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USEPA Approved Report

Total Maximum Daily Loads for the Twelvepole Creek Watershed, West Virginia

Prepared for
West Virginia Department of Environmental Protection
Division of Water and Waste Management
Watershed Assessment Branch, TMDL Section

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On the cover:
Photos provided by WVDEP Division of Water and Waste Management

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ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

7Q10	7-day, 10-year low flow
AMD	acid mine drainage
AML	abandoned mine land
AML&R	[WVDEP] Office of Abandoned Mine Lands & Reclamation
BMP	best management practice
BOD	biochemical oxygen demand
CFR	Code of Federal Regulations
CSGP	Construction Stormwater General Permit
CSR	Code of State Rules
DEM	Digital Elevation Model
DMR	[WVDEP] Division of Mining and Reclamation
DNR	West Virginia Division of Natural Resources
DO	dissolved oxygen
DWWM	[WVDEP] Division of Water and Waste Management
ERIS	Environmental Resources Information System
GIS	geographic information system
gpd	gallons per day
GPS	global positioning system
HAU	home aeration unit
LA	load allocation
ug/l	micrograms per liter
MDAS	Mining Data Analysis System
mg/L	milligrams per liter
mL	milliliter
MF	membrane filter counts per test
MPN	most probable number
MOS	margin of safety
MRLC	Multi-Resolution Land Characteristics Consortium
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NLCD	National Land Cover Dataset
NOAA-NCDC	National Oceanic and Atmospheric Administration, National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OGCSGP	Oil and Gas Construction Stormwater General Permit
OOG	[WVDEP] Office of Oil and Gas
POTW	publicly owned treatment works
SI	stressor identification
SRF	State Revolving Fund
STATSGO	State Soil Geographic database
TMDL	Total Maximum Daily Load

TSS	total suspended solids
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UNT	unnamed tributary
WLA	wasteload allocation
WVDEP	West Virginia Department of Environmental Protection
WVSCI	West Virginia Stream Condition Index
WVU	West Virginia University

Watershed

A general term used to describe a drainage area within the boundary of a United States Geologic Survey's 8-digit hydrologic unit code. Throughout this report, the Twelvepole Creek watershed refers to the tributary streams that ultimately drain to the Twelvepole Creek (**Figure I-1**). Tributaries of Twelvepole Creek have been dammed to create Beech Fork Lake and East Lynn Lake in Wayne County. However, lake TMDLs were not developed in this modeling effort because Beech Fork and East Lynn Lakes are not impaired for parameters addressed in this TMDL. The term "watershed" is also used more generally to refer to the land area that contributes precipitation runoff that eventually drains to the mouth of the Twelvepole Creek.

TMDL Watershed

This term is used to describe the total land area draining to an impaired stream for which a TMDL is being developed. This term also takes into account the land area drained by un-impaired tributaries of the impaired stream, and may include impaired tributaries for which additional TMDLs are presented. This report addresses 194 impaired streams contained within 17 TMDL watersheds in the Twelvepole Creek watershed.

Subwatershed

The subwatershed delineation is the most detailed scale of the delineation that breaks each TMDL watershed into numerous catchments for modeling purposes. The TMDL watershed have been subdivided into 446 modeled subwatersheds. Pollutant sources, allocations and reductions are presented at the subwatershed scale to facilitate future permitting actions and TMDL implementation.

Assessment Units

Assessment units are the smallest reach of a stream for which attainment of water quality standards is assessed and reported by the WVDEP in the USEPA Assessment, Total Maximum Daily Load Tracking and Implementation System (ATTAINS). Assessment unit designations appearing in this TMDL will be utilized in future reports in ATTAINS. Assessment unit identifiers (AUIDs) are created by combining NHD codes with an ordering system following a top-down schema with "01" being in the headwaters and orders increasing downstream.

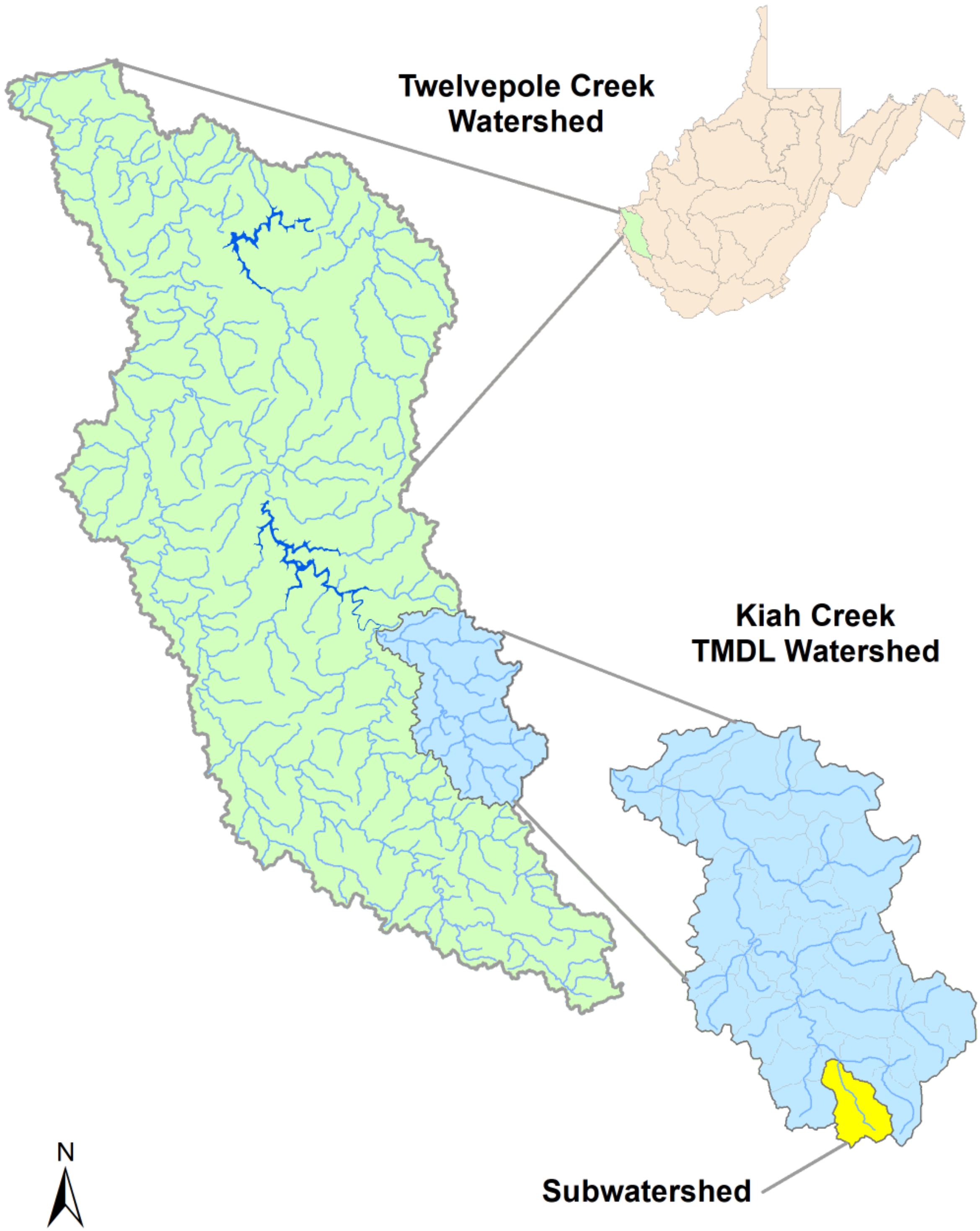


Figure I-1. Examples of a watershed and subwatershed

EXECUTIVE SUMMARY

This report includes Total Maximum Daily Loads (TMDLs) for 194 impaired streams in the Twelvepole Creek watershed. This project was organized into 17 TMDL watersheds, which account for all streams draining to the Twelvepole Creek. TMDLs are presented for assessment units. Assessment units are the smallest reach of the stream for which attainment of water quality standards is assessed and reported by the WVDEP in the USEPA Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS). Assessment unit designations appearing in this TMDL will be utilized in future reports in ATTAINS. Depending upon the size of the drainage area and predominant land uses, some streams may be broken down into multiple assessment units.

A TMDL establishes the maximum allowable pollutant loading for a waterbody to comply with water quality standards, distributes the load among pollutant sources, and provides a basis for actions needed to restore water quality. West Virginia's water quality standards are codified in Title 47 of the *Code of State Rules* (CSR), Series 2, and titled *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*. The standards include designated uses of West Virginia waters and numeric and narrative criteria to protect those uses. The West Virginia Department of Environmental Protection routinely assesses use support by comparing observed water quality data with criteria and reports impaired waters every two years as required by Section 303(d) of the Clean Water Act ("303(d) list"). The Act requires that TMDLs be developed for listed impaired waters.

Many of the impaired streams are included on the West Virginia's 2016 Section 303(d) List. Documented impairments are related to numeric water quality criteria for total iron, pH, aluminum, selenium, beryllium, dissolved oxygen, and fecal coliform bacteria. The narrative water quality criterion of 47 CSR 2–3.2.i prohibits the presence of wastes in state waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, and biological components of aquatic ecosystems. Historically, WVDEP based assessment of biological integrity on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index (WVSCI). WVSCI-based "biological impairments" were included on West Virginia Section 303(d) lists from 2002 through 2010.

In 2012, legislative action (codified in §22-11-7b) directed the agency to develop and secure legislative approval of new rules to interpret the narrative criterion for biological impairment found in 47 CSR 2-3.2.i.

§22-11-7b indicates, rules promulgated may not establish measurements that would establish standards less protective than requirements that existed during the 2012 regular session. Thus, WVDEP has continued to list biological impairment based on WVSCI for subsequent 303d lists, including the most recent list in 2016. In response to the legislation, WVDEP prepared a procedural rule (47 CSR 2B) in 2019 establishing the methodology for determining compliance with the biological component of narrative criteria. A public comment period extended through May 6, 2019 and a public hearing was held the same day. Response to comment and final filing was delayed, requiring that the same procedural rule be proposed again in 2020. The public comment period ran through April 20, 2020 and a public hearing was held the same day. At the time of this TMDL completion, WVDEP was responding to comments and preparing to finalize

the procedural rule. WVDEP has suspended biological impairment TMDL development pending approval of the procedural rule.

Although "biological impairment" TMDLs are not presented in this project, assessment units for which available benthic information demonstrates non-attainment of the threshold described in the assessment methodology presented in 47CSR2B, were subjected to a biological stressor identification (SI) process. The results of the SI process are discussed in **Section 4** of this report and displayed in **Appendix K** of the Technical Report. **Section 4** of this report also discusses the relationship of the pollutant-specific TMDLs developed herein to WVSCI-based biological impacts.

Impaired waters were organized into 17 TMDL watersheds. For hydrologic modeling purposes, watersheds of impaired and unimpaired streams were further divided into 446 smaller subwatershed units. The subwatershed delineation provided a basis for georeferencing pertinent source information, monitoring data, and presentation of the TMDLs.

The Mining Data Analysis System (MDAS) was used to represent linkage between pollutant sources and instream responses for fecal coliform bacteria, pH, aluminum, selenium, and iron. The MDAS is a comprehensive data management and modeling system that is capable of representing loads from nonpoint and point sources in the watershed and simulating instream processes.

In general, point and nonpoint sources contribute to the fecal coliform bacteria impairments in the watershed. Failing on-site septic systems, direct discharges of untreated sewage, and precipitation runoff from agricultural and residential areas are nonpoint sources of fecal coliform bacteria. Point sources of fecal coliform bacteria include the effluents of sewage treatment facilities public and private. The presence of individual source categories and their relative significance varies by subwatershed.

There are two dissolved oxygen impairments in two TMDL watersheds. In general, sources contributing to dissolved oxygen impairments are the same as those for fecal coliform. Because of the effect of reducing organic loadings, the fecal coliform TMDLs developed by WVDEP are appropriate surrogates for the dissolved oxygen impairment for these streams.

Iron impairments are also attributable to both point and nonpoint sources. Nonpoint sources of iron include roads, oil and gas operations, timbering, agriculture, urban/residential land disturbance and streambank erosion. Iron point sources include the permitted discharges from industrial stormwater and construction sites. The presence of individual source categories and their relative significance also varies by subwatershed. Iron is a naturally-occurring element that is present in soils and the iron loading from many of the identified sources is associated with sediment contributions.

Four selenium impaired streams in three TMDL watersheds are addressed in this report. Active, reclaimed, and abandoned mining are dominant landuses in these TMDL watersheds and presumed to be the contributing sources of selenium.

The pH and dissolved aluminum impairments in the watershed are attributable to legacy mining (including abandoned mine lands and permitted bond forfeited sites). In certain watersheds with low buffering capacity, acidic precipitation decreases pH below the pH criterion. Decreased pH may in turn increase the portion of aluminum in solution and result in exceedances of the dissolved aluminum criterion. Atmospheric deposition was not found to be a causative source of impairment as effects are mitigated by available watershed buffering capacity. All active mining sources were represented. Prescribed WLAs were not more stringent than existing NPDES permit limits. Abandoned mine land sources (seeps) are a source of dissolved aluminum and acidity resulting in criteria impairments. In most cases, the acidic pH impairments coincide with overlapping metals impairments and the TMDLs for pH impairments were developed using an approach where instream metal (iron and aluminum) concentrations were reduced for attainment of iron and aluminum water quality criteria coupled with direct pollutant reductions to offset acid load from acid precipitation and legacy mine sources. Pollutant reductions are measured and expressed in the amount of alkalinity needed to offset the acid load.

One beryllium impaired stream, Left Fork/Camp Creek (NHD: WV-OT-45-Q-2), in one TMDL watershed is addressed in this report. Beryllium exceedances were only detected in this stream when the pH was less than 5 and where legacy mining influences were prevalent. This is the most likely source of beryllium and acidity. The most elevated beryllium exceedances were observed during low flow conditions. Acidity abatement pursuant to the pH TMDLs will create instream pH conditions that limit the solubility of beryllium to the point where the beryllium water quality criterion will be attained. Thus the 2009 pH TMDL for Left Fork/Camp Creek will serve as a surrogate for beryllium water quality criterion nonattainment.

This report describes the TMDL development and modeling processes, identifies impaired streams and existing pollutant sources, discusses future growth and TMDL achievability, and documents the public participation associated with the process. This report also contains a detailed discussion of the allocation methodologies applied for various impairments. Various provisions attempt to ensure the attainment of criteria throughout the watershed, achieve equity among categories of sources, and target pollutant reductions from the most problematic sources. Nonpoint source reductions were not specified beyond natural (background) levels. Similarly, point source WLAs were no more stringent than numeric water quality criteria.

In 2009, WVDEP developed TMDLs for pH, metals, and fecal coliform, and biological impairments for impaired streams in the Camp Creek Watershed (WVDEP, 2009). Camp Creek is a tributary of East Fork/Twelvepole Creek. In total, TMDLs were developed for 5 streams within the Camp Creek Watershed. Iron, aluminum, pH, fecal coliform, and biological impairments were addressed. In this project, fecal coliform TMDLs developed in 2009 for Left Fork/Camp Creek (WV-OT-45-Q-2) and Tiger Fork (WV-OT-45-Q-2-A) have been re-evaluated. New TMDLs are presented for current identified fecal coliform impairments. Likewise, the 2009 iron TMDL for Left Fork/Camp Creek (WV-OT-45-Q-2) has been re-evaluated and a new TMDL is presented in this project. Appendix A provides details of which previous TMDLs remain in effect from 2009 in the Twelvepole Creek Watershed and which are superseded by TMDLs in this project.

Considerable resources were used to acquire recent water quality and pollutant source information upon which the TMDLs are based. TMDL modeling is among the most sophisticated methods available, and incorporates sound scientific principles. TMDL outputs are presented in various formats to assist user comprehension and facilitate use in implementation, including allocation spreadsheets, an ArcGIS Viewer Project, and a Technical Report.

Applicable TMDLs are displayed in **Section 10** of this report. The accompanying spreadsheets provide TMDLs and allocations of loads to categories of point and nonpoint sources that achieve the total TMDL.

Also provided is the ESRI Online Viewer Tool at https://arcg.is/1TWiij that allows for the exploration of spatial relationships among the source assessment data. A Technical Report is available that describes the detailed technical approaches used in the process and displays the data upon which the TMDLs are based.

1.0 REPORT FORMAT

The following report describes the overall total maximum daily load (TMDL) development process for select streams in the Twelvepole Creek watershed, identifies impaired streams, and outlines the source assessment for all pollutants for which TMDLs are presented. Also described are the modeling process, allocation approach, and measures that will be taken to ensure that the TMDLs are met. The applicable TMDLs are displayed in **Section 10** of this report. An ArcGIS Viewer Project supports this report by providing further details on the data and allows the user to explore the spatial relationships among the source assessment data, magnify streams and view other features of interest. In addition to the TMDL report, spreadsheets (in Microsoft Excel format) that display detailed source allocations associated with successful TMDL scenarios are provided. A Technical Report is included that describes the detailed technical approaches used in the process and displays the data upon which the TMDLs are based.

2.0 INTRODUCTION

The West Virginia Department of Environmental Protection (WVDEP), Division of Water and Waste Management (DWWM), is responsible for the protection, restoration, and enhancement of the State's waters. Along with this duty comes the responsibility for TMDL development in West Virginia.

2.1 Total Maximum Daily Loads

Section 303(d) of the federal Clean Water Act and the U.S. Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (at Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to identify waterbodies that do not meet water quality standards and to develop appropriate TMDLs. A TMDL establishes the maximum allowable pollutant loading for a waterbody to achieve compliance with applicable standards. It also distributes the load among pollutant sources and provides a basis for the actions needed to restore water quality.

A TMDL is 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), implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. TMDLs can be expressed in terms of mass per time or other appropriate units. Conceptually, this definition is denoted by the following equation:

$$\text{TMDL} = \text{sum of WLAs} + \text{sum of LAs} + \text{MOS}$$

WVDEP typically develops TMDLs in concert with a geographically-based approach to water resource management in West Virginia—the Watershed Management Framework. Adherence to the Framework ensures efficient and systematic TMDL development. Using the framework, each year, TMDLs are developed in specific geographic areas. In order to address priorities on the 303d list, WVDEP deviated from the framework for this TMDL project in Group E for the Big

Sandy, Lower Ohio, and Twelvepole Creek watersheds. **Figure 2-1** depicts the hydrologic groupings of West Virginia's watersheds.

WVDEP is committed to implementing a TMDL process that reflects the requirements of the TMDL regulations, provides for the achievement of water quality standards, and ensures that ample stakeholder participation is achieved in the development and implementation of TMDLs. A 48-month development process enables the agency to carry out an extensive data generating and gathering effort to produce scientifically defensible TMDLs. It also allows ample time for modeling, report finalization, and frequent public participation opportunities.

The TMDL development process begins with pre-TMDL water quality monitoring and source identification and characterization. Informational public meetings are held in the affected watersheds. Data obtained from pre-TMDL efforts are compiled, and the impaired waters are modeled to determine baseline conditions and the gross pollutant reductions needed to achieve water quality standards. The draft TMDL is advertised for public review and comment, and an informational meeting is held during the public comment period. Public comments are addressed, and the draft TMDL is submitted to USEPA for approval.

In 2009, WVDEP developed TMDLs for pH, metals, and fecal coliform, and biological impairments for impaired streams in the Camp Creek Watershed (WVDEP, 2009). Camp Creek is a tributary of East Fork/Twelvepole Creek. In total, TMDLs were developed for 5 streams within the Camp Creek Watershed. Iron, aluminum, pH, fecal coliform, and biological impairments were addressed. In this project, fecal coliform TMDLs developed in 2009 for Left Fork/Camp Creek (WV-OT-45-Q-2) and Tiger Fork (WV-OT-45-Q-2-A) have been re-evaluated. New TMDLs are presented for current identified fecal coliform impairments. Likewise, the 2009 iron TMDL for Left Fork/Camp Creek (WV-OT-45-Q-2) has been re-evaluated and a new TMDL is presented in this project. **Appendix A** provides details of which previous TMDLs remain in effect from 2009 in the Twelvepole Creek Watershed and which are superseded by TMDLs in this project.

Appendix A of the Technical Report lists TMDLs by pollutant and waterbody developed for this effort.

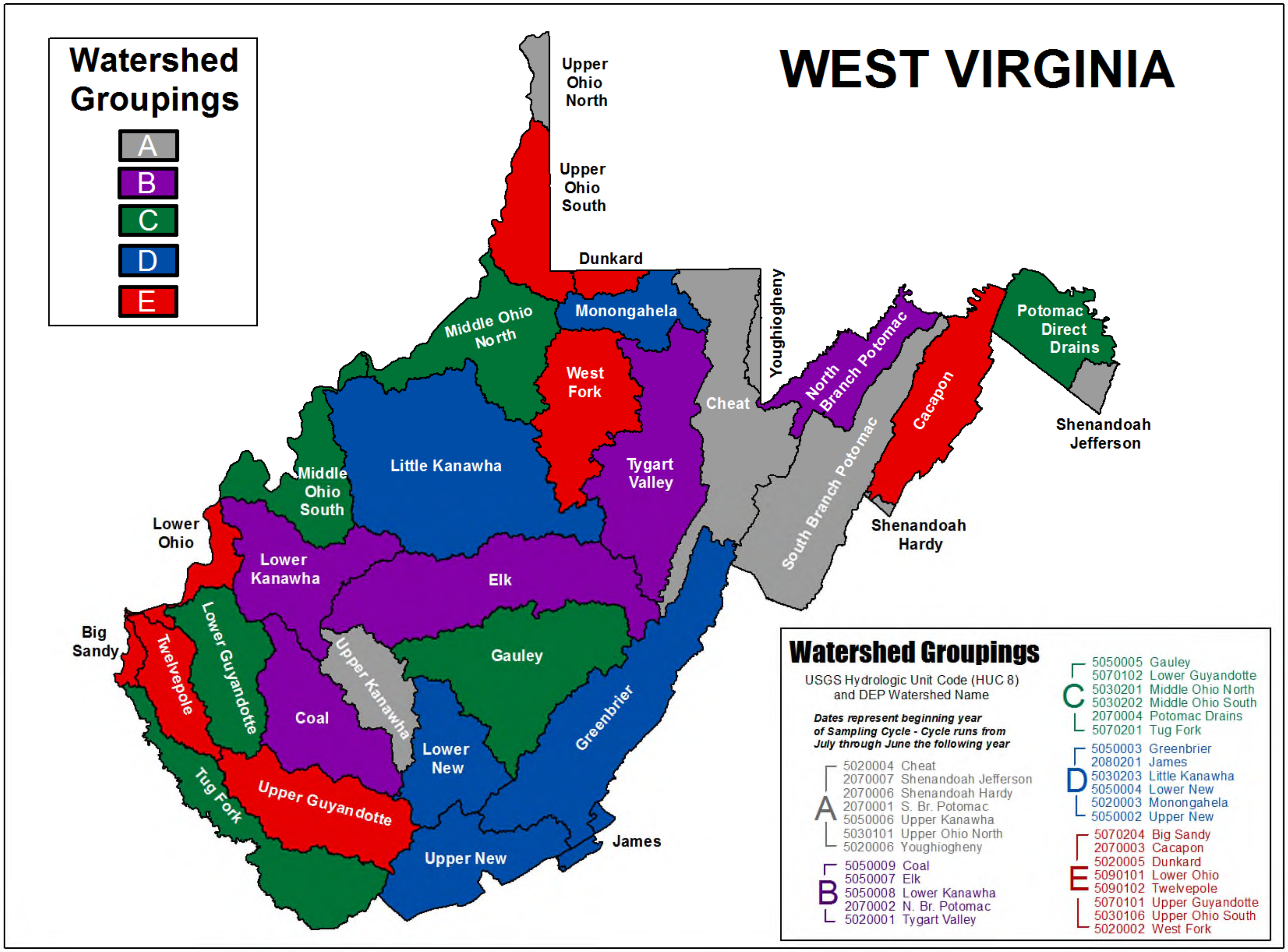


Figure 2-1. Hydrologic groupings of West Virginia's watersheds

2.2 Water Quality Standards

The determination of impaired waters involves comparing instream conditions to applicable water quality standards. West Virginia's water quality standards are codified in Title 47 of the *Code of State Rules* (CSR), Series 2, titled *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*. These standards can be obtained online from the West Virginia Secretary of State Internet site (http://apps.sos.wv.gov/adlaw/csr/rule.aspx?rule=47-02.)

Water quality standards consist of three components: designated uses; narrative and/or numeric water quality criteria necessary to support those uses; and an antidegradation policy. Appendix E of the Standards contains the numeric water quality criteria for a wide range of parameters, while Section 3 of the Standards contains the narrative water quality criteria.

According to 40 CFR Part 130, TMDLs must be designed to implement applicable water quality standards. The TMDLs presented herein are based upon the water quality criteria that are currently effective. If the West Virginia Legislature adopts Water Quality Standard revisions that alter the basis upon which the TMDL is developed, then the TMDL and allocations may be modified as warranted. Any future Water Quality Standard revision and/or TMDL modification must receive USEPA approval prior to implementation.

Designated uses in the Twelvepole Creek watershed include: propagation and maintenance of aquatic life in warmwater fisheries, water contact recreation, and public water supply. There are no trout waters identified in the Twelvepole Creek watershed. In various streams in the Twelvepole Creek watershed, warmwater fishery aquatic life use impairments have been determined pursuant to exceedances of dissolved oxygen, dissolved aluminum, total iron, total selenium, and/or pH numeric water quality criteria. Water contact recreation and/or public water supply use impairments have also been determined in various waters pursuant to exceedances of numeric water quality criteria for fecal coliform bacteria, pH, dissolved aluminum, total selenium, total beryllium, and total iron.

All West Virginia waters are subject to the narrative criteria in Section 3 of the Standards. That section, titled "Conditions Not Allowable in State Waters," contains various general provisions related to water quality. The narrative water quality criterion at Title 47 CSR Series 2 – 3.2.i prohibits the presence of wastes in state waters that cause or contribute to significant adverse impacts to the chemical, physical, hydrologic, and biological components of aquatic ecosystems. This provision has historically been the basis for "biological impairment" determinations. Recent legislation has altered procedures used by WVDEP to assess biological integrity and, therefore, biological impairment TMDLs are not being developed. The legislation and related issues are discussed in detail in **Section 4** of this report.

The numeric water quality criteria applicable to the impaired streams addressed by this report are summarized in **Table 2-1**. The stream-specific impairments related to numeric water quality criteria are displayed in **Table 3-3**.

Table 2-1. Applicable West Virginia water quality criteria

POLLUTANT	USE DESIGNATION				
	Aquatic Life				**Human Health**
	Warmwater Fisheries		**Troutwaters**		**Contact Recreation[3]/Public Water Supply[4]**
	Acute[1]	**Chronic[2]**	**Acute[1]**	**Chronic[2]**	
Aluminum, dissolved (µg/L)	750	750	750	87	--
Iron, total (mg/L)	--	1.5	--	1.0	1.5
Beryllium, total (µg/L)	130		130		4 (µg/L)
Dissolved oxygen	Not less than 5 mg/L at any time	Not less than 5 mg/L at any time	Not less than 6 mg/L at any time	Not less than 6 mg/L at any time	Not less than 5 mg/L at any time
Selenium, total (µg/L) [f]		5		5	50
8.27.1 Selenium (ug/g) [g] (based on instantaneous measurement) 8.0 ug/g Fish Whole-Body Concentration or 11.3 ug/g Fish Muscle (skinless, boneless filet)		--		--	
Selenium (ug/g) Fish Egg/Ovary Concentration [h] (based on instantaneous measurement)		15.8		15.8	
pH	No values below 6.0 or above 9.0				
Fecal coliform bacteria	**Human Health Contact Recreation/Public Water Supply**: Maximum allowable level of fecal coliform content for Primary Contact Recreation (either MPN [most probable number] or MF [membrane filter counts/test]) shall not exceed 200/100 mL as a monthly geometric mean based on not less than 5 samples per month; nor to exceed 400/100 mL in more than 10 percent of all samples taken during the month.				

[1] One-hour average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
[2] Four-day average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
[3] These criteria have been calculated to protect human health from toxic effects through fish consumption, unless otherwise noted. Annual geometric mean concentration not to be exceeded, unless otherwise noted.
[4] These criteria have been calculated to protect human health from toxic and/or organoleptic effects through drinking water and fish consumption, unless otherwise noted. Annual geometric mean concentration not to be exceeded, unless otherwise noted.
Source: 47 *CSR*, Series 2, *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*.
[f] Water column values take precedence over fish tissue values when new inputs of selenium occur in waters previously unimpacted by selenium, until equilibrium is reached between the water column and fish tissue.
[g] Overrides any water column concentration when water concentrations and either fish whole body or fish muscle (skinless, boneless filet) are measured, except in situations described in footnote [f]

[h] Overrides any fish whole-body, fish muscle (skinless, boneless filet), or water column concentration when fish egg/ovary concentrations are measured, except in situations described in footnote [f]

3.0 WATERSHED DESCRIPTION AND DATA INVENTORY

3.1 Watershed Description

Located within the Western Allegheny Plateau and Central Appalachian ecoregions, Twelvepole Creek is a tributary of the Ohio River, which joins the Mississippi and flows to the Gulf of Mexico. The Twelvepole Creek watershed consists of land draining to Twelvepole Creek and its east and west forks, which begin as headwater streams in northern Mingo County, and end at the confluence of Twelvepole Creek and the Ohio River in Ceredo, WV. Twelvepole Creek is approximately 32.5 miles (52.3 km) long from the confluence of the east and west forks to the Ohio River, and its watershed encompasses 442.1 square miles (1145.1 km^2). Two major tributaries of Twelvepole Creek have been dammed to create two large lakes. Beech Fork has been dammed to create Beech Fork Lake, and the East Fork of Twelvepole Creek has been dammed to create East Lynn Lake. For TMDL purposes, each lake is considered an independent water body. Neither lake is considered impaired for metals or fecal coliform bacteria and does not receive TMDL allocations. Flow and pollutant loads from Beech Fork and East Lynn Lakes were included in the modeling effort for TMDL development for receiving waters (Beech Fork and East Fork/Twelvepole Creek, respectively) immediately downstream of the lakes.

The Twelvepole Creek watershed occupies more than half of Wayne County, as well as portions of Cabell, Lincoln, and Mingo Counties (Figure 3-1). Cities and towns in the study area are Huntington, Ceredo, Lavalette, Wayne, and East Lynn. The highest point in the Twelvepole Creek watershed is 1,845 feet above sea level on an unnamed ridge above the headwaters of the East Fork of Twelvepole Creek. The lowest point in the watershed is 516 feet at the confluence of Twelvepole Creek and the Ohio River near the City of Ceredo. The average elevation in the watershed is 935 feet. Major tributaries of Twelvepole Creek include Beech Fork, Kiah Creek, East Fork of Twelvepole Creek and West Fork of Twelvepole Creek. The total population living in the subject watersheds of this report is estimated to be 30,000 people.

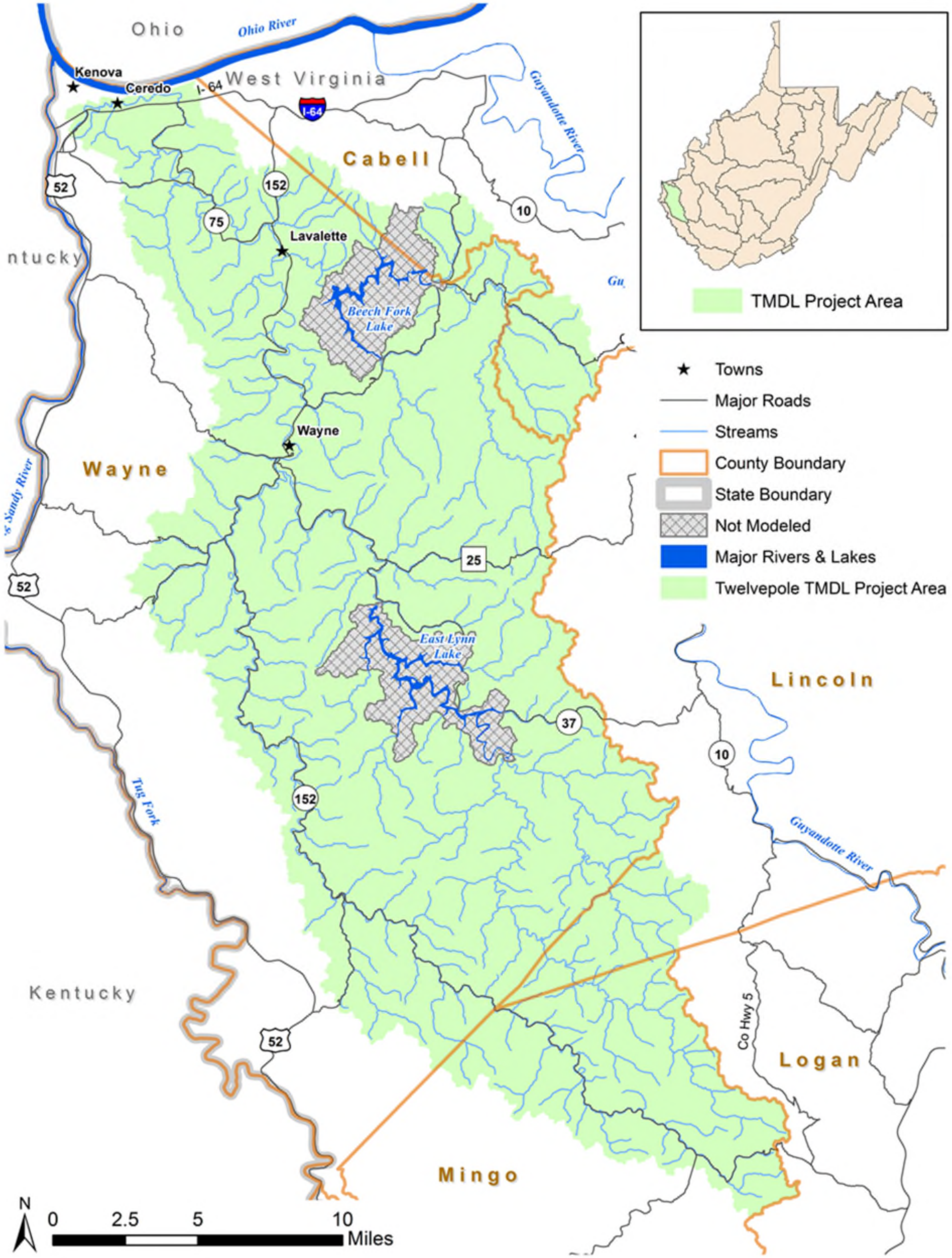


Figure 3-1. Location of the Twelvepole Creek watershed TMDL Project Area in West Virginia

Landuse and land cover estimates were originally obtained from vegetation data gathered from the National Land Cover Dataset (NLCD) (USGS 2011). The Multi-Resolution Land Characteristics Consortium (MRLC) produced the NLCD coverage. The NLCD database for West Virginia was derived from satellite imagery taken during the mid-2000s, and it includes detailed vegetative spatial data. Enhancements and updates to the NLCD coverage were made to create a modeled landuse by custom edits derived primarily from WVDEP source tracking information and 2016 aerial photography with 1-meter resolution. Additional information regarding the NLCD spatial database is provided in **Appendix D** of the Technical Report.

Table 3-1 displays the landuse distribution for the TMDL watersheds derived from NLCD as described above. The dominant landuse is forest, which constitutes 77.77 percent of the total landuse area. Other important modeled landuse types are grassland (9.31 percent), mining/quarry (4.5 percent) urban/residential (4.34 percent), forestry (2.23 percent). Individually, all other land cover types compose less than one percent of the total watershed area each.

Table 3-1. Modified landuse for the Twelvepole Creek TMDL watersheds

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
AML	16.06	0.03	0.01%
Barren	228.34	0.36	0.09%
Cropland	481.93	0.75	0.18%
Forest	204,959.72	320.25	77.77%
Forestry	5,889.48	9.20	2.23%
Grassland	24,525.79	38.32	9.31%
Mining/Quarry	11,855.83	18.52	4.50%
Oil and Gas	1,620.87	2.53	0.61%
Pasture	2,461.08	3.85	0.93%
Urban/Residential	11,426.73	17.85	4.34%
Water	95.51	0.15	0.04%

3.2 Data Inventory

Various sources of data were used in the TMDL development process. The data were used to identify and characterize sources of pollution and to establish the water quality response to those sources. Review of the data included a preliminary assessment of the watershed's physical and socioeconomic characteristics and current monitoring data. **Table 3-2** identifies the data used to support the TMDL assessment and modeling effort. These data describe the physical conditions of the TMDL watersheds, the potential pollutant sources and their contributions, and the impaired waterbodies for which TMDLs need to be developed. Prior to TMDL development, WVDEP collected comprehensive water quality data throughout the watershed. This pre-TMDL monitoring effort contributed the largest amount of water quality data to the process and is summarized in the Technical Report, **Appendix J**. The geographic information is provided in the ArcGIS Viewer Project.

Table 3-2. Datasets used in TMDL development

Type of Information		Data Sources
Watershed physiographic data	Stream network	USGS National Hydrography Dataset (NHD)
	Landuse	National Land Cover Dataset 2011 (NLCD)
	National Agriculture Imagery Program (NAIP) 2016 Aerial Photography (1-meter resolution)	U.S. Department of Agriculture (USDA)
	Counties	U.S. Census Bureau
	Cities/populated places	U.S. Census Bureau
	Soils	State Soil Geographic Database (STATSGO) USDA, Natural Resources Conservation Service (NRCS) soil surveys
	Hydrologic Unit Code boundaries	U.S. Geological Survey (USGS)
	Topographic and digital elevation models (DEMs)	National Elevation Dataset (NED)
	Dam locations	USGS
	Roads	2015 U.S. Census Bureau Topologically Integrated Geographic Encoding and Referencing database (TIGER), WVU WV Roads, West Virginia Trail Inventory (WVDOT)
	Water quality monitoring station locations	WVDEP
	Meteorological station locations	National Oceanic and Atmospheric Administration, National Climatic Data Center (NOAA-NCDC)
	Permitted facility information	WVDEP Division of Water and Waste Management (DWWM), WVDEP Division of Mining and Reclamation (DMR)
	Timber harvest data	WV Division of Forestry
	Oil and gas operations coverage	WVDEP Office of Oil and Gas (OOG)
	Abandoned mining coverage	WVDEP DMR
Monitoring data	Historical Flow Record (daily averages)	USGS
	Rainfall	NOAA-NCDC
	Temperature	NOAA-NCDC
	Wind speed	NOAA-NCDC
	Dew point	NOAA-NCDC
	Humidity	NOAA-NCDC
	Cloud cover	NOAA-NCDC

Type of Information		Data Sources
	Grid-scale radar observations with climatologically-aided interpolation of complex climate regimes	Parameter-Elevation Regressions on Independent Slopes Model (PRISM), North American Land Data Assimilation System (NLDAS-2)
	Water quality monitoring data	WVDEP
	National Pollutant Discharge Elimination System (NPDES) data	WVDEP DMR, WVDEP DWWM
	Discharge Monitoring Report data	WVDEP DMR, Mining Companies
	Abandoned mine land data	WVDEP DMR, WVDEP DWWM
Regulatory or policy information	Applicable water quality standards	WVDEP
	Section 303(d) list of impaired waterbodies	WVDEP, USEPA
	Nonpoint Source Management Plans	WVDEP

3.3 Impaired Waterbodies

WVDEP conducted extensive water quality monitoring throughout the Twelvepole Creek watershed from 2016 through 2017. The results of that effort were used to confirm the impairments of waterbodies identified on previous 303(d) lists and to identify other impaired waterbodies that were not previously listed.

In this TMDL development effort, modeling at baseline conditions demonstrated additional pollutant impairments to those identified via monitoring. The prediction of impairment through modeling is validated by applicable federal guidance for 303(d) listing. WVDEP could not perform water quality monitoring and source characterization at frequencies or sample location resolution sufficient to comprehensively assess water quality under the terms of applicable water quality standards, and modeling was needed to complete the assessment. Where existing pollutant sources were confidently predicted to cause noncompliance with a particular criterion, the subject water was characterized as impaired for that pollutant.

TMDLs were developed for impaired waters in 17 TMDL watersheds (**Figure 3-2**). The impaired waters for which TMDLs have been developed are presented in **Table 3-3**. The table includes the TMDL watershed, stream code, stream name, and impairments for each stream.

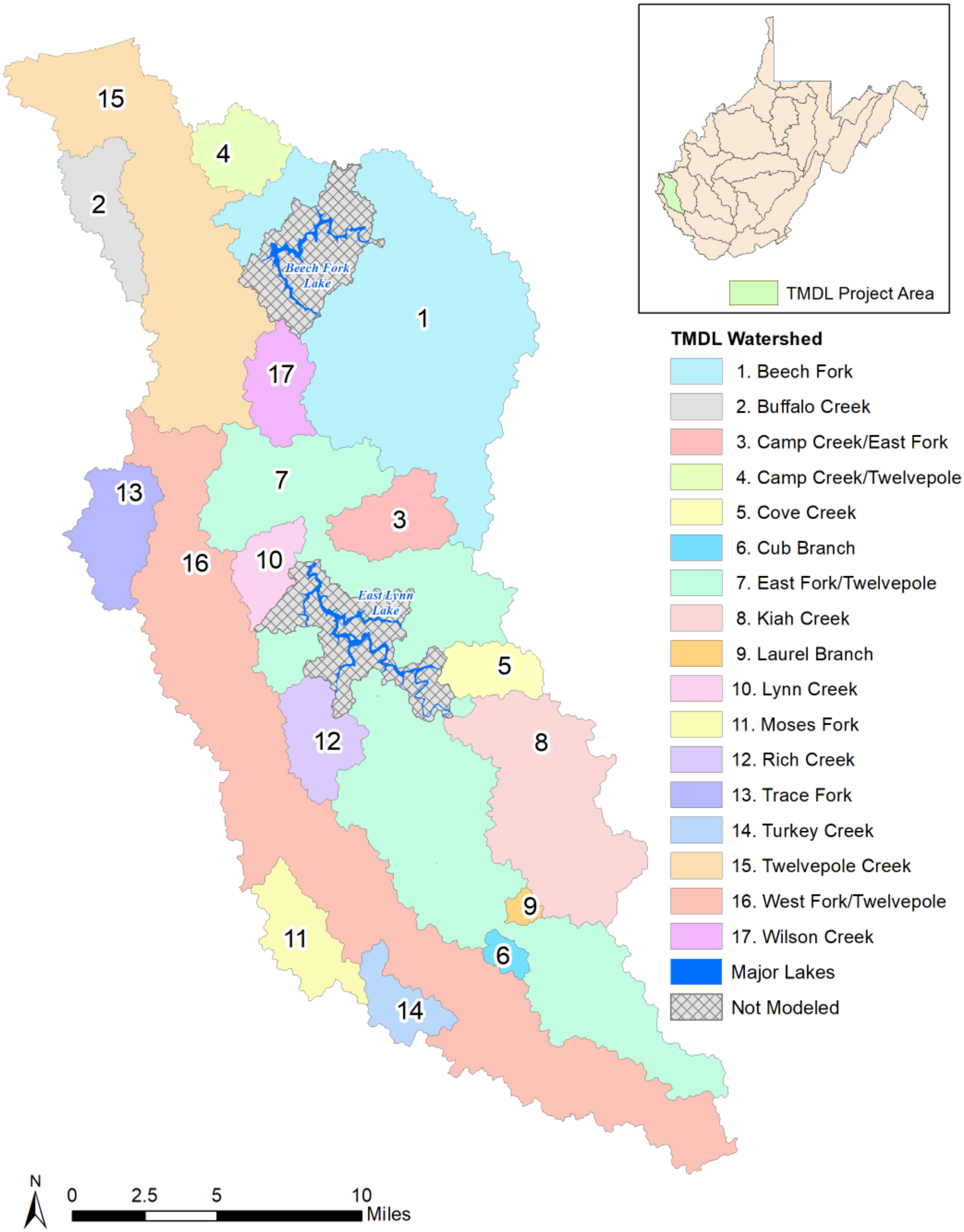


Figure 3-2. Twelvepole Creek TMDL Watersheds

Table 3-3. Waterbodies and impairments for which TMDLs have been developed.

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
Twelvepole Creek	WV-OT	Twelvepole Creek	WVO-2			X				X
Twelvepole Creek	WV-OT-1	Krout Creek	WVO-2-0.1A			M				X
Twelvepole Creek	WV-OT-4	Jordans Branch	WVO-2-0.5A			M				X
Twelvepole Creek	WV-OT-4-A	UNT/Jordans Branch RM 0.86				M				
Twelvepole Creek	WV-OT-5	UNT/Twelvepole Creek RM 2.97				M				
Twelvepole Creek	WV-OT-7	Walker Branch	WVO-2-A			M				X
Twelvepole Creek	WV-OT-8	UNT/Twelvepole Creek RM 5.72	WVO-2-A.1			M				X
Twelvepole Creek	WV-OT-10	Bobs Branch	WVO-2-B			M				X
Buffalo Creek	WV-OT-12	Buffalo Creek	WVO-2-C			M				X
Buffalo Creek	WV-OT-12-D	UNT/Buffalo Creek RM 2.21	WVO-2-C-4			M				X
Buffalo Creek	WV-OT-12-F	UNT/Buffalo Creek RM 3.50	WVO-2-C-6			M				X
Twelvepole Creek	WV-OT-14	Haneys Branch	WVO-2-D			M				
Twelvepole Creek	WV-OT-15	Plymale Branch	WVO-2-E			M				
Twelvepole Creek	WV-OT-15-C	UNT/Plymale Branch RM 0.61				M				
Twelvepole Creek	WV-OT-16	UNT/Twelvepole Creek RM 11.09				M				
Twelvepole Creek	WV-OT-17	UNT/Twelvepole Creek RM 11.90	WVO-2-E.6			M				X
Twelvepole Creek	WV-OT-18	UNT/Twelvepole Creek RM 13.38				M				
Twelvepole Creek	WV-OT-19	Newcomb Creek	WVO-2-F			M				
Camp Creek	WV-OT-21	Camp Creek	WVO-2-G		X	M				X
Camp Creek	WV-OT-21-A	UNT/Camp Creek RM 0.30				M				

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
Camp Creek	WV-OT-21-B	Right Fork/Camp Creek	WVO-2-G-1			M				X
Camp Creek	WV-OT-21-B-2	UNT/Right Fork RM 0.66/Camp Creek	WVO-2-G-1-B			M				X
Camp Creek	WV-OT-21-B-5	UNT/Right Fork RM 1.97/Camp Creek				M				
Camp Creek	WV-OT-21-D	UNT/Camp Creek RM 1.16	WVO-2-G-1.4			M				X
Beech Fork	WV-OT-24	Beech Fork	WVO-2-H		X	X				X
Beech Fork	WV-OT-24-C	UNT/Beech Fork RM 2.38	WVO-2-H-0.4			M				X
Beech Fork	WV-OT-24-D	Mays Branch	WVO-2-H-0.5			M				X
Beech Fork	WV-OT-24-H	Millers Fork	WVO-2-H-2			M				X
Beech Fork	WV-OT-24-H-12	Fisher Bowen Branch	WVO-2-H-2-C			M				X
Beech Fork	WV-OT-24-H-18	Left Fork/Millers Fork	WVO-2-H-2-D			M				X
Beech Fork	WV-OT-24-H-22	Fraley Fork	WVO-2-H-2-F			M				X
Beech Fork	WV-OT-24-U	Moxley Branch	WVO-2-H-6							X
Beech Fork	WV-OT-24-V	Long Branch	WVO-2-H-7			M				X
Beech Fork	WV-OT-24-V.2	Moxley Branch	WVO-2-H-7.2			M				
Beech Fork	WV-OT-24-V-3	Camp Branch	WVO-2-H-7-A			M				
Beech Fork	WV-OT-24-V-5	UNT/Long Branch RM 2.43				M				
Beech Fork	WV-OT-24-X	Butler Branch	WVO-2-H-8			M				
Beech Fork	WV-OT-24-AB	Grassy Lick	WVO-2-H-10			M				
Beech Fork	WV-OT-24-AD	Bowen Creek	WVO-2-H-11			M				X
Beech Fork	WV-OT-24-AI	Raccoon Creek	WVO-2-H-12			M				X
Beech Fork	WV-OT-24-AI-4	UNT/Raccoon Creek RM 2.20				M				
Beech Fork	WV-OT-24-AY	Wolfpen Branch	WVO-2-H-19			M				X
Beech Fork	WV-OT-24-AU	Right Fork/Beech Fork	WVO-2-H-18			M				X
Beech Fork	WV-OT-24-BC	Turkeycamp Branch	WVO-2-H-20			M				

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
Beech Fork	WV-OT-24-BG	Nestlow Branch	WVO-2-H-21			M				
Twelvepole Creek	WV-OT-26	Lynn Creek	WVO-2-I			M				X
Twelvepole Creek	WV-OT-35	Big Creek	WVO-2-K			M				X
Twelvepole Creek	WV-OT-37	Garrett Creek	WVO-2-L			M				X
Twelvepole Creek	WV-OT-38	Shoal Branch	WVO-2-M			M				X
Wilson Creek	WV-OT-39	Wilson Creek	WVO-2-N			M				X
Wilson Creek	WV-OT-39-A	Left Fork/Wilson Creek	WVO-2-N-1			M				X
Wilson Creek	WV-OT-39-A-1	Middle Fork/Left Fork/Wilson Creek	WVO-2-N-1-A			M				
Twelvepole Creek	WV-OT-44	Toms Creek	WVO-2-O			M				X
East Fork/Twelvepole Creek	WV-OT-45	East Fork/Twelvepole Creek	WVO-2-Q			X				X
East Fork/Twelvepole Creek	WV-OT-45-E	Onemile Creek	WVO-2-Q-2			M				
East Fork/Twelvepole Creek	WV-OT-45-G	Twomile Creek	WVO-2-Q-3			M				
East Fork/Twelvepole Creek	WV-OT-45-G-3	UNT/Twomile Creek RM 1.00				M				
East Fork/Twelvepole Creek	WV-OT-45-L	Newcomb Creek	WVO-2-Q-5			M				X
East Fork/Twelvepole Creek	WV-OT-45-M	Petercave Branch	WVO-2-Q-6			M				X
East Fork/Twelvepole Creek	WV-OT-45-P	Little Lynn Creek	WVO-2-Q-7			M				
East Fork/Twelvepole Creek	WV-OT-45-P-2	Right Fork/Little Lynn Creek	WVO-2-Q-7-A			M				
Camp Creek	WV-OT-45-Q	Camp Creek	WVO-2-Q-8			BC			X	X
Camp Creek	WV-OT-45-Q-2	Left Fork/Camp Creek	WVO-2-Q-8-A					X*		XRe
Camp Creek	WV-OT-45-Q-2-A	Tiger Fork	WVO-2-Q-8-A-1							XRe
Camp Creek	WV-OT-45-Q-3	Right Fork/Camp Creek	WVO-2-Q-8-B						X	X
Lynn Creek	WV-OT-45-R	Lynn Creek	WVO-2-Q-9			M				X
Lynn Creek	WV-OT-45-R-1	Battern Fork	WVO-2-Q-9-A			M				X
Lynn Creek	WV-OT-45-R-4	Right Fork/Lynn Creek	WVO-2-Q-9-D			M				X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
Lynn Creek	WV-OT-45-R-5	Left Fork/Lynn Creek	WVO-2-Q-9-C			M				X
East Fork/Twelvepole Creek	WV-OT-45-W	Laurel Creek/East Fork	WVO-2-Q-10			M				X
East Fork/Twelvepole Creek	WV-OT-45-W-8	Stephens Fork	WVO-2-Q-10-A			M				
East Fork/Twelvepole Creek	WV-OT-45-Z	Brush Creek	WVO-2-Q-11			M				
East Fork/Twelvepole Creek	WV-OT-45-AD	Lick Creek	WVO-2-Q-12			M				
East Fork/Twelvepole Creek	WV-OT-45-AD-4	Right Fork/Lick Creek	WVO-2-Q-12-A			M				
Rich Creek	WV-OT-45-AG	Rich Creek	WVO-2-Q-14			X				
Rich Creek	WV-OT-45-AG-6	Geiger Branch	WVO-2-Q-14-0.8A			M				
Rich Creek	WV-OT-45-AG-7	Right Fork/Rich Creek	WVO-2-Q-14-A							X
Rich Creek	WV-OT-45-AG-8	Left Fork/Rich Creek	WVO-2-Q-14-B			M				
East Fork/Twelvepole Creek	WV-OT-45-AH	Beechy Branch	WVO-2-Q-15			M				X
East Fork/Twelvepole Creek	WV-OT-45-AJ	Bluelick Branch	WVO-2-Q-16			M				
Cove Creek	WV-OT-45-AK	Cove Creek	WVO-2-Q-17			M				X
Cove Creek	WV-OT-45-AK-9	Trace Fork	WVO-2-Q-17-E							X
East Fork/Twelvepole Creek	WV-OT-45-AM	Alum Fork	WVO-2-Q-17.8			M				X
Kiah Creek	WV-OT-45-AN	Kiah Creek	WVO-2-Q-18			M				X
Kiah Creek	WV-OT-45-AN-3	Little Laurel Creek	WVO-2-Q-18-A			M				
Kiah Creek	WV-OT-45-AN-4	Hurricane Branch	WVO-2-Q-18-A.5			M				
Kiah Creek	WV-OT-45-AN-6	Big Laurel Creek	WVO-2-Q-18-B			M				X
Kiah Creek	WV-OT-45-AN-6-C	Dalton Fork	WVO-2-Q-18-B-1			M				
Kiah Creek	WV-OT-45-AN-11	Trough Fork	WVO-2-Q-18-C			M				X
Kiah Creek	WV-OT-45-AN-11-D	Vance Branch	WVO-2-Q-18-C-1			M				
Kiah Creek	WV-OT-45-AN-11-F	Tomblin Branch	WVO-2-Q-18-C-2			M				X
Kiah Creek	WV-OT-45-AN-16	Parker Branch	WVO-2-Q-18-D			M				

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
Kiah Creek	WV-OT-45-AN-16-A	Left Fork/Parker Branch	WVO-2-Q-18-D-1			M				
Kiah Creek	WV-OT-45-AN-16-B	Sumate Fork	WVO-2-Q-18-D-2			M				
Kiah Creek	WV-OT-45-AN-20	Rollem Fork	WVO-2-Q-18-E			M				
Kiah Creek	WV-OT-45-AN-20-C	UNT/Rollem Fork RM 0.92	WVO-2-Q-18-E-3			M				
Kiah Creek	WV-OT-45-AN-21	Frances Creek	WVO-2-Q-18-F			M				X
Kiah Creek	WV-OT-45-AN-21-D	Pretty Branch	WVO-2-Q-18-F-1			M				X
Kiah Creek	WV-OT-45-AN-21-E	Sandlick Branch	WVO-2-Q-18-F-2			M				
Kiah Creek	WV-OT-45-AN-22	Witcher Fork	WVO-2-Q-18-F.2			M				X
Kiah Creek	WV-OT-45-AN-24	Copley Trace Branch	WVO-2-Q-18-G			M			X	X
Kiah Creek	WV-OT-45-AN-25	Jims Branch	WVO-2-Q-18-H			M				X
Kiah Creek	WV-OT-45-AN-26	UNT/Kiah Creek RM 11.84	WVO-2-Q-18-I			M				
East Fork/Twelvepole Creek	WV-OT-45-AS	Milam Creek	WVO-2-Q-20			M				
East Fork/Twelvepole Creek	WV-OT-45-AS-3	Queenscamp Branch	WVO-2-Q-20-A			M				
East Fork/Twelvepole Creek	WV-OT-45-AS-4	Little Milam Creek	WVO-2-Q-20-B			M				
East Fork/Twelvepole Creek	WV-OT-45-AS-5	Honeytrace Fork	WVO-2-Q-20-C			M				
East Fork/Twelvepole Creek	WV-OT-45-AY	Spry Branch	WVO-2-Q-21.8			M				
East Fork/Twelvepole Creek	WV-OT-45-BA	Devilstrace Branch	WVO-2-Q-21.9			X				
East Fork/Twelvepole Creek	WV-OT-45-BD	Maynard Branch	WVO-2-Q-23			M				X
East Fork/Twelvepole Creek	WV-OT-45-BG	McComas Branch	WVO-2-Q-24			M				X
East Fork/Twelvepole Creek	WV-OT-45-BH	Frank Branch	WVO-2-Q-24.2			M				X
East Fork/Twelvepole Creek	WV-OT-45-BJ	Cranes Nest Branch	WVO-2-Q-25			M				
East Fork/Twelvepole Creek	WV-OT-45-BK	Bluewater Branch	WVO-2-Q-26			XDMR				
East Fork/Twelvepole Creek	WV-OT-45-BP	Wiley Branch	WVO-2-Q-28			M				

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
East Fork/Twelvepole Creek	WV-OT-45-BP-1	UNT/Wiley Branch RM 0.72	WVO-2-Q-28-A			M				
East Fork/Twelvepole Creek	WV-OT-45-BQ	Honey Branch	WVO-2-Q-29			M				
Laurel Branch	WV-OT-45-BS	Laurel Branch	WVO-2-Q-30			M				
Laurel Branch	WV-OT-45-BS-1	UNT/Laurel Branch RM 0.34	WVO-2-Q-30-A			M			X DMR	
Cub Branch	WV-OT-45-BT	Cub Branch	WVO-2-Q-31			M				X
Cub Branch	WV-OT-45-BT-1	Right Fork/Cub Branch	WVO-2-Q-31-A			M				X
East Fork/Twelvepole Creek	WV-OT-45-BU	UNT/East Fork RM 38.31/Twelvepole Creek	WVO-2-Q-31.8			M				X
East Fork/Twelvepole Creek	WV-OT-45-BV	Andy Branch	WVO-2-Q-32			M				
East Fork/Twelvepole Creek	WV-OT-45-BX	Old House Branch	WVO-2-Q-32.8			X				X
East Fork/Twelvepole Creek	WV-OT-45-BY	Caney Fork	WVO-2-Q-33			M				X
East Fork/Twelvepole Creek	WV-OT-45-BY-3	UNT/Caney Fork RM 2.29				M				
East Fork/Twelvepole Creek	WV-OT-45-CA	Pretty Branch	WVO-2-Q-35							X
East Fork/Twelvepole Creek	WV-OT-45-CB	Mare Branch	WVO-2-Q-36			M				X
East Fork/Twelvepole Creek	WV-OT-45-CB-2	UNT/Mare Branch RM 0.97	WVO-2-Q-36-B			M				
East Fork/Twelvepole Creek	WV-OT-45-CC	McCloud Branch	WVO-2-Q-37			M				
East Fork/Twelvepole Creek	WV-OT-45-CG	Big Branch	WVO-2-Q-39			M				
East Fork/Twelvepole Creek	WV-OT-45-CH	Hurricane Branch	WVO-2-Q-40			M				X
East Fork/Twelvepole Creek	WV-OT-45-CI	Hogger Branch	WVO-2-Q-41			M				X
East Fork/Twelvepole Creek	WV-OT-45-CK	Marcum Branch	WVO-2-Q-42.5			M				X
East Fork/Twelvepole Creek	WV-OT-45-CM	Lick Branch	WVO-2-Q-43.5			M				
East Fork/Twelvepole Creek	WV-OT-45-CP	UNT/East Fork RM 48.19/Twelvepole Creek	WVO-2-Q-44.6			M				X
West Fork/Twelvepole Creek	WV-OT-46	West Fork/Twelvepole Creek	WVO-2-P			X				X
West Fork/Twelvepole Creek	WV-OT-46-F	Big Branch	WVO-2-P-1			M				X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
West Fork/Twelvepole Creek	WV-OT-46-J	Patrick Creek	WVO-2-P-2			M				X
Trace Fork	WV-OT-46-O	Trace Fork	WVO-2-P-4			M				X
Trace Fork	WV-OT-46-O-1	Booth Branch	WVO-2-P-4-0.1A			M				
Trace Fork	WV-OT-46-O-3	Wolf Creek	WVO-2-P-4-A			M				X
Trace Fork	WV-OT-46-O-4	Greenbrier Creek	WVO-2-P-4-B			M				X
Trace Fork	WV-OT-46-O-7	Orchard Branch	WVO-2-P-4-C			M				
West Fork/Twelvepole Creek	WV-OT-46-T	Joels Branch	WVO-2-P-5			M				
West Fork/Twelvepole Creek	WV-OT-46-X	Deephole Branch	WVO-2-P-7			M				X
West Fork/Twelvepole Creek	WV-OT-46-Y	Sycamore Branch	WVO-2-P-8			M				X
West Fork/Twelvepole Creek	WV-OT-46-Z	Flat Branch	WVO-2-P-9			M				X
West Fork/Twelvepole Creek	WV-OT-46-AB	Drift Branch	WVO-2-P-10			M				X
West Fork/Twelvepole Creek	WV-OT-46-AD	Jackson Branch	WVO-2-P-11			M				X
West Fork/Twelvepole Creek	WV-OT-46-AE	Billy Branch	WVO-2-P-12			M				X
West Fork/Twelvepole Creek	WV-OT-46-AL	Martha Noe Branch	WVO-2-P-13							X
West Fork/Twelvepole Creek	WV-OT-46-AN	Big Branch	WVO-2-P-14			M				
West Fork/Twelvepole Creek	WV-OT-46-AR	Ferguson Branch	WVO-2-P-15							X
West Fork/Twelvepole Creek	WV-OT-46-AQ	Matty Ferguson Branch	WVO-2-P-14.5	X			X			
West Fork/Twelvepole Creek	WV-OT-46-AS	Donathan Branch	WVO-2-P-15.3			M				
West Fork/Twelvepole Creek	WV-OT-46-AV	UNT/West Fork RM 20.26/Twelvepole Creek	WVO-2-P-15.8			M				X
West Fork/Twelvepole Creek	WV-OT-46-AW	Licklog Branch	WVO-2-P-16			M				
West Fork/Twelvepole Creek	WV-OT-46-AX	Sycamore Branch	WVO-2-P-17			M				X
West Fork/Twelvepole Creek	WV-OT-46-AZ	Big Branch	WVO-2-P-18			M				X
West Fork/Twelvepole Creek	WV-OT-46-BK	Wells Branch	WVO-2-P-19			M				X
West Fork/Twelvepole Creek	WV-OT-46-BM	Missouri Branch	WVO-2-P-20			M				
Moses Fork	WV-OT-46-BN	Moses Fork	WVO-2-P-21			M				X
Moses Fork	WV-OT-46-BN-5	Johnnies Branch	WVO-2-P-21-B.5			M				

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
Moses Fork	WV-OT-46-BN-8	Right Fork/Moses Fork	WVO-2-P-21-C			M				X
Moses Fork	WV-OT-46-BN-9	Bark Camp Branch	WVO-2-P-21-C.5			M				
West Fork/Twelvepole Creek	WV-OT-46-BP	Arkansas Branch	WVO-2-P-23			M				
West Fork/Twelvepole Creek	WV-OT-46-BQ	Wiley Branch	WVO-2-P-24			M				X
West Fork/Twelvepole Creek	WV-OT-46-BS	Sweetwater Branch	WVO-2-P-25			M				X
West Fork/Twelvepole Creek	WV-OT-46-BS-2	Right Fork/Sweetwater Branch	WVO-2-P-25-B			M				
West Fork/Twelvepole Creek	WV-OT-46-BT	Long Branch	WVO-2-P-26			M				
West Fork/Twelvepole Creek	WV-OT-46-BW	Spruce Fork	WVO-2-P-27			M				
West Fork/Twelvepole Creek	WV-OT-46-BX	Gourd Branch	WVO-2-P-28			M				
Turkey Creek	WV-OT-46-BY	Turkey Creek	WVO-2-P-29			XDMR				X
Turkey Creek	WV-OT-46-BY-4	Jacks Fork	WVO-2-P-29-B			XDMR				X
West Fork/Twelvepole Creek	WV-OT-46-CE	Poor Branch	WVO-2-P-33							X
West Fork/Twelvepole Creek	WV-OT-46-CF	Bull Branch	WVO-2-P-34			M				
West Fork/Twelvepole Creek	WV-OT-46-CI	UNT/West Fork RM 39.30/Twelvepole Creek	WVO-2-P-35.3			M				X
West Fork/Twelvepole Creek	WV-OT-46-CJ	Pumpkin Field Branch	WVO-2-P-35.5			M				X
West Fork/Twelvepole Creek	WV-OT-46-CK	Breeden Creek	WVO-2-P-36			X				X
West Fork/Twelvepole Creek	WV-OT-46-CK-4	UNT/Breeden Creek RM 2.17				M				
West Fork/Twelvepole Creek	WV-OT-46-CM	UNT/West Fork RM 41.41/Twelvepole Creek	WVO-2-P-36.5			M				X
West Fork/Twelvepole Creek	WV-OT-46-CN	UNT/West Fork RM 42.13/Twelvepole Creek	WVO-2-P-36.8			M				X
West Fork/Twelvepole Creek	WV-OT-46-CO	Openmouth Branch	WVO-2-P-37			XDMR				
West Fork/Twelvepole Creek	WV-OT-46-CO-1	Left Fork/Openmouth Branch	WVO-2-P-37-A			M				
West Fork/Twelvepole Creek	WV-OT-46-CP	UNT/West Fork RM 43.91/Twelvepole Creek	WVO-2-P-37.1			M				X
West Fork/Twelvepole Creek	WV-OT-46-CS	Trace Branch	WVO-2-P-38			M				X

TMDL Watershed	NHD Code	Stream Name	WV Code	pH	DO	Fe	Al	Be	Se	FC
West Fork/Twelvepole Creek	WV-OT-46-CT	Big Sang Kill	WVO-2-P-39			M				X
West Fork/Twelvepole Creek	WV-OT-46-CT-2	UNT/Big Sang Kill RM 1.42				M				
West Fork/Twelvepole Creek	WV-OT-46-CW	Hogger Run	WVO-2-P-40.5			X				X
West Fork/Twelvepole Creek	WV-OT-46-CZ	Dingess Trace Branch	WVO-2-P-41			M				X
West Fork/Twelvepole Creek	WV-OT-46-DB	Camp Branch	WVO-2-P-42			M				X
West Fork/Twelvepole Creek	WV-OT-46-DF	Moses Fork	WVO-2-P-43			M				X
West Fork/Twelvepole Creek	WV-OT-46-DG	Messenger Branch	WVO-2-P-44	X		X				X

Note:
* Beryllium impairment will be addressed through implementation of the 2009 pH TMDL
BC boundary condition in model based on 2009 TMDL allocated condition
FC fecal coliform bacteria impairment
Fe iron impairment
M impairment determined via modeling
Mn manganese impairment
pH acidity impairment
RM river mile
Se selenium impairment
UNT unnamed tributary
X impairment determined via sampling
XDMR impairment determined via self-reported discharge monitoring

4.0 BIOLOGICAL IMPAIRMENT AND STRESSOR IDENTIFICATION

The narrative water quality criterion of 47 CSR 2 §3.2.i prohibits the presence of wastes in State waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems. Historically, WVDEP based assessment of biological integrity on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index (WVSCI). WVSCI-based "biological impairments" were included on West Virginia's Section 303(d) lists from 2002 through 2010. In 2012, legislative action (codified in §22-11-7b) directed the agency to develop and secure legislative approval of new rules to interpret the narrative criterion for biological impairment found in 47 CSR 2-3.2.i.

§22-11-7b indicates, rules promulgated may not establish measurements that would establish standards less protective than requirements that existed during the 2012 regular session. Thus, WVDEP has continued to list biological impairment based on WVSCI for subsequent 303d lists, including the most recent list in 2016. In response to the legislation, WVDEP prepared a procedural rule (47 CSR 2B) establishing the methodology for determining compliance with the biological component of narrative criteria. A public comment period extended through May 6, 2019 and a public hearing was held the same day. Response to comment and final filing was delayed, requiring that the same procedural rule be proposed again in 2020. The public comment period ran through April 20, 2020 and a public hearing was held the same day. At the time of this TMDL completion, WVDEP was responding to comments and preparing to finalize the procedural rule. WVDEP has suspended biological impairment TMDL development pending approval of the procedural rule.

The above notwithstanding, streams for which available benthic information demonstrates non-attainment of the threshold described in the assessment methodology presented in 47CSR2B, were subjected to the biological stressor identification (SI) process described in this section. The biological SI process allowed assessment unit-specific identification of the significant stressors associated with benthic macroinvertebrate community impact. If those stressors are resolved through the attainment of numeric water quality criteria, and TMDLs addressing such criteria are developed and approved, then additional "biological TMDL" development work is not needed. SI results are presented for assessment units with benthic macroinvertebrate impacts in **Appendix K** of the Technical Report, so that they may be considered in listing/delisting decision-making in future 303(d) processes. This project does not include "biological impairment" TMDLs. However, the SI process demonstrated that biological stress would be resolved in 78 assessment units (70 streams) through the implementation of numeric criterion TMDLs developed in this project.

4.1 Introduction

Impacts to benthic macroinvertebrate communities were rated using a multimetric index developed for use in the wadeable streams of West Virginia. The WVSCI (Gerritsen et al.,

2000) was designed to identify streams with benthic communities that differ from the reference condition presumed to constitute biological integrity. WVSCI is composed of six metrics that were selected to maximize discrimination between streams with known impairments and reference streams. Streams are assessed using WVSCI if the data was comparable (e.g., collected utilizing the same methods used to develop the WVSCI, adequate flow in riffle/run habitat, and within the index period). A WVSCI score of 72 (representing the 5th percentile of reference scores) is considered the attainment threshold. Streams with WVSCI scores less than 72 were included in the SI process to identify significant stressors associated with impacts to aquatic life.

USEPA developed *Stressor Identification: Technical Guidance Document* (Cormier et al., 2000) to assist water resource managers in identifying stressors and stressor combinations that cause biological impact. Elements of that guidance were used and custom analyses of biological data were performed to supplement the recommended framework.

The general SI process entailed reviewing available information, forming and analyzing possible stressor scenarios, and implicating causative stressors. The SI method provides a consistent process for evaluating available information. **Section 6** of the Technical Report discusses biological impairment and the SI process in detail.

4.2 Data Review

WVDEP generated the primary data used in SI through its pre-TMDL monitoring program. The program included water quality monitoring, benthic sampling, and habitat assessment. In addition, the biologists' comments regarding stream condition and potential stressors and sources were captured and considered. Other data sources were: source tracking data, WVDEP mining activities data, NLCD 2011 landuse information, Natural Resources Conservation Service (NRCS) State Soil Geographic database (STATSGO) soils data, National Pollutant Discharge Elimination System (NPDES) point source data, and literature sources.

4.3 Candidate Causes/Pathways

The first step in the SI process was to develop a list of candidate causes, or stressors. The candidate causes considered are listed below:

1. Metals contamination (including metals contributed through soil erosion) causes toxicity
2. Acidity (low pH <6) causes toxicity
3. Basic (high pH >9) causes toxicity
4. Increased ionic strength causes toxicity
5. Increased total suspended solids (TSS)/erosion and altered hydrology cause sedimentation and other habitat alterations
6. Increased metals flocculation and deposition causes habitat alterations (e.g., embeddedness)
7. Organic enrichment (e.g. sewage discharges and agricultural runoff cause habitat alterations)

8. Altered hydrology causes higher water temperature, resulting in direct impacts
9. Altered hydrology, nutrient enrichment, and increased biochemical oxygen demand (BOD) cause reduced dissolved oxygen (DO)
10. Algal growth causes food supply shift
11. High levels of ammonia cause toxicity (including increased toxicity due to algal growth)
12. Chemical spills cause toxicity

A conceptual model was developed to examine the relationship between candidate causes and potential biological effects. The conceptual model (**Figure 4-1**) depicts the sources, stressors, and pathways that affect the biological community.

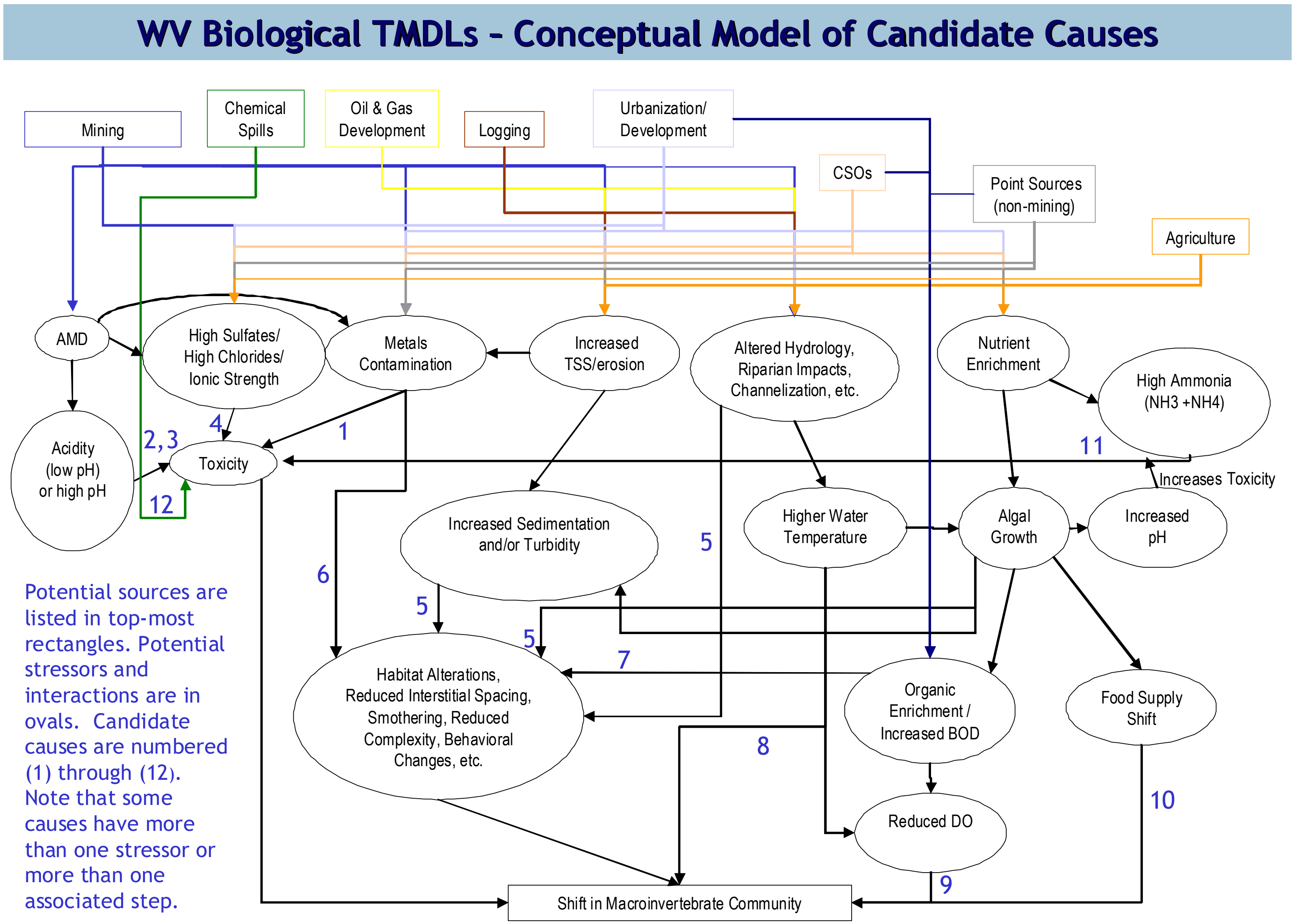


Figure 4-1. Conceptual model of candidate causes and potential biological effects

4.4 Stressor Identification Results

The SI process identified significant biological stressors for each assessment unit. Biological impact was linked to a single stressor in some cases and multiple stressors in others. The SI process identified the following stressors as present in the impacted waters in the Twelvepole Creek watershed:

- Organic enrichment (the combined effects of oxygen-demanding pollutants, nutrients, and the resultant algal growth and habitat alteration)
- Sedimentation
- Low pH
- Dissolved metals
- Metals flocculants
- Ionic strength

After stressors were identified, WVDEP also determined the pollutants in need of control to address the impacts.

In all streams for which the SI process identified organic enrichment as a significant biological stressor, data also indicated violations of the fecal coliform water quality criteria. The predominant sources of both organic enrichment and fecal coliform bacteria in the watershed are inadequately treated sewage and runoff from agricultural landuses. WVDEP determined that implementation of fecal coliform TMDLs would remove untreated sewage and significantly reduce loadings in agricultural runoff and thereby resolve organic enrichment stress.

There is a relationship between iron and sediment in West Virginia because there is a high iron content in soils and geology. Total iron is delivered to streams through erosion and sedimentation. Certain streams for which the SI process identified sedimentation as a significant stressor are also impaired pursuant to total iron water quality criteria and the TMDL assessment for iron included representation and allocation of iron loadings associated with sediment. WVDEP compared the amount of sediment reduction necessary in the iron TMDLs to the amount of reduction needed to achieve the normalized sediment loading of an unimpacted reference stream. In these streams, the sediment loading reduction necessary for attainment of water quality criteria for iron exceeds that which was determined to be necessary using the reference approach. Implementation of the iron TMDLs will resolve biological stress from sedimentation in these streams. See the Technical Report for further descriptions of the iron content of West Virginia soils and geology, and the correlation between sediment and iron, and the comparisons of sediment reductions under iron criterion attainment and reference watershed approaches.

The streams for which biological stress to benthic macroinvertebrates would be resolved through the implementation of the pollutant-specific TMDLs developed in this project are presented in **Table 4-1**. There are 26 assessment units (23 streams) for which the SI process did not indicate that TMDLs for numeric criteria would resolve the biological impacts.

Table 4-1. Biological impacts resolved by implementation of pollutant-specific TMDLs

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
Twelvepole Creek	WV-OT	WVO-2	OT_07	organic enrichment, sedimentation	fecal coliform, total iron
Twelvepole Creek	WV-OT	WVO-2	OT_09	organic enrichment, sedimentation	fecal coliform, total iron
Bobs Branch	WV-OT-10	WVO-2-B	OT-10_01	organic enrichment, sedimentation	fecal coliform, total iron
Buffalo Creek	WV-OT-12	WVO-2-C	OT-12_01	organic enrichment, sedimentation	fecal coliform, total iron
Buffalo Creek	WV-OT-12	WVO-2-C	OT-12_02	organic enrichment, sedimentation	fecal coliform, total iron
UNT/Buffalo Creek RM 2.21	WV-OT-12-D	WVO-2-C-4	OT-12-D_01	organic enrichment, sedimentation	fecal coliform, total iron
UNT/Buffalo Creek RM 3.50	WV-OT-12-F	WVO-2-C-6	OT-12-F_01	organic enrichment, sedimentation	fecal coliform, total iron
Plymale Branch	WV-OT-15	WVO-2-E	OT-15_01	organic enrichment, sedimentation	LA reductions fecal coliform, total iron
UNT/Twelvepole Creek RM 11.90	WV-OT-17	WVO-2-E.6	OT-17_01	organic enrichment, sedimentation	fecal coliform, total iron
Right Fork/Camp Creek	WV-OT-21-B	WVO-2-G-1	OT-21-B_01	organic enrichment, sedimentation	fecal coliform, total iron
UNT/Right Fork RM 0.66/Camp Creek	WV-OT-21-B-2	WVO-2-G-1-B	OT-21-B-2_01	organic enrichment, sedimentation	fecal coliform, total iron
Beech Fork	WV-OT-24	WVO-2-H	OT-24_01	organic enrichment, sedimentation	fecal coliform, total iron
Beech Fork	WV-OT-24	WVO-2-H	OT-24_03	organic enrichment, sedimentation	fecal coliform, total iron

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
Beech Fork	WV-OT-24	WVO-2-H	OT-24_04	organic enrichment, sedimentation	fecal coliform, total iron
Grassy Lick	WV-OT-24-AB	WVO-2-H-10	OT-24-AB_01	organic enrichment, sedimentation	LA reductions fecal coliform, total iron
Bowen Creek	WV-OT-24-AD	WVO-2-H-11	OT-24-AD_02	organic enrichment, sedimentation	fecal coliform, total iron
Raccoon Creek	WV-OT-24-AI	WVO-2-H-12	OT-24-AI_01	organic enrichment, sedimentation	fecal coliform, total iron
Wolfpen Branch	WV-OT-24-AY	WVO-2-H-19	OT-24-AY_01	organic enrichment, sedimentation	fecal coliform, total iron
UNT/Beech Fork RM 2.38	WV-OT-24-C	WVO-2-H-0.4	OT-24-C_01	organic enrichment, sedimentation	fecal coliform, total iron
Mays Branch	WV-OT-24-D	WVO-2-H-0.5	OT-24-D_01	organic enrichment, sedimentation	fecal coliform, total iron
Millers Fork	WV-OT-24-H	WVO-2-H-2	OT-24-H_01	organic enrichment, sedimentation	fecal coliform, total iron
Fisher Bowen Branch	WV-OT-24-H-12	WVO-2-H-2-C	OT-24-H-12_01	organic enrichment, sedimentation	fecal coliform, total iron
Left Fork/Millers Fork	WV-OT-24-H-18	WVO-2-H-2-D	OT-24-H-18_01	organic enrichment, sedimentation	fecal coliform, total iron
Fraley Fork	WV-OT-24-H-22	WVO-2-H-2-F	OT-24-H-22_01	organic enrichment, sedimentation	fecal coliform, total iron
Moxley Branch	WV-OT-24-U	WVO-2-H-6	OT-24-V.2_01	organic enrichment, sedimentation	fecal coliform, total iron
Long Branch	WV-OT-24-V	WVO-2-H-7	OT-24-V_01	organic enrichment, sedimentation	fecal coliform, total iron
Camp Branch	WV-OT-24-V-3	WVO-2-H-7-A	OT-24-V-3_01	organic enrichment, sedimentation	LA reductions fecal coliform, total iron
Butler Branch	WV-OT-24-X	WVO-2-H-8	OT-24-X_01	organic enrichment, sedimentation	LA reductions fecal coliform, total iron

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
Lynn Creek	WV-OT-26	WVO-2-I	OT-26_01	organic enrichment, sedimentation	fecal coliform, total iron
Big Creek	WV-OT-35	WVO-2-K	OT-35_01	organic enrichment, sedimentation	fecal coliform, total iron
Garrett Creek	WV-OT-37	WVO-2-L	OT-37_01	organic enrichment, sedimentation	fecal coliform, total iron
Shoal Branch	WV-OT-38	WVO-2-M	OT-38_01	organic enrichment, sedimentation	fecal coliform, total iron
Wilson Creek	WV-OT-39	WVO-2-N	OT-39_01	organic enrichment, sedimentation	fecal coliform, total iron
Left Fork/Wilson Creek	WV-OT-39-A	WVO-2-N-1	OT-39-A_01	organic enrichment, sedimentation	fecal coliform, total iron
Toms Creek	WV-OT-44	WVO-2-O	OT-44_01	organic enrichment, sedimentation	fecal coliform, total iron
East Fork/Twelvepole Creek	WV-OT-45	WVO-2-Q	OT-45_02	organic enrichment, sedimentation	fecal coliform, total iron
East Fork/Twelvepole Creek	WV-OT-45	WVO-2-Q	OT-45_04	organic enrichment, sedimentation	fecal coliform, total iron
Cove Creek	WV-OT-45-AK	WVO-2-Q-17	OT-45-AK_01	organic enrichment	fecal coliform, total iron
Tomblin Branch	WV-OT-45-AN-11-F	WVO-2-Q-18-C-2	OT-45-AN-11-F_01	organic enrichment, sedimentation	fecal coliform, total iron
McComas Branch	WV-OT-45-BG	WVO-2-Q-24	OT-45-BG_01	organic enrichment, sedimentation	fecal coliform, total iron
Honey Branch	WV-OT-45-BQ	WVO-2-Q-29	OT-45-BQ_01	sedimentation	total iron
Right Fork/Cub Branch	WV-OT-45-BT-1	WVO-2-Q-31-A	OT-45-BT-1_01	organic enrichment, sedimentation	fecal coliform, total iron

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
Twomile Creek	WV-OT-45-G	WVO-2-Q-3	OT-45-G_01	organic enrichment, sedimentation	LA reductions fecal coliform, total iron
Newcomb Creek	WV-OT-45-L	WVO-2-Q-5	OT-45-L_01	organic enrichment, sedimentation	fecal coliform, total iron
Petercave Branch	WV-OT-45-M	WVO-2-Q-6	OT-45-M_01	organic enrichment, sedimentation	fecal coliform, total iron
Left Fork/Camp Creek	WV-OT-45-Q-2	WVO-2-Q-8-A	OT-45-Q-2_01	organic enrichment, sedimentation	fecal coliform, 2009 TMDL total iron
Tiger Fork	WV-OT-45-Q-2-A	WVO-2-Q-8-A-1	OT-45-Q-2-A_01	organic enrichment, sedimentation	fecal coliform, 2009 TMDL LA reductions for total iron
Lynn Creek	WV-OT-45-R	WVO-2-Q-9	OT-45-R_01	organic enrichment, sedimentation	fecal coliform, total iron
Battern Fork	WV-OT-45-R-1	WVO-2-Q-9-A	OT-45-R-1_01	organic enrichment, sedimentation	fecal coliform, total iron
Right Fork/Lynn Creek	WV-OT-45-R-4	WVO-2-Q-9-D	OT-45-R-4_01	organic enrichment, sedimentation	fecal coliform, total iron
Left Fork/Lynn Creek	WV-OT-45-R-5	WVO-2-Q-9-C	OT-45-R-5_01	organic enrichment, sedimentation	fecal coliform, total iron
Laurel Creek/East Fork	WV-OT-45-W	WVO-2-Q-10	OT-45-W_01	organic enrichment, sedimentation	fecal coliform, total iron
Brush Creek	WV-OT-45-Z	WVO-2-Q-11	OT-45-Z_01	sedimentation	total iron
West Fork/Twelvepole Creek	WV-OT-46	WVO-2-P	OT-46_03	organic enrichment, sedimentation	fecal coliform, total iron
West Fork/Twelvepole Creek	WV-OT-46	WVO-2-P	OT-46_05	organic enrichment, sedimentation	fecal coliform, total iron

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
West Fork/Twelvepole Creek	WV-OT-46	WVO-2-P	OT-46_08	organic enrichment, sedimentation	fecal coliform, total iron
Drift Branch	WV-OT-46-AB	WVO-2-P-10	OT-46-AB_01	organic enrichment, sedimentation	fecal coliform, total iron
Jackson Branch	WV-OT-46-AD	WVO-2-P-11	OT-46-AD_01	organic enrichment, sedimentation	fecal coliform, total iron
Billy Branch	WV-OT-46-AE	WVO-2-P-12	OT-46-AE_01	organic enrichment, sedimentation	fecal coliform, total iron
Big Branch	WV-OT-46-AZ	WVO-2-P-18	OT-46-AZ_01	organic enrichment, sedimentation	fecal coliform, total iron
Wells Branch	WV-OT-46-BK	WVO-2-P-19	OT-46-BK_01	organic enrichment, sedimentation	fecal coliform, total iron
Moses Fork	WV-OT-46-BN	WVO-2-P-21	OT-46-BN_02	organic enrichment, sedimentation	fecal coliform, total iron
Right Fork/Moses Fork	WV-OT-46-BN-8	WVO-2-P-21-C	OT-46-BN-8_01	organic enrichment, sedimentation	fecal coliform, total iron
Breeden Creek	WV-OT-46-CK	WVO-2-P-36	OT-46-CK_01	organic enrichment, sedimentation	fecal coliform, total iron
Dingess Trace Branch	WV-OT-46-CZ	WVO-2-P-41	OT-46-CZ_01	organic enrichment, sedimentation	fecal coliform, total iron
Camp Branch	WV-OT-46-DB	WVO-2-P-42	OT-46-DB_01	organic enrichment, sedimentation	fecal coliform, total iron
Moses Fork	WV-OT-46-DF	WVO-2-P-43	OT-46-DF_01	organic enrichment, sedimentation	fecal coliform, total iron
Big Branch	WV-OT-46-F	WVO-2-P-1	OT-46-F_01	organic enrichment, sedimentation	fecal coliform, total iron
Patrick Creek	WV-OT-46-J	WVO-2-P-2	OT-46-J_01	organic enrichment, sedimentation	fecal coliform, total iron

Stream Name	NHD Code	WV Code	Assessment Unit ID	Significant Stressors	TMDLs Developed
Trace Fork	WV-OT-46-O	WVO-2-P-4	OT-46-O_01	organic enrichment, sedimentation	fecal coliform, total iron
Trace Fork	WV-OT-46-O	WVO-2-P-4	OT-46-O_02	organic enrichment, sedimentation	fecal coliform, total iron
Wolf Creek	WV-OT-46-O-3	WVO-2-P-4-A	OT-46-O-3_01	organic enrichment, sedimentation	fecal coliform, total iron
Greenbrier Creek	WV-OT-46-O-4	WVO-2-P-4-B	OT-46-O-4_01	organic enrichment, sedimentation	fecal coliform, total iron
Joels Branch	WV-OT-46-T	WVO-2-P-5	OT-46-T_01	organic enrichment, sedimentation	LA reductions fecal coliform, total iron
Deephole Branch	WV-OT-46-X	WVO-2-P-7	OT-46-X_01	organic enrichment, sedimentation	fecal coliform, total iron
Sycamore Branch	WV-OT-46-Y	WVO-2-P-8	OT-46-Y_01	organic enrichment, sedimentation	fecal coliform, total iron
Flat Branch	WV-OT-46-Z	WVO-2-P-9	OT-46-Z_01	organic enrichment, sedimentation	fecal coliform, total iron
Walker Branch	WV-OT-7	WVO-2-A	OT-7_01	organic enrichment, sedimentation	fecal coliform, total iron

*Note: Although direct pollutant TMDL was not developed for this assessment unit, reductions to sources in this watershed necessary to attain water quality standards in downstream water bodies were prescribed and will resolve stress to aquatic life.

**Implementation of 2009 TMDL for Camp Creek will resolve stress to aquatic life.

5.0 METALS AND SELENIUM SOURCE ASSESSMENT

This section identifies and examines the potential sources of metals impairments in the Twelvepole Creek watershed. Sources can be classified as point (permitted) or nonpoint (non-permitted) sources. For the sake of consistency, the same modeled landuse setup was used for all metals nonpoint sources. Non-mining point sources were also modeled consistently in terms of drainage area and flow, although chemical concentrations (e.g. iron, TSS) were configured specifically for different pollutant sources.

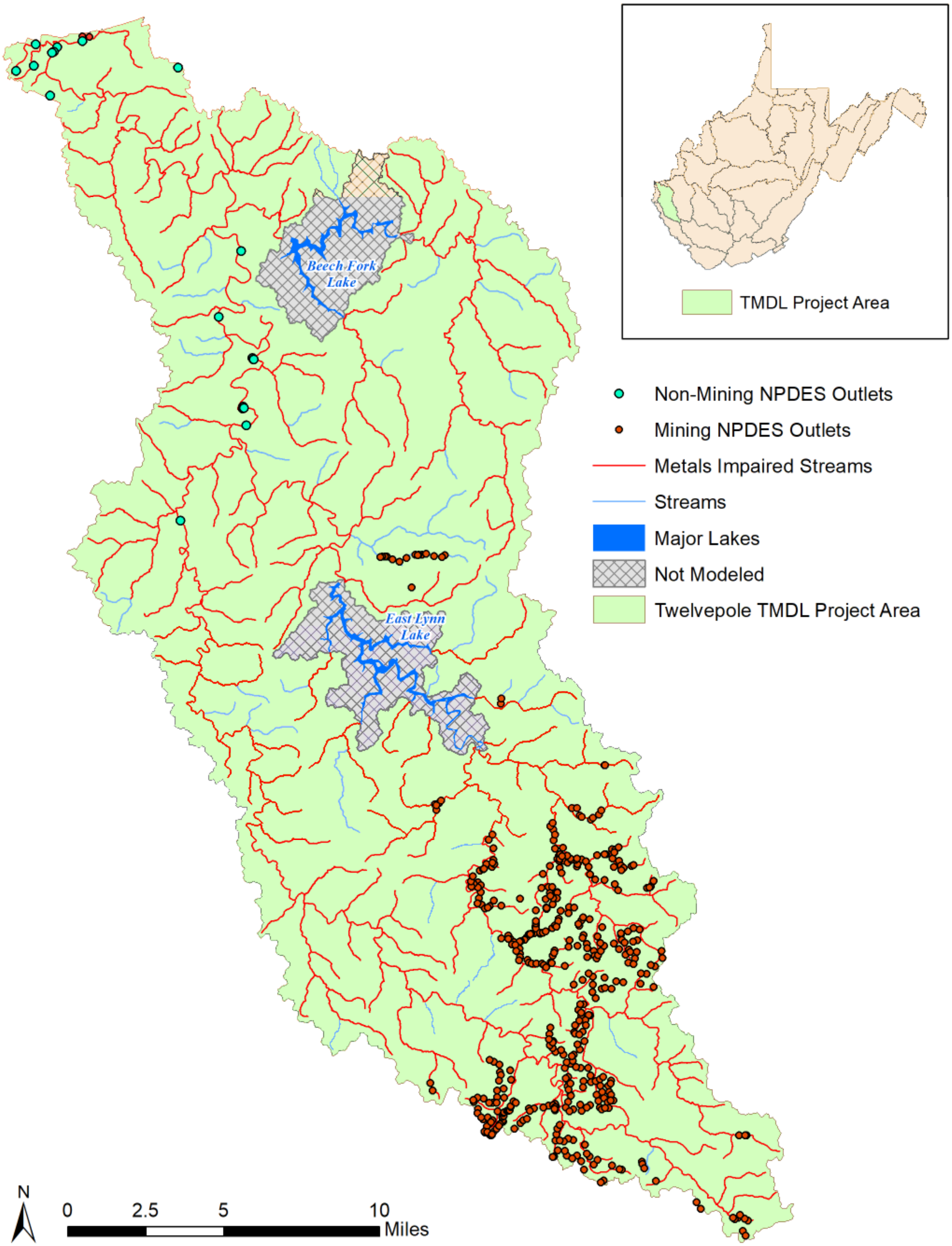
A point source, according to 40 CFR 122.3, is any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, and vessel or other floating craft from which pollutants are or may be discharged. The NPDES program, established under Clean Water Act Sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources. For purposes of this TMDL, NPDES-permitted discharge outfalls are considered point sources.

Nonpoint sources of pollutants are diffuse, non-permitted sources and they most often result from precipitation-driven runoff. For the purposes of these TMDLs only, WLAs are given to NPDES-permitted discharge points, and LAs are given to discharges from activities that do not have an associated NPDES permit, such as nonpoint source pollution associated with oil and gas wells permitted through the WVDEP Office of Oil and Gas (OOG). The assignment of LAs to OOG permitted wells does not reflect any determination by WVDEP or USEPA as to whether there are, in fact, unpermitted point source discharges within this landuse. Likewise, by establishing these TMDLs with OOG permitted discharges treated as LAs, WVDEP and USEPA are not determining that these discharges are exempt from NPDES permitting requirements.

The physiographic data discussed in **Section 3.2** enabled the characterization of pollutant sources. As part of the TMDL development process, WVDEP performed additional field-based source tracking activities to supplement the available source characterization data. WVDEP staff recorded physical descriptions of pollutant sources and the general stream condition in the vicinity of the sources. WVDEP collected global positioning system (GPS) data and water quality samples for laboratory analysis as necessary to characterize the sources and their impacts. Source tracking information was compiled and electronically plotted on maps using GIS software. Detailed information, including the locations of pollutant sources, is provided in the following sections, the Technical Report, and the ArcGIS Viewer Project.

5.1 Metals and Selenium Point Sources

Metals point sources are classified by the type of permits issued by WVDEP. The following sections discuss the potential impacts and the characterization of these source types, the locations of which are displayed in **Figure 5-1**.



(Note: outlets in close proximity appear to overlap in the figure)

Figure 5-1. Point sources in the Twelvepole Creek Watershed

5.1.1 Mining Point Sources

The Surface Mining Control and Reclamation Act of 1977 (SMCRA, Public Law 95-87) and its subsequent revisions were enacted to establish a nationwide program to protect the beneficial uses of land or water resources, protect public health and safety from the adverse effects of current surface coal mining operations, and promote the reclamation of mined areas left without adequate reclamation prior to August 3, 1977. SMCRA requires a permit for development of new, previously mined, or abandoned sites for the purpose of surface mining. Permittees are required to post a performance bond that will be sufficient to ensure the completion of reclamation requirements by a regulatory authority in the event that the applicant forfeits its permit. When a bond is forfeited, WVDEP assumes the responsibility for the reclamation requirements. In past TMDLs, bond forfeiture sites were classified as nonpoint sources. The judicial decision, West Virginia Highlands Conservancy, Inc., and West Virginia Rivers Coalition, Inc. v. Randy Huffman, Secretary, West Virginia Department of Environmental Protection. [1:07CV87]. 2009, requires WVDEP to obtain an NPDES permit for discharges from forfeited sites. As such, this project classifies bond forfeiture sites as point sources and provides WLAs.

Mines that ceased operations before the effective date of SMCRA (often called "pre-law" mines) are not subject to the requirements of the SMCRA.

SMCRA Title IV is designed to provide assistance for the reclamation and restoration of abandoned mines; whereas Title V states that any surface coal mining operations must be required to meet all applicable performance standards. Some general performance standards include the following:

- Restoring the affected land to a condition capable of supporting the uses that it was capable of supporting prior to any mining;
- Backfilling and compacting (to ensure stability or to prevent leaching of toxic materials) to restore the approximate original contour of the land, including all highwalls; and
- Minimizing disturbances to the hydrologic balance and to the quality and quantity of water in surface water and groundwater systems both during and after surface coal mining operations and during reclamation by avoiding acid or other toxic mine drainage.

Untreated mining-related point source discharges from deep, surface, and other mines may have low pH values (i.e. acidic) and contain high concentrations of metals (iron and aluminum). Mining-related activities are commonly issued NPDES discharge permits that contain effluent limits for total iron, total manganese, total suspended solids, and pH. Many permits also include effluent monitoring requirements for total aluminum and some, more recently issued permits include aluminum water quality based effluent limits. WVDEP's Division of Mining and Reclamation (DMR) provided a spatial coverage of the mining-related NPDES permit outlets. The discharge characteristics, related permit limits, and discharge data for these NPDES outlets were acquired from West Virginia's ERIS database system. The spatial coverage was used to determine the location of the permit outlets. Additional information was needed, however, to determine the areas of the mining activities. WVDEP DMR also provided spatial coverage of the mining permit areas and related SMCRA Article 3 and NPDES permit information. WVDEP

DWWM personnel used the information contained in the SMCRA Article 3 and NPDES permits to further characterize the mining point sources. Information gathered included type of discharge, pump capacities, and drainage areas (including total and disturbed areas).

The permitted mining point sources (open NPDES outlets) were grouped into landuse categories based on the type and status of mining activity and effluent discharge characteristics. Co-mingled discharges contain effluent discharges from both surface and deep mining activities. Surface mines, and co-mingled surface mines were treated as land-based precipitation-induced sources. The deep mine portions of co-mingled mines were characterized as continuous flow point sources. Deep mines were also characterized as continuous flow point sources.

There are 39 mining-related NPDES permits, with 320 associated outlets in the metals impaired watersheds of the Twelvepole Creek watershed (Appendix F, HPU Metals Model Outlets Tab). Point sources were represented differently during model calibration than they were during the allocation process. To match model results to historical water quality data for calibration, it was necessary to represent the existing point sources using available historical data. During the allocation process, permitted sources were represented at their allowable permit limits in the baseline condition. Reductions were made to the baseline condition when necessary to attain the TMDL endpoint in the allocated condition.

For metals modeling, Phase II and Completely Released permitted facilities were represented at concentrations similar to background because reclamation of these mines is completed or nearly complete and have programmatically progressed to the point where NPDES permit limits for the TMDL endpoints of metals such as total iron, total aluminum, or manganese have been removed from the permit. (WVDEP, 2000). There are 19 reclamation-related NPDES permits, with 120 associated outlets present in the watershed (Appendix F, Reclamation Outlets Tab).

Details for both active and reclaimed mining point sources are provided in **Appendix F** of the Technical Report. **Figure 5-1** illustrates the extent of the mining NPDES outlets in the watershed.

5.1.2 Non-mining Point Sources

WVDEP DWWM controls water quality impacts from non-mining activities with point source discharges through the issuance of NPDES permits. WVDEP's OWRNPDES GIS coverage was used to determine the locations of these sources, and detailed permit information was obtained from WVDEP's ERIS database. Sources may include the process wastewater discharges from water treatment plants and industrial manufacturing operations, and stormwater discharges associated with industrial activity. There are 20 industrial wastewater discharges in the watersheds of metals impaired streams in the Twelvepole Creek watershed.

In the Twelvepole Creek watershed, there are limited sewage treatment facilities existing in the watersheds of metals impaired streams. The NPDES permits for those facilities do not contain iron effluent limitations; were not considered to be substantive metals sources; and were not explicitly represented in the modeling. Existing discharges from such sources do not require wasteload allocations pursuant to the metals TMDLs. A list of such negligible sources appears in **Appendix F** of the Technical Report. Any metals loading associated with such sources is contained in the background loading and accounted for in model calibration.

There are 20 modeled non-mining NPDES permitted outlets (1 water treatment plant, 11 Multi Sector Storm water general permits for industrial discharges, and 1 WV DOH stormwater discharges) in the watersheds containing or contributing to metals impaired streams, which are displayed in **Figure 5-1**. The assigned WLAs for all non-mining NPDES outlets allow for continued discharge under existing permit requirements, whether those are expressed in effluent limits or benchmark values. For non-construction stormwater permits, BMP based limits with benchmark values to monitor BMP effectiveness constitute acceptable implementation of the WLAs. A complete list of the permits and outlets is provided in **Appendix F** of the Technical Report.

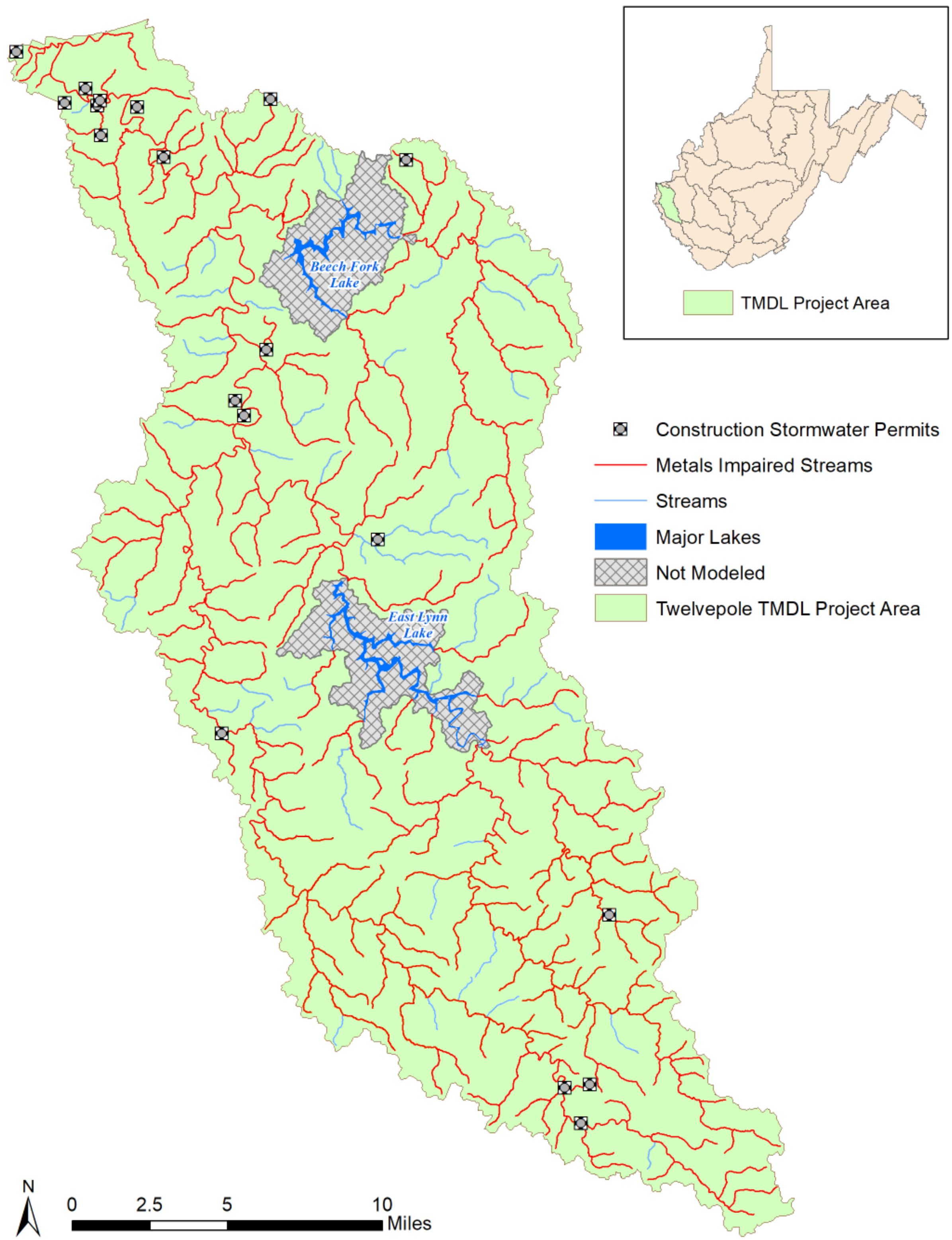
5.1.3 Construction Stormwater Permits

The discharges from construction activities that disturb more than one acre of land are legally defined as point sources and the sediment introduced from such discharges can contribute iron. WVDEP issues a general NPDES permit (permit WV0115924, referred to as the Construction Stormwater General Permit or CSGP) to regulate stormwater discharges associated with construction activities with a land disturbance greater than one acre.

WVDEP also issues a general NPDES permit to regulate the discharge of stormwater runoff associated with oil and gas related construction activities (permit WV0116815, referred to as the Oil and Gas Construction Stormwater General Permit or OGCSGP) authorizes discharges composed entirely of stormwater associated with oil and gas field activities or operations associated with exploration, production, processing or treatment operations or transmission facilities, disturbing one acre or greater of land area, to the waters of the State.

Both of these permits require that the site have properly installed best management practices (BMPs), such as silt fences, sediment traps, seeding/mulching, and riprap, to prevent or reduce erosion and sediment runoff. The BMPs will remain intact until the construction is complete and the site has been stabilized.

At the time of model set-up, 15 active construction sites with a total disturbed area of 108 acres registered under the CSGP were represented in the Twelvepole Creek watershed. Four registrations under the OGCSGP were represented in the model with a total disturbance of 24 acres. CSGP and OGCSGP registrations are shown in **Figure 5-2.** Specific WLAs are not prescribed for individual sites. Instead, subwatershed-based allocations are provided for concurrently disturbed area registered under the permits as described in **Sections 9.7.1** and **10.0**.



(Note: permits in close proximity appear to overlap in the figure)

Figure 5-2. Construction stormwater permits in the Twelvepole Creek watershed

5.1.4 Municipal Separate Storm Sewer Systems (MS4)

Runoff from residential and urbanized areas during storm events can be a significant sediment source. USEPA's stormwater permitting regulations require public entities to obtain NPDES permit coverage for stormwater discharges from MS4s in specified urbanized areas. As such, their stormwater discharges are considered point sources and are prescribed WLAs. The MS4 entities are registered under the MS4 General Permit (WV0116025). Individual registration numbers for the MS4 entities are City of Ceredo (WVR030014), City of Huntington (WVR030033), City of Kenova (WVR030039), the Veterans Administration-Huntington Medical Center (WVR030046), and the West Virginia Division of Highways (WVDOH) (WVR030004).

The MS4 permit areas fall within established city limits. WVDOH MS4 area occurs inside and on the southern periphery of the greater City of Huntington municipal area.

MS4 source representation was based upon precipitation and runoff from landuses determined from the modified NLCD 2011 landuse data, the jurisdictional boundary of the city, and the transportation-related drainage areas for which WVDOH has MS4 responsibility. The representation also includes streambank erosion loads for the portions of streams within the MS4 boundaries. The location and extent of the MS4 jurisdictions are shown in **Figure 5-3**.

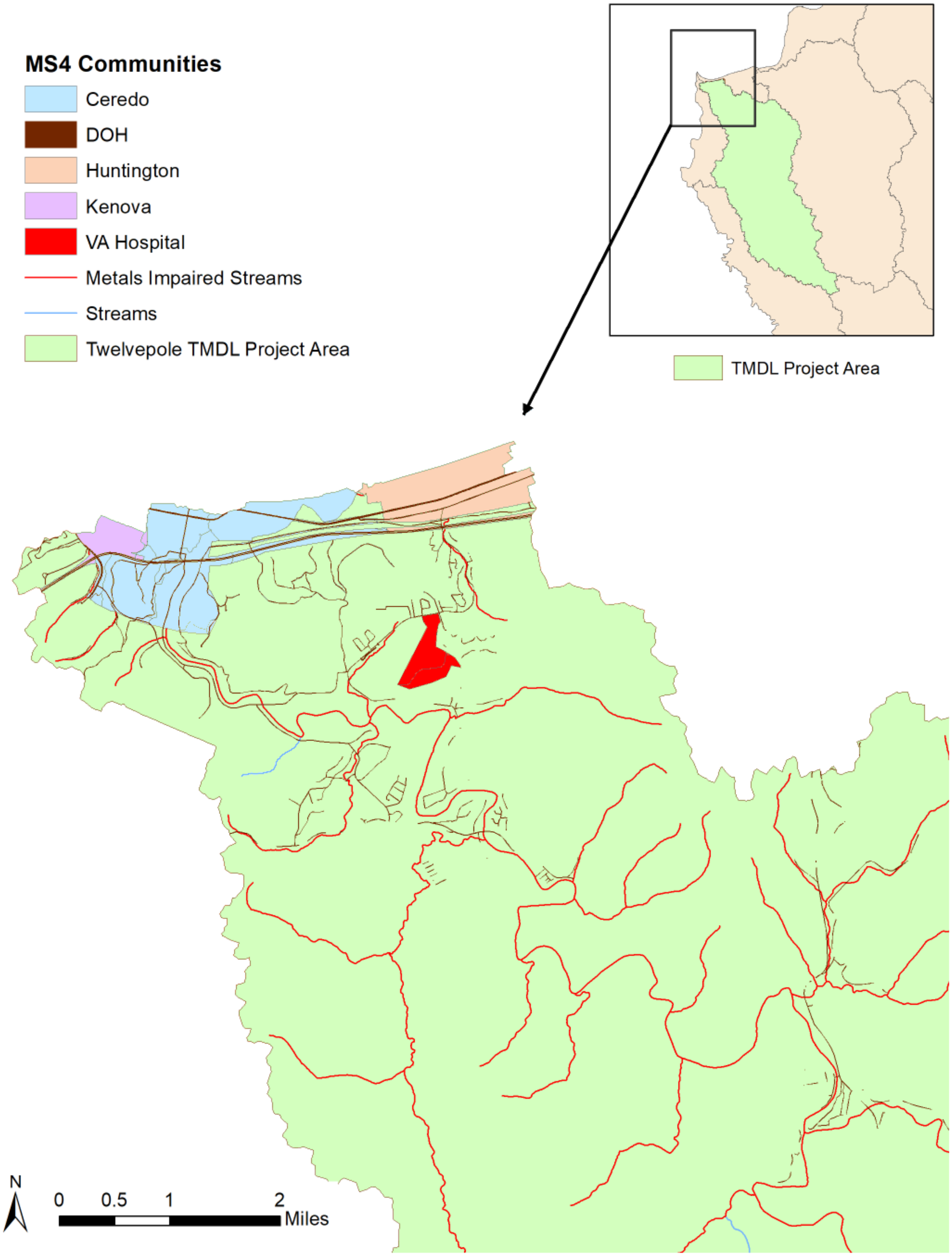


Figure 5-3. Municipal Separate Storm Sewer System permits in the Twelvepole Creek watershed

5.2 Metals Nonpoint Sources

In addition to point sources, nonpoint sources can contribute to water quality impairments related to metals. For modeling purposes, land disturbing activities that introduce excess sediment are considered nonpoint sources of metals.

5.2.1 Abandoned Mine Lands

WVDEP's Office of Abandoned Mine Lands & Reclamation (AML&R) was created in 1981 to manage the reclamation of lands and waters affected by mining prior to passage of SMCRA in 1977. AML&R's mission is to protect public health, safety, and property from past coal mining and to enhance the environment through the reclamation and restoration of land and water resources. The AML program is funded by a fee placed on coal mining. Allocations from the AML fund are made to state and tribal agencies through the congressional budgetary process.

The Office of AML&R identified locations of AML in the Twelvepole Creek watershed from their records. In addition, source tracking efforts by WVDEP DWWM and AML&R identified additional AML sources (discharges, seeps, portals, and refuse piles). Field data, such as GPS locations, water samples, and flow measurements, were collected to represent these sources and characterize their impact on water quality. Based on this work, AML represents a significant source of metals in certain metals impaired streams for which TMDLs are presented. In TMDL watersheds with metals, aluminum, pH, and selenium impairments, a total of 4 seeps associated with legacy mine practices, 16 acres of AML area were incorporated into the TMDL model.

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as AML discharges are modeled as nonpoint sources. The decision to assign LAs to those sources does not reflect a determination by WVDEP or USEPA as to whether they are, in fact, non-permitted point source discharges. Likewise, by establishing these TMDLs with these discharges treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.

5.2.2 Sediment Sources

Land disturbance can increase sediment loading to impaired waters. The control of sediment-producing sources has been determined to be necessary to meet water quality criteria for total iron during high-flow conditions. Nonpoint sources of sediment include forestry operations, oil and gas operations, roads, agriculture, stormwater from construction sites less than one acre, and stormwater from urban and residential land in non-MS4 (Municipal Separate Storm Sewer System) areas. Additionally, streambank erosion represents a significant sediment source throughout the watershed. Upland sediment nonpoint sources are summarized below.

Forestry

West Virginia recognizes the water quality issues posed by sediment from logging sites. In 1992, the West Virginia Legislature passed the Logging Sediment Control Act. The act requires the use of BMPs to reduce sediment loads to nearby waterbodies. Without properly installed BMPs, logging and associated access roads can increase sediment loading to streams. The West Virginia Bureau of Commerce's Division of Forestry provided information on forest industry sites (registered logging sites) in the metals impaired TMDL watersheds. This information included the 6,302 acres of harvested area within the TMDL impaired streams watersheds, of which subset of land disturbed by roads and landings is 504 acres. According to the Division of Forestry, illicit logging operations represent approximately 2.5 percent of the total harvested forest area (registered logging sites) throughout West Virginia. This rate of illicit activity has been represented in the model. These illicit operations do not have properly installed BMPs and can contribute sediment to streams. In addition, 845 acres of burned forest were reported and included as disturbed land for calibration purposes only. **Figure 5-4** displays metals nonpoint sources burned forest and logging operations in TMDL watersheds represented in the model.

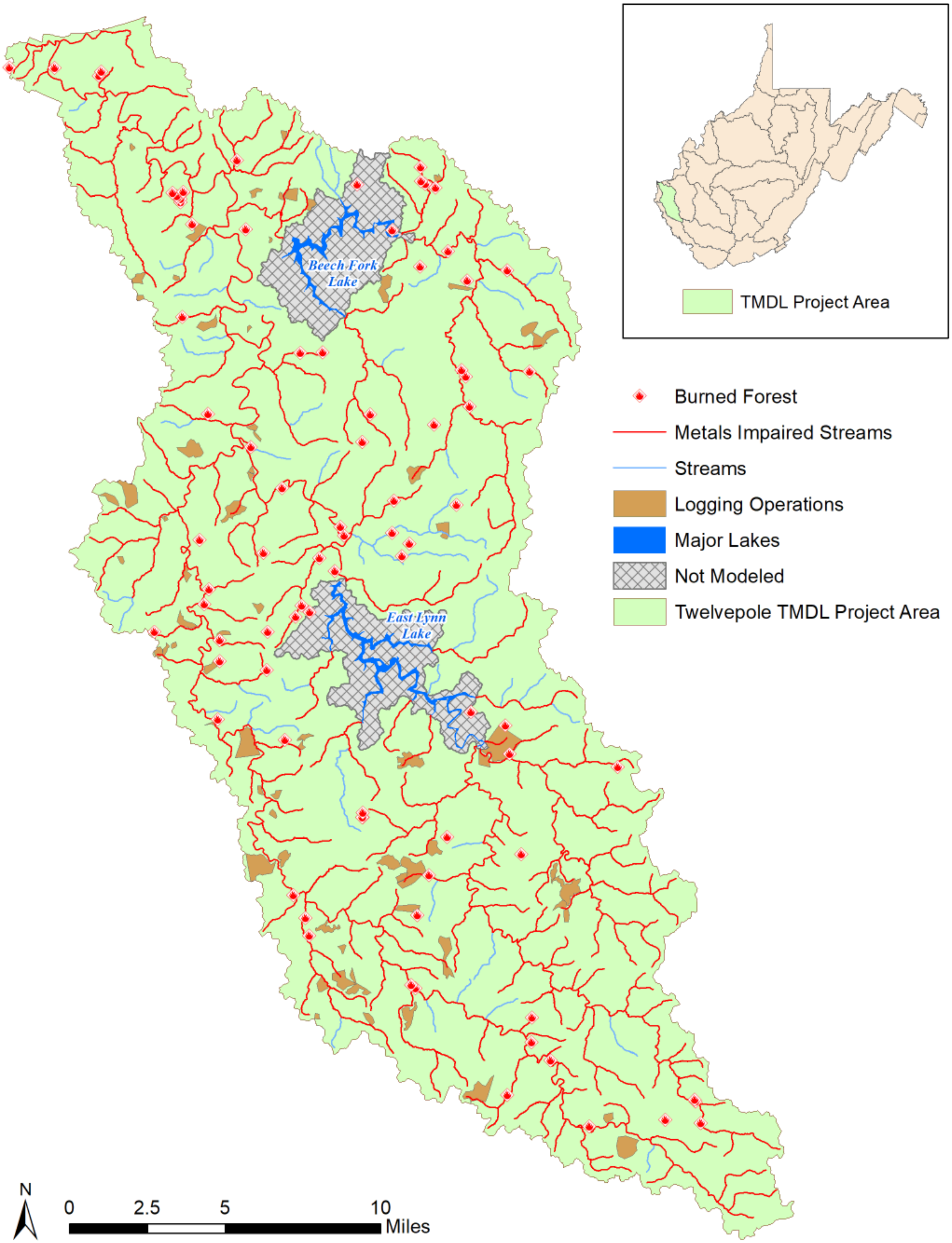


Figure 5-4. Logging and burned forest in the Twelvepole Creek watershed

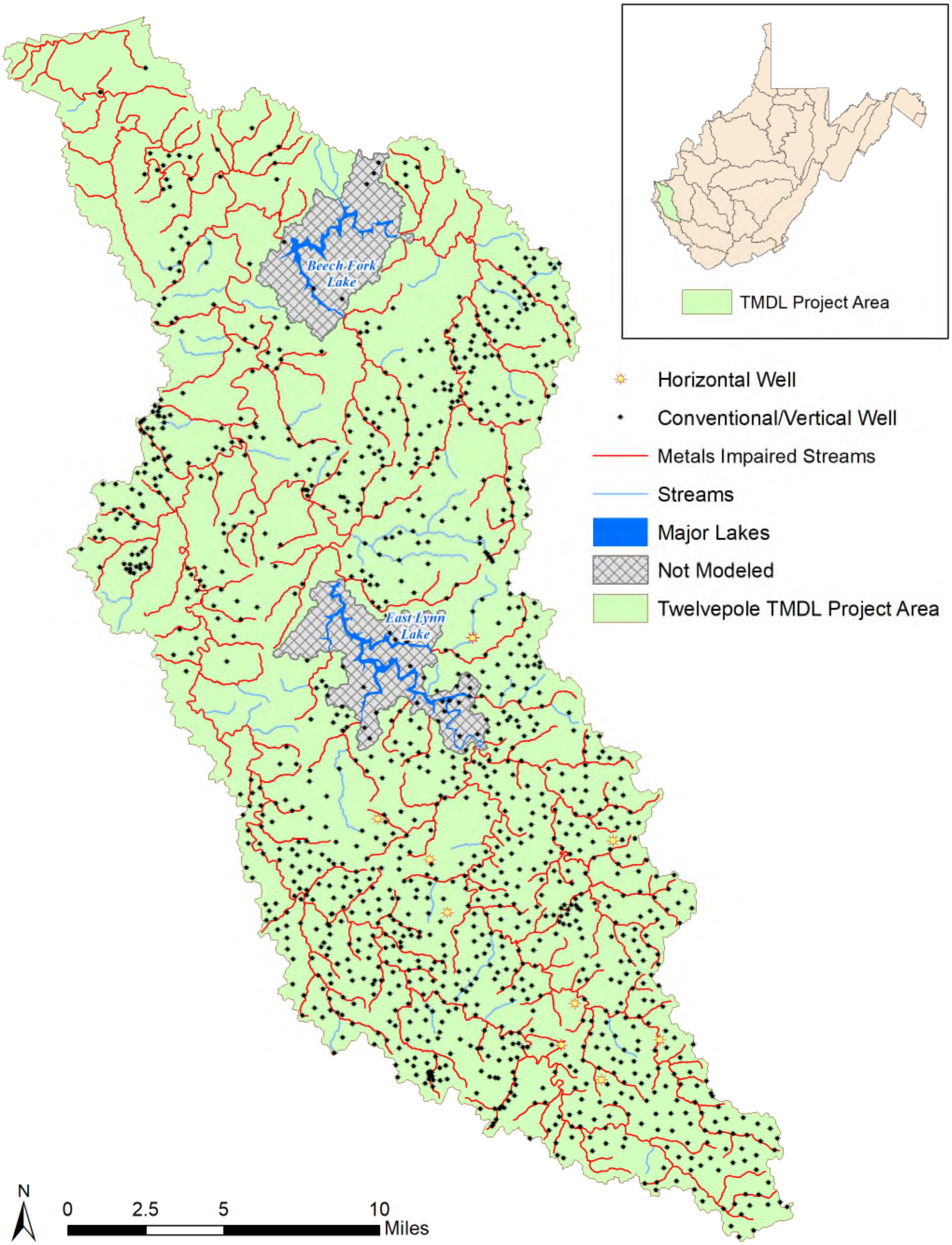
Oil and Gas

The WVDEP OOG is responsible for monitoring and regulating all actions related to the exploration, drilling, storage, and production of oil and natural gas in West Virginia. It maintains records on more than 55,000 active and 15,000 inactive oil and gas wells, and manages the Abandoned Well Plugging and Reclamation Program. The OOG also ensures that surface water and groundwater are protected from oil and gas activities.

Gas wells targeting the Marcellus Shale geologic formation use hydraulic fracturing techniques that result in significantly higher land disturbance than conventional wells. Horizontal Marcellus drilling sites typically require a flat “pad” area of several acres to hold equipment, access roads capable of supporting heavy vehicle traffic, and temporary ponds for storing water used during the drilling process. Vertical and horizontal Marcellus drilling sites were identified and represented in the model, in addition to conventional wells.

Oil and gas data incorporated into the TMDL model were obtained from the WVDEP OOG GIS coverage. There are 1,179 active conventional and vertical oil and gas wells (represented as 1,551 acres), and 11 horizontal wells (represented as 35 acres) represented in the metals impaired TMDL watersheds addressed in this report. Runoff from unpaved access roads to these wells and the disturbed areas around the wells contribute sediment to adjacent streams (**Figure 5-5**).

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as oil and gas discharges are modeled as nonpoint sources. The decision to assign LAs to those sources does not reflect a determination by WVDEP or USEPA as to whether they are, in fact, non-permitted point source discharges. Likewise, by establishing these TMDLs with these discharges treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.



(Note: wells in close proximity appear to overlap in the figure)

Figure 5-5. Oil and Gas Well locations in the Twelvepole Creek watershed

Roads

Heightened stormwater runoff from paved roads (impervious surface) can increase erosion potential. Unpaved roads can contribute sediment through precipitation-driven runoff. Roads that traverse stream paths elevate the potential for direct deposition of sediment. Road construction and repair can further increase sediment loads if BMPs are not properly employed.

Modeled paved roads acreages were developed from paved road data obtained from the U.S. Census Bureau's 2015 TIGER line shapefiles. Modeled unpaved roads acreages were estimated using a combination of several sources. Baseline unpaved roads acreages were extracted from 2015 TIGER roads data. TIGER road data has been observed to be incomplete in many West Virginia rural areas, therefore an effort was made to account for additional unpaved roads present in the watershed but not captured by TIGER.

A sample of 15 subwatersheds was analyzed using 2016 NAIP aerial photographs to digitize unpaved roads not captured by TIGER. A 12-foot width of the digitized unpaved roads was assumed. For the Twelvepole Creek watershed, the subwatersheds analyzed indicated that there could be an additional 0.24 percent of the subwatershed that consisted of unpaved roads not captured by TIGER.

Some of the unpaved roads in the Twelvepole Creek watershed are recreational off-road vehicle trails. Many of these trails have been digitally mapped to facilitate use. West Virginia Trail Inventory GIS data is maintained by the West Virginia Department of Transportation (WVDOT 2019). Trail Inventory trails were assumed to be 12 feet wide for the purposes of calculating acreage. To avoid double counting unpaved roads in areas with significant recreational trail acreage, a formula was applied to calculate the final modeled unpaved road acreage. Where Trail Inventory unpaved roads exceeded 0.24 percent of the subwatershed, then the total modeled unpaved roads acreage equaled TIGER unpaved roads plus the Trail Inventory unpaved roads. If the Trail Inventory road acreage was less than 0.24 percent of the subwatershed (in many subwatersheds it was zero), then the total modeled unpaved roads acreage equaled the sum of the TIGER unpaved roads plus the additional unpaved road acreage estimate by subwatershed that was derived from digitizing the sample of unpaved roads from the aerial photos (0.24 percent).

Agriculture

Agricultural landuses account for roughly 1 percent of the modeled land area in the watershed. Although agricultural activity accounts for a small percentage of the overall watershed, agriculture is a significant localized nonpoint source of iron and sediment. Bacteria upland loading representation was based on precipitation and runoff, in which accumulation rates were developed using source tracking information regarding number of livestock, proximity and access to streams, and overall runoff potential. Sedimentation/iron impacts from agricultural landuses are also indirectly reflected in the streambank erosion allocations.

Streambank Erosion

Streambank erosion has been determined to be a significant sediment source across the watershed. WVDEP conducted a series of special bank erosion pin studies in West Virginia watersheds which, combined with soils data and vegetative cover assessments, formed the foundation for representation of the baseline streambank sediment and iron loadings. The sediment loading from bank erosion is considered a nonpoint source and LAs are assigned for stream segments.

Other Land-Disturbance Activities

Stormwater runoff from residential and urban landuses in non-MS4 areas is a significant source of sediment in parts of the watershed. Outside urbanized area boundaries, these landuses are considered to be nonpoint sources and load allocations are prescribed. The modified NLCD 2011 landuse data were used to determine the extent of residential and urban areas not subject to MS4 permitting requirements and source representation was based upon precipitation and runoff.

The NLCD 2011 landuse data also classifies certain areas as “barren” land. In the model configuration process, portions of the barren landuse were reclassified to account for other known sources. The remainder is represented as a specific nonpoint source category in the model.

Construction activities disturbing less than one acre are not subject to construction stormwater permitting. While not specifically represented in the model, their impact is indirectly accounted for in the loading rates established for the urban/residential landuse category.

5.3 Beryllium Source Assessment

One stream, Left Fork/Camp Creek (WV-OT-45-Q-2) in the Twelvepole Creek watershed has been listed in the 2016 303(d) list pursuant to the water quality criteria for beryllium, based on pre-TMDL data collected by WVDEP from 2016- 2017. Left Fork/Camp Creek has TMDLs previously developed in 2009 for aluminum, pH, iron, fecal coliform, and biological impairment.

Beryllium is a naturally occurring element in the Earth’s crust in the forms of beryllium metal, beryllium alloys, and beryllium oxides. Beryllium is most often released into the environment through industrial processes and combustion of fossil fuels, such as coal, resulting in emission of beryllium into atmosphere, soils, and surface waters (IPCS, 2001). Another source of beryllium in surface water is weathering of rock and soil containing beryllium. In West Virginia, beryllium is found in coal formations in varying concentrations (WVGES, 2002). Beryllium compounds are amphoteric and will become soluble as a positive or negative ion depending on the pH of water. In general, beryllium is catonic in aqueous solution in pH below 5. Beryllium forms insoluble hydroxides or hydrate complexes at pH 5-8. pH above 8 beryllium is found in a beryllate-like complex (Drury et al. 1978).

An analysis of the WAB data in Left Fork/Camp Creek determined that all occurrences of beryllium water quality criterion exceedances were associated with pH less than 5 (**Figure 5-6**).

Beryllium exceedances occurred in watersheds where legacy mining influences were prevalent and the most likely source of beryllium and acidity.

There is an AML seep characterized by WVDEP source tracking approximately 0.1 mile upstream of the pre-TMDL water quality monitoring station on the Left Fork/Camp Creek. This seep (WVO2Q8PAM300-100) when sampled on March 9, 2018, was observed to be flowing at approximately 200 gallons per minute. The pH measurement recorded in the field was 3.32, and the grab sample was analyzed to 25.6 ug/l total beryllium.

The most elevated beryllium exceedances were observed during low flow conditions during which the continuous flow acid sources are dominant. Particulate beryllium is not expected to occur in the water column in concentrations that result in criterion exceedances when solids become transient during precipitation induced flow conditions.

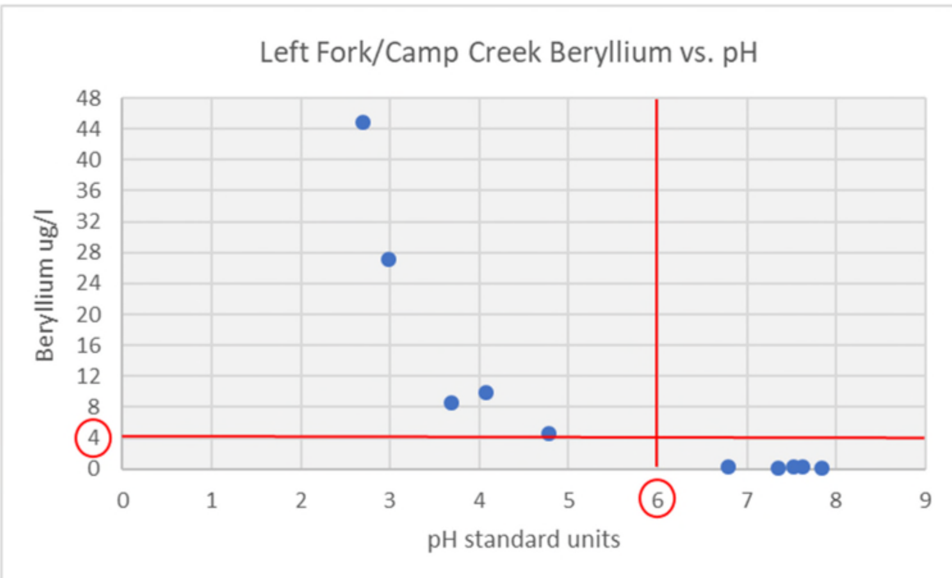


Figure 5-6. Beryllium and pH observations from pre-TMDL monitoring data

Acidity abatement pursuant to the 2009 pH TMDL will create instream pH conditions that limit the solubility of beryllium resulting in precipitation and settling of particulate compounds (i.e., bound to metals hydroxides). Thus the 2009 pH TMDL developed for Left Fork/Camp Creek serves as a surrogate for beryllium water quality criterion nonattainment.

5.4 Selenium Source Assessment

Selenium is a naturally occurring element that is found in Cretaceous marine sedimentary rocks, coal and other fossil fuel deposits (Dreher and Finkelman 1992; CCREM 1987; Haygarth 1994). When such deposits are mined, mobilization of selenium is typically enhanced from the crushing of ore and waste materials along with the resulting increase in surface area of material exposed to weathering processes. Studies have shown that selenium mobilization appears to be associated with various surface disturbance activities associated with surface coal mining in Wyoming and western Canada (Dreher and Finkelman 1992; McDonald and Strosher 1998). In West Virginia, coal beds of the Middle Pennsylvanian era exhibit the highest selenium contents. Lower selenium content is found in both the Lower Pennsylvanian and Upper Pennsylvanian eras (WVGES, 2002). Selenium is contained in those coals and mining often exposes partings and interburden of selenium containing shales.

The Twelvepole watershed is comprised of four major geologic formation(s)/group(s) within the lower and middle Pennsylvanian geologic system(s) that create the surface lithology (**Figure 5-7**). The predominant being the Conemaugh group which makes up approximately 52.5% of the Twelvepole watershed and the Pottsville group comprising approximately 23.3%. The Allegheny formation and Monongahela group make up the remaining 18.8% and 5.3% respectively.

These formations are comprised mainly of sandstone, limestone and shale interburden with coal beds and coal lenses dispersed throughout the stratigraphic column. Within the Twelvepole watershed stratigraphy, the Upper Freeport coal seam of the lower Conemaugh group contains significant reserve coal assets. The Kanawha formation found within the upper Pottsville group holds significant mineable coal reserves such as Mercer, Stockton, Coalburg and Winifrede seams. Mineable reserve seams such as the Freeport, Kittanning, Stockton, No. 5 Block and Upper No. 5 Block coal seams are found within the Allegheny formation.

West Virginia University published a study in 2008 focusing on concentrations of Selenium specifically in the Kanawha formation of southern West Virginia. The 2008 study noted, “The Low-S Coalburg and Winifrede coals of the upper Kanawha Formation in West Virginia contain Se at higher concentrations than found in many other West Virginia coal beds.” (Vesper, 2008) This study directly correlates with the WV DEP mandate to encapsulate coal partings and interburden within these seams that exceed 1mg/kg Se > 1ft of interburden thickness when mined.

The higher concentrations of selenium found within the interburden layers of shale and coal within the upper Kanawha formation and Allegheny and Conemaugh groups create potential for discharge of excess levels of Selenium into adjacent streams. This potential is increased by surface mining activities but can also be discharged naturally due to pressure induced fracturing of overburden in non-mining areas. Approximately 42% of the Twelvepole watershed has potential to produce above average selenium discharge rates, especially in the headwater regions where surface and underground mining is more prevalent. Although the Allegheny and Conemaugh groups and Kanawha formation of the Pottsville group demonstrate increased potential for selenium discharge due to elevated in-situ selenium concentrations, the majority of the Twelvepole watershed does not contain minable reserves, therefore mining influence is reduced and selenium discharge less prevalent for the majority of the watershed.

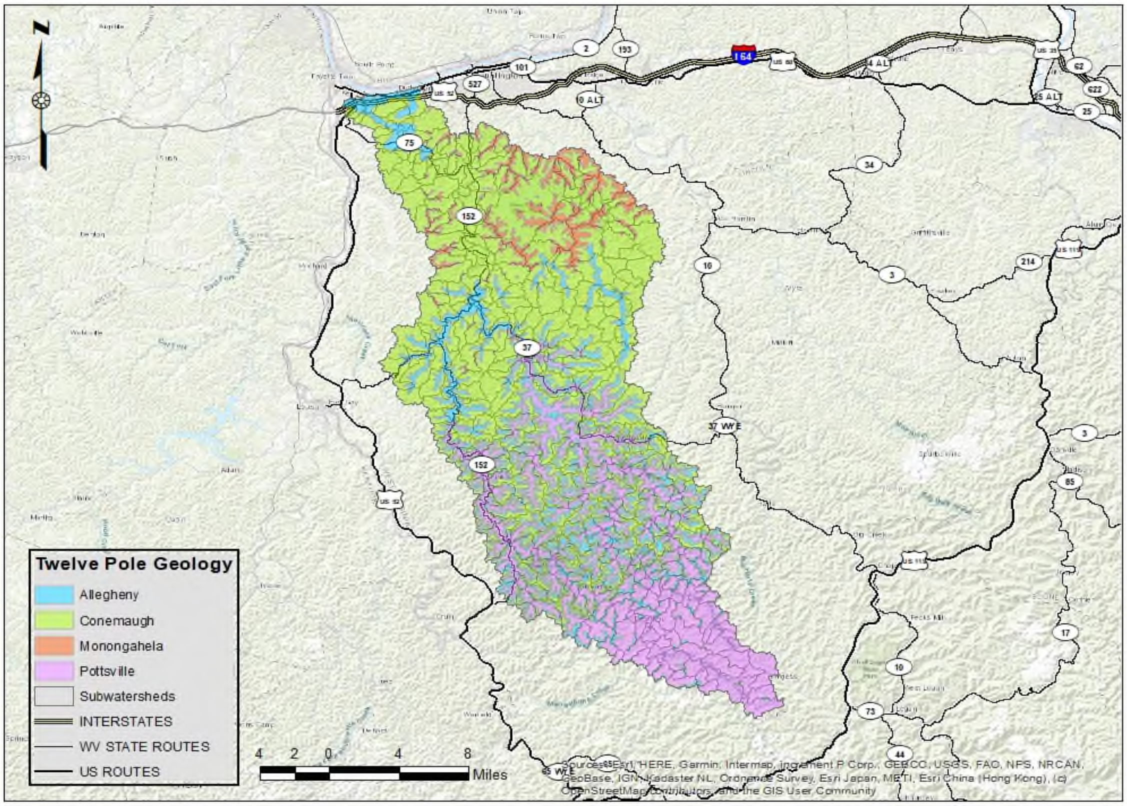


Figure 5-7: Twelvepole Creek geologic formations

Four streams in this TMDL project have been listed in the WV 2016 303(d) list pursuant to the aquatic life criteria for selenium, based on pre-TMDL data collected by WVDEP from 2016-2017 or from data submitted by permittees through monthly discharge reports assessed for the 303d list and TMDL work directive. Surface mining operations exist in the impaired watersheds; and both active and reclaimed mining are the dominant landuses. Given the selenium content of coals being mined in this region, and the prevalence of mining activity in proximity to observed exceedances of the selenium water quality criterion, it can be concluded that the disturbances associated with the existing operations and abandoned mine lands directly contribute to the selenium impairment.

Other nonpoint sources associated with surface disturbances (i.e., barren areas, unpaved roads, and oil and gas well operations) were considered to be negligible sources of selenium because these land disturbances typically do not disrupt subsurface strata that contain selenium. In this and prior TMDL development efforts, WVDEP did not identify selenium impairments in streams where surface-disturbing nonpoint sources were prevalent in the watershed and mining activities were absent.

6.0 pH SOURCE ASSESSMENT

pH impairments in the study area were caused by acidity introduced by historical mining activities and atmospheric acid deposition in the Twelvepole Creek watershed. WVDEP source tracking and pre-TMDL water quality monitoring observations were used to characterize the causative sources. Acid precipitation and the low buffering capacity of certain watersheds can contribute to lower observed pH. Atmospheric acid deposition was represented in the model, and it was found to be the causative source for one impaired stream (Messenger Branch WV-OT-46-DG) in the Twelvepole Creek watershed.

6.1 Abandoned Mine Land Seeps

Discharges from historical mining activities can cause low pH impairments, iron and/or aluminum impairments. Because of the complex chemical interactions that occur between dissolved metals and acidity, the TMDL approach focused on reducing metals concentrations to meet metals and associated pH water quality criteria while accounting for watershed dynamics associated with buffering capacity. One AML seep in Matty Ferguson Branch (WV-OT-46-AQ) was prescribed metals reductions in the TMDL allocation scenario in order for the stream to meet water quality standards.

6.2 Acid Deposition

Acid rain is produced when atmospheric moisture reacts with gases to form sulfuric acid, nitric acid, and carbonic acid. These gases are primarily formed from nitrogen dioxides and sulfur dioxide, which enter the atmosphere through exhaust and smoke from burning fossil fuels such as gas, oil, and coal. Two-thirds of sulfur dioxides and one-fourth of nitrogen oxides present in the atmosphere are attributed to fossil fuel burning electric power generating plants (USEPA, 2005). Acid rain crosses watershed boundaries and may originate in the Ohio River Valley or the Midwestern United States.

The majority of the acid deposition occurs in the eastern United States. In March 2005, the USEPA issued the Clean Air Interstate Rule (CAIR), which places caps on emissions for sulfur dioxide and nitrogen dioxides for the eastern United States. It was expected that CAIR would reduce sulfur dioxide emissions by over 70 percent and nitrogen oxides emissions by over 60 percent from the 2003 emission levels (USEPA, 2005).

Effective January 1, 2015, CAIR was replaced by the Cross-State Air Pollution Rule (CSAPR). Similar to CAIR, CSAPR also places caps on emissions for sulfur dioxide and nitrogen oxides for the eastern United States. Combined with other final state and EPA actions, CSAPR will reduce power plant SO_2 emissions by 73 percent and NOx emissions by 54 percent from 2005 levels in the CSAPR region (USEPA, 2016).

On October 15, 2020, EPA proposed the Revised Cross-State Air Pollution Rule Update in order to fully address 21 states' outstanding interstate pollution transport obligations for the 2008 ozone National Ambient Air Quality Standards (NAAQS). Starting in the 2021 ozone season, the proposed rule would require additional emissions reductions of nitrogen oxides (NOx) from power plants in 12 states, including West Virginia (USEPA, 2021). This new rule does not change SO_2 reduction targets previously established. Because pollution is highly mobile in the atmosphere, reductions based on these rules in West Virginia, Ohio, and Pennsylvania will likely improve the quality of precipitation in the watershed.

Acid deposition occurs by two main methods: wet and dry. Wet deposition occurs through rain, fog, and snow. Dry deposition originates from gases and particles. Dry deposition accounts for approximately half of the atmospheric deposition of acidity (USEPA, 2005). Winds blow the particles and gases contributing to acid deposition over large distances, including political boundaries, such as state boundaries. After dry deposition occurs, particles and gases can be washed into streams from trees, roofs, and other surfaces by precipitation.

Weekly wet deposition data were retrieved from National Atmospheric Deposition Program station WV04-Babcock State Park in Fayette County from 2000 to the most recent data 2014. The Clean Air Status and Trends Network (CASTNET) was accessed to retrieve dry deposition data from CDR119 in Gilmer County.

6.3 pH – Natural Alkalinity Sources

Soils with moderate buffering capacity such as skeletal loamy residuum weathered from sandstone and shale, as well as colluvium derived from sandstone and siltstone, could be a source of alkalinity in some modeled subwatersheds. Dissolution of carbonate rocks neutralizes the excessive acidity from atmospheric precipitation and provides natural loading of alkalinity to the streams. As a result, alkaline conditions are commonly, but not exclusively, observed in the streams from geologic formations present in the Twelvepole Creek Watershed.

Parameters such as base saturation, cation exchange capacity, dissolution susceptibility of aluminum minerals (aluminum hydroxides), and soil CO_2 control acidification of soils and the land outflows. The heterogeneous nature of these parameters results in different buffering capacities for different soil types. Thus, different soil types in subwatersheds were assumed to react differently to the acidity from atmospheric deposition.

7.0 FECAL COLIFORM SOURCE ASSESSMENT

7.1 Fecal Coliform Point Sources

Publicly and privately owned sewage treatment facilities and home aeration units are point sources of fecal coliform bacteria. The following sections discuss the specific types of fecal coliform point sources that were identified in the Twelvepole Creek watershed.

7.1.1 Individual NPDES Permits

WVDEP issues individual NPDES permits to both publicly owned and privately owned wastewater treatment facilities. Publicly owned treatment works (POTWs) are relatively large sewage treatment facilities with extensive wastewater collection systems, whereas private facilities are usually used in smaller applications such as subdivisions and shopping centers. Additionally specific discharges from industrial facilities are regulated for fecal coliform bacteria.

In the subject watersheds of this report, 1 individually permitted POTW discharges treated effluent at 2 outlets. This POTW is the Town of Wayne (WV0024562). Two mining bathhouse permits discharge to TMDL streams in the Twelvepole Creek TMDL watersheds via 2 outlets.

These sources are regulated by NPDES permits that require effluent disinfection and compliance with strict fecal coliform effluent limitations (200 counts/100 mL [geometric mean monthly] and 400 counts/100 mL [maximum daily]). Compliant facilities do not cause fecal coliform bacteria impairments because effluent limitations are more stringent than water quality criteria. Refer to the Technical Report **Appendix F** for details regarding NPDES permits.

7.1.2 Overflows

Combined Sewer Overflows (CSOs) are outfalls from POTW sewer systems that discharge untreated domestic waste and surface runoff. CSOs are permitted to discharge only during precipitation events. Sanitary sewer overflows (SSOs) are unpermitted overflows that occur as a result of excess inflow and/or infiltration to POTW separate sanitary collection systems. Both types of overflows contain fecal coliform bacteria.

In the subject watersheds, there were a total of 3 CSO outlets associated with the POTW collection system operated by the Town of Wayne. No significant SSO discharges were represented in the model.

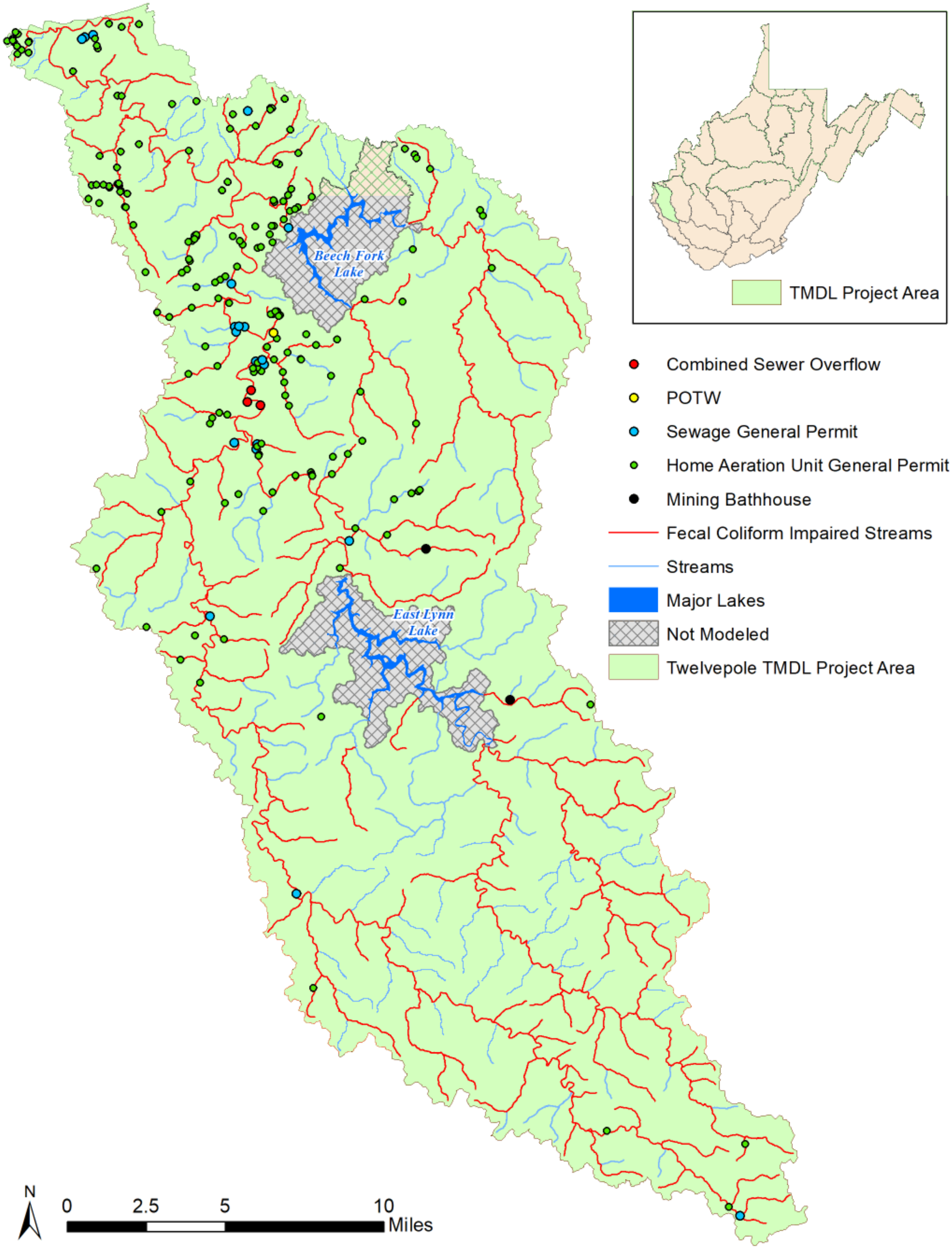
7.1.3 Municipal Separate Storm Sewer Systems (MS4)

Runoff from residential and urbanized areas during storm events can be a significant fecal coliform source. USEPA’s stormwater permitting regulations require public entities to obtain NPDES permit coverage for stormwater discharges from MS4s in specified urbanized areas. As such, MS4 stormwater discharges are considered point sources and are prescribed WLAs.

MS4 entities and their areas of responsibility are described in **Section 5.1.4** and displayed in **Figure 5-3**. MS4 source representation is based upon precipitation and runoff from landuses determined from the modified NLCD 2011 landuse data, the jurisdictional boundary of the cities, and the transportation-related drainage areas for which WVDOH has MS4 responsibility. In certain areas, urban/residential stormwater runoff may drain to both CSO and MS4 systems. WVDEP consulted with local governments and obtained information to determine drainage areas to the respective systems and best represent MS4 pollutant loadings.

7.1.4 General Sewage Permits

General sewage permits are designed to cover like discharges from numerous individual owners and facilities throughout the state. General Permit WV0103110 regulates small, privately owned sewage treatment plants (“package plants”) that have a design flow of 50,000 gallons per day (gpd) or less. General Permit WV0107000 regulates home aeration units (HAUs). HAUs are small sewage treatment plants primarily used by individual residences where site considerations preclude typical septic tank and leach field installation. Both general permits contain fecal coliform effluent limitations identical to those in individual NPDES permits for sewage treatment facilities. In the areas draining to streams for which fecal coliform TMDLs have been developed, 22 facilities are registered under the “package plant” general permit, and 207 are registered under the HAU general permit. Modeled point source locations are shown on **Figure 7-1.**



(Note: outlets in close proximity appear to overlap in the figure)

Figure 7-1. Fecal coliform point sources

7.2 Fecal Coliform Nonpoint Sources

7.2.1 On-site Treatment Systems

Failing septic systems and straight pipes are significant nonpoint sources of fecal coliform bacteria. Information collected during source tracking efforts by WVDEP yielded an estimate of 13,500 homes that are not served by centralized sewage collection and treatment systems and are within 100 meters of a stream. Homes located more than 100 meters from a stream were not considered significant potential sources of fecal coliform because of the natural attenuation of fecal coliform concentrations that occurs because of bacterial die-off during overland travel (Walsh and Kunapo, 2009). Estimated septic system failure rates across the watershed range from 3 percent to 28 percent. Section 3.1.4 of the Technical Report describes the methods used to characterize failing septic systems.

Due to a wide range of available literature values relating to the bacteria loading associated with failing septic systems, a customized Microsoft Excel spreadsheet tool was created to represent the fecal coliform bacteria contribution from failing on-site septic systems. WVDEP's pre-TMDL monitoring and source tracking data were used in the calculations. To calculate loads, values for both wastewater flow and fecal coliform concentration are needed.

To calculate failing septic wastewater flows, the TMDL watersheds were divided into three septic failure zones. During the WVDEP source tracking process, septic failure zones were delineated by soil characteristics (soil permeability, depth to bedrock, depth to groundwater and drainage capacity) as shown in United States Department of Agriculture (USDA) county soil survey maps. Two types of failure were considered, complete failure and periodic failure. For the purposes of this analysis, complete failure was defined as 50 gallons per house per day of untreated sewage escaping a septic system as overland flow to receiving waters and periodic failure was defined as 25 gallons per house per day. **Figure 7-2** shows the fecal coliform counts per year represented in the model from failing septic systems relative to the total stream length in meters for each subwatershed.

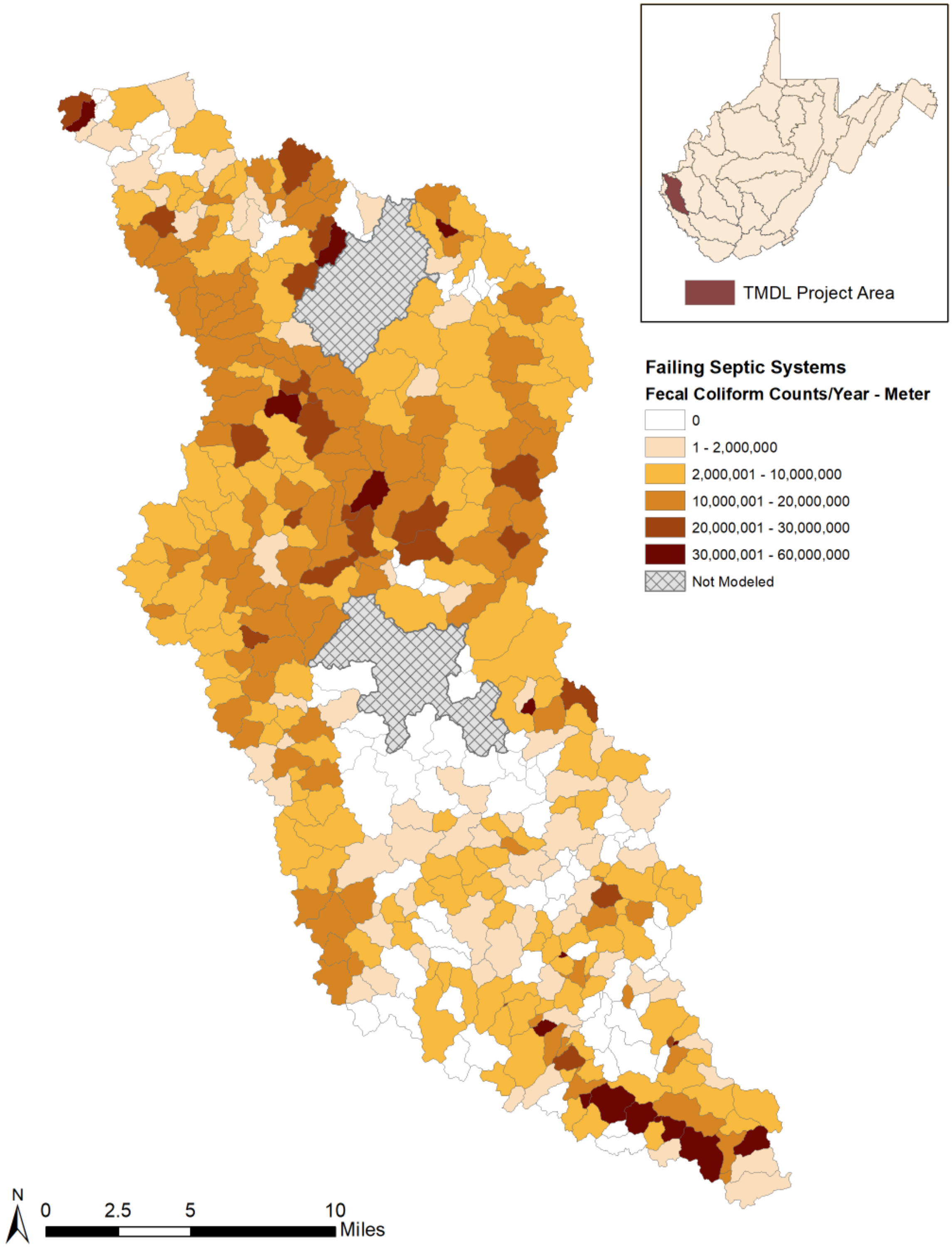


Figure 7-2. Fecal coliform counts attributed to failing septic systems per year relative to the stream lengths (meters) in each subwatershed in the Twelvepole Creek watershed as represented in modeling.

Once failing septic flows were modeled, a fecal coliform concentration was determined at the TMDL watershed scale. Based on past experience with other West Virginia TMDLs, a base concentration of 10,000 counts per 100 ml was used as a beginning concentration for failing septic systems, and was further refined during model calibration. A sensitivity analysis was performed by varying the modeled failing septic concentrations in multiple model runs, and then comparing model output to pre-TMDL monitoring data.

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as failing septic systems and straight pipes, are considered nonpoint sources. The decision to assign LAs to those sources does not reflect a determination by WVDEP or USEPA as to whether they are, in fact, non-permitted point source discharges. Likewise, by establishing these TMDLs with failing septic systems and straight pipes treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.

7.2.2 Urban/Residential Runoff

Stormwater runoff from residential and urbanized areas that are not subject to MS4 permitting requirements can be a significant source of fecal coliform bacteria. These landuses are considered to be nonpoint sources and load allocations are prescribed. The modified NLCD 2011 landuse data were used to determine the extent of residential and urban areas not subject to MS4 permitting requirements and source representation was based upon precipitation and runoff.

7.2.3 Agriculture

Agricultural activities can contribute fecal coliform bacteria to receiving streams through surface runoff or direct deposition. Grazing livestock and land application of manure result in the deposition and accumulation of bacteria on land surfaces. These bacteria are then available for wash-off and transport during rain events. In addition, livestock with unrestricted access can deposit feces directly into streams.

Although agricultural activity accounts for a small percentage of the overall watershed, agriculture is a significant localized nonpoint source of fecal coliform bacteria. Source tracking efforts identified pastures and feedlots near impaired segments that have localized impacts on instream bacteria levels. Source representation was based upon precipitation and runoff, and source tracking information regarding number of livestock, proximity and access to stream, and overall runoff potential were used to develop accumulation rates.

7.2.4 Natural Background (Wildlife)

A certain “natural background” contribution of fecal coliform bacteria can be attributed to deposition by wildlife in forested areas. Accumulation rates for fecal coliform bacteria in forested areas were developed using reference numbers from past TMDLs, which incorporated wildlife estimates obtained from West Virginia’s Division of Natural Resources (WVDNR). In addition, WVDEP conducted storm-sampling on a 100 percent forested subwatershed (Shrewsbury Hollow) within the Kanawha State Forest, Kanawha County, West Virginia to determine wildlife contributions of fecal coliform and these results were used during the model calibration process. On the basis of the low fecal accumulation rates for forested areas, the storm water sampling results, and model simulations, wildlife is not considered to be a significant nonpoint source of fecal coliform bacteria in the watershed.

8.0 DISSOLVED OXYGEN SOURCE ASSESSMENT

As noted in Table 3-3, there are 2 streams that are impaired for dissolved oxygen and fecal coliform bacteria, both commonly associated with organic enrichment. Excessive amounts of organic matter increase fecal coliform bacteria counts and reduce dissolved oxygen levels. Generally, point and non-point sources contributing to dissolved oxygen impairments are the same as those for fecal coliform. Streams impaired for both dissolved oxygen and fecal coliform are listed below:

- Camp Creek WV-OT-21
- Beech Fork WV-OT-24

Camp Creek

Camp Creek a medium sized watershed, approximately 5,000 acres. Much of the watershed is forested, with little agricultural activity. There are approximately 250 acres of residential landuse in the watershed. High densities of failing septic systems were estimated to occur based on numbers of homes not served by public sewage systems. One package plant and 11 HAUs discharge treated sewage in the watershed. Fecal coliform concentrations were consistently high (800 to 12,000 counts per 100 ml) during warmer months. Three DO violations occurred during low flow in summer 2016. The sources of the fecal coliform appeared likely to be failing septic systems and runoff from residential areas. Implementation of the fecal coliform TMDL will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

Beech Fork

DO and fecal coliform violations were observed at pre-TMDL monitoring stations on Beech Fork upstream of Beech Fork Lake. Subwatersheds were predominantly forested with little agricultural activity. There was approximately 300 acres of residential landuse near the violating monitoring stations. A high percentage of homes in the watershed were predicted to have failing systems. Those homes were also situated within the geologic zone with the highest probability of septic failure. The sources of the fecal coliform appeared likely to be failing septic systems and runoff from residential areas. Implementation of the fecal coliform TMDL will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

9.0 MODELING PROCESS

Establishing the relationship between the instream water quality targets and source loadings is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses with flow and loading conditions. This section presents the approach taken to develop the linkage between sources and instream response for TMDL development in the Twelvepole Creek watershed.

9.1 Model Selection

Selection of the appropriate analytical technique for TMDL development was based on an evaluation of technical and regulatory criteria. The following key technical factors were considered in the selection process:

- Scale of analysis;
- Point and nonpoint sources;
- Metals and fecal coliform bacteria impairments are temporally variable and occur at low, average, and high flow conditions;
- Total iron loadings and instream concentrations are related to sediment;
- Time-variable aspects of land practices have a large effect on instream pollutant concentrations; and
- Pollutant transport mechanisms are variable and often weather-dependent.

The primary regulatory factor that influenced the selection process was West Virginia's water quality criteria. According to 40 CFR Part 130, TMDLs must be designed to implement applicable water quality standards. The applicable water quality criteria for iron, aluminum, pH, selenium, and fecal coliform bacteria in West Virginia are presented in **Section 2.2**, **Table 2-1**. West Virginia numeric water quality criteria are applicable at all stream flows greater than the 7-day, 10-year low flow (7Q10), defined as the lowest flow for seven day average flow that occurs once every ten years. The approach or modeling technique must permit representation of instream concentrations under a variety of flow conditions to evaluate critical flow periods for comparison with criteria.

The TMDL development approach must also consider the dominant processes affecting pollutant loadings and instream fate. In the Twelvepole Creek watershed, an array of point and nonpoint sources contributes to the various impairments. Most nonpoint sources are rainfall-driven with pollutant loadings primarily related to surface runoff, but some, such as inadequate onsite residential sewage treatment systems, function as continuous discharges. Similarly, certain point sources are precipitation-induced while others are continuous discharges. While loading function variations must be recognized in the representation of the various sources, the TMDL allocation process must prescribe WLAs for all contributing point sources and LAs for all contributing nonpoint sources.

The MDAS was developed specifically for TMDL application in West Virginia to facilitate large scale, data intensive watershed modeling applications. The MDAS is a system designed to support TMDL development for areas affected by nonpoint and point sources. The MDAS component most critical to TMDL development is the dynamic watershed model because it provides the linkage between source contributions and instream response. The MDAS is used to simulate watershed hydrology and pollutant transport as well as stream hydraulics and instream water quality. It is capable of simulating different flow regimes and pollutant loading variations. A key advantage of the MDAS' development framework is that it has no inherent limitations in terms of modeling size or upper limit of model operations. In addition, the MDAS model allows for seamless integration with modern-day, widely available software such as Microsoft Access and Excel. Sediment, total iron, aluminum, pH, selenium, and fecal coliform bacteria were modeled using the MDAS.

9.2 Model Setup

Model setup consisted of configuring the following four separate MDAS models: iron/sediment; aluminum/pH, selenium, and fecal coliform bacteria.

9.2.1 General MDAS Configuration

Configuration of the MDAS model involved subdividing the TMDL watersheds into subwatershed modeling units connected by stream reaches. Physical characteristics of the subwatersheds, weather data, landuse information, continuous discharges, and stream data were used as input. Flow and water quality were continuously simulated on an hourly time-step.

Two grid-based weather data products were used to develop MDAS model weather input files for TMDL modeling. The Parameter-Elevation Regressions on Independent Slopes Model (PRISM) and the North American Land Data Assimilation System (NLDAS-2) are both publicly available weather datasets. PRISM data features daily weather on 4 km grid spatial scale, and NLDAS-2 data has hourly weather on a 12 km grid scale. Both datasets combine rain gauge data with radar observations to predict hourly weather parameters such as precipitation, solar radiation, wind, and humidity. For more information on PRISM and NLDAS-2, refer to Section 2 of the Technical Report.

PRISM daily weather data and NLDAS-2 hourly precipitation data were obtained and processed to create a time series for each PRISM grid cell that contained modeled TMDL watersheds. Using the precipitation and temperature time series, a model weather input file was developed for each PRISM grid cell. Given that only slight variability was observed between the grid cells at the 12-digit Hydrologic Unit Code (HUC) scale, and to allow for faster model run times, one weather input file per each of the twenty-two 12-digit HUCs in the Twelvepole Creek watershed was developed by taking an area-weighted average of PRISM values within each 12-digit HUC. Model subwatersheds falling within each 12-digit HUC were then assigned the appropriate weather input file for hydrologic modeling purposes.

The 17 TMDL watersheds were broken into 446 separate subwatershed units, based on the groupings of impaired streams shown in **Figure 3-2**. The TMDL watersheds were divided to allow evaluation of water quality and flow at pre-TMDL monitoring stations. This subdivision process also ensures a proper stream network configuration within the basin.

9.2.2 Metals and Sediment Configuration

The modeled landuse categories contributing metals via precipitation and runoff include forest, pasture, cropland, wetlands, barren, residential/urban impervious, and residential/urban pervious. These sources were represented explicitly by consolidating existing NLCD 2011 landuse categories to create modeled landuse groupings. Several additional landuse categories were created to account for landuses either not included in the NLCD 2011 and/or representing recent land disturbance activities (e.g., harvested forest and skid roads, oil and gas operations, paved and unpaved roads). The process of consolidating and updating the modeled landuses is explained in further detail in the Technical Report. Non-sediment related iron land-based sources were modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget.

Traditional point sources (e.g., industrial discharges) were modeled as direct, continuous-flow sources in the model, with the baseline flow and pollutant characteristics obtained from permitting databases.

Sediment-producing landuses and bank erosion are sources of iron because the relatively high iron content of the soils in the watershed. Statistical analyses using pre-TMDL monitoring data collected in the TMDL watersheds were performed to establish the correlation between instream sediment and iron metals concentrations. The results were then applied to the sediment from sediment-producing landuses and stream bank erosion to calculate the iron loads delivered to the streams.

Generation of upland sediment loads depends on the intensity of surface runoff and varies by landuse and the characteristics of the soil. Surface sediment sources were modeled as soil detachment and sediment transport by landuse. Soil erodibility and sediment washoff coefficients varied among soil types and landuses and were used to simulate sediment erosion by surface runoff. Sediment delivery paths modeled were surface runoff erosion and streambank erosion. Streambank erosion was modeled as a unique sediment source independent of other upland-associated erosion sources.

The MDAS bank erosion model takes into account stream flow and bank stability using the following methodology. Each stream segment has a flow threshold (Q threshold) above which streambank erosion occurs. This threshold is estimated as the flow that occurs at bank full depth. The bank erosion rate per unit area is a function of bank flow volume above the specified threshold and the bank erodible area (Q Bank Erosion). The bank scouring process is a power function dependent on high-flow events, defined as exceeding the flow threshold. Bank erosion rates increase with flow above the Q Threshold.

The wetted perimeter and reach length represent ground area covered by water (**Figure 9-1**). The erodible wetted perimeter is equal to the difference between the actual wetted perimeter and wetted perimeter during threshold flow conditions. The bank erosion rate per unit area was multiplied by the erodible perimeter and the reach length to obtain an estimate of sediment mass eroded corresponding to the stream segment.

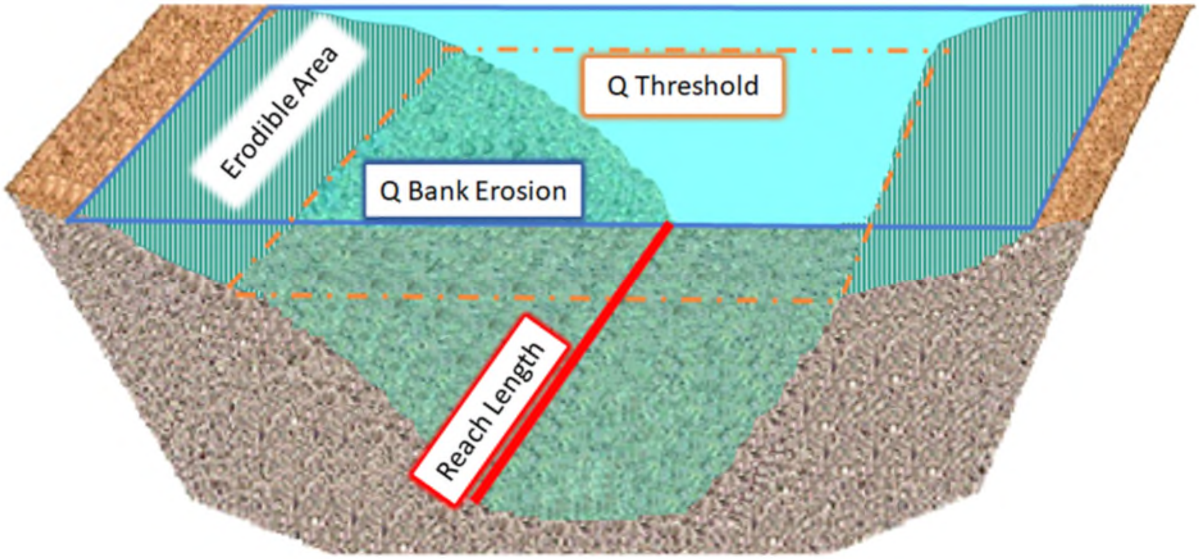


Figure 9-1. Conceptual diagram of stream channel components used in the bank erosion model

Another important variable in the prediction of sediment yield is bank stability as defined by coefficient for scour of the bank matrix soil (referred to as "kber") for the reach. Both quantitative and qualitative assessments indicated that vegetative cover was the most important factor controlling bank stability. Overall bank stability was initially characterized by assessing and rating bank vegetative cover from aerial photography on a subwatershed basis. The erodibility coefficient from soils data was used to refine this assessment. Using the aerial assessment and the soil erodibility data together, the subwatershed's bank condition was scored and each level was associated with a kber value. Modeled streambank erosion annual soil loss results were compared to field data available from previous WVDEP streambank erosion pin studies to verify that the amount of lost sediment generated by the model was within reason.

The Technical Report provides more detailed discussions on the technical approaches used for streambank erosion and sediment modeling.

9.2.3 Aluminum and pH Configuration

The MDAS model includes a dynamic chemical species fate and transport module that simulates soil subsurface and in-stream water quality taking into account chemical species interaction and transformation. The time series for total chemical concentration and flows generated by MDAS are used as inputs for the modules' pollutant transformation and transport routines. The modules simulate soil subsurface and in-stream chemical reactions, assuming instant mixing and concentrations equally distributed throughout soil and stream segments. The model supports major chemical reactions, including acid/base, complexation, precipitation, and dissolution reactions and some kinetic reactions. The model selection process, modeling methodologies, and technical approaches are discussed further in the Technical Report.

Pollutant Source Configuration

Legacy mining discharges generate metal and acidity loadings. These sources were identified and sampled for pH, cations and anions including targeted metals during source tracking. Flow rates from these sources were measured simultaneously. The model incorporates these stationary sources as direct, continuous-flow sources based on the observed data. Due to the potential time variable nature of the sources, the constant loadings were adjusted during the model calibration using the instream water quality data.

Precipitation induced land-based sources of total aluminum and total iron were modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget. The contributions of acidity and species that impact the calculation of alkalinity and pH were represented in the land-based loadings in the model.

In order to represent the effects of acid precipitation, soil type parameters were selected using the literature and refined based on site data ranges. The concentrations of the wet deposition data were assigned to rainfall events. The dry deposition was assumed to accumulate daily and wash off during the precipitation events and was assumed to be included implicitly in the loads being generated at the surface. Clean Air Status and Trends Network (CASTNET) was accessed to retrieve the dry deposition data. Adjustment and verification of these parameters occurred by examining water quality data in streams where watersheds did not include legacy mine discharges or alkalinity mitigation. This aspect of the model provided the link between atmospheric deposition and soil buffering capacity.

Instream Chemical Reaction

All the loadings from the previously described upland loading sources were discharged to the stream via the hydrologic functionalities of the model. All added loadings were subjected to subsequent instream chemical reactions. The important reactions identified to control instream pH and dissolved aluminum are:

- mineral precipitation
- Stream travel time relative to reaction time
- The stream buffering capacity
- Sediment deposition rates in relation to stream velocity

During the model calibration, it was identified that the instream dissolved aluminum/pH conditions were mostly influenced by mineral precipitation. Precipitation and deposition were more likely to occur during low flow conditions when more time was available for chemical reactions. The model indicated that the available buffering capacity of the stream to counteract hydrogen acidity from the precipitation reaction was also important. Alkalinity dosing scenarios provided more buffering capacity. Buffering and dilution positively affected downstream concentrations.

9.2.4 Selenium Configuration

Modeled landuse categories contributing selenium via precipitation and runoff include background undeveloped land, AML lands, AML highwalls, legacy mine areas, and active surface mining permits. Other sources, such as pumped discharges from active mines and legacy mine seeps were modeled as direct, continuous-flow sources in the model.

Selenium loading rates for background and AML sources were derived through model calibration to replicate instream selenium concentrations observed during pre-TMDL monitoring. Legacy mine loading rates were developed from WVDEP source tracking sampling during field investigations. Active mining permits were characterized by their contributing acreage for surface mines, or flow volume for deep mines with continuous flow. For mine outlets with selenium permit limits, modeled selenium concentrations were the same as the permit limit. For mine outlets without selenium limits, an estimate of selenium concentration derived from discharge monitoring report data was used, initially. The estimate of selenium concentrations from these mine outlets was adjusted so that modeled selenium concentrations more closely approximated in-stream water quality observations collected during pre-TMDL stream monitoring. No outlets with effluent limits derived through fish bioaccumulation studies were present in modeled watersheds.

9.2.5 Fecal Coliform Configuration

Modeled landuse categories contributing bacteria via precipitation and runoff include pasture, cropland, urban/residential pervious lands, urban/residential impervious lands, grassland, forest, barren land, and wetlands. Other sources, such as failing septic systems and discharges from sewage treatment facilities, were modeled as direct, continuous-flow sources in the model.

The basis for the initial bacteria loading rates for landuses and direct sources is described in the Technical Report. The initial estimates were further refined during the model calibration. A variety of modeling tools were used to develop the fecal coliform bacteria TMDLs, including the MDAS, and a customized spreadsheet to determine the fecal loading from failing residential septic systems identified during source tracking efforts by the WVDEP. **Section 7.2.1** describes the process of assigning flow and fecal coliform concentrations to failing septic systems.

9.3 Hydrology Calibration

Hydrology and water quality calibration were performed in sequence because water quality modeling is dependent on an accurate hydrology simulation. Typically, hydrology calibration involves a comparison of model results with instream flow observations from USGS flow gauging stations throughout the watershed. One USGS gauging stations located in Twelvepole Creek watershed had adequate recorded data for model hydrology calibration:

- USGS 03206600 East Fork Twelvepole Creek Near Dunlow, WV

Hydrology calibration compared observed data from the stations and modeled runoff from the landuses present in the watershed. Key considerations for hydrology calibration included the overall water balance, the high- and low-flow distribution, storm flows, and seasonal variation. The hydrology was validated for the time period of January 1, 2008 to December 31, 2017. As a starting point, many of the hydrology calibration parameters originated from the USGS Scientific Investigations Report 2005-5099 (Atkins, 2005). Final adjustments to model hydrology were based on flow measurements obtained during WVDEP's pre-TMDL monitoring in the Twelvepole Creek watershed. A detailed description of the hydrology calibration and a summary of the results and validation are presented in the Technical Report in **Appendix I**.

9.4 Water Quality Calibration

After the model was configured and calibrated for hydrology, the next step was to perform water quality calibration for the subject pollutants. The goal of water quality calibration was to refine model parameter values to reflect the unique characteristics of the watershed so that model output would predict field conditions as closely as possible. Both spatial and temporal aspects were evaluated through the calibration process.

The water quality was calibrated by comparing modeled versus observed pollutant concentrations. The water quality calibration consisted of executing the MDAS model, comparing the model results to available observations, and adjusting water quality parameters within reasonable ranges. Initial model parameters for the various pollutant parameters were derived from previous West Virginia TMDL studies, storm sampling efforts, and literature values. Available monitoring data in the watershed were identified and assessed for application to calibration. Monitoring stations with observations that represented a range of hydrologic conditions, source types, and pollutants were selected. The time-period for water quality calibration was selected based on the availability of the observed data and their relevance to the current conditions in the watershed.

WVDEP also conducted storm monitoring on Shrewsbury Hollow in Kanawha State Forest, Kanawha County, West Virginia. The data gathered during this sampling episode was used in the calibration of fecal coliform and to enhance the representation of background conditions from undisturbed areas. The results of the storm sampling fecal coliform calibration are shown in **Figure 9-2**.

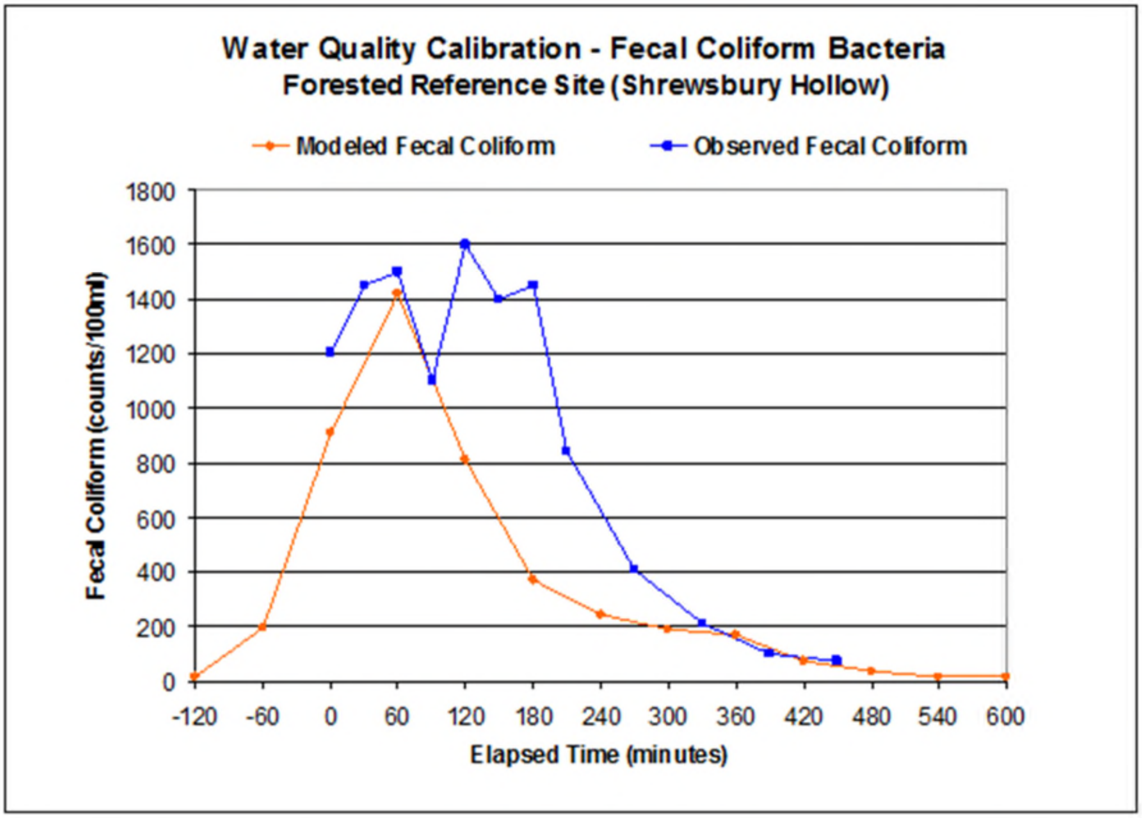


Figure 9-2. Shrewsbury Hollow fecal coliform observed data

Sediment calibration consisted of adjusting the soil erodibility and sediment transport parameters by landuse, and the coefficient of scour for bank-erosion. Initial values for these parameters were based on available landuse-specific storm-sampling monitoring data. Initial values were adjusted so that the model's suspended solids output closely matched observed instream data in watersheds with predominately one type of source.

9.5 Modeling Technique for Biological Impacts with Sedimentation Stressors

The SI process discussed in **Section 4** identified sedimentation as a significant biological stressor in some of the streams. Often streams with sedimentation impairments, are also impaired pursuant to the total iron criterion for aquatic life protection and WVDEP determined that implementation of the iron TMDLs would require sediment reductions sufficient to resolve the biological impacts. The sediment reduction necessary to attain iron criteria was compared to the sediment reduction necessary to resolve biological stress under a "reference watershed" approach. The approach was based on selecting watersheds with acceptable biological condition that share similar landuse, ecoregion, and geomorphologic characteristics with the watersheds of impacted streams. The normalized loading associated with the reference stream is assumed to represent the conditions needed to resolve sedimentation stress in impacted streams. A reference watershed was evaluated. Upon finalization of modeling based on the reference watershed approach, it was determined that sediment reductions necessary to ensure compliance with iron criteria are greater than those necessary to correct the biological impacts associated with sediment. As such, the iron TMDLs presented for the subject waters are appropriate surrogates to address impacts related to sediment. Refer to the Technical Report and **Appendix L** for details regarding the iron surrogate approach.

9.6 Allocation Strategy

As explained in **Section 2**, a TMDL is composed of the sum of individual WLAs for point sources, LAs for nonpoint sources, and natural background levels. In addition, the TMDL must include a MOS, implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. TMDLs can be expressed in terms of mass per time or other appropriate units. Conceptually, this definition is denoted by the equation:

TMDL = sum of WLAs + sum of LAs + MOS

To develop the TMDLs for each of the impairments listed in **Table 3-3** of this report, the following approach was taken:

- Define TMDL endpoints;
- Simulate baseline conditions;
- Assess source loading alternatives; and
- Determine the TMDL and source allocations.

9.6.1 TMDL Endpoints

TMDL endpoints represent the water quality targets used to quantify TMDLs and their individual components. In general, West Virginia's numeric water quality criteria for the subject pollutants and an explicit five percent MOS were used to identify endpoints for TMDL development. The TMDL endpoints for the various criteria are displayed in **Table 9-1**.

The five percent explicit MOS was used to counter uncertainty in the modeling process. Long-term water quality monitoring data were used for model calibration. Although these data represented actual conditions, they were not of a continuous time series and might not have captured the full range of instream conditions that occurred during the simulation period.

The allocation process prescribes criterion end-of-pipe WLAs for continuous discharges and instream treatment structures and thereby provides an implicit MOS for criterion attainment at all model assessment locations. Similarly, an explicit MOS was not applied for total iron and selenium TMDLs in certain subwatersheds where mining point sources create an effluent dominated scenario and/or the regulated mining activity encompasses a large percentage of the watershed area. Within these scenarios, WLAs are established at the value of the criteria and little uncertainty is associated with the source/water quality linkage. The TMDL endpoints for the various criteria are displayed in Table 9-1.

Table 9-1. TMDL endpoints

Water Quality Criterion	Designated Use	Criterion Value	TMDL Endpoint
Dissolved Aluminum	Aquatic Life, warmwater fisheries	0.75 mg/L (1-hour average)	0.7125 mg/L (1-hour average)
Total Iron	Aquatic Life, warmwater fisheries	1.5 mg/L (4-day average)	1.425 mg/L (4-day average)
Total Selenium *	Aquatic Life	0.005 mg/L (4-day average)	0.005 mg/L (4-day average)
pH	Aquatic Life	6.00 Standard Units (Minimum)	6.02 Standard Units (Minimum)
Fecal Coliform	Water Contact Recreation and Public Water Supply	200 counts / 100 mL (Monthly Geometric Mean)	190 counts / 100 mL (Monthly Geometric Mean)
Fecal Coliform	Water Contact Recreation and Public Water Supply	400 counts / 100 mL (Daily, 10% exceedance)	380 counts / 100 mL (Daily, 10% exceedance)

* Possible mining outlets with fish tissue study bioaccumulation criteria based limits.

TMDLs are presented as average daily loads that were developed to meet TMDL endpoints under a range of conditions observed throughout the year. For most pollutants, analysis of available data indicated that critical conditions occur during both high- and low-flow events. To appropriately address the low- and high-flow critical conditions, the TMDLs were developed using continuous simulation (modeling over a period of several years that captured precipitation extremes), which inherently considers seasonal hydrologic and source loading variability.

9.6.2 Baseline Conditions and Source Loading Alternatives

The calibrated model provides the basis for performing the allocation analysis. The first step is to simulate baseline conditions, which represent point sources loadings at permit limits and existing nonpoint source loadings. Baseline conditions allow for an evaluation of instream water quality under the highest expected loading conditions.

Baseline Conditions for MDAS

The MDAS model was run for baseline conditions using hourly precipitation data for a representative six-year simulation period (January 1, 2012 through December 31, 2017). The precipitation experienced over this period was applied to the landuses and pollutant sources as they existed at the time of TMDL development. Predicted instream concentrations were compared directly with the TMDL endpoints. This comparison allowed for the evaluation of the magnitude and frequency of exceedances under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods. **Figure 9-3** presents the seasonal rainfall totals for the years 2007 through 2017 at the Huntington Tri-State Airport (WBAN 03860) weather station near Ceredo, West Virginia. The years 2012 to 2017 are highlighted to indicate the range of precipitation conditions used for TMDL development in the Twelvepole Creek watershed.

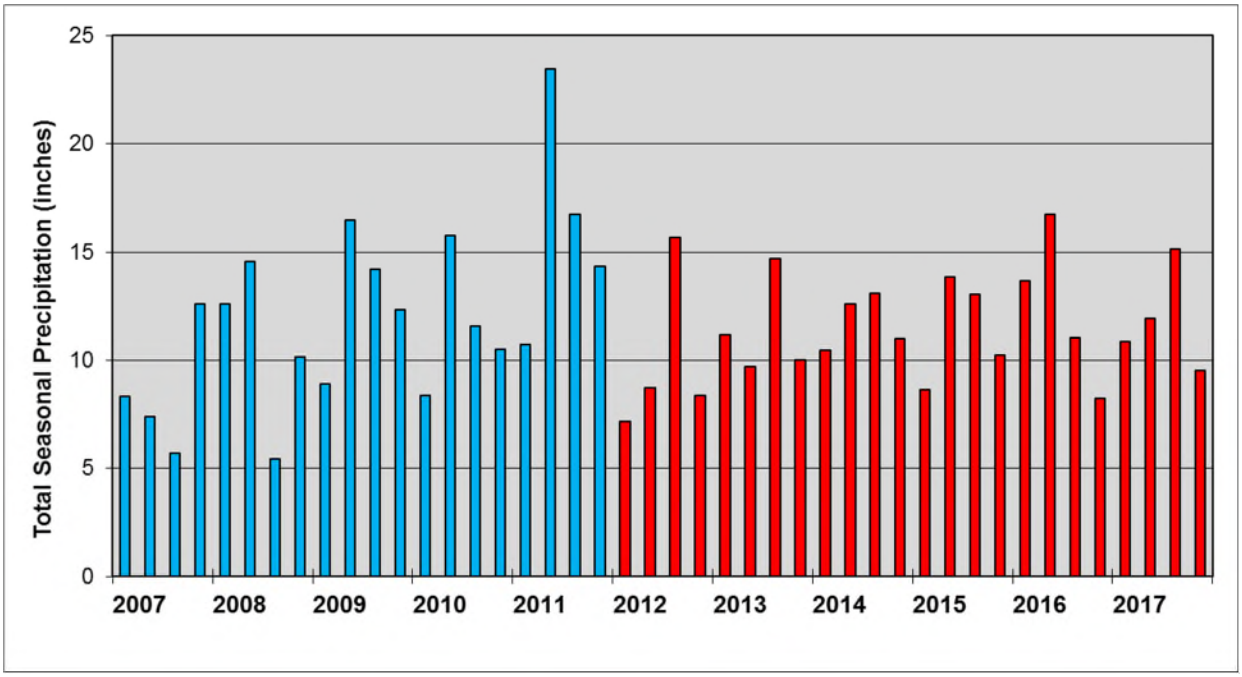


Figure 9-3. Seasonal precipitation totals for the Huntington Tri-State Airport (WBAN 03860) weather station

NPDES permits contain effluent limitations for iron concentrations. In the baseline condition, discharges that are influenced by precipitation were represented using precipitation and drainage area. Baseline concentrations varied by parameter. For iron, baseline concentrations were generally established at the technology based concentration (3.2 mg/l) or water quality based concentration (1.5 mg/l) concentrations, as applicable to each permit.

Based upon guidance from WVDEP’s permitting program, 2.5 percent of the total subwatershed area was allotted for concurrent construction activity under the CSGP, where possible. Baseline loadings were based upon precipitation and runoff and an assumption that proper installation and maintenance of required BMPs will achieve a total suspended solid (TSS) benchmark value of 100 mg/L.

Sediment producing nonpoint source and background loadings were represented using precipitation, drainage area, and the iron loading associated with their predicted sediment contributions.

Effluents from sewage treatment plants were represented under baseline conditions as continuous discharges, using the design flow for each facility and the monthly geometric mean fecal coliform effluent limitation of 200 counts/100 mL. Baseline characteristics for non-stormwater industrial wastewater sources were obtained from effluent limitations and other permitting information.

CSO outlets were represented as discreet point sources in the model. CSO flow and discharge frequency was derived from overflow data supplied by the POTWs, when available. This information was augmented with precipitation analysis and watershed modeling to develop model inputs needed to build fecal coliform loading values for a ten-year time series from which annual average fecal coliform loading values could be calculated. CSO effluent was represented in the model at a concentration of 100,000 counts/100 mL to reflect baseline conditions for untreated CSO discharges. MS4, nonpoint source and background loadings for fecal coliform were represented using drainage area, precipitation, and pollutant accumulation and wash off rates, as appropriate for each landuse.

Source Loading Alternatives

Simulating baseline conditions allowed for the evaluation of each stream's response to variations in source contributions under a variety of hydrologic conditions. Performing this sensitivity analysis gave insight into the dominant sources and the mechanisms by which potential decreases in loads would affect instream pollutant concentrations. The loading contributions from the various existing sources were individually adjusted; and the modeled instream concentrations were then evaluated.

Multiple allocation scenarios were run for the impaired waterbodies. Successful scenarios achieved the TMDL endpoints under all flow conditions throughout the modeling period. The averaging period and allowable exceedance frequency associated with West Virginia water quality criteria were considered in these assessments. In general, loads contributed by sources that had the greatest impact on instream concentrations were reduced first. If additional load reductions were required to meet the TMDL endpoints, less significant source contributions were subsequently reduced. **Figure 9-4** shows an example of model output for a baseline condition and a successful TMDL scenario.

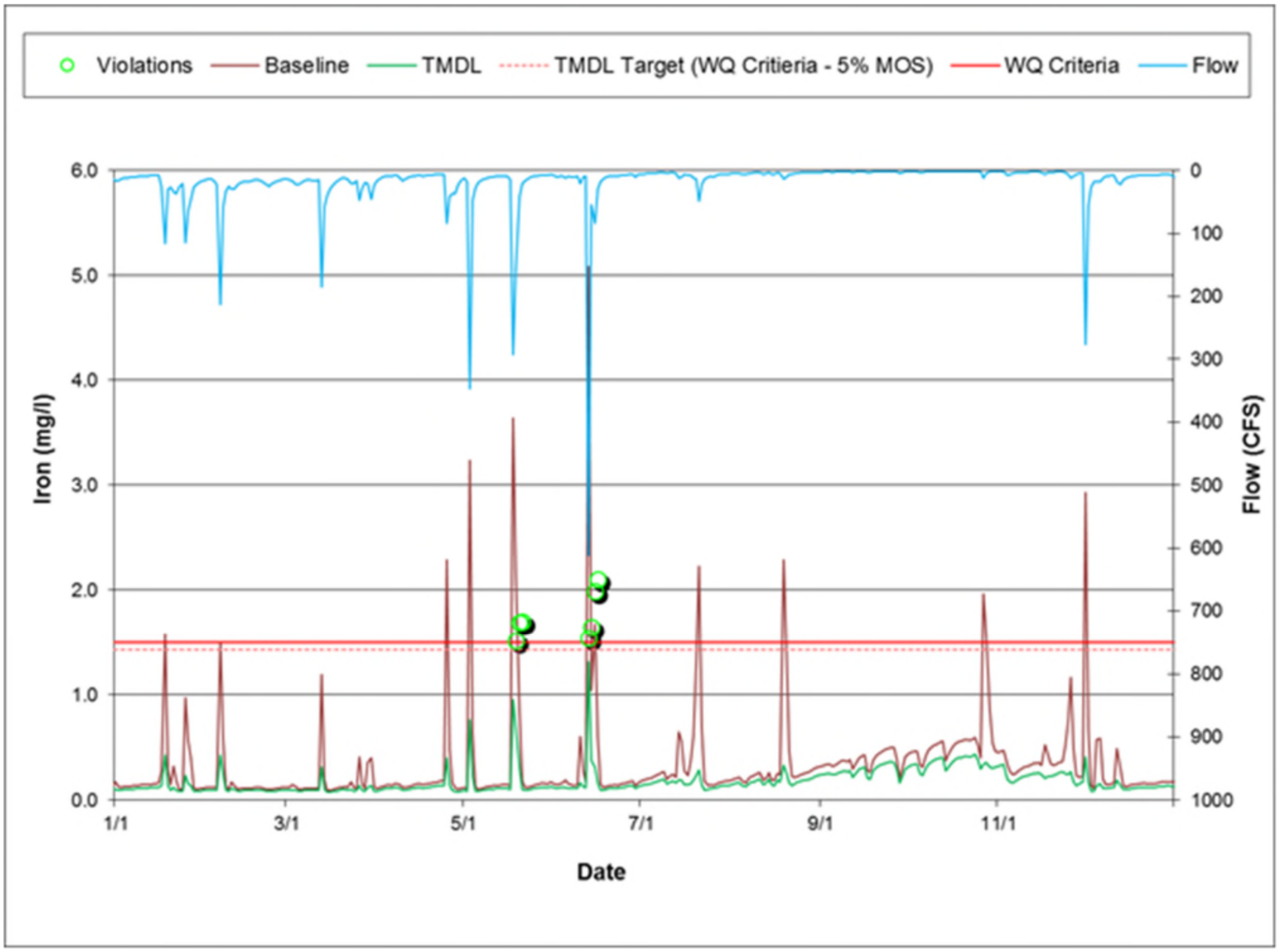


Figure 9-4. Example of baseline and TMDL conditions for total iron

9.7 TMDLs and Source Allocations

9.7.1 Total Iron TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the iron impaired streams of the Twelvepole Creek watersheds. In order to meet iron criterion and allow for equitable allocations, reductions to existing sources were first assigned using the following iterative steps in a series of model runs, reducing to meet the TMDL endpoint:

1. The loading from streambank erosion was first reduced to the loading characteristics of the streams with the best observed streambank conditions.
2. The following land disturbing sources were equitably reduced to the iron loading associated with 100 mg/L TSS.
    - Barren
    - Cropland
    - Pasture
    - Urban/MS4 Pervious

- Oil and gas
- Unpaved Roads
- Forestry Skid Roads and Landings

3. Harvested Forest was reduced to the sediment and iron loading associated with Forest.
4. No point sources were greater than water quality criteria end of pipe (1.5 mg/L iron) in baseline, so no reductions to point sources were necessary.

In addition to reducing the streambank erosion and source contributions, activity under the CSGP and OGCSGP was considered. Area based WLAs were provided for each subwatershed to accommodate existing and future registrations under the CSGP or OGCSGP. 2.5 percent of the subwatershed area was allocated for activity in almost all subwatersheds to account for future growth.

After executing the above provisions, model output was evaluated to determine the criterion attainment status at all subwatershed pour points. A pour point is the most downstream point of a modeled reach within a subwatershed, just before the modeled flow "pours" into the receiving stream of the next adjacent subwatershed.

Using this method ensured that contributions from all sources were weighted equitably and that cumulative load endpoints were met at the most downstream subwatershed for each impaired stream. Reductions in sources affecting impaired headwaters ultimately led to improvements downstream and effectively decreased necessary loading reductions from downstream sources. Nonpoint source reductions did not result in allocated loadings less than natural conditions. Permitted source reductions did not result in allocated loadings to a permittee that would be more stringent than water quality criteria.

Wasteload Allocations (WLAs)

WLAs were developed for all point sources permitted to discharge iron under a NPDES permit. Because of the established relationship between iron and TSS, iron WLAs are also provided for facilities with stormwater discharges that are regulated under NPDES permits that contain TSS and/or iron effluent limitations or benchmarks values, and facilities registered under the General NPDES permit for construction stormwater. NPDES permits must contain effluent limits and conditions consistent with the assumptions and requirements of the WLAs in the TMDL (40 CFR § 122.44(d)(1)(vii)(B)). WLAs for non-construction stormwater sources should be translated into effective, measurable water quality effluent limits in the form of numeric limits or measurable, objective BMP-based limits projected to achieve the WLAs, with benchmark values and monitoring to determine BMP effectiveness.

Active Mining Operations

WLAs are provided for all existing outlets of NPDES permits for mining activities, except those where reclamation has progressed to the point where existing limitations are based upon the Post-Mining Area provisions of Subpart E of 40 CFR 434. The WLAs for active mining operations consider the functional characteristics of the permitted outlets (i.e. precipitation driven, pumped continuous flow, gravity continuous flow, commingled) and their respective impacts at high and low flow conditions.

The federal effluent guidelines for the coal mining point source category (40 CFR 434) provide various alternative limitations for discharges caused by precipitation. Under those technology-based guidelines, effluent limitations for total iron and TSS may be replaced with an alternative limitation for "settleable solids" during certain magnitude precipitation events that vary by mining subcategory. The water quality-based WLAs and future growth provisions of the iron TMDLs preclude the applicability of the "alternative precipitation" iron provisions of 40 CFR 434. Also, the established relationship between iron and TSS requires continuous control of TSS concentration in permitted discharges to achieve iron WLAs. As such, the "alternative precipitation" TSS provisions of 40 CFR 434 should not be applied to point source discharges associated with the iron TMDLs.

The limits set forth in the NPDES permits for the point sources were calculated in a site-specific manner consistent with West Virginia's anti-degradation procedures and West Virginia's NPDES permit regulations. This TMDL is not intended to serve as a basis for relaxation of effluent limitations in existing permits pursuant to CWA Section 303(d)(4)(A)(i) or otherwise, nor is this TMDL intended to serve as a basis for departing from applicable regulations and processes for calculating water quality-based effluent limitations to address site-specific conditions.

Specific WLAs are not provided for "post-mining" outlets because programmatic reclamation was assumed to have returned disturbed areas to conditions that approach background. Barring unforeseen circumstances that alter their current status, such outlets are authorized to continue to discharge under the existing terms and conditions of their NPDES permit.

Bond Forfeiture Sites

WLAs were established for bond forfeiture sites. Baseline iron conditions were generally established under the same protocols used for active mining operations. In instances where effluent characteristics were not directly available, baseline conditions were established at the technology based effluent limits of 40 CFR 434 and reduced as necessary to attain the TMDL endpoints.

Discharges regulated by the Multi Sector Stormwater Permit

Certain registrations under the general permit for stormwater associated with industrial activity implement TSS and/or iron benchmark values. Facilities that are compliant with such limitations are not considered to be significant sources of sediment or iron. Facilities that are present in the watersheds of iron-impaired streams are assigned WLAs that allow for continued discharge under existing permit conditions, whether those requirements are expressed in effluent limits or benchmark values. BMP based limits constitute acceptable implementation of the wasteload allocations for stormwater discharges.

Municipal Separate Storm Sewer System (MS4)

USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for stormwater discharges from MS4s. In the TMDL watersheds of Twelvepole Creek there are five designated MS4 entities listed below. Each entity will be registered under, and subject to, the requirements of General Permit Number WV0110625. The stormwater discharges from MS4s are point sources for which the TMDLs prescribe WLAs. Individual registration numbers for the MS4 entities are as follows:

- City of Ceredo WVR030014
- City of Huntington WVR030033
- City of Kenova WVR030039
- Veterans Administration – Huntington Medical Center WVR030046
- West Virginia Division of Highways WVR030004

In the majority of the subwatersheds where MS4 entities have areas of responsibility, the urban, residential and road landuses strongly influence bank erosion. As such, portions of the baseline and allocated loads associated with bank erosion are included in the MS4 WLAs. The subdivision of the bank erosion component between point and nonpoint sources, and where applicable, between multiple MS4 entities, is proportional to their respective drainage areas within each subwatershed. Model representation of bank erosion is accomplished through consideration of a number of inputs including slope, soils, imperviousness, and the stability of existing streambanks. Bank erosion loadings are most strongly influenced by upland impervious area and bank stability. The decision to include bank erosion in the MS4 WLAs results from the predominance of urban/residential/road landuses and impacts in MS4 areas. WVDEP's assumption is that upland management practices will be implemented under the MS4 permit to directly address impacts from bank erosion. However, even if the implementation of stormwater controls on uplands is maximized, and the volume and intensity of stormwater runoff are minimized, the existing degraded stability of streambanks may continue to accelerate erosion. The erosion of unstable streambanks is a nonpoint source of sediment that is included in the MS4 allocations. Natural attenuation of legacy impacts cannot be expected in the short term, but may be accelerated by bank stabilization projects. The inclusion of the bank erosion load component in the WLAs of MS4 entities is not intended to prohibit or discourage cooperative bank stabilization projects between MS4 entities and WVDEP's Nonpoint Source Program, or to prohibit the use of Section 319 funding as a component of those projects.

Construction Stormwater

Specific WLAs for activity under the CSGP are provided at the subwatershed scale and are described in **Section 5.1.3**. With several exceptions, an allocation of 2.5 percent of undeveloped subwatershed area was provided with loadings based upon precipitation and runoff and an assumption that required BMPs, if properly installed and maintained, will achieve a TSS benchmark value of 100 mg/L. In certain areas, the existing level of activity under the CSGP does not conform to the subwatershed allocations. In these instances the WVDEP, DWWM permitting program will require stabilization and permit termination in the shortest time possible. Thereafter the program will maintain concurrently disturbed area as allocated or otherwise control future activity through provisions described in **Section 11**.

Other Non-mining Point Sources

Non-stormwater municipal and industrial sources for which existing NPDES permits did not contain iron were not considered to be substantive sources and were not explicitly represented in the modeling. A list of such negligible sources appears in **Appendix F** of the Technical Report. Existing discharges from such sources do not require wasteload allocations pursuant to the iron TMDLs. Any metals loading associated with such sources is contained in the background loading and accounted for in model calibration.

Load Allocations (LAs)

LAs are made for the dominant nonpoint source categories as follows:

- AML: loading from abandoned mine lands, including loads from highwalls, deep mine discharges and seeps
- Sediment sources: loading associated with sediment contributions from barren land, forestry skid roads and landings, oil and gas well operations, agricultural landuses, and residential/urban/road landuses and streambank erosion in non-MS4 areas
- Background sources: loading from undisturbed forest and grasslands (loadings associated with this category were represented but not reduced)

9.7.2 Dissolved Aluminum and pH TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the dissolved aluminum and/or pH impaired streams of the Twelvepole Creek watershed. The allocation approach focused on reducing metals concentrations and increasing pH by assigning buffering capacity (alkalinity) using the MDAS model to meet metals water quality criteria and then verifying that the resultant pH under these conditions would be in compliance with pH criteria.

As general steps of the allocation process, substantive sources (e.g., seeps) were reduced first as described in **Section 8.7.1**. Dissolved aluminum and pH model results were evaluated under the reduced iron loadings condition. If model results predicted non-attainment of the pH and dissolved aluminum criteria, alkalinity additions were prescribed, and total aluminum was reduced from primary causative sources such as AML seeps. The following methodology was used to predict necessary alkalinity additions and total aluminum reductions in the model simulation:

Initially, the pH and Aluminum model was calibrated against observed data to quantify certain characteristics of sources, such as the aluminum partitioning ratio between solid and dissolved phases. The baseline metal and hydrogen acidity loadings from sources were used to estimate the required alkalinity and total aluminum reduction necessary to achieve improved water quality conditions for pH and aluminum concentrations. If criteria were not met, acidity and metal sources were evaluated and prioritized per subwatershed based on the source loading magnitude. Alkalinity was applied to offset the pollutant loads from the land uses to achieve the pH criterion.

In some instances, acidity released from instream metal precipitation lowered the pH and resulted in re-suspension of dissolved aluminum. If these reactions resulted in non-attainment of pH and/or dissolved aluminum criteria additional alkalinity was prescribed to seeps and then mining sources of acidity.

The mitigation of acid loadings by alkalinity addition coupled with reductions of total aluminum loading from land-based sources are predicted to result in attainment of both dissolved aluminum and pH water quality criteria at all evaluated locations in the pH and dissolved aluminum impaired streams.

Wasteload Allocations (WLAs)

No active mining or non-mining NPDES point sources were present in aluminum and pH impaired streams in the Twelvepole Creek Watershed. Had point sources been present, WLAs would have been developed for active point source discharges by starting with their current NPDES permit effluent limits and design flows.

Baseline loadings from non-mining point sources, including facilities registered under the Construction Stormwater General Permits were represented to properly account for aluminum associated with sediment sources. Negligible amounts of acidity or dissolved aluminum are attributed to these sources, thus no reductions were necessary and aluminum-specific control actions are not prescribed.

Load Allocations (LAs)

LAs of total aluminum and acidity were determined for contributing nonpoint source categories as follows:

AML: loading from abandoned mine lands, including loads from highwalls, deep mine discharges and seeps

Other nonpoint sources: loading associated with acid precipitation influences from barren land, harvested forest, oil and gas well operations, agriculture, and residential/urban/road landuses

Background sources: loading associated with acid precipitation influences from undisturbed forest and grasslands

All sources were represented and provided allocations in terms of the total aluminum and net acidity loadings. No reductions were prescribed for background nonpoint sources. For abandoned mine sources, aluminum allocations represent the background loading from precipitation runoff from land and the reduced loads from AML seeps.

Baseline and TMDL load allocations (LAs) include the natural background sources of buffering capacity. The TMDLs prescribe additional acidity reduction (alkalinity addition) for acidic sources to meet instream pH water quality criterion and associated aluminum reductions.

9.7.3 Total Selenium TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the selenium impaired streams of the Twelvepole Creek watershed. In order to meet water quality criterion and allow for equitable allocations, reductions to existing sources were first assigned using the following iterative steps in a series of model runs, reducing to meet the TMDL endpoint :

1. The loading from legacy mines was reduced to water quality end of pipe (5 ug/L selenium).
2. The loading from instream ponds was reduced to water quality criterion end of pipe.
3. The loading from continuous discharges was reduced to water quality criterion end of pipe.
4. The loading from on bench structures was reduced to water quality criterion end of pipe using a top-down approach in subwatersheds where the model indicated non-attainment

Using this method ensured that contributions from all sources were weighted equitably and that cumulative load endpoints were met at the most downstream subwatershed for each impaired stream. Reductions in sources affecting impaired headwaters ultimately led to improvements downstream and effectively decreased necessary loading reductions from downstream sources. Nonpoint source reductions did not result in allocated loadings less than natural conditions. Permitted source reductions did not result in allocated loadings to a permittee that would be more stringent than water quality criteria.

The presented Selenium TMDLs are based solely upon the water column concentration component of the aquatic life protection criteria of the currently effective West Virginia Water Quality Standards (47 CSR 2-8.27.1). The operable wasteload allocations for point sources are also presented in concentration terms with expected implementation in accordance with the TSD.

It is important to note that the water quality standards include selenium criteria in terms of fish whole-body/muscle and egg/ovary concentrations. The water quality standards provide implementation protocols where whole-body/muscle criterion assessment results override those based upon the water column concentration criterion, and where egg/ovary criterion assessment results override those based upon whole-body/muscle and/or water column concentration criteria. As such, the water quality standards recognize that site specific conditions in waters of the State may allow attainment and protection of aquatic life designated uses in the presence of selenium concentrations greater than those prescribed by the water column concentration criterion component. (*See 47 CSR-2-8.27.1, 47 CSR-2-8.27.2, 47 CSR-2-8.27.3 and footnotes f and g*)

The Selenium TMDLs do not preclude the pursuit of use attainment evaluations through fish tissue studies envisioned by the water quality standards. If site-specific fish whole-body/muscle and/or egg/ovary concentrations are measured and subsequent analysis demonstrates aquatic life use protection at water column selenium concentrations greater than 5 ug/l, then point source controls alternative to the TMDL wasteload allocations may be implemented and considered consistent with wasteload allocations to the extent demonstrated by the assessment to be protective of the immediate receiving stream and all downstream waters for which selenium TMDLs have been developed.

Wasteload Allocations (WLAs)

WLAs were developed for all mining related point source discharges. WLAs for active mining operations considered the functional characteristics of the permitted outlets (i.e. precipitation driven, pumped continuous flow, or commingled) and their respective impacts at high and low flow conditions.

Load Allocations (LAs)

LAs were developed for background sources, and other nonpoint sources. LAs were divided into several landuse categories: undisturbed forest and grasslands and abandoned mine lands. Loadings associated with background and other nonpoint sources were represented but not reduced.

9.7.4 Fecal Coliform Bacteria TMDLs

TMDLs and source allocations were developed for impaired streams and their tributaries on a subwatershed basis throughout the watershed. The following general methodology was used when allocating loads to fecal coliform bacteria sources:

- The effluents from all NPDES permitted sewage treatment plants were set at the permit limit (200 counts/100 mL monthly geometric mean);
- Because West Virginia Bureau for Public Health regulations prohibit the discharge of raw sewage into surface waters, all illicit discharges of human waste (from failing septic systems and straight pipes) were reduced by 100 percent in the model
- All CSO discharges were assigned WLAs at the value of the fecal coliform water quality criterion (200 counts/100ml); and
- If further reduction was necessary, MS4s, non-point source loadings from agricultural lands and residential areas were subsequently reduced until instream water quality criteria were met.

Wasteload Allocations (WLAs)

WLAs were developed for all facilities permitted to discharge fecal coliform bacteria, including MS4s, as described below.

Sewage Treatment Plant Effluents

The fecal coliform effluent limitations for NPDES permitted sewage treatment plants are more stringent than water quality criteria; therefore, all effluent discharges from sewage treatment facilities were given WLAs equal to existing monthly fecal coliform effluent limitations of 200 counts/100 mL. When there are permitted stormwater outlets at sewage treatment plants, BMP based limits constitute acceptable implementation of the wasteload allocations for stormwater discharges.

Combined Sewer Overflows

In TMDL watersheds there are a total of 3 CSO outlets associated with POTWs operated by the Town of Wayne (WV0024562).

All fecal coliform bacteria WLAs for CSO discharges have been established at 200 counts/100mL Implementation can be accomplished by CSO elimination or by disinfection treatment and discharge in compliance with the operable, concentration-based allocations.

In establishing the WLAs for CSOs, WVDEP first considered the appropriateness of mixing zones for bacteria. WVDEP concluded that mixing zones would allow elevated levels of bacteria that may not conform to the mixing zone provisions at 47 CSR 2 §5.2.c., 5.2.g. and 5.2.h.3. Because 47 CSR 2 §5.2.c. prohibits pollutant concentrations greater than criteria for the protection of human health at any point unless a mixing zone has been assigned, the CSO WLAs were established at the value of the fecal coliform water quality criterion.

It is important to note that even if mixing zone rules are alternatively interpreted or changed in the future, dilution is generally not available to allow CSO allocations to be substantively greater than criteria. In previous projects, WVDEP used the calibrated model to examine the magnitude of CSO allocations that could be shown to result in criteria attainment when coupled with the allocations for other sources prescribed in this project and demonstrated nonattainment at multiple modeled locations when CSO were modestly increased above 200 counts/100 ml.

Municipal Separate Storm Sewer System (MS4)

USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for stormwater discharges from MS4s. The City of Ceredo, City of Huntington, City of Kenova, VA Huntington Medical Center, and the WVDOH are designated MS4 entities in the subject watersheds. Each entity will be registered under, and subject to, the requirements of General Permit Number WV0110625. The stormwater discharges from MS4s are point sources for which the TMDLs prescribe WLAs.

Load Allocations (LAs)

Fecal coliform LAs are assigned to the following source categories:

- Pasture/Cropland;
- On-site Sewage Systems — loading from all illicit discharges of human waste (including failing septic systems and straight pipes);
- Residential — loading associated with urban/residential runoff from non-MS4 areas; and
- Background and Other Nonpoint Sources — loading associated with wildlife sources from all other landuses (contributions/loadings from wildlife sources were not reduced).

9.7.5 Seasonal Variation

Seasonal variation was considered in the formulation of the modeling analysis. Continuous simulation (modeling over a period of several years that captured precipitation extremes) inherently considers seasonal hydrologic and source loading variability**.** The pollutant concentrations simulated on a daily time step by the model were compared with TMDL endpoints. Allocations that met these endpoints throughout the modeling period were developed.

9.7.6 Critical Conditions

A critical condition represents a scenario where water quality criteria are most susceptible to violation. Analysis of water quality data for the impaired streams addressed in this effort shows high pollutant concentrations during both high- and low-flow thereby precluding selection of a single critical condition. Both high-flow and low-flow periods were taken into account during TMDL development by using a long period of weather data that represented wet, dry, and average flow periods.

Nonpoint source loading is typically precipitation-driven and impacts tend to occur during wet weather and high surface runoff. During dry periods little or no land-based runoff occurs, and elevated instream pollutant levels may be due to point sources (Novotny and Olem, 1994).

9.7.7 TMDL Presentation-

The TMDLs for all impairments are shown in **Section 10** of this report. Loads are divided into assessment units. The TMDLs for iron and selenium are presented as average daily loads derived from annual loads, in pounds per day. The TMDLs for fecal coliform bacteria are presented in average number of colonies per day derived from annual colonies. All TMDLs were developed to meet TMDL endpoints under a range of conditions observed over the modeling period. TMDLs and their components are also presented in the allocation spreadsheets associated with this report. The filterable spreadsheets also display detailed source allocations and include multiple display formats that allow comparison of pollutant loadings among categories and facilitate implementation of the TMDL to restore the waterbody.

The iron WLAs for active mining operations and bond forfeitures are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are the operable allocations and are to be implemented by conversion to monthly average and daily maximum effluent limitations using USEPA's Technical Support Document for Water Quality-based Toxics Control (USEPA, 1991). In a number of subwatersheds, reductions from existing effluent limits for individual outlets were not prescribed, thus multiple operable allocations may be presented for a single permit. Appendix F provides a list of outlets and their baseline representation in the modeling effort to determine which operable allocation applies to permits for which no reductions were prescribed.

The iron WLAs for future Construction Stormwater General Permit registrations are presented as both annual average loads, for comparison with other sources, and equivalent area registered under the permit. The registered area is the operable allocation. The iron WLAs for non-construction sectors registered under the Multi Sector Stormwater Permit are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are operable, and because they are equivalent to existing effluent limitations/benchmark values, they are to be directly implemented.

The fecal coliform bacteria WLAs for sewage treatment plant effluents and CSOs are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are the operable allocations for NPDES permit implementation.

The WLAs for precipitation induced MS4 discharges are presented in terms of average annual daily loads (Fe) or average number of colonies per year (FC) and the percent pollutant reduction from baseline conditions. The “MS4 WLA Summary” tabs of the allocation spreadsheets contain the operable allocations expressed as percent reductions. The “MS4 WLA Detailed” tabs on the allocation spreadsheets provide drainage areas of various land use types represented in the baseline condition (without BMPs) for each MS4 entity at the subwatershed scale. That information is intended to assist registrants under the MS4 General Permit in describing the management practices to be employed to achieve prescribed allocations.

This TMDL does not mandate change to the form of regulation in existing NPDES permits that regulate stormwater discharges under the BMP basis and include benchmark values and monitoring to assess BMP effectiveness, when values are less than or equal to specified concentration-based wasteload allocations.”

10.0 TMDL RESULTS

Table 10-1. Iron TMDLs

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Twelvepole Creek	WV-OT-1_01	Krout Creek	WVO-2-0.1A	2.64	8.22	0.57	11.43
Twelvepole Creek	WV-OT_10	Twelvepole Creek	WVO-2	2216.08	235.78	129.05	2580.90
Twelvepole Creek	WV-OT-4_01	Jordans Branch	WVO-2-0.5A	1.58	6.08	0.40	8.06
Twelvepole Creek	WV-OT-4-A_01	UNT/Jordans Branch RM 0.86		0.49	1.58	0.11	2.17
Twelvepole Creek	WV-OT-5_01	UNT/Twelvepole Creek RM 2.97		0.55	0.14	0.04	0.73
Twelvepole Creek	WV-OT-7_01	Walker Branch	WVO-2-A	2.91	0.54	0.18	3.63
Twelvepole Creek	WV-OT-8_01	UNT/Twelvepole Creek RM 5.72	WVO-2-A.1	1.68	1.09	0.15	2.91
Twelvepole Creek	WV-OT-10_01	Bobs Branch	WVO-2-B	4.17	0.78	0.26	5.20
Buffalo Creek	WV-OT-12_02	Buffalo Creek	WVO-2-C	13.64	2.01	0.82	16.48
Buffalo Creek	WV-OT-12-D_01	UNT/Buffalo Creek RM 2.21	WVO-2-C-4	1.79	0.30	0.11	2.20
Buffalo Creek	WV-OT-12-F_01	UNT/Buffalo Creek RM 3.50	WVO-2-C-6	1.60	0.27	0.10	1.96
Buffalo Creek	WV-OT-12_01	Buffalo Creek	WVO-2-C	5.24	0.83	0.32	6.39
Twelvepole Creek	WV-OT_09	Twelvepole Creek	WVO-2	1953.85	157.84	111.14	2222.82
Twelvepole Creek	WV-OT-14_01	Haneys Branch	WVO-2-D	1.80	0.33	0.11	2.25
Twelvepole Creek	WV-OT-15_01	Plymale Branch	WVO-2-E	3.12	0.54	0.19	3.85
Twelvepole Creek	WV-OT-15-C_01	UNT/Plymale Branch RM 0.61		0.76	0.14	0.05	0.95
Twelvepole Creek	WV-OT-16_01	UNT/Twelvepole Creek RM 11.09		1.48	0.27	0.09	1.83
Twelvepole Creek	WV-OT-17_01	UNT/Twelvepole Creek RM 11.90	WVO-2-E.6	1.64	0.29	0.10	2.03
Twelvepole Creek	WV-OT-18_01	UNT/Twelvepole Creek RM 13.38		1.07	0.19	0.07	1.33
Twelvepole Creek	WV-OT-19_01	Newcomb Creek	WVO-2-F	3.84	0.71	0.24	4.78
Camp Creek	WV-OT-21_01	Camp Creek	WVO-2-G	14.95	2.52	0.92	18.39
Camp Creek	WV-OT-21-A_01	UNT/Camp Creek RM 0.30		0.93	0.18	0.06	1.16
Camp Creek	WV-OT-21-B_01	Right Fork/Camp Creek	WVO-2-G-1	6.81	1.19	0.42	8.42
Camp Creek	WV-OT-21-B-2_01	UNT/Right Fork RM 0.66/Camp Creek	WVO-2-G-1-B	2.51	0.47	0.16	3.14
Camp Creek	WV-OT-21-B-5_01	UNT/Right Fork RM 1.97/Camp Creek		0.58	0.10	0.04	0.72

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Camp Creek	WV-OT-21-D_01	UNT/Camp Creek RM 1.16	WVO-2-G-1.4	1.57	0.29	0.10	1.95
Beech Fork	WV-OT-24_05	Beech Fork	WVO-2-H	575.81	1.25	30.37	607.44
Beech Fork	WV-OT-24-C_01	UNT/Beech Fork RM 2.38	WVO-2-H-0.4	1.21	0.23	0.08	1.52
Beech Fork	WV-OT-24-D_01	Mays Branch	WVO-2-H-0.5	1.32	0.26	0.08	1.66
Beech Fork	WV-OT-24-H-12_01	Fisher Bowen Branch	WVO-2-H-2-C	3.46	0.58	0.21	4.25
Beech Fork	WV-OT-24-H-18_01	Left Fork/Millers Fork	WVO-2-H-2-D	5.68	0.92	0.35	6.95
Beech Fork	WV-OT-24-H_01	Millers Fork	WVO-2-H-2	6.23	0.99	0.38	7.60
Beech Fork	WV-OT-24-H-22_01	Fraley Fork	WVO-2-H-2-F	1.41	0.24	0.09	1.74
Beech Fork	WV-OT-24-V_01	Long Branch	WVO-2-H-7	6.33	1.04	0.39	7.76
Beech Fork	WV-OT-24-V-3_01	Camp Branch	WVO-2-H-7-A	1.33	0.23	0.08	1.65
Beech Fork	WV-OT-24-V-5_01	UNT/Long Branch RM 2.43		1.42	0.25	0.09	1.76
Beech Fork	WV-OT-24-V.2_01	Moxley Branch	WVO-2-H-7.2	1.18	0.22	0.07	1.48
Beech Fork	WV-OT-24_04	Beech Fork	WVO-2-H	66.45	8.24	3.93	78.62
Beech Fork	WV-OT-24-X_01	Butler Branch	WVO-2-H-8	1.03	0.18	0.06	1.27
Beech Fork	WV-OT-24-AB_01	Grassy Lick	WVO-2-H-10	2.05	0.35	0.13	2.52
Beech Fork	WV-OT-24-AD_02	Bowen Creek	WVO-2-H-11	6.85	1.15	0.42	8.42
Beech Fork	WV-OT-24-AD_01	Bowen Creek	WVO-2-H-11	3.63	0.62	0.22	4.48
Beech Fork	WV-OT-24-AI_01	Raccoon Creek	WVO-2-H-12	12.59	2.04	0.77	15.39
Beech Fork	WV-OT-24-AI-4_01	UNT/Raccoon Creek RM 2.20		1.16	0.20	0.07	1.43
Beech Fork	WV-OT-24_03	Beech Fork	WVO-2-H	39.38	6.00	2.39	47.76
Beech Fork	WV-OT-24-AY_01	Wolfpen Branch	WVO-2-H-19	1.65	0.28	0.10	2.03
Beech Fork	WV-OT-24-AU_01	Right Fork/Beech Fork	WVO-2-H-18	5.15	0.87	0.32	6.34
Beech Fork	WV-OT-24_01	Beech Fork	WVO-2-H	12.81	1.96	0.78	15.55
Beech Fork	WV-OT-24-BC_01	Turkeycamp Branch	WVO-2-H-20	1.79	0.27	0.11	2.17
Beech Fork	WV-OT-24-BG_01	Nestlow Branch	WVO-2-H-21	0.84	0.13	0.05	1.02
Twelvepole Creek	WV-OT_08	Twelvepole Creek	WVO-2	1039.94	150.04	62.63	1252.61
Twelvepole Creek	WV-OT-26_01	Lynn Creek	WVO-2-I	4.43	0.70	0.27	5.39
Twelvepole Creek	WV-OT-35_01	Big Creek	WVO-2-K	2.29	0.38	0.14	2.81
Twelvepole Creek	WV-OT-37_01	Garrett Creek	WVO-2-L	5.61	0.86	0.34	6.81
Twelvepole Creek	WV-OT-38_01	Shoal Branch	WVO-2-M	1.10	0.18	0.07	1.35
Wilson Creek	WV-OT-39_01	Wilson Creek	WVO-2-N	9.76	1.52	0.59	11.87

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Wilson Creek	WV-OT-39-A_01	Left Fork/Wilson Creek	WVO-2-N-1	4.31	0.69	0.26	5.27
Wilson Creek	WV-OT-39-A-1_01	Middle Fork/Left Fork/Wilson Creek	WVO-2-N-1-A	2.12	0.35	0.13	2.60
Twelvepole Creek	WV-OT_07	Twelvepole Creek	WVO-2	904.84	144.66	55.24	1104.74
Twelvepole Creek	WV-OT-44_01	Toms Creek	WVO-2-O	4.29	0.71	0.26	5.26
East Fork/Twelvepole Creek	WV-OT-45_05	East Fork/Twelvepole Creek	WVO-2-Q	543.92	24.56	29.92	598.39
East Fork/Twelvepole Creek	WV-OT-45-E_01	Onemile Creek	WVO-2-Q-2	1.00	0.15	0.06	1.21
East Fork/Twelvepole Creek	WV-OT-45-G_01	Twomile Creek	WVO-2-Q-3	4.25	0.65	0.26	5.15
East Fork/Twelvepole Creek	WV-OT-45-G-3_01	UNT/Twomile Creek RM 1.00		1.51	0.23	0.09	1.83
East Fork/Twelvepole Creek	WV-OT-45-L_01	Newcomb Creek	WVO-2-Q-5	2.75	0.40	0.17	3.32
East Fork/Twelvepole Creek	WV-OT-45-M_01	Petercave Branch	WVO-2-Q-6	1.63	0.25	0.10	1.98
East Fork/Twelvepole Creek	WV-OT-45-P_01	Little Lynn Creek	WVO-2-Q-7	5.77	0.86	0.35	6.98
East Fork/Twelvepole Creek	WV-OT-45-P-2_01	Right Fork/Little Lynn Creek	WVO-2-Q-7-A	2.16	0.33	0.13	2.63
Camp Creek	WV-OT-45-Q_02	Camp Creek	WVO-2-Q-8	68.15	17.82	4.52	90.49
Lynn Creek	WV-OT-45-R_01	Lynn Creek	WVO-2-Q-9	7.53	1.08	0.45	9.07
Lynn Creek	WV-OT-45-R-1_01	Battern Fork	WVO-2-Q-9-A	1.35	0.21	0.08	1.64
Lynn Creek	WV-OT-45-R-4_01	Right Fork/Lynn Creek	WVO-2-Q-9-D	2.22	0.33	0.13	2.69
Lynn Creek	WV-OT-45-R-5_01	Left Fork/Lynn Creek	WVO-2-Q-9-C	1.85	0.27	0.11	2.23
East Fork/Twelvepole Creek	WV-OT-45-W_01	Laurel Creek/East Fork	WVO-2-Q-10	6.43	1.93	0.44	8.80
East Fork/Twelvepole Creek	WV-OT-45-W-8_01	Stephens Fork	WVO-2-Q-10-A	0.87	0.13	0.05	1.05
East Fork/Twelvepole Creek	WV-OT-45-Z_01	Brush Creek	WVO-2-Q-11	4.33	0.68	0.26	5.27
East Fork/Twelvepole Creek	WV-OT-45-AD_02	Lick Creek	WVO-2-Q-12	10.59	1.62	0.64	12.85
East Fork/Twelvepole Creek	WV-OT-45-AD-4_01	Right Fork/Lick Creek	WVO-2-Q-12-A	5.35	0.84	0.33	6.52
Rich Creek	WV-OT-45-AG_02	Rich Creek	WVO-2-Q-14	9.95	1.51	0.60	12.07
Rich Creek	WV-OT-45-AG-6_01	Geiger Branch	WVO-2-Q-14-0.8A	1.42	0.23	0.09	1.74
Rich Creek	WV-OT-45-AG-8_01	Left Fork/Rich Creek	WVO-2-Q-14-B	2.21	0.35	0.13	2.70
East Fork/Twelvepole Creek	WV-OT-45-AH_01	Beechy Branch	WVO-2-Q-15	1.66	0.27	0.10	2.02
East Fork/Twelvepole Creek	WV-OT-45-AJ_01	Bluelick Branch	WVO-2-Q-16	2.47	0.38	0.15	3.00
Cove Creek	WV-OT-45-AK_01	Cove Creek	WVO-2-Q-17	7.18	1.68	0.47	9.32
East Fork/Twelvepole Creek	WV-OT-45-AM_01	Alum Fork	WVO-2-Q-17.8	0.64	0.09	0.04	0.77
Kiah Creek	WV-OT-45-AN_04	Kiah Creek	WVO-2-Q-18	60.27	102.39	8.56	171.22

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Kiah Creek	WV-OT-45-AN-3_01	Little Laurel Creek	WVO-2-Q-18-A	1.51	0.24	0.09	1.84
Kiah Creek	WV-OT-45-AN-4_01	Hurricane Branch	WVO-2-Q-18-A.5	0.64	0.11	0.04	0.79
Kiah Creek	WV-OT-45-AN-6_01	Big Laurel Creek	WVO-2-Q-18-B	4.89	1.23	0.32	6.44
Kiah Creek	WV-OT-45-AN-6-C_01	Dalton Fork	WVO-2-Q-18-B-1	0.77	0.12	0.05	0.94
Kiah Creek	WV-OT-45-AN_03	Kiah Creek	WVO-2-Q-18	44.22	100.51	7.62	152.35
Kiah Creek	WV-OT-45-AN-11_01	Trough Fork	WVO-2-Q-18-C	4.57	18.81	1.23	24.61
Kiah Creek	WV-OT-45-AN-11-D_01	Vance Branch	WVO-2-Q-18-C-1	0.04	6.64	0.35	7.03
Kiah Creek	WV-OT-45-AN-11-F_01	Tomblin Branch	WVO-2-Q-18-C-2	0.59	0.10	0.04	0.72
Kiah Creek	WV-OT-45-AN-16_01	Parker Branch	WVO-2-Q-18-D	3.84	5.32	0.48	9.65
Kiah Creek	WV-OT-45-AN-16-A_01	Left Fork/Parker Branch	WVO-2-Q-18-D-1	1.06	0.13	0.06	1.25
Kiah Creek	WV-OT-45-AN-16-B_01	Sumate Fork	WVO-2-Q-18-D-2	0.71	0.66	0.07	1.44
Kiah Creek	WV-OT-45-AN-20_01	Rollem Fork	WVO-2-Q-18-E	3.32	12.86	0.85	17.02
Kiah Creek	WV-OT-45-AN-20-C_01	UNT/Rollem Fork RM 0.92	WVO-2-Q-18-E-3	1.21	6.10	0.38	7.69
Kiah Creek	WV-OT-45-AN_02	Kiah Creek	WVO-2-Q-18	22.09	33.50	2.93	58.52
Kiah Creek	WV-OT-45-AN-21_01	Frances Creek	WVO-2-Q-18-F	6.92	12.07	1.00	19.99
Kiah Creek	WV-OT-45-AN-21-D_01	Pretty Branch	WVO-2-Q-18-F-1	0.03	3.37	0.18	3.58
Kiah Creek	WV-OT-45-AN-21-E_01	Sandlick Branch	WVO-2-Q-18-F-2	2.34	0.39	0.14	2.87
Kiah Creek	WV-OT-45-AN-22_01	Witcher Fork	WVO-2-Q-18-F.2	2.34	0.92	0.17	3.43
Kiah Creek	WV-OT-45-AN-24_01	Copley Trace Branch	WVO-2-Q-18-G	3.62	5.93	0.50	10.05
Kiah Creek	WV-OT-45-AN_01	Kiah Creek	WVO-2-Q-18	5.71	12.59	0.96	19.26
Kiah Creek	WV-OT-45-AN-25_01	Jims Branch	WVO-2-Q-18-H	1.49	8.19	0.51	10.19
Kiah Creek	WV-OT-45-AN-26_01	UNT/Kiah Creek RM 11.84	WVO-2-Q-18-I	0.91	0.13	0.06	1.10
East Fork/Twelvepole Creek	WV-OT-45_04	East Fork/Twelvepole Creek	WVO-2-Q	119.82	85.44	10.80	216.06
East Fork/Twelvepole Creek	WV-OT-45-AS_02	Milam Creek	WVO-2-Q-20	11.38	3.34	0.77	15.49
East Fork/Twelvepole Creek	WV-OT-45-AS-3_01	Queenscamp Branch	WVO-2-Q-20-A	1.97	0.55	0.13	2.66
East Fork/Twelvepole Creek	WV-OT-45-AS-4_01	Little Milam Creek	WVO-2-Q-20-B	1.88	0.30	0.11	2.30
East Fork/Twelvepole Creek	WV-OT-45-AS_01	Milam Creek	WVO-2-Q-20	4.74	0.76	0.29	5.79
East Fork/Twelvepole Creek	WV-OT-45-AS-5_01	Honeytrace Fork	WVO-2-Q-20-C	1.46	0.24	0.09	1.79
East Fork/Twelvepole Creek	WV-OT-45-AY_01	Spry Branch	WVO-2-Q-21.8	1.34	0.22	0.08	1.64
East Fork/Twelvepole Creek	WV-OT-45-BA_01	Devilstrace Branch	WVO-2-Q-21.9	0.04	6.15	0.33	6.52
East Fork/Twelvepole Creek	WV-OT-45-BD_01	Maynard Branch	WVO-2-Q-23	0.57	11.59	0.64	12.80

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
East Fork/Twelvepole Creek	WV-OT-45-BG_01	McComas Branch	WVO-2-Q-24	4.33	0.66	0.26	5.25
East Fork/Twelvepole Creek	WV-OT-45-BH_01	Frank Branch	WVO-2-Q-24.2	0.81	1.75	0.13	2.70
East Fork/Twelvepole Creek	WV-OT-45-BJ_01	Cranes Nest Branch	WVO-2-Q-25	2.99	0.48	0.18	3.66
East Fork/Twelvepole Creek	WV-OT-45-BK_01	Bluewater Branch	WVO-2-Q-26	1.69	0.71	0.13	2.53
East Fork/Twelvepole Creek	WV-OT-45-BP_01	Wiley Branch	WVO-2-Q-28	1.79	8.84	0.56	11.19
East Fork/Twelvepole Creek	WV-OT-45-BP-1_01	UNT/Wiley Branch RM 0.72	WVO-2-Q-28-A	0.43	2.61	0.16	3.20
East Fork/Twelvepole Creek	WV-OT-45-BQ_01	Honey Branch	WVO-2-Q-29	1.37	0.21	0.08	1.66
East Fork/Twelvepole Creek	WV-OT-45_03	East Fork/Twelvepole Creek	WVO-2-Q	49.91	41.02	4.79	95.72
Laurel Branch	WV-OT-45-BS_01	Laurel Branch	WVO-2-Q-30	1.18	6.04	0.38	7.60
Laurel Branch	WV-OT-45-BS-1_01	UNT/Laurel Branch RM 0.34	WVO-2-Q-30-A	0.42	2.44	0.15	3.02
Cub Branch	WV-OT-45-BT_01	Cub Branch	WVO-2-Q-31	2.43	0.37	0.15	2.94
Cub Branch	WV-OT-45-BT-1_01	Right Fork/Cub Branch	WVO-2-Q-31-A	1.18	0.18	0.07	1.43
East Fork/Twelvepole Creek	WV-OT-45-BU_01	UNT/East Fork RM 38.31/Twelvepole Creek	WVO-2-Q-31.8	0.77	0.00	0.04	0.81
East Fork/Twelvepole Creek	WV-OT-45-BV_01	Andy Branch	WVO-2-Q-32	1.29	1.24	0.13	2.66
East Fork/Twelvepole Creek	WV-OT-45-BX_01	Old House Branch	WVO-2-Q-32.8	0.29	4.00	0.23	4.52
East Fork/Twelvepole Creek	WV-OT-45-BY_01	Caney Fork	WVO-2-Q-33	4.50	11.15	0.82	16.47
East Fork/Twelvepole Creek	WV-OT-45-BY-3_01	UNT/Caney Fork RM 2.29		0.72	3.16	0.20	4.08
East Fork/Twelvepole Creek	WV-OT-45_02	East Fork/Twelvepole Creek	WVO-2-Q	26.65	9.65	1.91	38.21
East Fork/Twelvepole Creek	WV-OT-45-CB_01	Mare Branch	WVO-2-Q-36	1.68	2.09	0.20	3.97
East Fork/Twelvepole Creek	WV-OT-45-CB-2_01	UNT/Mare Branch RM 0.97	WVO-2-Q-36-B	0.43	0.24	0.04	0.71
East Fork/Twelvepole Creek	WV-OT-45-CC_01	McCloud Branch	WVO-2-Q-37	1.26	0.22	0.08	1.56
East Fork/Twelvepole Creek	WV-OT-45-CG_01	Big Branch	WVO-2-Q-39	0.57	0.10	0.04	0.70
East Fork/Twelvepole Creek	WV-OT-45-CH_01	Hurricane Branch	WVO-2-Q-40	0.92	0.16	0.06	1.14
East Fork/Twelvepole Creek	WV-OT-45-CI_01	Hogger Branch	WVO-2-Q-41	0.92	0.17	0.06	1.15
East Fork/Twelvepole Creek	WV-OT-45-CK_01	Marcum Branch	WVO-2-Q-42.5	0.74	0.13	0.05	0.92
East Fork/Twelvepole Creek	WV-OT-45_01	East Fork/Twelvepole Creek	WVO-2-Q	10.80	5.77	0.87	17.44
East Fork/Twelvepole Creek	WV-OT-45-CM_01	Lick Branch	WVO-2-Q-43.5	1.06	0.19	0.07	1.31
East Fork/Twelvepole Creek	WV-OT-45-CP_01	UNT/East Fork RM 48.19/Twelvepole Creek	WVO-2-Q-44.6	1.24	0.22	0.08	1.54
West Fork/Twelvepole Creek	WV-OT-46_08	West Fork/Twelvepole Creek	WVO-2-P	313.97	118.56	22.77	455.30

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
West Fork/Twelvepole Creek	WV-OT-46-F_01	Big Branch	WVO-2-P-1	2.04	0.32	0.12	2.48
West Fork/Twelvepole Creek	WV-OT-46-J_01	Patrick Creek	WVO-2-P-2	2.84	0.43	0.17	3.45
Trace Fork	WV-OT-46-O_02	Trace Fork	WVO-2-P-4	20.40	2.95	1.23	24.58
Trace Fork	WV-OT-46-O-1_01	Booth Branch	WVO-2-P-4-0.1A	1.09	0.17	0.07	1.33
Trace Fork	WV-OT-46-O-3_01	Wolf Creek	WVO-2-P-4-A	5.01	0.70	0.30	6.01
Trace Fork	WV-OT-46-O-4_01	Greenbrier Creek	WVO-2-P-4-B	5.88	0.93	0.36	7.16
Trace Fork	WV-OT-46-O_01	Trace Fork	WVO-2-P-4	6.03	0.97	0.37	7.37
Trace Fork	WV-OT-46-O-7_01	Orchard Branch	WVO-2-P-4-C	1.52	0.25	0.09	1.86
West Fork/Twelvepole Creek	WV-OT-46_07	West Fork/Twelvepole Creek	WVO-2-P	267.00	114.15	20.06	401.21
West Fork/Twelvepole Creek	WV-OT-46-T_01	Joels Branch	WVO-2-P-5	2.22	0.34	0.13	2.69
West Fork/Twelvepole Creek	WV-OT-46-Y_01	Sycamore Branch	WVO-2-P-8	1.79	0.28	0.11	2.18
West Fork/Twelvepole Creek	WV-OT-46-Z_01	Flat Branch	WVO-2-P-9	1.79	0.26	0.11	2.16
West Fork/Twelvepole Creek	WV-OT-46-AB_01	Drift Branch	WVO-2-P-10	2.23	0.34	0.14	2.71
West Fork/Twelvepole Creek	WV-OT-46-AD_01	Jackson Branch	WVO-2-P-11	1.22	0.18	0.07	1.47
West Fork/Twelvepole Creek	WV-OT-46-AE_01	Billy Branch	WVO-2-P-12	3.67	0.56	0.22	4.45
West Fork/Twelvepole Creek	WV-OT-46_06	West Fork/Twelvepole Creek	WVO-2-P	212.09	111.02	17.01	340.12
West Fork/Twelvepole Creek	WV-OT-46-AN_01	Big Branch	WVO-2-P-14	1.37	0.22	0.08	1.67
West Fork/Twelvepole Creek	WV-OT-46-AS_01	Donathan Branch	WVO-2-P-15.3	1.31	0.21	0.08	1.59
West Fork/Twelvepole Creek	WV-OT-46-AV_01	UNT/West Fork RM 20.26/Twelvepole Creek	WVO-2-P-15.8	1.07	0.16	0.06	1.30
West Fork/Twelvepole Creek	WV-OT-46-AW_01	Licklog Branch	WVO-2-P-16	1.42	0.23	0.09	1.73
West Fork/Twelvepole Creek	WV-OT-46-AX_01	Sycamore Branch	WVO-2-P-17	1.55	0.25	0.09	1.90
West Fork/Twelvepole Creek	WV-OT-46-AZ_01	Big Branch	WVO-2-P-18	2.79	0.44	0.17	3.40
West Fork/Twelvepole Creek	WV-OT-46_05	West Fork/Twelvepole Creek	WVO-2-P	148.09	107.89	13.47	269.44
West Fork/Twelvepole Creek	WV-OT-46-BK_01	Wells Branch	WVO-2-P-19	1.43	0.23	0.09	1.75
West Fork/Twelvepole Creek	WV-OT-46-BM_01	Missouri Branch	WVO-2-P-20	3.16	0.49	0.19	3.84
Moses Fork	WV-OT-46-BN_02	Moses Fork	WVO-2-P-21	13.11	1.89	0.79	15.79
Moses Fork	WV-OT-46-BN-5_01	Johnnies Branch	WVO-2-P-21-B.5	1.37	0.21	0.08	1.67
Moses Fork	WV-OT-46-BN-8_01	Right Fork/Moses Fork	WVO-2-P-21-C	1.72	0.27	0.10	2.10
Moses Fork	WV-OT-46-BN_01	Moses Fork	WVO-2-P-21	6.06	0.89	0.37	7.32
Moses Fork	WV-OT-46-BN-9_01	Bark Camp Branch	WVO-2-P-21-C.5	1.25	0.19	0.08	1.51

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
West Fork/Twelvepole Creek	WV-OT-46_04	West Fork/Twelvepole Creek	WVO-2-P	109.41	104.50	11.26	225.16
West Fork/Twelvepole Creek	WV-OT-46-BP_01	Arkansas Branch	WVO-2-P-23	1.80	0.28	0.11	2.19
West Fork/Twelvepole Creek	WV-OT-46-BQ_01	Wiley Branch	WVO-2-P-24	1.19	0.19	0.07	1.45
West Fork/Twelvepole Creek	WV-OT-46-BS_01	Sweetwater Branch	WVO-2-P-25	2.80	0.44	0.17	3.41
West Fork/Twelvepole Creek	WV-OT-46-BS-2_01	Right Fork/Sweetwater Branch	WVO-2-P-25-B	1.11	0.18	0.07	1.35
West Fork/Twelvepole Creek	WV-OT-46-BT_01	Long Branch	WVO-2-P-26	1.66	0.28	0.10	2.03
West Fork/Twelvepole Creek	WV-OT-46-BW_01	Spruce Fork	WVO-2-P-27	2.50	0.42	0.15	3.07
West Fork/Twelvepole Creek	WV-OT-46-BX_01	Gourd Branch	WVO-2-P-28	0.99	0.16	0.06	1.22
Turkey Creek	WV-OT-46-BY_01	Turkey Creek	WVO-2-P-29	11.04	4.70	0.83	16.57
Turkey Creek	WV-OT-46-BY-4_01	Jacks Fork	WVO-2-P-29-B	1.71	3.07	0.25	5.03
West Fork/Twelvepole Creek	WV-OT-46-CF_01	Bull Branch	WVO-2-P-34	1.02	0.72	0.09	1.83
West Fork/Twelvepole Creek	WV-OT-46-CI_01	UNT/West Fork RM 39.30/Twelvepole Creek	WVO-2-P-35.3	0.39	0.06	0.02	0.48
West Fork/Twelvepole Creek	WV-OT-46-CJ_01	Pumpkin Field Branch	WVO-2-P-35.5	0.68	3.48	0.22	4.38
West Fork/Twelvepole Creek	WV-OT-46_03	West Fork/Twelvepole Creek	WVO-2-P	42.70	91.58	7.07	141.35
West Fork/Twelvepole Creek	WV-OT-46-CK_01	Breeden Creek	WVO-2-P-36	4.57	17.10	1.14	22.81
West Fork/Twelvepole Creek	WV-OT-46-CK-4_01	UNT/Breeden Creek RM 2.17		0.25	3.95	0.22	4.42
West Fork/Twelvepole Creek	WV-OT-46-CM_01	UNT/West Fork RM 41.41/Twelvepole Creek	WVO-2-P-36.5	0.14	1.12	0.07	1.32
West Fork/Twelvepole Creek	WV-OT-46-CN_01	UNT/West Fork RM 42.13/Twelvepole Creek	WVO-2-P-36.8	0.58	3.82	0.23	4.63
West Fork/Twelvepole Creek	WV-OT-46-CO_01	Openmouth Branch	WVO-2-P-37	1.37	16.66	0.95	18.99
West Fork/Twelvepole Creek	WV-OT-46-CO-1_01	Left Fork/Openmouth Branch	WVO-2-P-37-A	0.63	6.54	0.38	7.54
West Fork/Twelvepole Creek	WV-OT-46-CP_01	UNT/West Fork RM 43.91/Twelvepole Creek	WVO-2-P-37.1	0.68	3.51	0.22	4.41
West Fork/Twelvepole Creek	WV-OT-46-CS_01	Trace Branch	WVO-2-P-38	0.78	2.89	0.19	3.87
West Fork/Twelvepole Creek	WV-OT-46-CT_01	Big Sang Kill	WVO-2-P-39	2.59	10.72	0.70	14.01
West Fork/Twelvepole Creek	WV-OT-46-CT-2_01	UNT/Big Sang Kill RM 1.42		0.15	3.59	0.20	3.94
West Fork/Twelvepole Creek	WV-OT-46-CW_01	Hogger Run	WVO-2-P-40.5	2.41	3.45	0.31	6.18
West Fork/Twelvepole Creek	WV-OT-46_02	West Fork/Twelvepole Creek	WVO-2-P	15.59	25.51	2.16	43.27
West Fork/Twelvepole Creek	WV-OT-46-CZ_01	Dingess Trace Branch	WVO-2-P-41	2.59	0.43	0.16	3.18

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
West Fork/Twelvepole Creek	WV-OT-46-DB_01	Camp Branch	WVO-2-P-42	0.96	0.15	0.06	1.17
West Fork/Twelvepole Creek	WV-OT-46-DF_01	Moses Fork	WVO-2-P-43	2.32	0.36	0.14	2.82
West Fork/Twelvepole Creek	WV-OT-46_01	West Fork/Twelvepole Creek	WVO-2-P	2.26	23.29	1.35	26.90
West Fork/Twelvepole Creek	WV-OT-46-DG_01	Messenger Branch	WVO-2-P-44	1.64	0.27	0.10	2.01

UNT = unnamed tributary; RM = river mile.

Table 10-2. pH TMDLs

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	LA daily average net acidity load under TMDL condition (lbs as CaCO3/day)	WLA daily average net acidity load under TMDL condition (lbs as CaCO3/day)	MOS daily average net acidity load (lbs as CaCO3/day)	TMDL daily average net acidity load (lbs as CaCO3/day)
Twelevepole Creek	WV-OT-46-AQ_01	Matty Ferguson Branch	WVO-2-P-14.5	-43.84	0.00	2.19	-41.75
Twelevepole Creek	WV-OT-46-DG_01	Messenger Branch	WVO-2-P-44	-938.68	0.00	44.93	-893.97

Table 10-3. Aluminum TMDLs

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Al TMDL (lbs/day)
Twelvepole Creek	WV-OT-46-AQ_01	Matty Ferguson Branch	WVO-2-P-14.5	0.36	0.00	0.02	0.38

Table 10-4. Selenium TMDLs

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Se TMDL (lbs/day)
Camp Creek/East Fork	WV-OT-45-Q_02	Camp Creek	WVO-2-Q-8	0.0632	0.0130	0.0040	0.0802
Camp Creek/East Fork	WV-OT-45-Q-3_01	Right Fork/Camp Creek	WVO-2-Q-8-B	0.0184	0.0130	0.0017	0.0331
Kiah Creek	WV-OT-45-AN-24_01	Copley Trace Branch	WVO-2-Q-18-G	0.0031	0.0461	0.0026	0.0519
Laurel Branch	WV-OT-45-BS-1_01	UNT/Laurel Branch RM 0.34	WVO-2-Q-30-A	0.0020	0.0079	0.0005	0.0105

Table 10-5. Fecal Coliform Bacteria TMDLs

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Twelvepole Creek	WV-OT_07	Twelvepole Creek	WVO-2	3.56E+11	1.66E+10	1.96E+10	3.92E+11
Twelvepole Creek	WV-OT_08	Twelvepole Creek	WVO-2	4.17E+11	1.73E+10	2.29E+10	4.58E+11
Twelvepole Creek	WV-OT_09	Twelvepole Creek	WVO-2	5.75E+11	1.76E+10	3.12E+10	6.24E+11
Twelvepole Creek	WV-OT_10	Twelvepole Creek	WVO-2	6.55E+11	3.66E+10	3.64E+10	7.29E+11
Twelvepole Creek	WV-OT-1_01	Krout Creek	WVO-2-0.1A	1.12E+10	4.63E+09	8.31E+08	1.66E+10
Twelvepole Creek	WV-OT-4_01	Jordans Branch	WVO-2-0.5A	8.20E+09	3.74E+09	6.28E+08	1.26E+10
Twelvepole Creek	WV-OT-7_01	Walker Branch	WVO-2-A	5.45E+09	2.03E+06	2.87E+08	5.74E+09

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Twelvepole Creek	WV-OT-8_01	UNT/Twelvepole Creek RM 5.72	WVO-2-A.1	4.86E+09	3.66E+08	2.75E+08	5.50E+09
Twelvepole Creek	WV-OT-10_01	Bobs Branch	WVO-2-B	5.83E+09	1.50E+05	3.07E+08	6.14E+09
Buffalo Creek	WV-OT-12_01	Buffalo Creek	WVO-2-C	8.35E+09	3.79E+07	4.42E+08	8.83E+09
Buffalo Creek	WV-OT-12_02	Buffalo Creek	WVO-2-C	1.99E+10	1.15E+08	1.06E+09	2.11E+10
Buffalo Creek	WV-OT-12-D_01	UNT/Buffalo Creek RM 2.21	WVO-2-C-4	2.90E+09	3.79E+06	1.53E+08	3.06E+09
Buffalo Creek	WV-OT-12-F_01	UNT/Buffalo Creek RM 3.50	WVO-2-C-6	2.84E+09	2.65E+07	1.51E+08	3.01E+09
Twelvepole Creek	WV-OT-17_01	UNT/Twelvepole Creek RM 11.90	WVO-2-E.6	2.44E+09	0.00E+00	1.29E+08	2.57E+09
Camp Creek	WV-OT-21_01	Camp Creek	WVO-2-G	1.76E+10	8.33E+07	9.31E+08	1.86E+10
Camp Creek	WV-OT-21-B_01	Right Fork/Camp Creek	WVO-2-G-1	7.53E+09	1.61E+07	3.97E+08	7.94E+09
Camp Creek	WV-OT-21-B-2_01	UNT/Right Fork RM 0.66/Camp Creek	WVO-2-G-1-B	2.86E+09	1.21E+07	1.51E+08	3.03E+09
Camp Creek	WV-OT-21-D_01	UNT/Camp Creek RM 1.16	WVO-2-G-1.4	1.93E+09	8.18E+06	1.02E+08	2.04E+09
Beech Fork	WV-OT-24_01	Beech Fork	WVO-2-H	1.66E+10	0.00E+00	8.73E+08	1.75E+10
Beech Fork	WV-OT-24_03	Beech Fork	WVO-2-H	3.99E+10	0.00E+00	2.10E+09	4.20E+10
Beech Fork	WV-OT-24_04	Beech Fork	WVO-2-H	8.60E+10	1.21E+07	4.53E+09	9.06E+10
Beech Fork	WV-OT-24_05	Beech Fork	WVO-2-H	1.09E+11	1.30E+08	5.73E+09	1.15E+11
Beech Fork	WV-OT-24-C_01	UNT/Beech Fork RM 2.38	WVO-2-H-0.4	1.62E+09	7.58E+06	8.57E+07	1.71E+09
Beech Fork	WV-OT-24-D_01	Mays Branch	WVO-2-H-0.5	1.95E+09	1.52E+07	1.03E+08	2.07E+09
Beech Fork	WV-OT-24-H_01	Millers Fork	WVO-2-H-2	1.03E+10	4.55E+06	5.40E+08	1.08E+10
Beech Fork	WV-OT-24-H_02	Millers Fork	WVO-2-H-2	2.42E+10	1.29E+07	1.27E+09	2.55E+10
Beech Fork	WV-OT-24-H-12_01	Fisher Bowen Branch	WVO-2-H-2-C	5.98E+09	8.33E+06	3.15E+08	6.30E+09
Beech Fork	WV-OT-24-H-18_01	Left Fork/Millers Fork	WVO-2-H-2-D	8.86E+09	4.55E+06	4.67E+08	9.33E+09
Beech Fork	WV-OT-24-H-22_01	Fraley Fork	WVO-2-H-2-F	2.42E+09	4.55E+06	1.28E+08	2.56E+09
Beech Fork	WV-OT-24-V.2_01	Moxley Branch	WVO-2-H-7.2	2.59E+09	3.79E+06	1.36E+08	2.73E+09
Beech Fork	WV-OT-24-V_01	Long Branch	WVO-2-H-7	1.24E+10	1.52E+07	6.54E+08	1.31E+10
Beech Fork	WV-OT-24-AD_01	Bowen Creek	WVO-2-H-11	5.44E+09	0.00E+00	2.86E+08	5.73E+09
Beech Fork	WV-OT-24-AD_02	Bowen Creek	WVO-2-H-11	1.10E+10	0.00E+00	5.79E+08	1.16E+10

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Beech Fork	WV-OT-24-AI_01	Raccoon Creek	WVO-2-H-12	1.35E+10	0.00E+00	7.11E+08	1.42E+10
Beech Fork	WV-OT-24-AU_01	Right Fork/Beech Fork	WVO-2-H-18	8.18E+09	0.00E+00	4.30E+08	8.61E+09
Beech Fork	WV-OT-24-AY_01	Wolfpen Branch	WVO-2-H-19	2.55E+09	0.00E+00	1.34E+08	2.69E+09
Twelvepole Creek	WV-OT-26_01	Lynn Creek	WVO-2-I	8.26E+09	7.65E+07	4.39E+08	8.77E+09
Twelvepole Creek	WV-OT-35_01	Big Creek	WVO-2-K	3.20E+09	1.59E+07	1.69E+08	3.39E+09
Twelvepole Creek	WV-OT-37_01	Garrett Creek	WVO-2-L	1.04E+10	1.93E+08	5.56E+08	1.11E+10
Twelvepole Creek	WV-OT-38_01	Shoal Branch	WVO-2-M	1.91E+09	2.80E+07	1.02E+08	2.04E+09
Wilson Creek	WV-OT-39_01	Wilson Creek	WVO-2-N	1.56E+10	4.32E+07	8.24E+08	1.65E+10
Wilson Creek	WV-OT-39-A_01	Left Fork/Wilson Creek	WVO-2-N-1	7.41E+09	2.42E+07	3.91E+08	7.83E+09
Twelvepole Creek	WV-OT-44_01	Toms Creek	WVO-2-O	5.96E+09	1.59E+07	3.15E+08	6.29E+09
East Fork/Twelvepole Creek	WV-OT-45_01	East Fork/Twelvepole Creek	WVO-2-Q	1.13E+10	3.79E+06	5.96E+08	1.19E+10
East Fork/Twelvepole Creek	WV-OT-45_02	East Fork/Twelvepole Creek	WVO-2-Q	2.55E+10	3.79E+06	1.34E+09	2.68E+10
East Fork/Twelvepole Creek	WV-OT-45_03	East Fork/Twelvepole Creek	WVO-2-Q	5.13E+10	3.79E+06	2.70E+09	5.40E+10
East Fork/Twelvepole Creek	WV-OT-45_04	East Fork/Twelvepole Creek	WVO-2-Q	1.14E+11	3.79E+06	6.00E+09	1.20E+11
East Fork/Twelvepole Creek	WV-OT-45_05	East Fork/Twelvepole Creek	WVO-2-Q	7.00E+10	4.52E+08	3.71E+09	7.42E+10
East Fork/Twelvepole Creek	WV-OT-45-A_01	Johnnys Branch	WVO-2-Q-0.5	1.64E+09	4.55E+07	8.89E+07	1.78E+09
East Fork/Twelvepole Creek	WV-OT-45-L_01	Newcomb Creek	WVO-2-Q-5	4.38E+09	1.52E+07	2.31E+08	4.63E+09
East Fork/Twelvepole Creek	WV-OT-45-M_01	Petercave Branch	WVO-2-Q-6	2.06E+09	0.00E+00	1.08E+08	2.16E+09
Camp Creek	WV-OT-45-Q_02	Camp Creek	WVO-2-Q-8	1.52E+10	2.87E+08	8.16E+08	1.63E+10
Camp Creek	WV-OT-45-Q-2_01	Left Fork/Camp Creek	WVO-2-Q-8-A	3.42E+09	0.00E+00	1.80E+08	3.60E+09
Camp Creek	WV-OT-45-Q-2_02	Left Fork/Camp Creek	WVO-2-Q-8-A	9.47E+09	4.55E+06	4.99E+08	9.97E+09
Camp Creek	WV-OT-45-Q-2-A_01	Tiger Fork	WVO-2-Q-8-A-1	3.58E+09	0.00E+00	1.89E+08	3.77E+09
Camp Creek	WV-OT-45-Q-3_01	Right Fork/Camp Creek	WVO-2-Q-8-B	3.20E+09	2.82E+08	1.83E+08	3.67E+09
Lynn Creek	WV-OT-45-R_01	Lynn Creek	WVO-2-Q-9	8.49E+09	0.00E+00	4.47E+08	8.94E+09
Lynn Creek	WV-OT-45-R-1_01	Battern Fork	WVO-2-Q-9-A	1.80E+09	0.00E+00	9.46E+07	1.89E+09
Lynn Creek	WV-OT-45-R-5_01	Left Fork/Lynn Creek	WVO-2-Q-9-C	2.11E+09	0.00E+00	1.11E+08	2.22E+09

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Lynn Creek	WV-OT-45-R-4_01	Right Fork/Lynn Creek	WVO-2-Q-9-D	2.53E+09	0.00E+00	1.33E+08	2.66E+09
East Fork/Twelvepole Creek	WV-OT-45-W_01	Laurel Creek/East Fork	WVO-2-Q-10	8.52E+09	0.00E+00	4.48E+08	8.97E+09
Rich Creek	WV-OT-45-AG-7_01	Right Fork/Rich Creek	WVO-2-Q-14-A	5.36E+09	0.00E+00	2.82E+08	5.64E+09
East Fork/Twelvepole Creek	WV-OT-45-AH_01	Beechy Branch	WVO-2-Q-15	2.37E+09	0.00E+00	1.25E+08	2.50E+09
Cove Creek	WV-OT-45-AK_01	Cove Creek	WVO-2-Q-17	9.94E+09	2.34E+07	5.24E+08	1.05E+10
Cove Creek	WV-OT-45-AK-9_01	Trace Fork	WVO-2-Q-17-E	1.29E+09	0.00E+00	6.77E+07	1.35E+09
East Fork/Twelvepole Creek	WV-OT-45-AM_01	Alum Fork	WVO-2-Q-17.8	8.08E+08	0.00E+00	4.25E+07	8.51E+08
Kiah Creek	WV-OT-45-AN_01	Kiah Creek	WVO-2-Q-18	5.67E+09	0.00E+00	2.99E+08	5.97E+09
Kiah Creek	WV-OT-45-AN_02	Kiah Creek	WVO-2-Q-18	1.97E+10	0.00E+00	1.04E+09	2.08E+10
Kiah Creek	WV-OT-45-AN_03	Kiah Creek	WVO-2-Q-18	4.03E+10	0.00E+00	2.12E+09	4.24E+10
Kiah Creek	WV-OT-45-AN_04	Kiah Creek	WVO-2-Q-18	5.48E+10	0.00E+00	2.88E+09	5.76E+10
Kiah Creek	WV-OT-45-AN-6_01	Big Laurel Creek	WVO-2-Q-18-B	7.44E+09	0.00E+00	3.91E+08	7.83E+09
Kiah Creek	WV-OT-45-AN-11_01	Trough Fork	WVO-2-Q-18-C	7.15E+09	0.00E+00	3.76E+08	7.52E+09
Kiah Creek	WV-OT-45-AN-11-F_01	Tomblin Branch	WVO-2-Q-18-C-2	6.04E+08	0.00E+00	3.18E+07	6.36E+08
Kiah Creek	WV-OT-45-AN-21_01	Frances Creek	WVO-2-Q-18-F	7.40E+09	0.00E+00	3.90E+08	7.79E+09
Kiah Creek	WV-OT-45-AN-21-D_01	Pretty Branch	WVO-2-Q-18-F-1	5.63E+08	0.00E+00	2.97E+07	5.93E+08
Kiah Creek	WV-OT-45-AN-22_01	Witcher Fork	WVO-2-Q-18-F.2	1.11E+09	0.00E+00	5.84E+07	1.17E+09
Kiah Creek	WV-OT-45-AN-24_01	Copley Trace Branch	WVO-2-Q-18-G	1.95E+09	0.00E+00	1.03E+08	2.06E+09
Kiah Creek	WV-OT-45-AN-25_01	Jims Branch	WVO-2-Q-18-H	1.49E+09	0.00E+00	7.85E+07	1.57E+09
East Fork/Twelvepole Creek	WV-OT-45-BD_01	Maynard Branch	WVO-2-Q-23	1.24E+09	0.00E+00	6.51E+07	1.30E+09
East Fork/Twelvepole Creek	WV-OT-45-BG_01	McComas Branch	WVO-2-Q-24	5.80E+09	0.00E+00	3.05E+08	6.10E+09
East Fork/Twelvepole Creek	WV-OT-45-BH_01	Frank Branch	WVO-2-Q-24.2	1.32E+09	0.00E+00	6.96E+07	1.39E+09
Cub Branch	WV-OT-45-BT_01	Cub Branch	WVO-2-Q-31	3.33E+09	0.00E+00	1.75E+08	3.51E+09
Cub Branch	WV-OT-45-BT-1_01	Right Fork/Cub Branch	WVO-2-Q-31-A	1.61E+09	0.00E+00	8.46E+07	1.69E+09
East Fork/Twelvepole Creek	WV-OT-45-BU_01	UNT/East Fork RM 38.31/Twelvepole Creek	WVO-2-Q-31.8	2.90E+08	0.00E+00	1.53E+07	3.05E+08
East Fork/Twelvepole Creek	WV-OT-45-BX_01	Old House Branch	WVO-2-Q-32.8	6.05E+08	0.00E+00	3.19E+07	6.37E+08

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
East Fork/Twelvepole Creek	WV-OT-45-BY_01	Caney Fork	WVO-2-Q-33	5.27E+09	0.00E+00	2.77E+08	5.54E+09
East Fork/Twelvepole Creek	WV-OT-45-CA_01	Pretty Branch	WVO-2-Q-35	2.25E+09	0.00E+00	1.18E+08	2.37E+09
East Fork/Twelvepole Creek	WV-OT-45-CB_01	Mare Branch	WVO-2-Q-36	2.16E+09	0.00E+00	1.14E+08	2.28E+09
East Fork/Twelvepole Creek	WV-OT-45-CH_01	Hurricane Branch	WVO-2-Q-40	9.29E+08	0.00E+00	4.89E+07	9.78E+08
East Fork/Twelvepole Creek	WV-OT-45-CI_01	Hogger Branch	WVO-2-Q-41	1.05E+09	0.00E+00	5.52E+07	1.10E+09
East Fork/Twelvepole Creek	WV-OT-45-CK_01	Marcum Branch	WVO-2-Q-42.5	7.66E+08	0.00E+00	4.03E+07	8.06E+08
East Fork/Twelvepole Creek	WV-OT-45-CP_01	UNT/East Fork RM 48.19/Twelvepole Creek	WVO-2-Q-44.6	1.30E+09	3.79E+06	6.88E+07	1.38E+09
West Fork/Twelvepole Creek	WV-OT-46_01	West Fork/Twelvepole Creek	WVO-2-P	5.50E+09	6.82E+07	2.93E+08	5.87E+09
West Fork/Twelvepole Creek	WV-OT-46_02	West Fork/Twelvepole Creek	WVO-2-P	2.52E+10	7.20E+07	1.33E+09	2.66E+10
West Fork/Twelvepole Creek	WV-OT-46_03	West Fork/Twelvepole Creek	WVO-2-P	6.25E+10	7.58E+07	3.29E+09	6.58E+10
West Fork/Twelvepole Creek	WV-OT-46_04	West Fork/Twelvepole Creek	WVO-2-P	1.24E+11	7.58E+07	6.55E+09	1.31E+11
West Fork/Twelvepole Creek	WV-OT-46_05	West Fork/Twelvepole Creek	WVO-2-P	1.64E+11	9.09E+07	8.61E+09	1.72E+11
West Fork/Twelvepole Creek	WV-OT-46_06	West Fork/Twelvepole Creek	WVO-2-P	1.96E+11	9.47E+07	1.03E+10	2.06E+11
West Fork/Twelvepole Creek	WV-OT-46_07	West Fork/Twelvepole Creek	WVO-2-P	2.35E+11	1.45E+08	1.24E+10	2.47E+11
East Fork/Twelvepole Creek	WV-OT-46_08	West Fork/Twelvepole Creek	WVO-2-P	2.67E+11	2.39E+08	1.41E+10	2.81E+11
East Fork/Twelvepole Creek	WV-OT-46-F_01	Big Branch	WVO-2-P-1	1.77E+09	3.79E+06	9.35E+07	1.87E+09
East Fork/Twelvepole Creek	WV-OT-46-J_01	Patrick Creek	WVO-2-P-2	3.75E+09	0.00E+00	1.97E+08	3.95E+09
Trace Fork	WV-OT-46-O_01	Trace Fork	WVO-2-P-4	5.50E+09	3.79E+06	2.89E+08	5.79E+09
Trace Fork	WV-OT-46-O_02	Trace Fork	WVO-2-P-4	1.94E+10	1.14E+07	1.02E+09	2.04E+10
Trace Fork	WV-OT-46-O-3_01	Wolf Creek	WVO-2-P-4-A	4.88E+09	0.00E+00	2.57E+08	5.14E+09
Trace Fork	WV-OT-46-O-4_01	Greenbrier Creek	WVO-2-P-4-B	6.46E+09	3.79E+06	3.40E+08	6.80E+09
West Fork/Twelvepole Creek	WV-OT-46-X_01	Deephole Branch	WVO-2-P-7	2.16E+09	0.00E+00	1.14E+08	2.27E+09
West Fork/Twelvepole Creek	WV-OT-46-Y_01	Sycamore Branch	WVO-2-P-8	3.08E+09	0.00E+00	1.62E+08	3.24E+09
West Fork/Twelvepole Creek	WV-OT-46-Z_01	Flat Branch	WVO-2-P-9	2.34E+09	0.00E+00	1.23E+08	2.47E+09
West Fork/Twelvepole Creek	WV-OT-46-AB_01	Drift Branch	WVO-2-P-10	3.66E+09	4.55E+06	1.93E+08	3.86E+09
West Fork/Twelvepole Creek	WV-OT-46-AD_01	Jackson Branch	WVO-2-P-11	2.45E+09	3.79E+06	1.29E+08	2.58E+09

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
West Fork/Twelvepole Creek	WV-OT-46-AE_01	Billy Branch	WVO-2-P-12	6.30E+09	0.00E+00	3.32E+08	6.63E+09
West Fork/Twelvepole Creek	WV-OT-46-AL_01	Martha Noe Branch	WVO-2-P-13	9.78E+08	0.00E+00	5.15E+07	1.03E+09
West Fork/Twelvepole Creek	WV-OT-46-AR_01	Ferguson Branch	WVO-2-P-15	2.55E+09	0.00E+00	1.34E+08	2.69E+09
West Fork/Twelvepole Creek	WV-OT-46-AV_01	UNT/West Fork RM 20.26/Twelvepole Creek	WVO-2-P-15.8	1.76E+09	0.00E+00	9.25E+07	1.85E+09
West Fork/Twelvepole Creek	WV-OT-46-AX_01	Sycamore Branch	WVO-2-P-17	2.23E+09	0.00E+00	1.17E+08	2.34E+09
West Fork/Twelvepole Creek	WV-OT-46-AZ_01	Big Branch	WVO-2-P-18	3.25E+09	0.00E+00	1.71E+08	3.42E+09
West Fork/Twelvepole Creek	WV-OT-46-BK_01	Wells Branch	WVO-2-P-19	2.50E+09	0.00E+00	1.32E+08	2.63E+09
Moses Fork	WV-OT-46-BN_01	Moses Fork	WVO-2-P-21	8.68E+09	0.00E+00	4.57E+08	9.13E+09
Moses Fork	WV-OT-46-BN_02	Moses Fork	WVO-2-P-21	1.90E+10	3.79E+06	1.00E+09	2.00E+10
Moses Fork	WV-OT-46-BN-8_01	Right Fork/Moses Fork	WVO-2-P-21-C	3.31E+09	3.79E+06	1.74E+08	3.48E+09
West Fork/Twelvepole Creek	WV-OT-46-BQ_01	Wiley Branch	WVO-2-P-24	1.81E+09	0.00E+00	9.54E+07	1.91E+09
West Fork/Twelvepole Creek	WV-OT-46-BS_01	Sweetwater Branch	WVO-2-P-25	3.95E+09	0.00E+00	2.08E+08	4.16E+09
Turkey Creek	WV-OT-46-BY_01	Turkey Creek	WVO-2-P-29	1.12E+10	0.00E+00	5.87E+08	1.17E+10
Turkey Creek	WV-OT-46-BY-4_01	Jacks Fork	WVO-2-P-29-B	2.31E+09	0.00E+00	1.22E+08	2.44E+09
West Fork/Twelvepole Creek	WV-OT-46-CE_01	Poor Branch	WVO-2-P-33	1.20E+09	0.00E+00	6.32E+07	1.26E+09
West Fork/Twelvepole Creek	WV-OT-46-CI_01	UNT/West Fork RM 39.30/Twelvepole Creek	WVO-2-P-35.3	6.34E+08	0.00E+00	3.33E+07	6.67E+08
West Fork/Twelvepole Creek	WV-OT-46-CJ_01	Pumpkin Field Branch	WVO-2-P-35.5	1.20E+09	0.00E+00	6.31E+07	1.26E+09
West Fork/Twelvepole Creek	WV-OT-46-CK_01	Breeden Creek	WVO-2-P-36	7.09E+09	0.00E+00	3.73E+08	7.46E+09
West Fork/Twelvepole Creek	WV-OT-46-CM_01	UNT/West Fork RM 41.41/Twelvepole Creek	WVO-2-P-36.5	3.91E+08	0.00E+00	2.06E+07	4.11E+08
West Fork/Twelvepole Creek	WV-OT-46-CN_01	UNT/West Fork RM 42.13/Twelvepole Creek	WVO-2-P-36.8	7.76E+08	0.00E+00	4.08E+07	8.17E+08
West Fork/Twelvepole Creek	WV-OT-46-CP_01	UNT/West Fork RM 43.91/Twelvepole Creek	WVO-2-P-37.1	8.56E+08	0.00E+00	4.51E+07	9.02E+08
West Fork/Twelvepole Creek	WV-OT-46-CS_01	Trace Branch	WVO-2-P-38	1.26E+09	0.00E+00	6.63E+07	1.33E+09
West Fork/Twelvepole Creek	WV-OT-46-CT_01	Big Sang Kill	WVO-2-P-39	3.83E+09	0.00E+00	2.02E+08	4.03E+09

TMDL Watershed	Assessment Unit ID	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
West Fork/Twelvepole Creek	WV-OT-46-CW_01	Hogger Run	WVO-2-P-40.5	2.79E+09	0.00E+00	1.47E+08	2.94E+09
West Fork/Twelvepole Creek	WV-OT-46-CZ_01	Dingess Trace Branch	WVO-2-P-41	3.88E+09	0.00E+00	2.04E+08	4.08E+09
West Fork/Twelvepole Creek	WV-OT-46-DB_01	Camp Branch	WVO-2-P-42	1.28E+09	0.00E+00	6.72E+07	1.34E+09
West Fork/Twelvepole Creek	WV-OT-46-DF_01	Moses Fork	WVO-2-P-43	3.92E+09	0.00E+00	2.06E+08	4.12E+09
West Fork/Twelvepole Creek	WV-OT-46-DG_01	Messenger Branch	WVO-2-P-44	1.78E+09	0.00E+00	9.35E+07	1.87E+09

NA = not applicable; UNT = unnamed tributary; RM = river mile.

“Scientific notation” is a method of writing or displaying numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10. The scientific notation of 10,492, for example, is 1.0492 $\times 10^4$ or 1.0492E+4.

11.0 FUTURE GROWTH

11.1 Iron, Aluminum, pH, and Selenium

With the exception of allowances provided for CSGP registrations discussed below, this TMDL does not include specific future growth allocations. However, the absence of specific future growth allocations does not prohibit the permitting of new or expanded activities in the watersheds of streams for which metals TMDLs have been developed. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits must be "consistent with the assumptions and requirements of any available WLAs for the discharge...." In addition, the federal regulations generally prohibit issuance of a permit to a new discharger "if the discharge from its construction or operation will cause or contribute to the violation of water quality standards." A discharge permit for a new discharger could be issued under the following scenarios:

- A new facility could be permitted anywhere in the watershed, provided that effluent limitations are based on the achievement of water quality standards at end-of-pipe for the pollutants of concern in the TMDL.

- NPDES permitting rules mandate effluent limitations for metals to be prescribed in the total recoverable form. West Virginia water quality criteria for iron are in total recoverable form and may be directly implemented.
- Because aluminum water quality criteria are in dissolved form, a dissolved/total pollutant translator is needed to determine total aluminum effluent limitations. In aluminum impaired warmwater fisheries, a new facility could be permitted if total aluminum effluent limitations are based on the dissolved aluminum, acute, aquatic life protection criterion and dissolved/total aluminum translation equal to 1.0.

- The alternative precipitation provisions of 40 CFR 434 that suspend applicability of iron and TSS limitations, cannot be applied to new discharges in iron TMDL watersheds.

- Remining (under an NPDES permit) could occur without a specific allocation to the new permittee, provided that the requirements of existing State remining regulations are met and remining activities will not worsen water quality and, in some instances, may result in improved water quality in abandoned mining areas.

- Reclamation and release of existing permits could provide an opportunity for future growth provided that permit release is conditioned on achieving discharge quality better than the WLA prescribed by the TMDL.

- Most traditional, non-mining point source discharges are assigned technology-based TSS effluent limitations. The iron associated with such discharges would not cause or contribute to violations of iron water quality standards. For example, NPDES permits for sewage treatment and industrial manufacturing facilities contain monthly average TSS effluent limitations between 30 and 100 mg/L. New point sources may be permitted in the watersheds of iron impaired streams with the implementation of applicable technology based TSS requirements. If iron is identified as a pollutant of concern in a process wastewater discharge from a new, non-mining activity, then the discharge can be permitted if effluent limitations are based on the achievement of water quality standards at end-of-pipe.

- Lands associated with the Construction Stormwater and Multi-sector Stormwater General Permits are not significant or causative sources of dissolved aluminum, pH, or selenium impairments. New registrations may be permitted in the watersheds of impaired streams without specific wasteload allocations for those parameters.

- Subwatershed-specific future growth allowances have been provided for site registrations under the CSGP. The successful TMDL allocation provides subwatershed-specific disturbed areas that may be registered under the general permit at any point in time. The iron allocation spreadsheet also provides cumulative area allowances of disturbed area for the immediate subwatershed and all upstream contributing subwatersheds. Projects in excess of the acreage provided for the immediate subwatershed may also be registered under the general permit, provided that the total registered disturbed area in the immediate subwatershed and all upstream subwatersheds is less than the cumulative area provided. Furthermore, projects with disturbed area larger than allowances may be registered under the general permit under any of the following provisions:

    - A larger total project area can be registered if the construction activity is authorized in phases that adhere to the future growth area allowances.

    - All disturbed areas that will occur on non-background land uses can be registered without regard to the future growth allowances.

    - Registration may be conditioned by implementing controls beyond those afforded by the general permit, if it can be demonstrated that the additional controls will result in a lower unit area loading condition than the 100 mg/l TSS expectation for typical permit BMPs and that the improved performance is proportional to the increased area.

11.2 Fecal Coliform Bacteria

Specific fecal coliform bacteria future growth allocations are not prescribed. The absence of specific future growth allocations does not prohibit new development in the watersheds of streams for which fecal coliform bacteria TMDLs have been developed, or preclude the permitting of new sewage treatment facilities.

In many cases, the implementation of the TMDLs will consist of providing public sewer service to unsewered areas. The NPDES permitting procedures for sewage treatment facilities include technology-based fecal coliform effluent limitations that are more stringent than applicable water quality criteria. Therefore, a new sewage treatment facility may be permitted anywhere in the watershed, provided that the permit includes monthly geometric mean and maximum daily fecal coliform limitations of 200 counts/100 mL and 400 counts/100 mL, respectively. Furthermore, WVDEP will not authorize construction of combined collection systems nor permit overflows from newly constructed collection systems.

12.0 PUBLIC PARTICIPATION

12.1 Public Meetings

An informational public meeting was held on May 3, 2016 at Wayne County Health Department in Wayne, WV. The meetings occurred prior to pre-TMDL stream monitoring and pollutant source tracking and included a general TMDL overview and a presentation of planned monitoring and data gathering activities.

Due to COVID-19, no travel or public meetings were permitted during the comment period. WVDEP representatives hosted a virtual meeting to present an overview of the TMDL development process and answer questions on December 15, 2020.

12.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised via email, social media, and news release. The notice was shared directly with interested stakeholders. A public comment period began on November 30, 2020 and ended on January 12, 2021. The electronic documents were also posted on the WVDEP's internet site at www.dep.wv.gov/tmdl. An ESRI StoryMap was created to provide an overview of the TMDL at https://arcg.is/1TWiij.

12.3 Response Summary

WVDEP received combined written comments on the Draft TMDLs for select streams in the Lower Ohio River, Big Sandy River, and Twelvepole Creek watersheds. Comments were submitted by Ohio Valley Environmental Coalition and West Virginia Rivers Coalition, representing the League of Women Voters of West Virginia, Ohio River Waterkeeper, Ohio River Foundation, West Virginia Highlands Conservancy, West Virginia Environmental Council, and the National Wildlife Federation. Comments and comment summaries are in boldface and italic. Agency responses appear in plain text.

Multiple commenters referenced the development and pending approval of a procedural rule describing the assessment methodology for the biological component of the narrative criteria in wadeable streams, as well as the direction in 2012 from the State legislature to develop this rule pointing out that WVDEP has not accomplished this task in over 8 years. The commenters acknowledged that the majority of impaired streams in the watersheds are resolved through pollutant TMDLs and only a portion are not. The commenters also expressed that the assessment methodology should be based on a genus level IBI referred to GLIMPSS.

WVDEP released a third version of the procedural rule on February 10, 2021 with changes to address public comments previously submitted. As described in Section 4.0 in each of the three watershed reports, streams with WVSCI scores below the threshold for attainment were subject to a stressor identification process. One hundred and forty-eight streams with biological stressors of organic enrichment and/or sedimentation, will be addressed through pollutant TMDLs for fecal coliform or total iron. Technical Report Appendix K provides details on impaired streams in Big Sandy, Lower Ohio, and Twelvepole that can be resolved through pollutant TMDLs and list those that will not, because of stress due to ionic strength. Impaired streams will be retained on the 303d list and be the subject of future TMDL efforts to address ionic strength. WVDEP and the USEPA are currently collaborating on a project to determine a TMDL endpoint and identify sources of ions in West Virginia streams. Comments regarding the use of GLIMPSS in the assessment methodology are noted.

Commenters expressed disagreement with the assumption in the TMDL that compliant permits are not causing fecal coliform impairment in the streams. The commenter disagrees that the permit limits are protective of the water quality standards. The commenter asserted that the TMDL should address permit non-compliance, that permits should require continuous monitoring, and the TMDL should require reductions from permitted facilities. Commenters also cited Notice of Violations issued for permit non-compliance stated the draft TMDL does not support its conclusion that "no significant SSOs were represented in the model." Commenters asked for clarification if the statement meant no SSOs occur in the watershed or if no significant SSOs were represented in the model, concluding that it would be an accomplishment if there were genuinely no SSO events in the past ten years.

WVDEP contends that permit limits are at least equivalent to the fecal coliform water quality criteria, because both include a 200 counts/100ml monthly geometric mean component and a 400 counts/ 100ml daily maximum component. DEP views the effluent limits as more restrictive because the water quality criteria allow daily values to be exceeded 10% of the time in a month whereas the permitted effluent limits allow no exceedance of the daily value.

Per the Technical Support Document (https://www3.epa.gov/npdes/pubs/owm0264.pdf), wasteload allocations based upon a human health criteria are to be implemented as the monthly average limit in a permit. As such, the baseline and allocated concentrations established in the TMDL are consistent with the existing limitations in the permits.

Attainment of instream water quality standards in the TMDL allocated scenario are based on attaining both the monthly geomean and maximum daily. The model demonstrates that when in compliance, wastewater treatment plants discharging at existing limits are protective of water quality standards. Permit monitoring frequencies and non-compliance are outside of the purview of the TMDL development.

The statement, "no significant SSOs were represented in the model," means that no significant SSOs were represented in the model. WVDEP acknowledges that episodic SSOs events from permitted wastewater collection systems may contribute loads impairing streams and are not directly represented during calibration and baseline scenarios. In general, the availability of SSO release data is limited to spill reports, making identification of these potential sources arduous. The benefits of informing model calibration do not justify the time-consuming task of identifying episodic SSOs events. Based on a long-standing interpretation of the Clean Water Act, SSOs are illegal and cannot be permitted. When SSOs are known to be present, they should receive a zero wasteload allocation in a TMDL.

The pollutant loads from SSOs events are captured in urban/residential landuse representation in specific subwatersheds during calibration, opposed to being attributed to, or masking impacts from, unrelated nonpoint sources. Prescribed reductions to urban residential sources may be accomplished, in part, through identification of and resolution of SSOs and illicit discharges into stormwater systems.

Commenters questioned the use of a 5% margin of safety (MOS) and references the use of 10% MOS in other jurisdictions for fecal coliform TMDLs.

Choosing an appropriate MOS is influenced by many factors, including but not limited to past precedent, quality of monitoring data, understanding of pollutant, and sophistication of the TMDL model. The use of 5% MOS for fecal coliform TMDLs waters in WV was established by the USEPA twenty years ago, prior to WVDEP administering the TMDL Program. WVDEP maintains this long-standing MOS is appropriate. WVDEP WAB maintains an excellent standard of data collection, analysis, and quality assurance. Section 7.0 and the TMDL Technical Report describe the function and capacity of the modeling tools used to develop the Big Sandy, Lower Ohio, and Twelvepole TMDL. Modeling techniques and source representation have only improved in the past two decades.

Commenters expressed disagreement with reducing impermissible discharges of human waste 100% in the TMDL allocated scenario, stating, "if the final TMDL assumes all illicit discharges will be corrected but that does not reflect reality, the TMDL endpoints will not be reached." Commenters also expressed concern that the TMDL is lacking information on pollution remediation from nonpoint sources and asserts that the Draft TMDL should explore alternative allocations that will meet the TMDL endpoints, including seeking further reductions from point sources.

Discharges from failing septic systems are represented in the TMDL calibration and baseline condition, with loads attributed to an estimated number of households per subwatershed. Because the discharging of untreated waste is impermissible, no loads are allocated to failing septic systems in the TMDL, which effectively means the TMDL prescribes elimination. The TMDL is a restoration plan. Identifying the contributions from failing septic systems in the baseline model establishes the need for implementation. Implementation planning is the next step in the restoration process. Section 13.3 in the Twelvepole TMDL report and Section 12.3 in the Big Sandy and Lower Ohio TMDL reports provide a brief description of WVDEPs responsibility related to evaluating and funding sewer projects, which may extend service to unsewered areas, assimilate sewage currently routed through failing onsite systems and accomplish the local fecal coliform bacteria reductions prescribed by the TMDLs.

The WVDEP maintains that permitted outlets discharging at water quality criteria end-of-pipe are protective of water quality standards. Fecal coliform allocations for wastewater treatment plant point sources reflect existing technology-based effluent limits, which are at least equivalent to water quality criteria end-of-pipe. Including failing septic system loads in allocated conditions would not influence the allocation strategy and policy for permitted sources.

Multiple commenters pointed out that the Draft TMDL's source identification work related to Abandoned Mine Land (AML) as a significant nonpoint source of metals in certain metal-

impaired streams is important to allow state authorities to take necessary steps to address those pollution problems. Commenters also express concern that while identification represents the first step, the TMDL does not discuss use of AML project funding for projects to remediate metals impairments. Commenters assert that the TMDL should prioritize sources to be remediated.

WVDEP agrees with the importance of identifying AML sources. In addition to mapped sources through the AML program, instream water quality conditions may point to unidentified legacy mining sources of pollution. Source tracking efforts endeavor to identify pollutant sources and report on their location in the TMDL report. In addition to identifying sources, the purpose of the TMDL is to prescribe reductions to nonpoint source loads as necessary to attain water quality standards. Prioritizing projects and detailing funding are outside the purview of the TMDL. These decisions are made by the WVDEP Office of Abandoned Mine Lands & Reclamation, whose mission is to protect public health, safety, and property from past coal mining and enhance the environment through reclamation and restoration of land and water resources. The responsibility of prioritizing and allocating funding must account for AML sources throughout the State of WV.

Multiple commenters expressed concern that the TMDL is lacking in a comprehensive analysis of implementation strategies, as well as a discussion on how future development will affect cleanup and attainment of water quality standards.

The purpose of a TMDL project is to determine the load of pollutant a stream can assimilate and meet the identified designated use of the stream. TMDLs attempt to provide implementation guidance for various sources or categories of sources but are not intended to be a detailed implementation plan. The development of TMDLs is the first step toward stream restoration. Implementation plans are those that build upon the TMDL results by prioritizing waters, determine restorative programs (including best management practices, funding sources, et cetera) to attain water quality standards.

The TMDL addresses future growth related to point (permitted) sources. See the **Future Growth** section for additional details. WVDEP will continue to monitor and report on water quality throughout the state according to the Watershed Framework. TMDLs can be updated in the future to capture the most up to date information.

Multiple commenters identified communities that rely on select streams in the TMDL watersheds for drinking water and expressed the importance of TMDL implementation to protect valuable these valuable resources.

WVDEP acknowledges and agrees with these comments. The allocated scenarios pollutants presented in the Big Sandy River, Lower Ohio River, and Twelvepole Creek watershed TMDLs are protective of all designated uses, including public drinking water supplies.

A commenter expressed beliefs that there should be ongoing biological analysis of the Twelvepole Creek, the Big Sandy River, and the Lower Ohio River to protect the health and safety of humans who utilize these waterways for recreational purposes and for source water usage in their homes or businesses. The commenter went on to say that stormwater from

urban areas exacerbate existing water quality problems. The commenter provided an example of pollution discouraging the use of select streams for recreation, because of obvious pollution.

The WVDEP acknowledges and agrees with the commenter regarding the need for additional analysis. As describe earlier, the TMDL is the first step in the restoration of the stream. The TMDL has identified sources of pollution including runoff from MS4 communities, as well as discharges of CSOs and failing septic systems. The TMDL prescribes reductions to these sources in order to attain water quality standards, protective of designated uses such as contact recreation.

A commenter inaccurately interpreted the purpose of the TMDL document stating, "This proposal related to TMDL's seems to go in the other direction, with less monitoring and enforcement on the horizon, and that could endanger not only the human population of this area but also some critical, and already impaired water ecosystems. Please reconsider your decisions on this and heed the concerns of citizens who will be impacted by these decisions."

The TMDLs presented for select impaired streams in the Big Sandy River, Lower Ohio River, and Twelvepole Creek watershed fulfill the requirements and purpose of a TMDL. Acting as a plan for restoration, TMDLs prescribe reductions of existing pollutant sources that will result in the attainment of water quality standards. The TMDL does not discourage monitoring, nor does it authorize less enforcement that could endanger human population or impaired water ecosystems.

13.0 REASONABLE ASSURANCE

Reasonable assurance for maintenance and improvement of water quality in the affected watershed rests primarily with two programs. The NPDES permitting program is implemented by WVDEP to control point source discharges. WVDEP's Watershed Improvement Branch (WIB) mission is to inspire and empower people to value and work for clean water. WIB administers programs that educate, provide assistance, plan and implement water quality protection, improvement and restoration projects.

13.1 NPDES Permitting

WVDEP's Division of Water and Waste Management (DWWM) is responsible for issuing non-mining NPDES permits within the State. WVDEP's Division of Mining and Reclamation (DMR) develops NPDES permits for mining activities. As part of the permit review process, permit writers have the responsibility to incorporate the required TMDL WLAs into new or reissued permits. New facilities will be permitted in accordance with future growth provisions described in **Section 11**.

Both the permitting and TMDL development processes have been synchronized with the Watershed Management Framework cycle, intending that the TMDLs are completed just before the permit expiration/reissuance time frames. In order to address priorities on the 303d list, WVDEP deviated from the framework for this TMDL project in Group E for the Big Sandy, Lower Ohio, and Twelvepole Creek watersheds. Because this TMDL was developed ahead of the scheduled sequence, wasteload allocation implementation for existing facilities will be accomplished at the next reissuance of WVNPDES permits.

The MS4 permitting program is being implemented to address stormwater impacts from urbanized areas. West Virginia has developed a General NPDES Permit for MS4 discharges (WV0110625). All of the cities with MS4 permits in subject waters of this report, plus the West Virginia Department of Transportation, WVDOH are registered under the permit. The permit is based upon national guidance and is non-traditional in that it does not contain numeric effluent limitations, but instead proposes Best Management Practices that must be implemented. At permit reissuance, registrants will be expected to specifically describe management practices intended for implementation that will achiever the WLAs prescribed in applicable TMDLs. A mechanism to assess the effectiveness of the BMPs in achieving the WLAs must also be provided. The TMDLs are not intended to mandate imposition of numerical effluent limitations and/or discharge monitoring requirements for MS4s. Reasonable alternative methodologies may be employed for targeting and assessing BMP effectiveness in relation to prescribed WLAs.

The “MS4 WLA Detailed” tabs on the allocation spreadsheets WLAs provide drainage areas of various land use types represented in the baseline condition (without BMPs) for each MS4 entity at the subwatershed scale. Through consideration of anticipated removal efficiencies of selected BMPs and their areas of application, it is anticipated that this information will allow MS4 permittees to make meaningful predictions of performance under the permit.

DWWM also implements a program to control discharges from CSOs. Specified fecal coliform WLAs for CSOs will be implemented in accordance with the provisions of the national Combined Sewer Overflow Control Policy and the state Combined Sewer Overflow Strategy. Those programs recognize that comprehensive CSO control may require significant resources and an extended period of time to accomplish. The WLAs prescribed for CSOs are necessary to achieve current fecal coliform water quality criteria. However, the TMDL should not be construed to supersede the prioritization and scheduling of CSO controls and actions pursuant to the national CSO program. Nor are the TMDLs intended to prohibit the pursuit of the water quality standard revisions envisioned in the national policy. TMDLs may be modified to properly implement future water quality standard revisions (designated use and/or criteria), if enacted and approved by the USEPA.

13.2 Watershed Improvement Branch- Nonpoint Source Program

The mission of the WVDEP Watershed Improvement Branch Nonpoint Source (NPS) Program is to inspire and empower people to value and work for clean water. The NPS Program coordinates efforts by multi-agency and non-governmental organizations to address nonpoint sources of pollution. In relationship to implementation of TMDLs, one key role that the NPS Program plays is administering the Clean Water Act Section 319 grant funding program. These funds are available to restore impaired waters through the development of watershed based plans, execution of watershed projects, and support to watershed organizations and other nonpoint partners. To learn more about the NPS Program visit:

https://dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx

Additional information regarding support specifically in the Twelvepole Creek Watershed, contact the Watershed Improvement Branch Western Basin Coordinator Tomi Bergstrom.

There are no active citizen-based watershed association representing the Twelvepole Creek watershed. For additional information concerning associations, visit: https://dep.wv.gov/WWE/getinvolved/WSA_Support/Pages/WGs.aspx

13.3 Public Sewer Projects

Within WVDEP DWWM, the Engineering and Permitting Branch's Engineering Section is charged with the responsibility of evaluating sewer projects and providing funding, where available, for those projects. All municipal wastewater loans issued through the State Revolving Fund (SRF) program are subject to a detailed engineering review of the engineering report, design report, construction plans, specifications, and bidding documents. The staff performs periodic on-site inspections during construction to ascertain the progress of the project and compliance with the plans and specifications. Where the community does not use SRF funds to undertake a project, the staff still performs engineering reviews for the agency on all POTWs prior to permit issuance or modification. For further information on upcoming projects, a list of funded and pending water and wastewater projects in West Virginia can be found at http://www.wvinfrastructure.com/projects/index.php.

14.0 MONITORING PLAN

The following monitoring activities are recommended:

14.1 NPDES Compliance

WVDEP's DWWM and DMR have the responsibility to ensure that NPDES permits contain effluent limitations as prescribed by the TMDL WLAs and to assess and compel compliance. The length of time afforded to achieve compliance may vary by discharge type or other factors and is a case-by-case determination in the permitting process. Permits will contain self-monitoring and reporting requirements that are periodically reviewed by WVDEP. WVDEP also inspects treatment facilities and independently monitors NPDES discharges. The combination of these efforts will ensure implementation of the TMDL WLAs.

14.2 Nonpoint Source Project Monitoring

All nonpoint source restoration projects should include a monitoring component specifically designed to document resultant local improvements in water quality. These data may also be used to predict expected pollutant reductions from similar future projects.

14.3 TMDL Effectiveness Monitoring

TMDL effectiveness monitoring should be performed to document water quality improvements after significant implementation activity has occurred where little change in water quality would otherwise be expected. Full TMDL implementation will take significant time and resources, particularly with respect to the abatement of nonpoint source impacts. WVDEP will continue monitoring on the rotating basin cycle and will include a specific TMDL effectiveness component in waters where significant TMDL implementation has occurred.

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