; WLA = Wasteload Allocation

5.3 TDS TMDLs

The Middle Fork Little Beaver Creek (Salem area) is the only segment listed as impaired due to TDS. This listing is due to high TDS concentrations that were observed in the stream during sampling conducted in 1999 (see Table 3-12). These high concentrations were associated with effluent from the Salem WWTP that often exceeded the water quality standard of 1,500 mg/L. Following the 1999 sampling, however, Ohio EPA notified the Salem WWTP of the problem and the company responsible drastically reduced its salt loadings to the plant. Effluent concentrations from the plant for the period 2002 to 2004 are estimated to be 760 mg/L[1].

Since the current discharge from the Salem WWTP is now well below 1,500 mg/L, no TMDL is necessary for the Middle Fork Little Beaver Creek (Salem area). Instead, future monitoring is recommended to ensure that in-stream TDS concentrations remain below 1,500 mg/L.

[1]Recent TDS data for the Salem WWTP effluent are not available in the Permit Compliance System database. However, 30 samples of specific conductivity are available and averaged 1,217 µs/cm during the period 2002 to 2004. Conductivity and TDS are strongly correlated and can be related as follows (OAC Chapter 3745-1-07; Table 7-1): TDS (mg/L) = 0.625 * Conductivity (µs/cm). TDS concentrations are therefore assumed to be approximately 760 mg/L.

5.4 Siltation TMDLs

The following streams are considered impaired due to siltation in the Little Beaver Creek watershed: Patterson Run, Brush Creek, Middle Fork Little Beaver Creek, West Fork Little Beaver Creek, and the mainstem Little Beaver Creek. The GWLF model was used to develop TMDLs for Patterson Run and Brush Creek and the results are summarized in Table 5-3. Significant load reductions were found to be necessary, primarily due to trying to achieve the 7.25 mg/L during wet weather events.

A load duration curve was used to identify observed and allowable TSS loads for the Little Beaver Creek at East Liverpool (Figure 5-1). The TMDL results are summarized in Table 5-3 and are intended to encompass the TMDL requirements for the Middle Fork Little Beaver Creek and West Fork Little Beaver Creek. Similar to Patterson Run and Brush Creek, TSS concentrations at high flows frequently exceed the 6 mg/L target (Figure 5-1) and the load reductions calculated for these high flows dominate the results. For example, the necessary annual reduction decreases from 81 percent to 17 percent if the highest flow percentile range is excluded.

The major sources of sediment in Patterson Run are surface mining operations, cattle, and erosion from row crops and the siltation problem in Brush Creek is associated with unrestricted cattle access (Jack Freda, Ohio EPA, personal communication, December 17, 2004). The major sources of sediment within the entire Little Beaver Creek watershed are runoff from pasture/hay and row crop land uses.

Table 5-3. Sediment (Siltation) TMDL Annual Allocation Summary Table for the Little Beaver Creek Watershed.

Stream Segment	Existing NPS Load (kg/yr)	Existing Point Source Load (kg/yr)	Existing Total Load (kg/yr)	LA (kg/yr)	WLA (kg/yr)	Total Allocation (kg/yr)	NPS Reduction (Percent)	PS Reduction (Percent)
Patterson Run	290,000	na	290,000	26,100	na	26,100	91%	na
Brush Creek	437,510	na	437,510	139,200	na	139,200	68%	na
Little Beaver Creek Mainstem[A]	14,164,000	na	14,164,000	2,400,000	na	2,400,000	83%	na

Notes: na = Not Applicable; LA = Load Allocation; WLA = Wasteload Allocation
[A] Applies to all streams upstream of East Liverpool, except Patterson Run and Brush Creek.

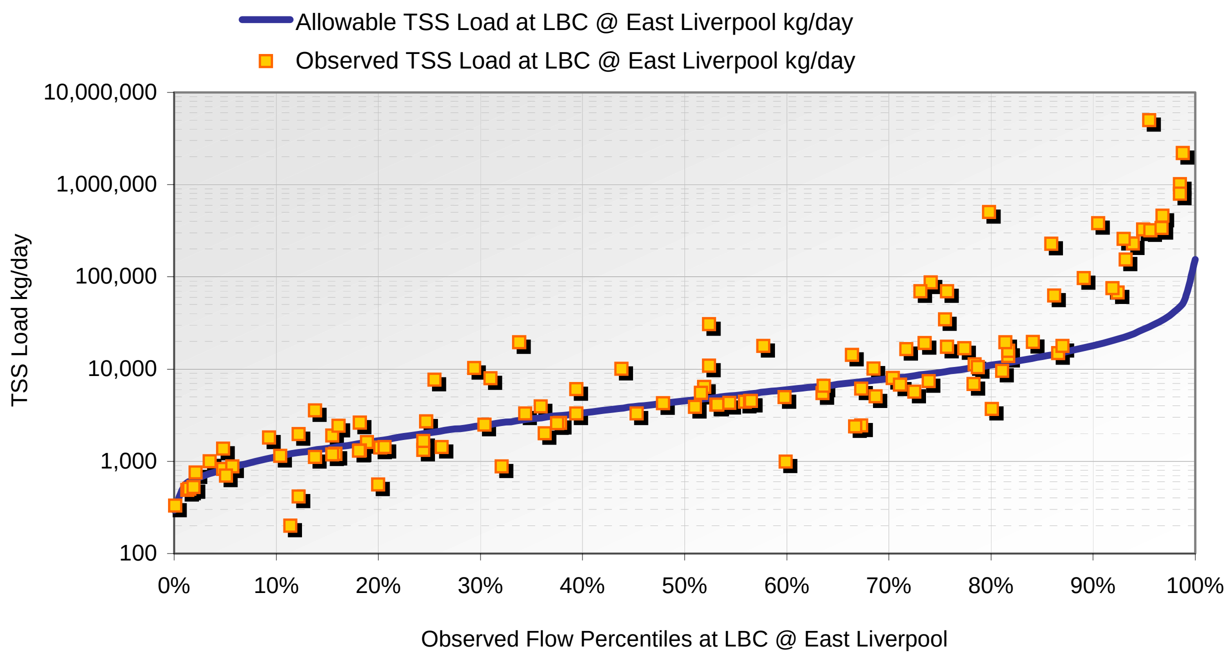


Figure 5-1. Results of the TSS load duration curve analysis for Little Beaver Creek at East Liverpool.

5.5 Fecal Coliform TMDLs

As mentioned above, the GWLF model does not simulate bacteria and there is not a strong conceptual link between the parameters it does predict (i.e., flow, sediment, and nutrients) and fecal coliform. In addition, insufficient fecal coliform data are available in the Little Beaver Creek watershed with which to make a direct comparison to Ohio's geometric mean water quality standard (which requires five samples in a 30-day period). Load duration curves were therefore used to get an initial estimate of existing conditions and potentially necessary TMDL reductions. Only recent (post 1997) data were used in the analysis and load reductions were based on meeting the 2,000 #/100 mL instantaneous standard. The data that were used to create the load duration curves are shown in Appendix E. The results of the analysis are presented below and indicate that a fecal coliform TMDL is only necessary for Brush Creek.

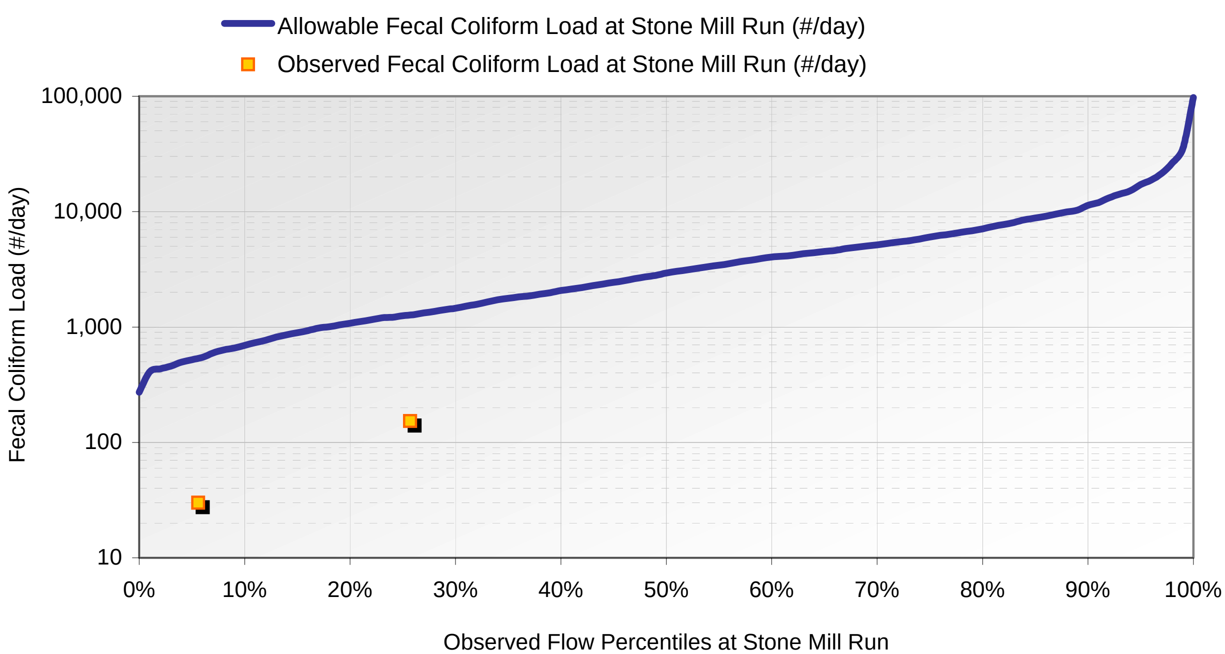
5.5.1 Middle Fork Little Beaver Creek, Stone Mill Run

Stone Mill Run in Assessment Unit 070 is one of the segments listed as being impaired due to fecal coliform. There are very limited (two samples) recent fecal coliform data in Stone Mill Run, as shown in Table 5-4and Figure 5-2. Both samples were taken during low flow conditions. Neither sample exceeded the 2,000/100 mL instantaneous standard but additional data are necessary to determine if a TMDL is necessary or if the segment can be de-listed.

Table 5-4. Fecal Coliform load duration analysis for Stone Mill Run.

Flow Percentile Ranges	2-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (#/day)	Observed Load (#/day)	Estimated Reduction (%)
0-10	1	1.06	520	30	0.0%
10-20	0	1.82	892	No Data	No Data
20-30	1	2.56	1,251	153	0.0%
30-40	0	3.62	1,772	No Data	No Data
40-50	0	4.99	2,441	No Data	No Data
50-60	0	7.01	3,432	No Data	No Data
60-70	0	9.22	4,510	No Data	No Data
70-80	0	12.31	6,022	No Data	No Data
80-90	0	17.95	8,782	No Data	No Data
90-100	0	34.94	17,099	No Data	No Data

Figure 5-2. Results of fecal coliform load duration analysis for Stone Mill Run.



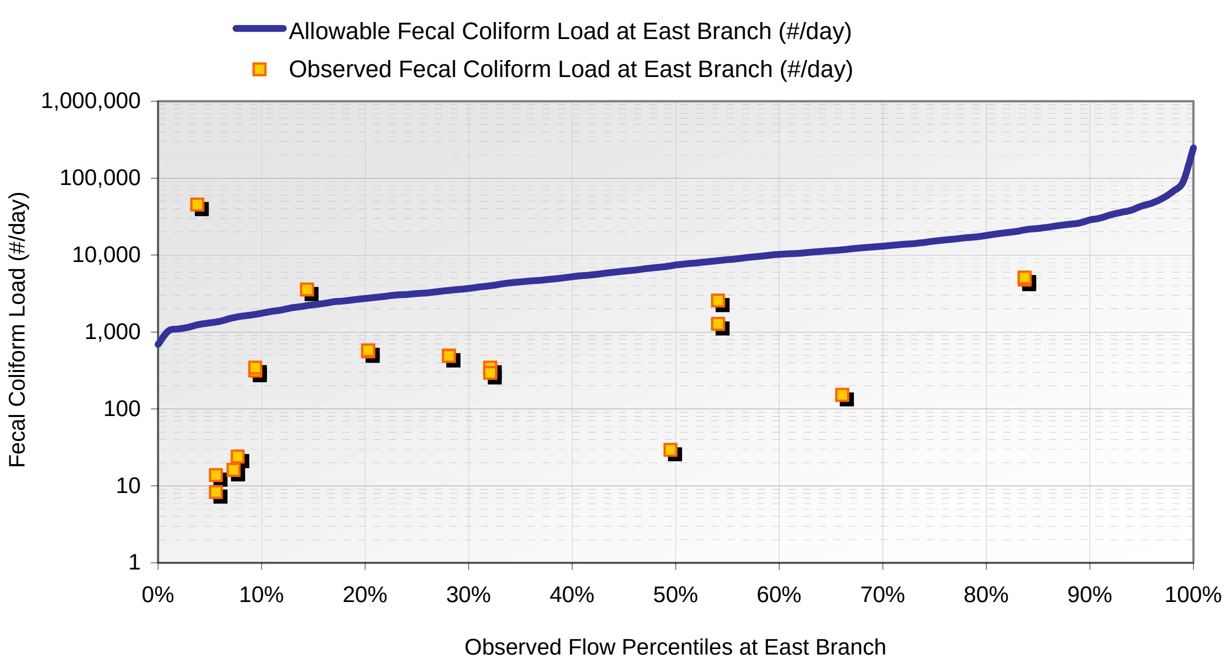
5.5.2 East Branch of the Middle Fork Little Beaver Creek

The East Branch of the Middle Fork Little Beaver Creek has also been identified as being impaired for fecal coliform. Twenty samples are available that cover both low, average, and high flow conditions (Table 5-5 and Figure 5-3). The available data indicate that only a few recent samples (during low flow conditions) have exceeded the 2,000/100 mL instantaneous standard, and the average loads in these flow percentile ranges are below the allowable load. Load reductions are, therefore, determined to be not necessary.

Table 5-5. Fecal coliform load duration analysis for East Branch.

Flow Percentile Ranges	20-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (#/day)	Observed Load (#/day)	Estimated Reduction (%)
0-10	5	2.69	1,316	16	0.0%
10-20	3	4.61	2,256	344	0.0%
20-30	4	6.47	3,165	525	0.0%
30-40	2	9.16	4,480	318	0.0%
40-50	1	12.61	6,172	29	0.0%
50-60	2	17.74	8,679	1,912	0.0%
60-70	1	23.31	11,405	152	0.0%
70-80	0	31.12	15,227	No Data	No Data
80-90	2	45.39	22,208	4,939	0.0%
90-100	0	88.36	43,238	No Data	No Data

Figure 5-3. Results of fecal coliform load duration curve for the East Branch of the Middle Fork Little Beaver Creek.



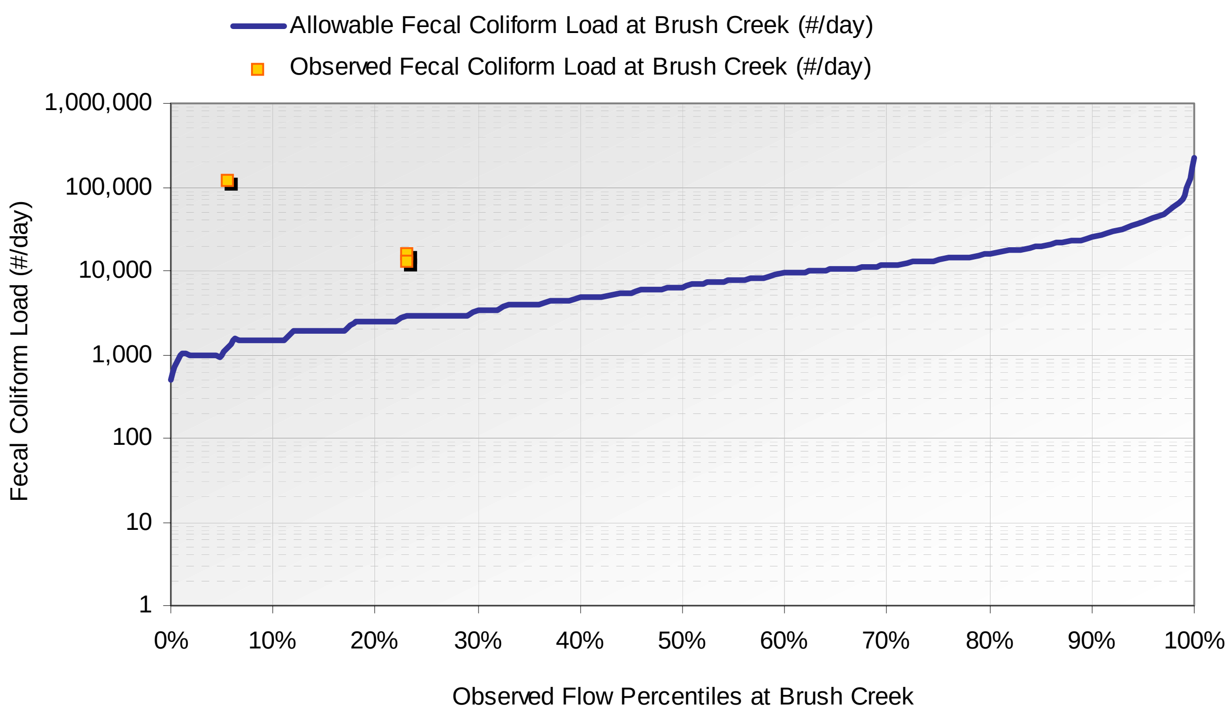
5.5.3 Brush Creek

Brush Creek in the West Fork of Little Beaver Creek subwatershed has been identified as being impaired due to fecal coliform. Only three samples are available from 1999 but all three samples greatly exceed the 2,000/100 mL instantaneous standard (Table 5-6 and Figure 5-4). Cattle were observed in the stream during the 1999 sampling and are believed to be the significant source of fecal coliform.

Table 5-6. Fecal coliform load duration analysis for Brush Creek

Flow Percentile Ranges	3-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (#/day)	Observed Load (#/day)	Estimated Reduction (%)
0-10	0	2.00	881	No Data	No Data
10-20	1	4.00	1,762	117,436	98.5%
20-30	2	6.00	2,642	14,459	81.7%
30-40	0	8.00	3,523	No Data	No Data
40-50	0	11.00	4,844	No Data	No Data
50-60	0	16.00	7,046	No Data	No Data
60-70	0	21.00	9,248	No Data	No Data
70-80	0	28.00	12,331	No Data	No Data
80-90	0	40.00	17,615	No Data	No Data
90-100	0	79.00	34,790	No Data	No Data

Figure 5-4. Results of fecal coliform load duration curve for Brush Creek.



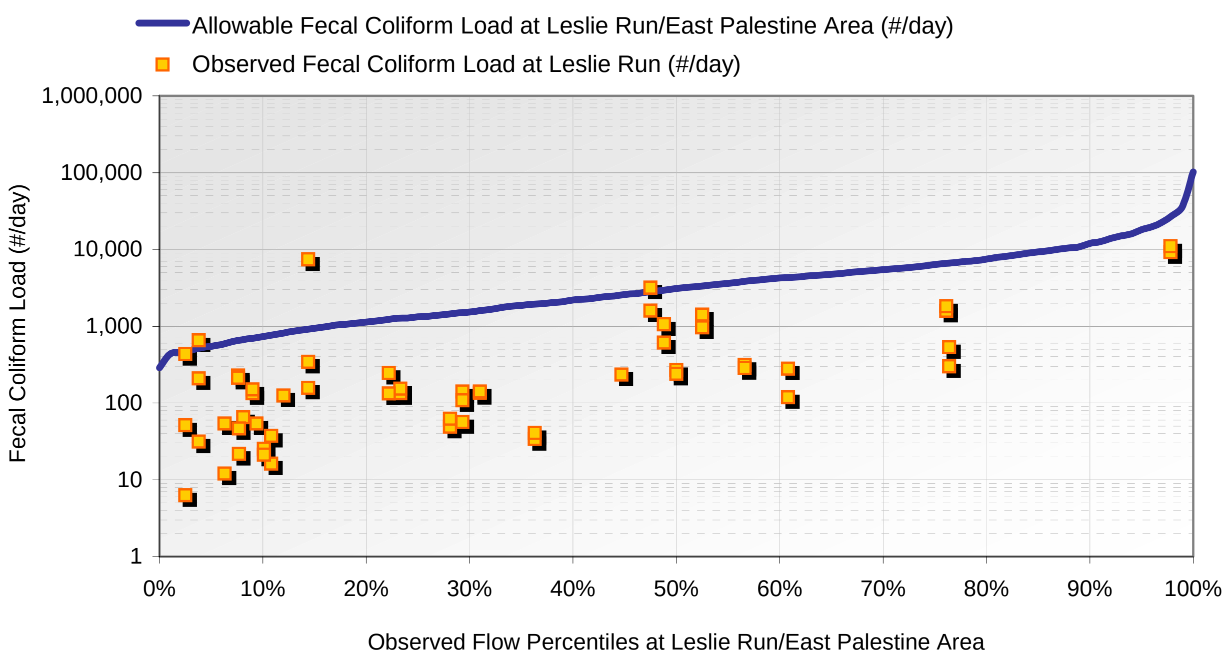
5.5.4 Little Beaver Creek, Leslie Run/East Palestine Area Streams

Fifty-six fecal coliform data are available for Leslie Run covering low, average, and high flow conditions. However, only two samples have exceeded the 2,000/100 mL instantaneous standard and the average observed load for these flow ranges is below the allowable load. No load reductions are therefore determined to be necessary (Table 5-7 and Figure 5-5).

Table 5-7. Fecal coliform load duration analysis for Leslie Run.

Flow Percentile Ranges	56-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (#/day)	Observed Load (#/day)	Estimated Reduction (%)
0-10	15	1.12	548	65	0.0%
10-20	9	1.92	940	54	0.0%
20-30	9	2.69	1,319	133	0.0%
30-40	4	3.82	1,867	88	0.0%
40-50	5	5.26	2,572	1,059	0.0%
50-60	6	7.39	3,617	299	0.0%
60-70	2	9.71	4,753	199	0.0%
70-80	4	12.97	6,345	1,058	0.0%
80-90	0	18.91	9,254	No Data	No Data
90-100	2	36.82	18,018	10,093	0.0%

Figure 5-5. Results of fecal coliform load duration curve for Leslie Run/East Palestine Area streams.



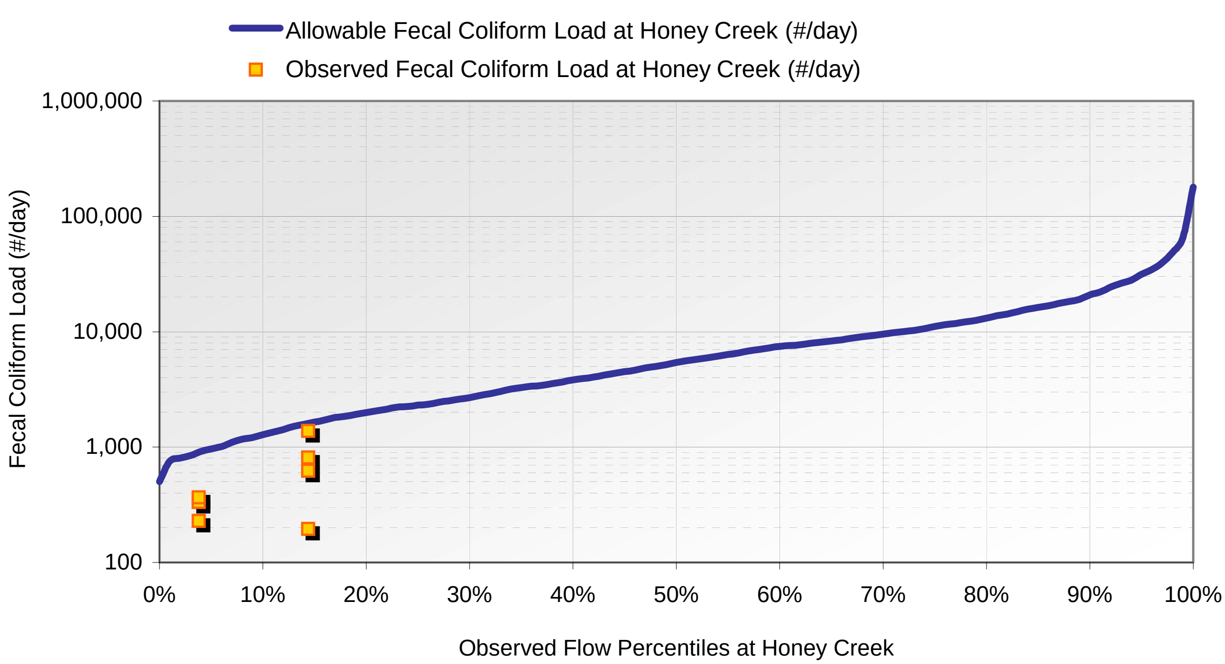
5.5.5 Honey Creek/New Middleton Area Streams

The load duration curve for Honey Creek near New Middleton is presented in Figure 5-6 and summarized in Table 5-8. Fecal coliform data are only available for low flow periods but the data do not indicate the need for load reductions.

Table 5-8. Fecal coliform load duration analysis for Honey Creek.

Flow Percentile Ranges	7-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (#/day)	Observed Load (#/day)	Estimated Reduction (%)
0-10	3	1.96	960	334	0.0%
10-20	4	3.36	1,646	718	0.0%
20-30	0	4.72	2,308	No Data	No Data
30-40	0	6.68	3,268	No Data	No Data
40-50	0	9.20	4,502	No Data	No Data
50-60	0	12.94	6,331	No Data	No Data
60-70	0	17.00	8,319	No Data	No Data
70-80	0	22.70	11,107	No Data	No Data
80-90	0	33.11	16,199	No Data	No Data
90-100	0	64.46	31,539	No Data	No Data

Figure 5-6. Results of fecal coliform load duration curve for Honey Creek.



5.6 Summary

Table 5-9 provides a summary of all of the TMDLs developed for the Little Beaver Creek watershed along with the necessary percent load reductions from nonpoint and point sources.

Table 5-9. Summary of TMDLs developed for the Little Beaver Creek watershed.

Stream Segment	Pollutant	NPS Reduction (Percent)	PS Reduction (Percent)
Middle Fork Little Beaver Creek			
Salem Area	Total Phosphorus	44%	95%
East Branch	Total Phosphorus	13%	69%
West Fork Little Beaver Creek			
Guilford Area	Total Phosphorus	44%	61%
Patterson Run	TSS	91%	na
Brush Creek	Ammonia	42%	na
Brush Creek	TSS	68%	na
Brush Creek	Fecal Coliform	82 to 99%	na
Little Beaver Creek, Including North Fork			
Long's Run	Total Phosphorus	10%	na
Leslie Run	Total Phosphorus	40%	48%
Leslie Run	Ammonia	77%	85%
Honey Creek	Total Phosphorus	44%	63%
Honey Creek	Ammonia	54%	50%
Little Beaver Creek Mainstem	TSS [A]	83%	na

[A] Applies to all streams upstream of East Liverpool, except Patterson Run and Brush Creek.

6.0 WASTELOAD ALLOCATIONS

Wasteload allocations have been determined for the WWTPs that discharge to streams with TP TMDLs (Table 6-1). The plant's design flows were used to develop the allowable monthly loads.

Table 6-1. Total phosphorus wasteload allocations (kg/yr) for the NPDES facilities in the Little Beaver Creek watershed.

Stream	East Branch		Leslie Run	Salem Area	Honey Creek	Guilford Area
Month/ Facility	**Leetonia STP OH0021652**	**Washingtonville OH0028011**	**(City of East Palestine) OH0021784**	**Salem STP OH0027324**	**New Middleton WWTP OH0037273**	**Guilford Lake WWTP OH0063681**
January	40	14	82	233	32	23
February	40	14	82	233	32	23
March	40	14	82	233	32	23
April	40	14	82	233	32	23
May	40	14	82	233	32	23
June	40	14	82	233	32	23
July	40	14	82	233	32	23
August	40	14	82	233	32	23
September	40	14	82	233	32	23
October	40	14	82	233	32	23
November	40	14	82	233	32	23
December	40	14	82	233	32	23
Total	**480**	**168**	**984**	**2796**	**384**	**276**

Wasteload allocations have also been determined for the WWTPs that discharge to streams with ammonia TMDLs (Table 6-2). The wasteload allocations were based on reducing existing point source loads by a similar reduction to that applied to all controllable nonpoint sources in the respective subwatersheds (see Table 5-2). Because of GWLF's limitations with regard to modeling ammonia, final ammonia permit limits for the NPDES facilities should be determined using standard wasteload allocation procedures as outlined in Ohio Administrative Code 3745-2-05.

Table 6-2. Ammonia wasteload allocations (kg/yr) for the NPDES facilities in the Little Beaver Creek watershed.

Stream	**Leslie Run**	**Honey Creek**
Month	**City of East Palestine (OH0021784)**	**New Middleton WWTP (OH0037273)**
January	40	80
February	40	60
March	50	70
April	50	80
May	60	60
June	40	50
July	50	50
August	40	50
September	40	50
October	60	40
November	50	50
December	40	50
Total	**560**	**690**

7.0 MARGIN OF SAFETY

The margin of safety (MOS) is a required component of the TMDL process and is intended to account for any uncertainty concerning the relationship between pollutant loading and receiving water quality. The MOS can be implicit (e.g., incorporated into the TMDL analysis through conservative assumptions) or explicit (e.g., expressed in the TMDL as a portion of the loading) or a combination of both. For the Little Beaver Creek TMDLs, an explicit 10 percent MOS was included by basing all load reductions on achieving the water quality targets minus 10 percent. This was done for all parameters. For example, the TP TMDLs presented above will actually result in meeting instream TP concentrations of 0.09 mg/L (or 10 percent less than the actual target of 0.10 mg/L). Similarily, the fecal coliform TMDLs presented in this report will actually result in meeting instream fecal counts of 1800/100 ml (or 10 percent less than the standard of 2000 counts/100 ml).

A relatively moderate margin of safety was chosen because, although the GWLF model is believed to be providing good information on the relationship between pollutant loadings and receiving water quality as evidenced by calibration results, it has limitations with regard to predicting some of the pollutants of concern (e.g., ammonia). Additional information on the performance of the GWLF model is presented in Appendix C. For the TMDLs calculated using the load duration curves, a relatively moderate MOS is acceptable because of the long period of flow record used in the analysis (about 35 years).

8.0 SEASONAL VARIATION

Pollutant loadings in the Little Beaver Creek watershed vary seasonally, due to variations in weather and source activity. To account for this seasonality, this TMDL establishes monthly allocations by ensuring that the water quality targets are met year-round, including during critical conditions. The allocations represent loads allocated to time periods of similar weather, runoff, and instream conditions and can help to identify times of greatest impairment. TMDL implementation can therefore focus efforts by identifying time periods needing greater load reductions.

All known flow and recent historical seasonal conditions are included in this approach. The Little Beaver Creek flow gage at East Liverpool includes about 35 years of daily flow data that were used in calculating the flow duration intervals. The TMDL and allocation calculations used the flow duration intervals; therefore, all known conditions are accounted for including critical ones and seasonal variability. One of the strengths of the load duration curve method is that it avoids determination of what the critical conditions are and what flow regime they occur under; instead it covers all flow conditions.

9.0 IMPLEMENTATION AND MONITORING RECOMMENDATIONS

Restoration methods to bring an impaired waterbody into attainment with water quality standards generally involve an increase in the waterbody's capacity to assimilate pollutants, a reduction of pollutant loads to the waterbody, or some combination of both. As described in Section 1.0, causes of impairment in the Little Beaver Creek watershed include nutrient enrichment, ammonia, sedimentation, habitat degradation, natural (wetlands), and dissolved solids. Therefore, an effective restoration strategy would include habitat improvements and reductions in pollutant loads combined with additional stream protection through land purchase, easements, and protective riparian zoning.

9.1 Reasonable Assurances

As part of an implementation plan, reasonable assurances provide a level of confidence that the wasteload allocations and load allocations in TMDLs will be implemented by Federal, State, or local authorities and/or by voluntary action. The stakeholders will develop and document a list that differentiates the enforceable and voluntary selected actions necessary to achieve the restoration targets. Reasonable assurances for planned point source controls, such as wastewater treatment plant upgrades and changes to NPDES permits, will be a schedule for implementation of planned NPDES permit actions. For voluntary actions (certain nonpoint source activities), assurances must include 1) demonstration of adequate funding; 2) process by which agreements/arrangements between appropriate parties (e.g., governmental bodies, private landowners) will be reached; 3) assessment of the future of government programs which contribute to implementation actions; and 4) demonstration of anticipated effectiveness of the actions. It will be important to coordinate activities with all parties within the watershed.

9.1.1. Minimum Elements of an Approvable Implementation Plan

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

- Implementation actions/management measures (Table 9-1),
- Time line (Table 9-2),
- Reasonable assurances (Table 9-2),
- Legal or regulatory controls (Table 9-2),
- Time required to attain water quality standards (Table 9-3),
- Monitoring plan (Table 9-3),
- Milestones for attaining water quality standards (Table 9-3),
- TMDL revision procedures (Narrative).

9.1.1.1 Reasonable Assurances Summary

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

Regulatory:

- Appropriate permit limits for phosphorus, ammonia, dissolved oxygen, and CBOD for NPDES dischargers.
- Phase I and II storm water requirements
- riparian ordinances (model language is currently available from several sources)
- 208 plans
- county oversight of the inspection of semi-public wastewater treatment systems (HB 110 activities)

Non-regulatory:

- Finalization of an implementation plan (see Section 9.1.1) which includes these components:
  -septic system management

-riparian corridor initiatives
-point source controls
-storm water management
-education

- Ohio EPA will continue to conduct chemical and biological sampling in the basin, following the five-year basin rotation strategy.
- Development and implementation of a Watershed Action Plan.
- Continued involvement the state and federal Scenic Rivers Programs.

Incentive-based:

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

9.1.1.2 Implementation Actions, Time line, and Reasonable Assurances
The implementation actions and measures are described in Table 9-1. The reasonable assurances are described in Table 9-2. A time line for implementation actions is included in both Tables 9-2 and 9-3.

<u>Combined Sewer Overflow</u>
The Little Beaver Creek watershed receives combined sewer overflows from the Lisbon WWTP. These overflows contribute to non attainment in the watershed by discharging large volumes of combined sewage containing bacteria, oxygen demanding substances, nutrients, suspended solids, and toxics from industrial wastewaters. The US EPA implemented a Combined Sewer Control Policy in April of 1994 and the Ohio EPA implemented a Combined Sewer Control Strategy in March of 1995.

The primary goal of Ohio's CSO Strategy (March, 1995) is to control CSOs so that they do not significantly contribute to violations of water quality standards or impairment of designated uses. Through provisions included in NPDES permits, all CSO communities must implement short-term controls, the nine minimum technology-based controls. If these are not sufficient to meet water quality standards, a community may be required to implement more extensive long-term controls. In addition, communities must characterize their collection systems and overflows, evaluate the wet weather treatment capabilities of their wastewater plants, and conduct instream bacterial monitoring. The City of Lisbon must develop Long Term Control Plans to address CSOs. Long term control plans have not yet been submitted to address combined sewer overflows in the Little Beaver Creek TMDL area.

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

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

Municipalities located in urbanized areas and that operate municipal separate storm sewer systems (MS4s) will be included in the program in the State of Ohio. Pollutants from MS4s include floatables, oil and grease, as well as other pollutants from illicit discharges.

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

The Six Minimum Control Measures are

- ✰ Public Education and Outreach Program on the impacts of storm water on surface water and possible steps to reduce storm water pollution. The program must be targeted at both the general community and commercial, industrial and institutional dischargers.
- ✰ Public Involvement and Participation in developing and implementing the Storm Water Management Plan.
- ✰ Elimination of Illicit Discharges to the MS4.
- ✰ Construction Site Storm Water Runoff Ordinance that requires the use of appropriate BMPs, pre-construction review of Storm Water Pollution Prevention Plans (SWP3s), site inspections during construction for compliance with the SWP3, and penalties for non-compliance.
- ✰ Post-Construction Storm Water Management Ordinance that requires the implementation of structural and non-structural BMPs within new development and redevelopment areas, including assurances of the long-term operation of these BMPs.
- ✰ Pollution Prevention and Good Housekeeping for municipal operations such as efforts to reduce storm water pollution from the maintenance of open space, parks and vehicle fleets.

Storm water control measures will help to improve water quality in the Little Beaver Creek watershed. Reduction in the sediment load will improve both habitat and chemical water quality. Identification of illicit discharges to storm sewer systems will also improve water quality.

It is also recommended that watershed stakeholders and citizens investigate and implement, when possible, additional storm water control measures. Human induced changes have dramatically altered watershed hydrology.

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

Currently no communities in the watershed are covered directly under the Phase II storm water regulations. Lisbon and Salem are being evaluated for their inclusion. All construction projects disturbing 1 acre of land or greater are required to obtain a storm water discharge permit.

Due to recent severe flooding events in the watershed it is recommended that both Columbiana County and all incorporated municipalities implement the six minimum control measures.

<u>Evaluation of all dams in Little Beaver Creek for removal opportunities</u>
Adverse impacts from dams can include a change in hydraulic regime, thermal and chemical water quality changes, and impaired habitat in the stream or river where they are located. A variety of impacts can result from the siting, construction, and operation of these facilities. Dams either reduce or eliminate the downstream flooding needed by some wetlands and riparian areas. Dams can also impede or block migration routes of fish.

All existing dams within the Little Beaver Creek TMDL study area shall be evaluated for the feasibility of removal. The process shall begin by compiling an inventory of all dams in the study area. The inventory shall be prioritized for removal opportunities based on ecological benefits of removal.

<u>Semipublic Sewage Disposal Systems</u>
Improperly maintained small (generally less than 25,000 gallons) sewage treatment systems can contribute oxygen demanding substances, nutrients, and bacteria to the Little Beaver Creek TMDL area. House Bill 110 programs (county inspection of small sewage treatment plants) are in place in Mahoning County, Ohio EPA conducts inspections in Columbiana County. These programs allow county health departments to register and

inspect semipublic sewage disposal systems. Increased oversight will allow for improved operation and identification of malfunctioning systems. Ohio EPA will continue as the agency responsible for regulating semi-public disposal systems in Columbiana County. Enforcement of regulations will still be conducted by the Ohio EPA.

Recently passed House Bill 231 distributes authority for some semipublic sewage systems (under 1,000 gallons, on-site systems) to local health departments.

Household Sewage Disposal Systems

Septic systems and other forms of home sewage disposal can contribute to water quality impairments. They have been identified as major sources of pollution in some areas and failure rates of on-site systems can be fairly high.

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

Currently impacted areas in Columbiana County include the following:

- Glenmoor/Lacroft,
- Hanoverton/New Kensington,
- Winona.

Other areas of concern in Columbiana County include the following:

- Rodgers,
- Westville Lake,
- Unity Township.

This TMDL also recommends that efforts be taken to develop septage receiving stations at local sewage treatment plants. Proper management of pumped septage can reduce nutrient and bacteria loading to the watershed.

208 Plan Updates

The 208 (Areawide Waste Treatment Management Plan prepared pursuant to Section 208 of the Clean Water Act) plan for the Little Beaver Creek basin area was completed in 1979. A 208 plan for Mahoning and Trumbull Counties, including part of the Little Beaver Creek basin, was completed in 1977 by the Eastgate Development and Transportation Agency. The purpose of the plans are to address municipal wastewater treatment issues and nonpoint source pollution. Resources are needed to sustain the Water Quality Management planning efforts at the area wide level so that plan recommendations will be acted on and adopted by local communities. Identifying an action in the 208 Plan for local government attention is the first step towards implementation.

Wetlands Protection

Wetland protection involves both federal (Army Corps of Engineers) and state (Ohio EPA) regulations. Isolated wetlands, those not connected to a navigable water body, are regulated solely by Ohio EPA. Wetlands are an important part of the watershed and perform many useful functions which relate to water quality. Preservation and enhancement of wetlands in the Little Beaver Creek TMDL area will help to improve water quality.

Ohio EPA's wetland classification system defines three classes of wetland based on both ecological quality and function. It is recommended that no new permits to impact Category 2 and 3 wetlands (highest quality) be issued in the Little Beaver Creek TMDL area without detailed studies of alternate options. All permits issued for impacts to Category 1 wetlands should ensure that mitigation is conducted on site if possible and at a minimum within the watershed area. If mitigation can not be conducted on site or within the watershed area for all impacted wetland categories, then a permit should not be issued for the proposed project.

Riparian Protection

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

Two mechanisms are proposed to promote riparian protection. The first mechanism proposed is the passage of stream setback ordinances. Another mechanism to promote riparian protection is comprehensive land use planning. Through the identification of sensitive natural areas communities can promote wise land use policy. These mechanisms will be promoted in the 208 plan, and Ohio EPA will encourage local governmental entities to use this authority to the extent they can.

Permitting Activities related to Wetland and Stream Impacts

Evaluation of all 401/404 permit applications in the Little Beaver Creek TMDL area should require mitigation to be conducted on site if possible and at a minimum within the watershed area. Mitigation should be conducted in a manner protective of biological, botanical, and hydrologic functions taking care to protect buffer areas. If mitigation can not be conducted on site or within the watershed area, then a permit should be considered as incomplete or denied for the proposed project. Export of both wetland mitigation and stream mitigation out of the watershed is a threat to protection, restoration, and improvement of habitat and water quality in the watershed. Local mitigation will be encouraged to the entent allowed by rule.

Headwater Streams

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

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

Point Source Control
Adequate point source control mechanisms shall be utilized for all direct discharges in the Little Beaver Creek TMDL area. NPDES permits for all point sources shall be prepared and issued with limits and conditions necessary to protect and restore water quality in the Little Beaver Creek TMDL area. Phosphorus limits of 1.0 mg/l have been recommended as appropriate for reducing loads in the Little Beaver Creek TMDL area. When appropriate, Ohio EPA shall take enforcement actions necessary to maintain compliance with discharge permit limits.

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

Wild and Scenic River Designation
Little Beaver Creek in Columbiana County was the first in Ohio to be designated a wild river by the Director of the Ohio Department of Natural Resources on January 15, 1974. It is one of only three rivers in Ohio which have also been included in the National Wild and Scenic Rivers Program. Little Beaver Creek State Wild and Scenic River is designated for approximately 36 river miles. Portions of the Middle Fork, North Fork and mainstem are included in the State and National systems.

Scenic Rivers Act
Ohio pioneered the river preservation movement in 1968 with the passage of the nation's first scenic rivers act. This legislation created a state program to protect Ohio's remaining high quality streams for future generations.

Scenic rivers retain most of their natural characteristics at a time when many rivers reflect the negative impacts of human activities.

Restoration of streamside forests is the single most important ingredient in maintaining the health of streams and rivers. The removal of forested corridors along waterways increases erosion, runoff and sedimentation, resulting in the degradation of water quality and the reduction of the natural diversity of aquatic communities.

Scenic River Designation
Scenic rivers are classified and designated according to the outstanding qualities a stream possesses. The Scenic Rivers Act provides three categories for river classification: wild, scenic and recreational. These criteria examine the stream's length, adjacent forest cover, biological characteristics, water quality, present use and natural conditions.

Scenic river designation is a cooperative venture among state and local government, citizen groups, and local communities within a watershed. The designation process depends ultimately upon support and protection authority of local governments and citizens. The Ohio Department of Natural Resources (ODNR) studies the proposed river to determine whether it meets the scenic river criteria. All interested parties, including state and local officials, community groups and concerned citizens, meet to discuss the scenic rivers program and to encourage local support for the protection of the river as a natural resource.

Protection of Scenic Rivers
The protection and preservation of a designated stream depend heavily upon local input and community involvement. The Scenic Rivers Act requires a citizens' advisory council, representing local officials,

landowners and conservation organizations, to be appointed for each designated river. The council provides advice about local river protection and preservation concerns.

Three approaches are used in scenic river protection:

* Public project review plays a major role in river preservation. The possible environmental impact of the construction of dams, bridges, roads or other publicly funded projects is carefully considered. ODNR has the authority to approve or disapprove all publicly funded projects on designated scenic rivers outside municipal corporation limits.
* Landowner assistance and education are vitally important components of river protection. ODNR scenic river staff advise landowners about streamside protection techniques and provide technical assistance in river corridor restoration. Scenic river designation does not affect private property rights.
* Water resource protection balances the relationship between the streamside forest buffer, aquatic habitat and water quality. While the maintenance and improvement of responsibility of the Ohio Environmental Protection Agency (OEPA), the most effective watershed protection involves cooperation among OEPA, ODNR and local governments. A stream quality monitoring and biological survey project using volunteers has been developed by the Division of Natural Areas and Preserves to supplement this effort. Division staff also work with federal, state and local agencies to reduce nonpoint source pollution, which causes serious environmental damage to rivers and streams.

Natural Areas Act

The Natural Areas Preservation Act became law in 1970, authorizing the Department of Natural Resources to acquire, dedicate and accept donations of public and privately owned lands as nature preserves. This act was amended in 1976 to create within Ohio Department of Natural Resources the Division of Natural Areas and Preserves, which established and administers a statewide system of nature preserves and wild, scenic and recreational rivers. The Division has the legal authority to manage and protect such lands and waters for education, scientific use and public visitation.

Added water quality protection is also afforded scenic rivers in Ohio Water Quality Standards.

<u>Farming BMPs</u>

The Ohio Department of Natural Resources, Soil and Water Conservation Districts, The Natural Resource Conservation Service, and the Ohio Department of Agriculture oversee farming operations in the state. Non point source pollution from farms includes sediment, nutrients, and bacteria. In addition, habitat destruction from farming practices and livestock access to streams contribute to water quality degradation in the watershed.

BMPs are designed to help reduce the amount of pollution in runoff and the amount of runoff itself. BMPs address agricultural impacts on water quality. Some examples of BMP's used to control agricultural impacts include contour strip farming, animal waste control, and retirement of highly erodible land. Contour strip farming reduces erosion by farming sloping land across the slopes to impede runoff and soil movement downhill. To control animal wastes entering into the hydrologic cycle, fences can be constructed to protect streams from cattle and livestock, and installation of alternative drinking water sources such as a trough, may also protect water quality by encouraging animals away from streams.

Farmers are encouraged to work with appropriate organizations to develop BMPs. Funding may also be available to local farmers.

<u>Local Land Use Planning</u>

Developing local land use planning in the watershed is very important. In general, land use is a decision left up to local governments. Decisions to utilize zoning or other forms of guidelines can have direct impacts on a watershed. Local ordinances for stream setbacks have been previously discussed. Their importance to habitat protection and water quality can not be overstated. In addition, habitat protection and floodplain management can have direct impacts on citizens and businesses within the watershed. Flooding is a natural process which can be extremely influenced by human activities.

This TMDL recommends that local jurisdictions develop comprehensive plans, floodplain management plans, and sediment and erosion control plans. The plans should encompass economic as well as ecological concerns in relation to watershed development.

<u>Nease Chemical Site</u>
The Nease Chemical site is located 2.5 miles northwest of the City of Salem, Ohio, in northern Columbiana County. The site covers approximately 44 acres and is surrounded by lightly developed land on three sides and an industrial plant to the northeast and 124 homes located within one mile of the site. Between 1961 and 1973, Nease Chemical produced various chemical compounds including household cleaning compounds, fire retardants, and pesticides (most notably mirex, a probable human carcinogen). During the facility's operation, hazardous substances were released to the soils and groundwater through five unlined ponds onsite that were used to treat manufacturing process waste. Contaminants were also released to the soils and groundwater when hazardous substances escaped from drums that had been buried onsite. Contamination was released to the Middle Fork of Little Beaver Creek (MFLBC) through surface water runoff from the ponds into creek tributaries that run through the site. The United States Environmental Protection Agency (U.S. EPA) and Ohio Environmental Protection Agency (OEPA) conducted investigations and inspections on and around the Nease property and documented contamination of soils, sediments, surface water, groundwater and fish along a thirty-mile reach of MFLBC. The MFLBC, its ecological corridor and associated wetlands are considered an important natural resource to this region with certain stretches designated as wild and scenic. The site was placed on the National Priorities List (Superfund) on September 8, 1983.

Groundwater, soil, and sediments are contaminated with volatile organic compounds (VOCs) and semi-VOCs. A 1987 U.S. EPA study showed contamination of fish, creek and adjacent floodplains sediments with mirex, a pesticide and fire retardant. Dairy herds on two nearby farms were also affected by mirex through exposure to creek and floodplain contamination. Access to the site and certain offsite areas are restricted by fencing and bridges. In 1989, the Ohio Department of Health (ODH) detected concentrations of mirex in the bloodstream of some local residents/workers. The ODH subsequently issued a health advisory against fishing and swimming along certain portions of the MFLBC.

Nease Chemical closed the facility in 1975 pursuant to a Consent Order with the OEPA to address its wastewater violations. During that time, Nease voluntarily drained the ponds, removed 115 buried drums and 5,700 cubic yards of soil from two highly contaminated areas onsite, and preliminarily assessed the nature and extent of contamination. Pursuant to the Administrative Order by Consent (AOC), effective February 1988, Nease (now Ruetgers-Nease Corp.) is conducting a multi-phase Remedial Investigation and Feasibility Study (RI/FS) which is being overseen by the U.S. EPA and the OEPA. The study has included: installation and seasonal monitoring of a 70-well groundwater and residential monitoring system; air monitoring, geophysical-cal studies, extensive onsite and offsite soil and sludge sampling, pond and MFLBC tributary sediment sampling. Additional phases included in-depth studies of mirex and related compounds in fish, sediments, water and floodplain soils along the 30-mile stretch, investigation of habitats and endangered species along the MFLBC ecological corridor, and hydrogeologic investigation of Dense Non-Aqueous Phase Liquids in groundwater. To abate the immediate threat to human health and the environment posed by surface water runoff and sediment migration (a major transport mechanism of mirex), a removal AOC was effected November 1993, whereby Nease installed a leachate collection and onsite treatment system, numerous sediment barriers and surface water diversion structures. Sediment studies have confirmed the effectiveness of these removal actions until they are integrated into a site-wide final remedial solution. The removal system remains in operation. RI/Risk Assessment is in progress.

The 2005 Ohio Sports Fish Consumption Advisory contains a **Do Not Eat** restriction for Middle Fork Little Beaver Creek due to Mirex contamination. The TMDL does not specifically address Mirex. This TMDL recommends that the Record of Decision, when finalized, for Nease Chemical will adequately address contaminated sediment and should be considered part of the implementation plan.

Table 9-1. Description of Implementation Actions and Measures

#	Implementation Actions & Management Measure	Affected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
1	Phase II Storm water	Little Beaver Creek TMDL area / See Appendix A for list of communities.	Storm water control will reduce sediment loading, eliminate illicit discharges to MS4s	If correctly implemented effectiveness will be very good.
2	Educational Programs	Entire Little Beaver Creek TMDL area	Educational programs within the area are existing and relatively strong. Education allows the public to be better informed on processes withing the watershed and their impacts to it.	An informed citizen body and informed public officials will be effective in promoting programs to restore water quality in the Little Beaver Creek TMDL area
3	Evaluation of all dams in Little Beaver Creek TMDL area for removal.	Little Beaver Creek and its tributaries.	Biological communities will be improved by addressing impacts associated with the dam. Dissolved oxygen deficits found in the impounded areas behind dams will be eliminated. Recreational opportunities will be enhances and made safer.	Dam removal will be highly effective at removing one barrier to upstream attainment of water quality standards
4	House Bill 110 program	Little Beaver Creek and its tributaries/ County Health Departments, Ohio EPA, Regulated Entities	Inspections and proper maintenance of semipublic sewage treatment systems will allow for some reductions in the discharge of oxygen demanding substances and nutrients.	High, proper functioning sewage disposal systems will result in pollutant loading reductions. Unsewered areas and streams within them will derive greater benefits.
5	Household sewage disposal systems - Inspection and maintenance programs	Little Beaver Creek and its tributaries/ Local Health Departments, Home Owners	Inspections and proper maintenance of household sewage disposal systems will allow for some reductions in the discharge of oxygen demanding substances and nutrients.	High, proper functioning sewage disposal systems will result in pollutant loading reductions. Unsewered areas and streams within them will derive greater benefits.
6	208 updates	Little Beaver Creek and its tributaries/Ohio EPA and EDATA	Comprehensive planning will help to promote better land use decisions and provide guidance to Ohio EPA and local sewer authorities. Storm water controls will help to reduce impacts associated wit development.	Very Good, if the guidance is followed.
7	Wetlands protection	Little Beaver Creek and its tributaries	Wetlands have a great number of benefits provided to the watershed, including water quality and flood protection.	Preservation, restoration, and enhancement of wetlands will be highly effective
8	Riparian protection	Little Beaver Creek and its tributaries	Streambank stability, water quality, biological integrity.	Very Good, if the guidance is followed and communities adopt riparian protection ordinances.
9	Headwater stream protection	Little Beaver Creek and its tributaries	Streambank stability, water quality, thermal regime stability, biological integrity.	Very Good, if the guidance, statutes, and regulations are followed. and communities adopt riparian protection ordinances

Table 9-1. Description of Implementation Actions and Measures				
#	**Implementation Actions & Management Measure**	**Affected Stream / Party**	**Parameters Effected/Benefits**	**Estimated Effectiveness**
10	NPDES permit limits	Little Beaver Creek and its tributaries / All NPDES permit holders in TMDL area potentially effected	Pollutant reduction.	Very Good if main source of impairment is from NPDES permitted dischargers.
11	Watershed Action Plan	Little Beaver Creek and its tributaries/ All watershed stakeholders , Little Beaver Creek Land Foundation	Establish stream protection and restoration targets, provide watershed education, possible source of funding.	Very Good, if the guidance is followed.
12	Wild and Scenic River designation	Certain defined sections of Little Beaver Creek./ Ohio DNR, National Wild and Scenic Rivers System	Establish stream protection and restoration targets to maintain designation, provide watershed education, tourism, possible source of funding.	Very Good, if the guidance is followed.
13	County-wide Comprehensive Land Use Plan	Little Beaver Creek and its tributaries	Streambank stability, water quality, biological integrity	Very Good, if the guidance is followed.
14	Farming BMP's	Little Beaver Creek and its tributaries	Streambank stability, water quality, biological integrity	Very Good, if the guidance is followed.
15	Nease Chemical Site clean-up	Middle Fork Little Beaver Creek, Little Beaver Creek	Removal/ restoration of contaminated sediment, address human health concerns, address wildlife contamination concerns	Very Good, if the Record of Decision is followed.
16	County-wide Erosion and Sediment Control Plan	Little Beaver Creek and its tributaries	Reduce input of sediment and associated pollutants / Improve water quality, habitat and biological integrity	Very Good, if the guidance is followed.
17	County-wide Floodplain Management Plan	Little Beaver Creek and its tributaries	Reduce input of sediment and associated pollutants / Allow watershed to provide flood control functions	Very Good, if the guidance is followed.
18	Develop septage receiving stations at local sewage treatment plants	Little Beaver Creek and its tributaries	Reduce nutrient input from failing systems / Reduce nutrient input from land applied septage	Very Good, if the guidance is followed.
19	Combined Sewer Control, Long Term Control Plans(LTCP)	Middle Fork Little Beaver Creek	CSO control programs will address oxygen demanding substances, bacteria, nutrients	CSO control is expected to be highly effective, effectiveness may be impacted by available finances to complete the program.

Table 9-2. Time line and Reasonable Assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics
1	Phase II Storm water	Ohio EPA, Local Soil Water Conservation Districts	Compliance beginning in March of 2003	US EPA Phase II storm water regulations
2	Educational Programs	Ohio EPA, Cuyahoga RAP, Local Soil Water Conservation Districts	Ongoing	Continuation and expansion of existing educational programs. See Appendix I for Cuyahoga RAP activities.
3	Evaluation of all dams in Little Beaver Creek TMDL area for removal.	Ohio EPA, Individual dam owners, local park departments	Ongoing	Compliance with Ohio Water Quality Standards
4	House Bill 110 program	Local Health Departments, Ohio EPA	Ongoing	House Bill 110 allows health departments and Ohio EPA to enter into contract for the purpose of licensing and inspecting semipublic sewage disposal systems. Existing regulations are utilized (ORC 6111)
5	Household sewage disposal systems	Local Health Departments, Ohio Department of Health	Ongoing	State and local home sewage treatment system regulations.
6	208 updates	Ohio EPA, EDATA	208's completed in 1977 and 1979	Section 208 of the Clean Water Act
7	Wetlands protection	Ohio EPA US Army Corps of Engineers	Existing rules	Sections 401 and 404 of the Clean Water Act. State of Ohio wetland regulations (OAC 3745)
8	Riparian protection	Local Governments, ODNR	Some existing some proposed	No direct reasonable assurances. Ancillary assurances may be tied to Phase II storm water regulations and comprehensive planning for local communities.
9	Headwater stream protection	Ohio EPA US Army Corps of Engineers	Existing rules	Sections 401 and 404 of the Clean Water Act. State of Ohio antidegradation regulations (OAC 3745)
10	NPDES permit limits	Ohio EPA	Ongoing	Section 402 of the Clean Water Act, State of Ohio (ORC Chapter 6111)
11	Watershed Action Plan	Ohio DNR/Local Watershed coordinator	Ongoing, submit plan for review and approval in December 2005.	319 Funding obligations
12	Wild and Scenic River designation	Ohio DNR/ National Wild and Scenic Rivers System	Ongoing	Federal Wild and Scenic Rivers Act, Ohio Revised Code Chapter 1517.
13	County-wide Comprehensive Land Use Plan	Local Governments	Unknown at this time.	Local regulation
14	Farming BMPs	USDA / Local SWCD's	Ongoing	Ohio Revised Code Chapter 1511, Ohio Administrative Code Chapter 1501, 319 Funding opportunities
15	Nease Chemical Site clean-up	US EPA / Ohio EPA	Ongoing	Superfund (CERCLA) Law, ,Record of Decision will identify clean-up goals and targets

Table 9-2. Time line and Reasonable Assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics
16	County-wide Erosion and Sediment Control Plan	Local Governments / Local SWCD's	Unknown at this time.	No direct reasonable assurances. Ancillary assurances may be tied to Phase II storm water regulations and comprehensive planning for local communities
17	County-wide Floodplain Management Plan	Local Governments	Unknown at this time.	No direct reasonable assurances. Ancillary assurances may be tied to Phase II storm water regulations and comprehensive planning for local communities. May address FEMA requirements
18	Develop septage receiving stations at local sewage treatment plants	Ohio EPA / Local Sewage Treatment Plants / Local Health Departments	Unknown at this time.	Household sewage treatment rules, Ohio EPA PTI program
19	Review and Approve Lisbon LTCP	Ohio EPA	Submit LTCP in July 2001	Both Ohio EPA and US EPA have CSO programs. Existing CSO permit for Lisbon WWTP (3PA00034*AD).

Table 9-3. Time line: Monitoring, Tracking and Implementation										
Action	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Phase II Storm water	Compliance by March 2003. Program ongoing									
Educational	Educational programs ongoing.									
House Bill 110	Program approved for Mahoning County. Ongoing.									
Household sewage disposal systems	Local Health Departments currently conduct inspections of home sewage disposal systems. Not all systems are inspected by all local health departments.									
208 updates	208's prepared in 1977, 1979									
Wetlands protection	Program ongoing.									
Riparian Protection	Work with and assist local governments to enact riparian protection ordinances.									
NPDES permit limits (permit expiration dates vary)	Modify NPDES permits to reflect TMDL									
		Compliance schedule for treatment system modifications								
			Attain and maintain compliance with NPDES permit							
Watershed Action Plan	Currently under development. Submit plan for review and approval in December 2005									
Nease Chemical Site Clean-up	Superfund process ongoing, Record of Decision to be completed in near future.									

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

9.1.2 Expected Effectiveness of Example Restoration Scenario

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

Community growth needs to be conducted in ways that are compatible with a healthy watershed. Riparian protection is one way of promoting and improving watershed health. Development of comprehensive land management plans will also provide additional assurances for water quality protection. These issues are currently being addressed as communities integrate the value of natural resources with developmental pressures.

The formation of watershed groups promotes awareness, stewardship, and education. These groups provide valuable local grassroots connection to waterways. Activism helps promote education and awareness while helping to keep state and federal agencies focused on issues in the Little Beaver Creek. Their continued involvement is crucial to restoring the water quality in Little Beaver Creek. The following is a list of watershed based groups in Little Beaver Creek:

- ✰ Little Beaver Creek Land Foundation (319 funded group)

9.2 Process for Monitoring and Revision

Ohio EPA will continue to monitor and assess the basin's chemical and biological water quality as part of the 5 year monitoring strategy. Revisions to the TMDL report would be completed the year following a watershed assessment.

In addition to Ohio EPA's monitoring program, citizen monitoring programs can provide valuable watershed information. The Scenic Rivers program at ODNR maintains several monitoring sites within the watershed.

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

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

10.0 PUBLIC PARTICIPATION

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

An initial meeting for the Little Beaver Creek TMDL was held on December 13, 2004. The purpose of the meeting was to discuss and gather public input on proposed implementation actions.

The public outreach activities also included a public comment period for the draft TMDL report. Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report was public noticed on June 3, 2005 and a copy of the draft report posted on Ohio EPA's web page (www.epa.state.oh.us/dsw/tMDL/index.html). Two public meetings were held in the watershed to discuss the draft TMDL. A summary of the public comments received and associated responses is included as Appendix F in the final report. The final report will be submitted to U.S. EPA Region 5 for approval.

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

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