TETRA TECH

September 2018

USEPA Approved Report

Total Maximum Daily Loads for the Hughes River 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 Hughes River Watershed refers to the tributary streams that ultimately drain to the Hughes River (**Figure I-1**). The North Fork of the Hughes River has been dammed to create North Bend Lake near of the City of Harrisville in Ritchie County. However, TMDLs for North Bend Lake were not developed in this modeling effort because it is not an impaired waterbody. 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 Hughes River.

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 186 impaired streams contained within 8 TMDL watersheds in the Hughes River 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 8 TMDL watersheds have been subdivided into 447 modeled subwatersheds. Pollutant sources, allocations and reductions are presented at the subwatershed scale to facilitate future permitting actions and TMDL implementation.

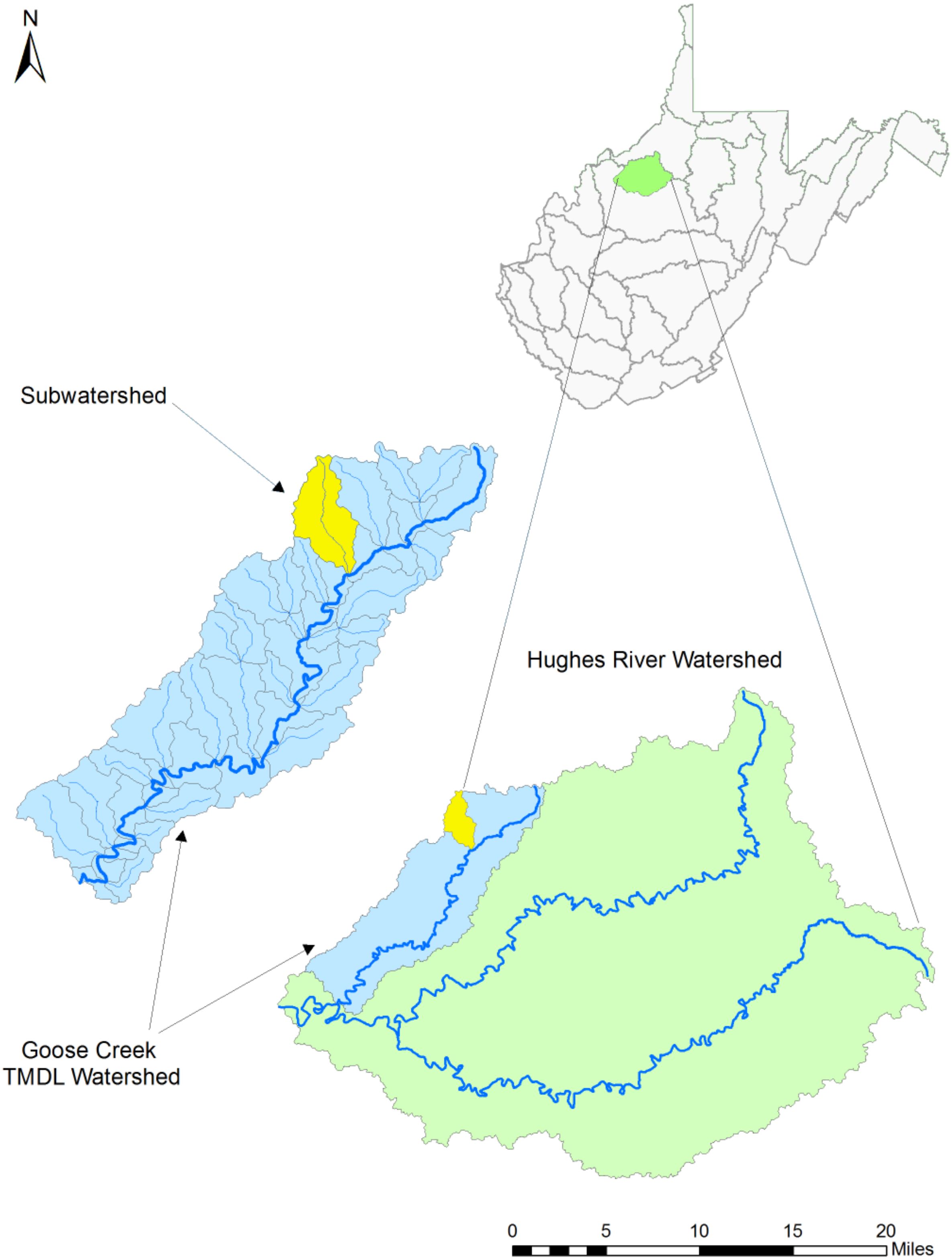


Figure I-1. Examples of a watershed, TMDL watershed, and subwatershed

EXECUTIVE SUMMARY

This report includes Total Maximum Daily Loads (TMDLs) for 186 impaired streams in the Hughes River watershed. This project was organized into 8 TMDL watersheds, which account for all streams draining to the Hughes River.

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 subject impaired streams are included on the West Virginia's 2014 Section 303(d) List or draft 2016 Section 303(d) List. Documented impairments are related to numeric water quality criteria for total iron 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.

Legislative action (Senate Bill 562) 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. A copy of the legislation may be viewed at:

http://www.legis.state.wv.us/Bill_Text_HTML/2012_SESSIONS/RS/pdf_bills/SB562%20SUB1%20enr%20PRINTED.pdf

In response to the legislation, WVDEP is developing an alternative methodology for interpreting 47 CSR 2–3.2.i which will be used in the future once approved. WVDEP has suspended biological impairment TMDL development pending receipt of legislative approval of the new assessment methodology.

Although "biological impairment" TMDLs are not presented in this project, 37 streams for which available benthic information demonstrates biological impact (via WVSCI assessment) were subjected to a biological stressor identification 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 8 TMDL watersheds. For hydrologic modeling purposes, impaired and unimpaired streams in these 8 TMDL watersheds were further divided into 447 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 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.

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.

The 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. The 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.

Considerable resources were used to acquire recent water quality and pollutant source information upon which the TMDLs are based. Project development included valuable assistance from the local watershed association. 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 Technical Report.

Applicable TMDLs are displayed in **Section 8** 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 ArcGIS Viewer Project 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 Hughes River 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 8** 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, a CD is provided that contains spreadsheets (in Microsoft Excel format) that display detailed source allocations associated with successful TMDL scenarios. 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 is developing 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. Each year, TMDLs are developed in specific geographic areas. The Framework dictates that 2017 TMDLs should be pursued in Hydrologic Group D, which includes the Little Kanawha River, of which the Hughes River is a major tributary. **Figure 2-1** depicts the hydrologic groupings of West Virginia's watersheds; the legend includes the target year for finalization of each TMDL.

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

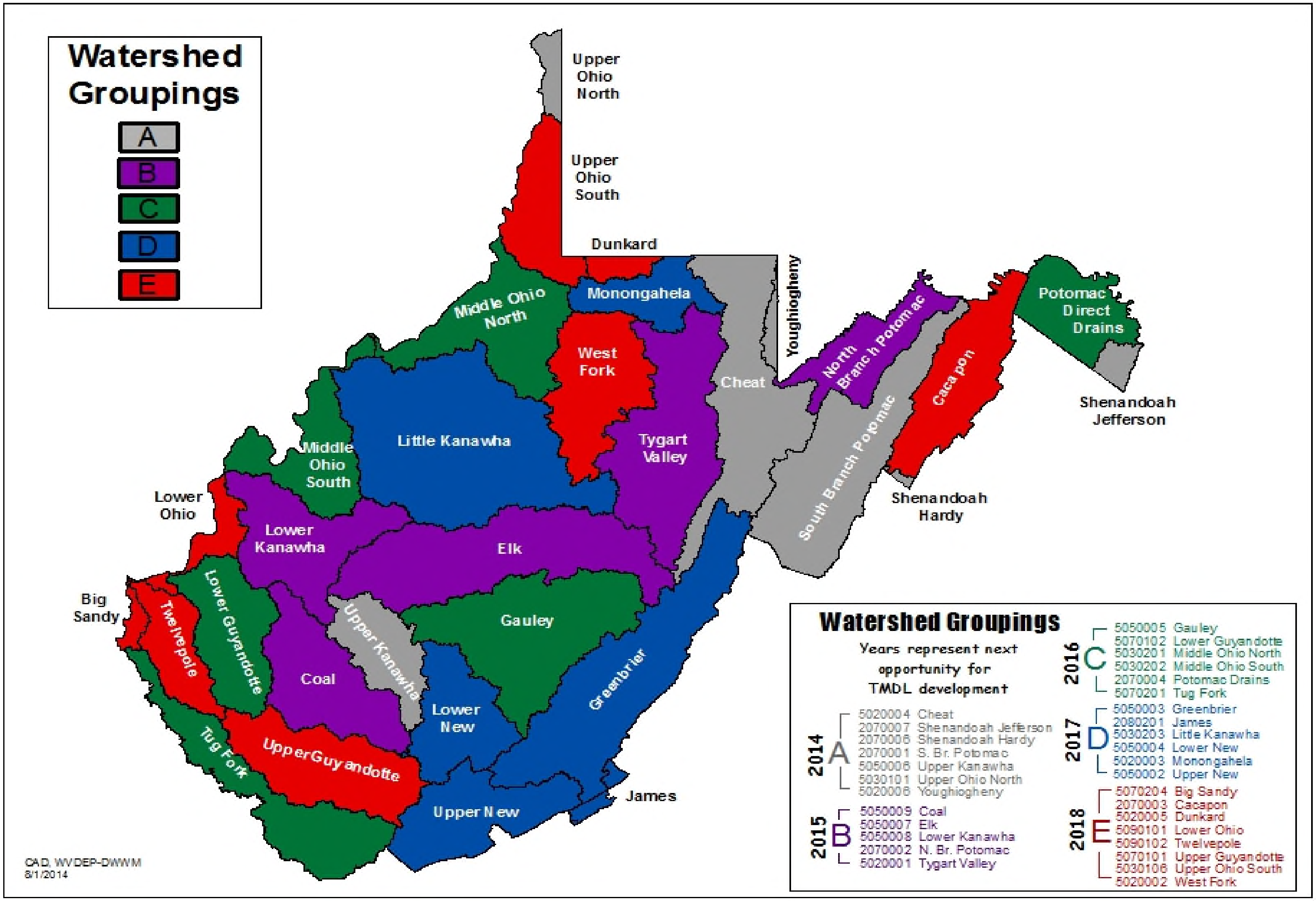


Figure 2-1. Hydrologic groupings of West Virginia's watersheds

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.

Designated uses in the Hughes River Watershed include: propagation and maintenance of aquatic life in warmwater fisheries, water contact recreation, and public water supply. In various streams in the Hughes River Watershed, warmwater fishery aquatic life use impairments have been determined pursuant to exceedances of total iron 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 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**.

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 TMDLs are developed, then the TMDLs and allocations may be modified as warranted. Any future Water Quality Standard revision and/or TMDL modification must receive USEPA approval prior to implementation.

Table 2-1. Applicable West Virginia water quality criteria

POLLUTANT	USE DESIGNATION				
	Aquatic Life				Human Health
	Warmwater Fisheries		Troutwaters		Contact Recreation/Public Water Supply
	Acute[a]	Chronic[b]	Acute[a]	Chronic[b]	
Iron, total (mg/L)	--	1.5	--	1.0	1.5
Fecal coliform bacteria	**Human Health Criteria** 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.				

[a] One-hour average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
[b] Four-day average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
Source: 47 *CSR*, Series 2, *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*.

3.0 WATERSHED DESCRIPTION AND DATA INVENTORY

3.1 Watershed Description

Located within the Central Appalachian ecoregion, the Hughes River is a major tributary of the Little Kanawha River, which is a major tributary of the Ohio River that joins the Mississippi and flows to the Gulf of Mexico. The Hughes River Watershed consists of land draining to the Hughes River, which begins at the confluence of the North and South Forks of the Hughes River in Ritchie County, and ends where the Hughes River and the Little Kanawha River converge approximately 18 miles upstream of the Ohio River. The Hughes River is approximately 14 miles (23 km) long, and its watershed encompasses 528.2 square miles (1,368.1 km^2). The North Fork of the Hughes River is dammed below the City of Harrisville in Ritchie County to make North Bend Lake. For TMDL purposes, the lake is considered its own water body separate from the river. The lake is not considered impaired for iron or fecal coliform bacteria, and does not receive TMDL allocations.

The Hughes River Watershed lies within the Western Allegheny Plateau of western West Virginia, and occupies all of Ritchie County, and small portions of Doddridge, Wirt, and Wood counties (**Figure 3-1**). Cities and towns in the vicinity of the area of study are Pennsboro, Harrisville, and Ellenboro. The highest point in the Hughes River Watershed is 1,427 feet above sea level on a ridge dividing Lizzies Roost Run from the headwaters of the North Fork Hughes River. The lowest point in the watershed is 582 feet at the confluence of the Hughes River and Little Kanawha River approximately 9 miles downstream of Elizabeth. The average elevation in the watershed is 929 feet. Major tributaries of the Hughes River include the North Fork Hughes River, South Fork Hughes River, and Goose Creek. The total population living in the subject watersheds of this report is estimated to be 10,000 people.

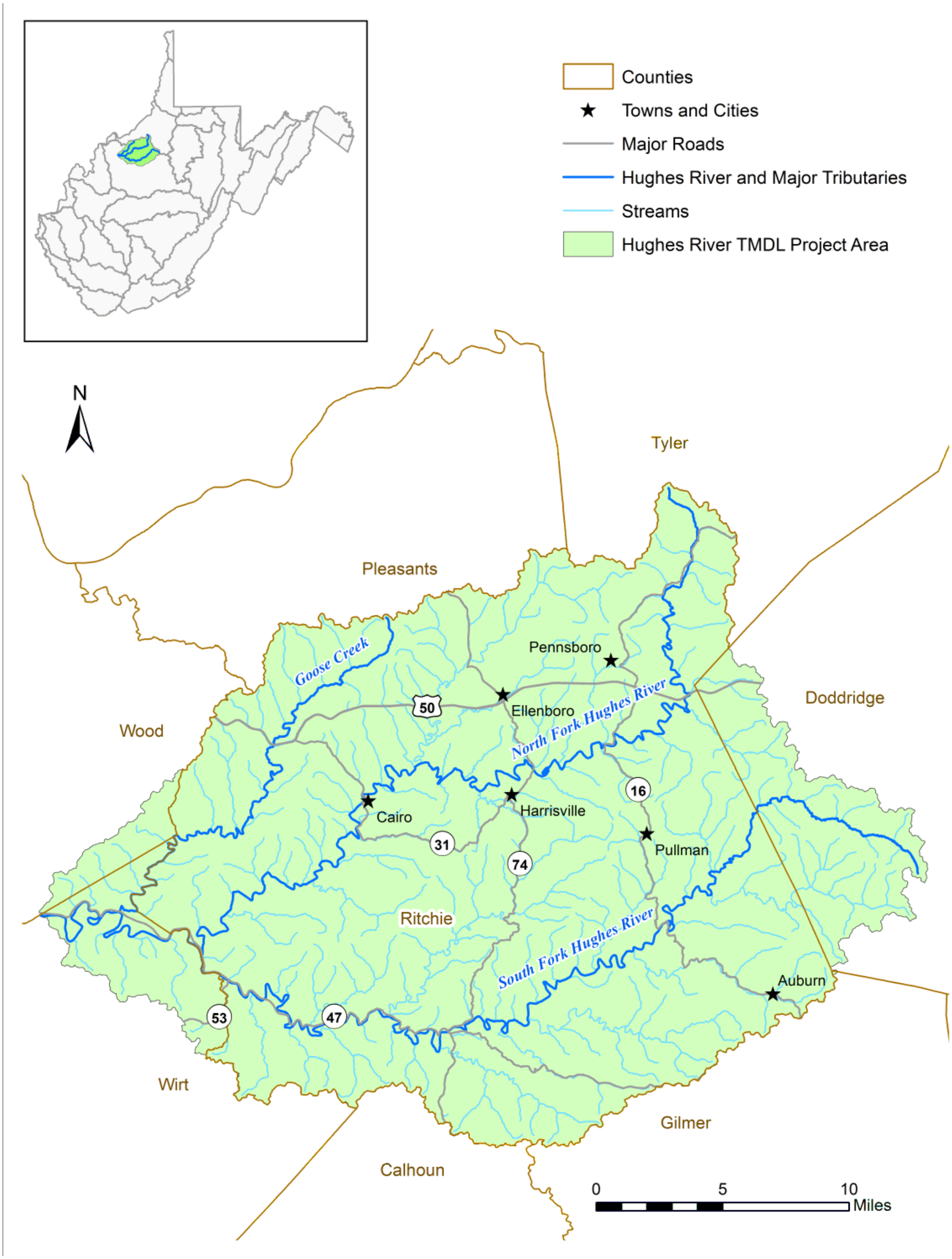


Figure 3-1. Location of the Hughes River Watershed TMDL Project Area in West Virginia

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 2014 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 83.26 percent of the total landuse area. Other important modeled landuse types are agricultural (cropland/pasture, 4.03 percent combined), grassland (3.82 percent), oil and gas (3.73 percent), forestry (2.23 percent), and urban/residential (1.89 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 Hughes TMDL watersheds

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
Barren	2,383.35	3.72	0.70%
Burned Forest	185.20	0.29	0.05%
Cropland	4,339.35	6.78	1.28%
Forest	281,488.60	439.83	83.26%
Forestry	7,536.65	11.78	2.23%
Grassland	12,923.61	20.19	3.82%
Oil and Gas	12,609.27	19.70	3.73%
Pasture	9,306.00	14.54	2.75%
Urban/Residential	6,390.64	9.99	1.89%
Water	914.17	1.43	0.27%
Total	338,076.85	528.25	100.00%

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)
	NAIP 2014 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 TIGER, WVU WV Roads
	Water quality monitoring station locations	WVDEP, USEPA STORET
	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
	Water quality monitoring data	USEPA STORET, WVDEP

Type of Information		Data Sources
	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 Hughes River Watershed from 2014 through 2015. 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 8 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.

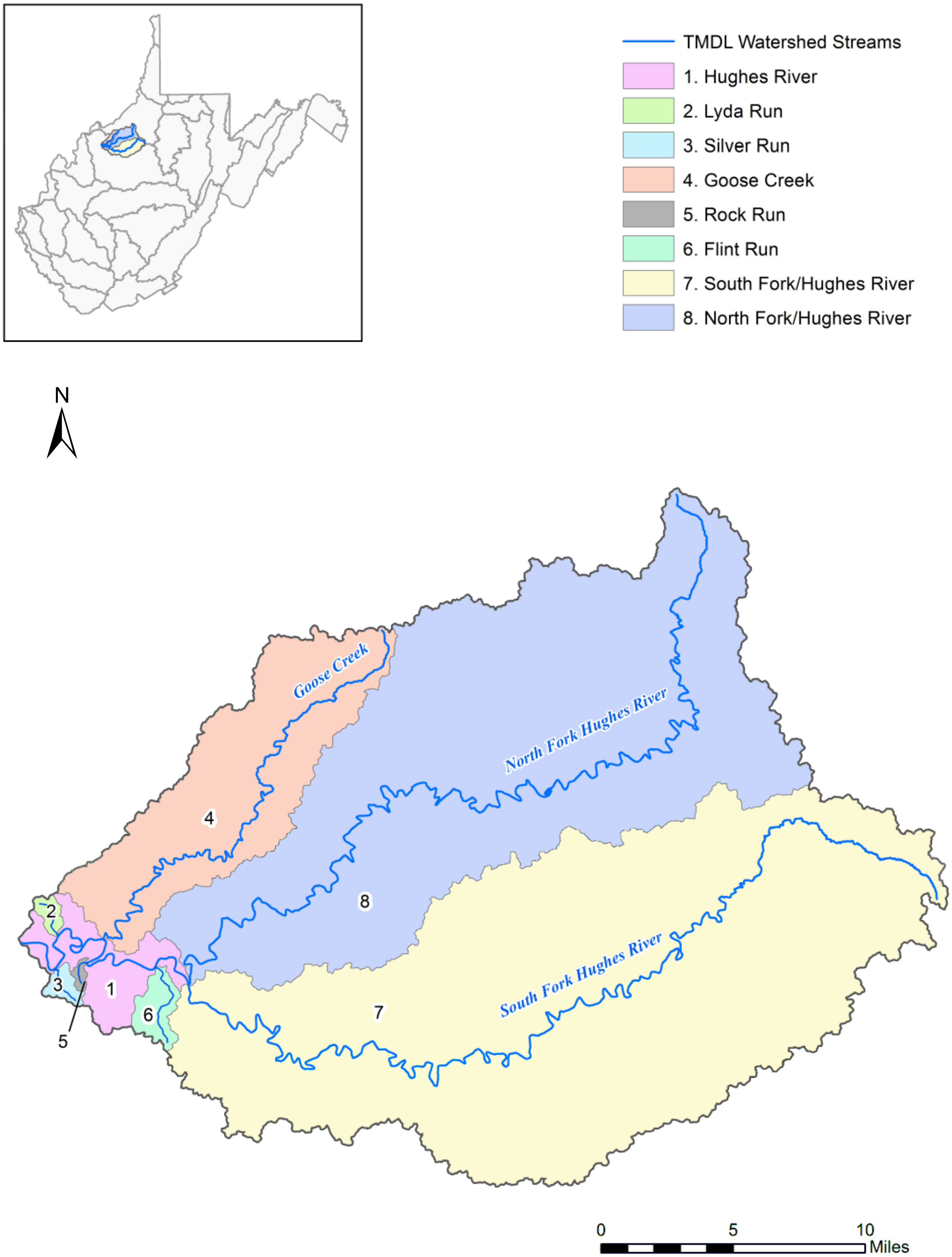


Figure 3-2. Hughes TMDL Watersheds

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

TMDL Watershed	NHD Code	Stream Name	WV Code	Fe	FC
Hughes River	WV-OLK-31	Hughes River	WVLKH	X	X
Silver Run	WV-OLK-31-B	Silver Run	WVLKH-1	X	X
Lyda Run	WV-OLK-31-C	Lyda Run	WVLKH-2	M	X
Gooseneck Run	WV-OLK-31-D	Gooseneck Run	WVLKH-3	M	
Goose Creek	WV-OLK-31-E	Goose Creek	WVLKH-4	M	X
Goose Creek	WV-OLK-31-E-1	Fox Run	WVLKH-4-0.5A	M	
Goose Creek	WV-OLK-31-E-2	Lick Run	WVLKH-4-A	M	X
Goose Creek	WV-OLK-31-E-3	Second Big Run	WVLKH-4-B		X
Goose Creek	WV-OLK-31-E-11	Oil Spring Run	WVLKH-4-G	X	X
Goose Creek	WV-OLK-31-E-13	Myers Fork	WVLKH-4-H		X
Goose Creek	WV-OLK-31-E-14	Lynn Run	WVLKH-4-H.5	M	
Goose Creek	WV-OLK-31-E-17	Long Run	WVLKH-4-I	M	X
Goose Creek	WV-OLK-31-E-18	Short Run	WVLKH-4-J		X
Goose Creek	WV-OLK-31-E-25	Nutter Fork	WVLKH-4-L	M	X
Goose Creek	WV-OLK-31-E-25-A	UNT/Nutter Fork RM 0.91	WVLKH-4-L-1	M	
Goose Creek	WV-OLK-31-E-31	Brushy Fork	WVLKH-4-N	M	X
Goose Creek	WV-OLK-31-E-36	Layfields Run	WVLKH-4-O	M	X
Goose Creek	WV-OLK-31-E-4	Combs Run	WVLKH-4-C	M	
Goose Creek	WV-OLK-31-E-41	Douglas Run	WVLKH-4-Q		X
Goose Creek	WV-OLK-31-E-7	Pigeonroost Run	WVLKH-4-E	M	
Rock Run	WV-OLK-31-F	Rock Run	WVLKH-5	X	X
Flint Run	WV-OLK-31-J	Flint Run	WVLKH-8		X
S. Fork/Hughes R.	WV-OLK-31-K	South Fork/Hughes River	WVLKH-9	X	X
S. Fork/Hughes R.	WV-OLK-31-K-4	Big Island Run	WVLKH-9-C		X
S. Fork/Hughes R.	WV-OLK-31-K-7	Louthers Run	WVLKH-9-E	M	
S. Fork/Hughes R.	WV-OLK-31-K-8	UNT/South Fork RM 5.98/Hughes River	WVLKH-9-E.3	M	
S. Fork/Hughes R.	WV-OLK-31-K-13	Laurel Run	WVLKH-9-F	M	X
S. Fork/Hughes R.	WV-OLK-31-K-13-B	UNT/Laurel Run RM 1.57	WVLKH-9-F-2	M	
S. Fork/Hughes R.	WV-OLK-31-K-15	MacFarlan Creek	WVLKH-9-G	X	X
S. Fork/Hughes R.	WV-OLK-31-K-15-A	Left Fork/Macfarlan Creek	WVLKH-9-G-1	M	
S. Fork/Hughes R.	WV-OLK-31-K-15-F	UNT/Macfarlan Creek RM 4.21	WVLKH-9-G-1.8	M	
S. Fork/Hughes R.	WV-OLK-31-K-16	Dutchman Run	WVLKH-9-H	M	X
S. Fork/Hughes R.	WV-OLK-31-K-16-C	Left Fork/Dutchman Run	WVLKH-9-H-1	M	
S. Fork/Hughes R.	WV-OLK-31-K-20	Indian Creek	WVLKH-9-J	X	X

TMDL Watershed	NHD Code	Stream Name	WV Code	Fe	FC
S. Fork/Hughes R.	WV-OLK-31-K-20-A	UNT/Indian Creek RM 0.06	WVLKH-9-J-0.3	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-AB	Moyers Run	WVLKH-9-J-13	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-AC	Den Run	WVLKH-9-J-14	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-AK	Bearwallow Run	WVLKH-9-J-16	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-L	Little Indian Run	WVLKH-9-J-7	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-O	King Knob Run	WVLKH-9-J-9	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-U	Dog Run	WVLKH-9-J-11	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-U-2	UNT/Dog Run RM 1.39	WVLKH-9-J-11-B	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-Z	Chevaux De Frise Run	WVLKH-9-J-12	M	X
S. Fork/Hughes R.	WV-OLK-31-K-20-Z-2	Davy Cain Run	WVLKH-9-J-12-A	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-Z-5	Twolick Run	WVLKH-9-J-12-B	M	
S. Fork/Hughes R.	WV-OLK-31-K-20-Z-6	Adds Run	WVLKH-9-J-12-C	M	
S. Fork/Hughes R.	WV-OLK-31-K-21	Lick Run	WVLKH-9-J.5	X	
S. Fork/Hughes R.	WV-OLK-31-K-26	Crab Run	WVLKH-9-K	M	
S. Fork/Hughes R.	WV-OLK-31-K-31	Leatherbark Creek	WVLKH-9-M	X	X
S. Fork/Hughes R.	WV-OLK-31-K-31-C	Road Fork	WVLKH-9-M-1	M	
S. Fork/Hughes R.	WV-OLK-31-K-31-J	Middle Fork/Leatherbark Creek	WVLKH-9-M-2	M	
S. Fork/Hughes R.	WV-OLK-31-K-31-J-3	Wolfpen Fork	WVLKH-9-M-2-A	M	
S. Fork/Hughes R.	WV-OLK-31-K-31-N	UNT/Leatherbark Creek RM 5.44	WVLKH-9-M-2.7	M	
S. Fork/Hughes R.	WV-OLK-31-K-31-Q	Rocklick Run	WVLKH-9-M-3	M	
S. Fork/Hughes R.	WV-OLK-31-K-31-T	Lynncamp Run	WVLKH-9-M-4	M	
S. Fork/Hughes R.	WV-OLK-31-K-32	UNT/South Fork RM 21.06/Hughes River	WVLKH-9-M.4	M	
S. Fork/Hughes R.	WV-OLK-31-K-36	Owl Run	WVLKH-9-O	M	X
S. Fork/Hughes R.	WV-OLK-31-K-39	Lamb Run	WVLKH-9-P	X	X
S. Fork/Hughes R.	WV-OLK-31-K-40	Grass Run	WVLKH-9-Q	M	X
S. Fork/Hughes R.	WV-OLK-31-K-40-J	UNT/Grass Run RM 5.65	WVLKH-9-Q-7	M	
S. Fork/Hughes R.	WV-OLK-31-K-41	UNT/South Fork RM 25.95/Hughes River	WVLKH-9-Q.5	M	
S. Fork/Hughes R.	WV-OLK-31-K-44	Spruce Creek	WVLKH-9-R	X	X
S. Fork/Hughes R.	WV-OLK-31-K-44-B	Rock Run	WVLKH-9-R-1	M	
S. Fork/Hughes R.	WV-OLK-31-K-44-D	Dry Run	WVLKH-9-R-2	M	
S. Fork/Hughes R.	WV-OLK-31-K-44-K	Straight Fork	WVLKH-9-R-4	M	
S. Fork/Hughes R.	WV-OLK-31-K-44-M	Laurel Fork	WVLKH-9-R-5	M	
S. Fork/Hughes R.	WV-OLK-31-K-44-N	Leatherbark Run	WVLKH-9-R-6	M	
S. Fork/Hughes R.	WV-OLK-31-K-44-T	Left Fork/Spruce Creek	WVLKH-9-R-9	M	X
S. Fork/Hughes R.	WV-OLK-31-K-44-U	Right Fork/Spruce Creek	WVLKH-9-R-8	M	X

TMDL Watershed	NHD Code	Stream Name	WV Code	Fe	FC
S. Fork/Hughes R.	WV-OLK-31-K-46	Long Run	WVLKH-9-S	M	X
S. Fork/Hughes R.	WV-OLK-31-K-49	Jesse Cain Run	WVLKH-9-T	M	X
S. Fork/Hughes R.	WV-OLK-31-K-51	Cain Run	WVLKH-9-U	M	
S. Fork/Hughes R.	WV-OLK-31-K-53	Smith Run	WVLKH-9-V	M	X
S. Fork/Hughes R.	WV-OLK-31-K-55	Slab Creek	WVLKH-9-W	M	X
S. Fork/Hughes R.	WV-OLK-31-K-55-B	Wolfpen Run	WVLKH-9-W-1	M	X
S. Fork/Hughes R.	WV-OLK-31-K-55-B-1	UNT/Wolfpen Run RM 0.51	WVLKH-9-W-1-A	M	
S. Fork/Hughes R.	WV-OLK-31-K-55-F	Isaac Fork	WVLKH-9-W-2	M	
S. Fork/Hughes R.	WV-OLK-31-K-55-I	Straight Fork	WVLKH-9-W-3	M	
S. Fork/Hughes R.	WV-OLK-31-K-55-J	Left Fork/Slab Creek	WVLKH-9-W-4	M	X
S. Fork/Hughes R.	WV-OLK-31-K-55-J-3	Star Fork	WVLKH-9-W-4-B	M	
S. Fork/Hughes R.	WV-OLK-31-K-55-K	Right Fork/Slab Creek	WVLKH-9-W-5	M	X
S. Fork/Hughes R.	WV-OLK-31-K-6	Bear Run	WVLKH-9-D	M	
S. Fork/Hughes R.	WV-OLK-31-K-62	Bone Creek	WVLKH-9-X	X	X
S. Fork/Hughes R.	WV-OLK-31-K-62-R	Big Run	WVLKH-9-X-4		X
S. Fork/Hughes R.	WV-OLK-31-K-62-S	Left Fork/Bone Creek	WVLKH-9-X-6	X	X
S. Fork/Hughes R.	WV-OLK-31-K-62-T	Right Fork/Bone Creek	WVLKH-9-X-5	X	X
S. Fork/Hughes R.	WV-OLK-31-K-69	Otterslide Creek	WVLKH-9-Y	M	X
S. Fork/Hughes R.	WV-OLK-31-K-72	Turtle Run	WVLKH-9-Z	M	X
S. Fork/Hughes R.	WV-OLK-31-K-73	Middle Fork/South Fork/Hughes River	WVLKH-9-AA	X	X
S. Fork/Hughes R.	WV-OLK-31-K-73-E	Bear Run	WVLKH-9-AA-2	M	X
S. Fork/Hughes R.	WV-OLK-31-K-73-I	Brush Run	WVLKH-9-AA-3.5	M	
S. Fork/Hughes R.	WV-OLK-31-K-73-J	Straight Fork	WVLKH-9-AA-4	M	X
S. Fork/Hughes R.	WV-OLK-31-K-73-L	Lower Run	WVLKH-9-AA-5	M	
S. Fork/Hughes R.	WV-OLK-31-K-73-M	Upper Run	WVLKH-9-AA-6	M	X
S. Fork/Hughes R.	WV-OLK-31-K-73-M-2	Jims Run	WVLKH-9-AA-6-A	M	
S. Fork/Hughes R.	WV-OLK-31-K-73-R	Mudlick Run	WVLKH-9-AA-9	M	
S. Fork/Hughes R.	WV-OLK-31-K-75	White Oak Creek	WVLKH-9-BB	X	X
S. Fork/Hughes R.	WV-OLK-31-K-75-A	Little White Oak Creek	WVLKH-9-BB-1	M	
S. Fork/Hughes R.	WV-OLK-31-K-75-B	Right Fork/White Oak Creek	WVLKH-9-BB-3	M	
S. Fork/Hughes R.	WV-OLK-31-K-75-C	Left Fork/White Oak Creek	WVLKH-9-BB-2	M	
S. Fork/Hughes R.	WV-OLK-31-K-76	Poverty Hollow	WVLKH-9-CC	M	X
S. Fork/Hughes R.	WV-OLK-31-K-82	Sugar Run	WVLKH-9-DD	M	
S. Fork/Hughes R.	WV-OLK-31-K-84	Clevenger Hollow	WVLKH-9-DD.5	M	X
S. Fork/Hughes R.	WV-OLK-31-K-85	Taylor Drain	WVLKH-9-EE	M	
S. Fork/Hughes R.	WV-OLK-31-K-87	Freds Run	WVLKH-9-FF	M	

TMDL Watershed	NHD Code	Stream Name	WV Code	Fe	FC
S. Fork/Hughes R.	WV-OLK-31-K-88	Sheep Run	WVLKH-9-GG	M	
S. Fork/Hughes R.	WV-OLK-31-K-93	Holt Run	WVLKH-9-GG.5	X	X
S. Fork/Hughes R.	WV-OLK-31-K-94	Big Run	WVLKH-9-HH	X	
S. Fork/Hughes R.	WV-OLK-31-K-103	Cain Run	WVLKH-9-OO	X	X
S. Fork/Hughes R.	WV-OLK-31-K-105	UNT/South Fork RM 55.73/Hughes River	WVLKH-9-PP	X	X
N. Fork/Hughes R.	WV-OLK-31-L	North Fork/Hughes River	WVLKH-10	X	X
N. Fork/Hughes R.	WV-OLK-31-L-1	Buffalo Run	WVLKH-10-A	M	X
N. Fork/Hughes R.	WV-OLK-31-L-4	Gillespie Run	WVLKH-10-C	M	X
N. Fork/Hughes R.	WV-OLK-31-L-7	Cabin Run	WVLKH-10-E	M	X
N. Fork/Hughes R.	WV-OLK-31-L-7-A	UNT/Cabin Run RM 0.52	WVLKH-10-E-1	M	
N. Fork/Hughes R.	WV-OLK-31-L-10	UNT/North Fork RM 7.87/Hughes River	WVLKH-10-F.3	M	X
N. Fork/Hughes R.	WV-OLK-31-L-11	Cow Run	WVLKH-10-F.5	M	
N. Fork/Hughes R.	WV-OLK-31-L-13	Devilhole Creek	WVLKH-10-G	M	
N. Fork/Hughes R.	WV-OLK-31-L-13-F	UNT/Devilhole Creek RM 2.47	WVLKH-10-G.7	M	
N. Fork/Hughes R.	WV-OLK-31-L-13-I	UNT/Devilhole Creek RM 4.03	WVLKH-10-G-2	M	
N. Fork/Hughes R.	WV-OLK-31-L-14	Sheep Run	WVLKH-10-H	M	X
N. Fork/Hughes R.	WV-OLK-31-L-14-A	UNT/Sheep Run RM 0.63	WVLKH-10-H-1	M	
N. Fork/Hughes R.	WV-OLK-31-L-16	Elm Run	WVLKH-10-I	M	
N. Fork/Hughes R.	WV-OLK-31-L-16-B	UNT/Elm Run RM 1.92	WVLKH-10-I-4	M	
N. Fork/Hughes R.	WV-OLK-31-L-17	Slaughterhouse Run	WVLKH-10-I.5	M	X
N. Fork/Hughes R.	WV-OLK-31-L-18	Addis Run	WVLKH-10-J	M	X
N. Fork/Hughes R.	WV-OLK-31-L-18-F	UNT/Addis Run RM 2.63	WVLKH-10-J-2	M	
N. Fork/Hughes R.	WV-OLK-31-L-19	Rush Run	WVLKH-10-K	M	X
N. Fork/Hughes R.	WV-OLK-31-L-20	Silver Run	WVLKH-10-L	M	X
N. Fork/Hughes R.	WV-OLK-31-L-21	Wildcat Run	WVLKH-10-M		X
N. Fork/Hughes R.	WV-OLK-31-L-23	Big Run	WVLKH-10-N	M	X
N. Fork/Hughes R.	WV-OLK-31-L-25	Buky Run	WVLKH-10-O	M	
N. Fork/Hughes R.	WV-OLK-31-L-26	Low Gap Run	WVLKH-10-P	M	
N. Fork/Hughes R.	WV-OLK-31-L-29	Bear Run	WVLKH-10-Q	M	
N. Fork/Hughes R.	WV-OLK-31-L-30	Bonds Creek	WVLKH-10-R	X	X
N. Fork/Hughes R.	WV-OLK-31-L-30-B	Hushers Run	WVLKH-10-R-1	X	X
N. Fork/Hughes R.	WV-OLK-31-L-30-B-21	UNT/Hushers Run RM 6.82	WVLKH-10-R-1-B.5	M	
N. Fork/Hughes R.	WV-OLK-31-L-30-D	Painter Run	WVLKH-10-R-3	M	
N. Fork/Hughes R.	WV-OLK-31-L-30-G	Wolfpen Run	WVLKH-10-R-3.5	M	

TMDL Watershed	NHD Code	Stream Name	WV Code	Fe	FC
N. Fork/Hughes R.	WV-OLK-31-L-30-K	Comfort Run	WVLKH-10-R-4	M	X
N. Fork/Hughes R.	WV-OLK-31-L-30-K-3	UNT/Comfort Run RM 0.97	WVLKH-10-R-4-0.5A	M	
N. Fork/Hughes R.	WV-OLK-31-L-30-K-5	Beech Run	WVLKH-10-R-4-A	M	X
N. Fork/Hughes R.	WV-OLK-31-L-30-O	Whiskey Run	WVLKH-10-R-5	M	X
N. Fork/Hughes R.	WV-OLK-31-L-30-U	UNT/Bonds Creek RM 11.47	WVLKH-10-R-5.7		X
N. Fork/Hughes R.	WV-OLK-31-L-30-X	McGregor Run	WVLKH-10-R-6	M	X
N. Fork/Hughes R.	WV-OLK-31-L-30-AE	Big Knot Run	WVLKH-10-R-7	M	X
N. Fork/Hughes R.	WV-OLK-31-L-30-AF	Blacks Run	WVLKH-10-R-8	M	X
N. Fork/Hughes R.	WV-OLK-31-L-30-AK	Charleys Run	WVLKH-10-R-9	X	
N. Fork/Hughes R.	WV-OLK-31-L-30-AN	Long Bottom	WVLKH-10-R-10	M	
N. Fork/Hughes R.	WV-OLK-31-L-31	UNT/North Fork RM 22.26/Hughes River	WVLKH-10-R.5	M	
N. Fork/Hughes R.	WV-OLK-31-L-35	Lost Run	WVLKH-10-S	M	
N. Fork/Hughes R.	WV-OLK-31-L-37	Third Run	WVLKH-10-T	M	
N. Fork/Hughes R.	WV-OLK-31-L-37-B	Back Run	WVLKH-10-T-1	M	X
N. Fork/Hughes R.	WV-OLK-31-L-37-B-1	UNT/Back Run RM 0.88	WVLKH-10-T-1-A	M	
N. Fork/Hughes R.	WV-OLK-31-L-37-B-3	UNT/Back Run RM 2.48	WVLKH-10-T-1-C	M	
N. Fork/Hughes R.	WV-OLK-31-L-41	Stewart Run	WVLKH-10-V	M	X
N. Fork/Hughes R.	WV-OLK-31-L-41-B	UNT/Stewart Run RM 0.51	WVLKH-10-V-2	M	
N. Fork/Hughes R.	WV-OLK-31-L-41-G	UNT/Stewart Run RM 2.17	WVLKH-10-V-7	M	
N. Fork/Hughes R.	WV-OLK-31-L-42	Cunningham Run	WVLKH-10-W	M	X
N. Fork/Hughes R.	WV-OLK-31-L-44	Rockcamp Run	WVLKH-10-X	M	
N. Fork/Hughes R.	WV-OLK-31-L-45	Bunnell Run	WVLKH-10-Y	M	X
N. Fork/Hughes R.	WV-OLK-31-L-45-I	Horner Run	WVLKH-10-Y-9	M	
N. Fork/Hughes R.	WV-OLK-31-L-46	Goose Run	WVLKH-10-Z	M	
N. Fork/Hughes R.	WV-OLK-31-L-51	Beason Run	WVLKH-10-AA	M	X
N. Fork/Hughes R.	WV-OLK-31-L-51-B	Little Beason Run	WVLKH-10-AA-0.7	M	
N. Fork/Hughes R.	WV-OLK-31-L-51-D	Davis Run	WVLKH-10-AA-2	M	
N. Fork/Hughes R.	WV-OLK-31-L-52	Spring Run	WVLKH-10-BB	M	X
N. Fork/Hughes R.	WV-OLK-31-L-52-B	Long Run	WVLKH-10-BB-1	M	
N. Fork/Hughes R.	WV-OLK-31-L-54	Bear Run	WVLKH-10-CC	M	
N. Fork/Hughes R.	WV-OLK-31-L-56	Lynncamp Run	WVLKH-10-DD	M	X
N. Fork/Hughes R.	WV-OLK-31-L-56-B	Buzzard Run	WVLKH-10-DD-1	M	
N. Fork/Hughes R.	WV-OLK-31-L-62	Cabin Run	WVLKH-10-EE	X	X
N. Fork/Hughes R.	WV-OLK-31-L-62-J	Leason Run	WVLKH-10-EE-1	M	X
N. Fork/Hughes R.	WV-OLK-31-L-62-K	UNT/Cabin Run RM 2.68	WVLKH-10-EE-2	M	

TMDL Watershed	NHD Code	Stream Name	WV Code	Fe	FC
N. Fork/Hughes R.	WV-OLK-31-L-62-N	UNT/Cabin Run RM 3.58	WVLKH-10-EE-4	M	
N. Fork/Hughes R.	WV-OLK-31-L-62-Q	UNT/Cabin Run RM 4.57	WVLKH-10-EE-7	M	
N. Fork/Hughes R.	WV-OLK-31-L-63	Dotson Run	WVLKH-10-FF	X	X
N. Fork/Hughes R.	WV-OLK-31-L-63-I	UNT/Dotson Run RM 2.17	WVLKH-10-FF-9	M	X
N. Fork/Hughes R.	WV-OLK-31-L-65	UNT/North Fork RM 44.47/Hughes River	WVLKH-10-FF.5	M	
N. Fork/Hughes R.	WV-OLK-31-L-68	Buck Run	WVLKH-10-GG	M	X
N. Fork/Hughes R.	WV-OLK-31-L-69	Gnat Run	WVLKH-10-HH	M	
N. Fork/Hughes R.	WV-OLK-31-L-72	Poplarlick Run	WVLKH-10-II	M	X
N. Fork/Hughes R.	WV-OLK-31-L-73	Haddox Run	WVLKH-10-JJ	M	
N. Fork/Hughes R.	WV-OLK-31-L-76	Burton Run	WVLKH-10-KK	M	X
N. Fork/Hughes R.	WV-OLK-31-L-79	Marsh Run	WVLKH-10-LL	M	X
N. Fork/Hughes R.	WV-OLK-31-L-80	Lizzies Roost Run	WVLKH-10-MM	M	X

Note:
RM river mile
UNT unnamed tributary
Fe iron impairment
FC fecal coliform bacteria impairment
M Impairment determined via modeling
X impairment determined via sampling

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.

During the 2012 Session, the Legislature passed Senate Bill 562, which 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. A copy of the legislation may be viewed at:

http://www.legis.state.wv.us/Bill_Text_HTML/2012_SESSIONS/RS/pdf_bills/SB562%20SUB1%20enr%20PRINTED.pdf

In accordance with the legislation, WVDEP began and is still in the process of developing a method other than WVSCI for interpreting 47 CSR 2 §3.2.i, which it will use upon approval to determine biological impairment and develop TMDLs. As a further result of this legislative mandate, WVDEP has suspended biological impairment TMDL development pending legislative approval of the new assessment methodology.

The above notwithstanding, biological impairment listings within the project area were subjected to the biological stressor identification (SI) process described in this section. The biological SI process allowed stream-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 streams 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 33 of those streams through the implementation of numeric criterion TMDLs developed in this project.

4.1 Introduction

Impact 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 are different from the reference condition presumed to constitute biological integrity. The SI process was implemented to identify the significant stressors associated with identified impacts. Streams with WVSCI scores less than 72 were included in the process.

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 7** 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.

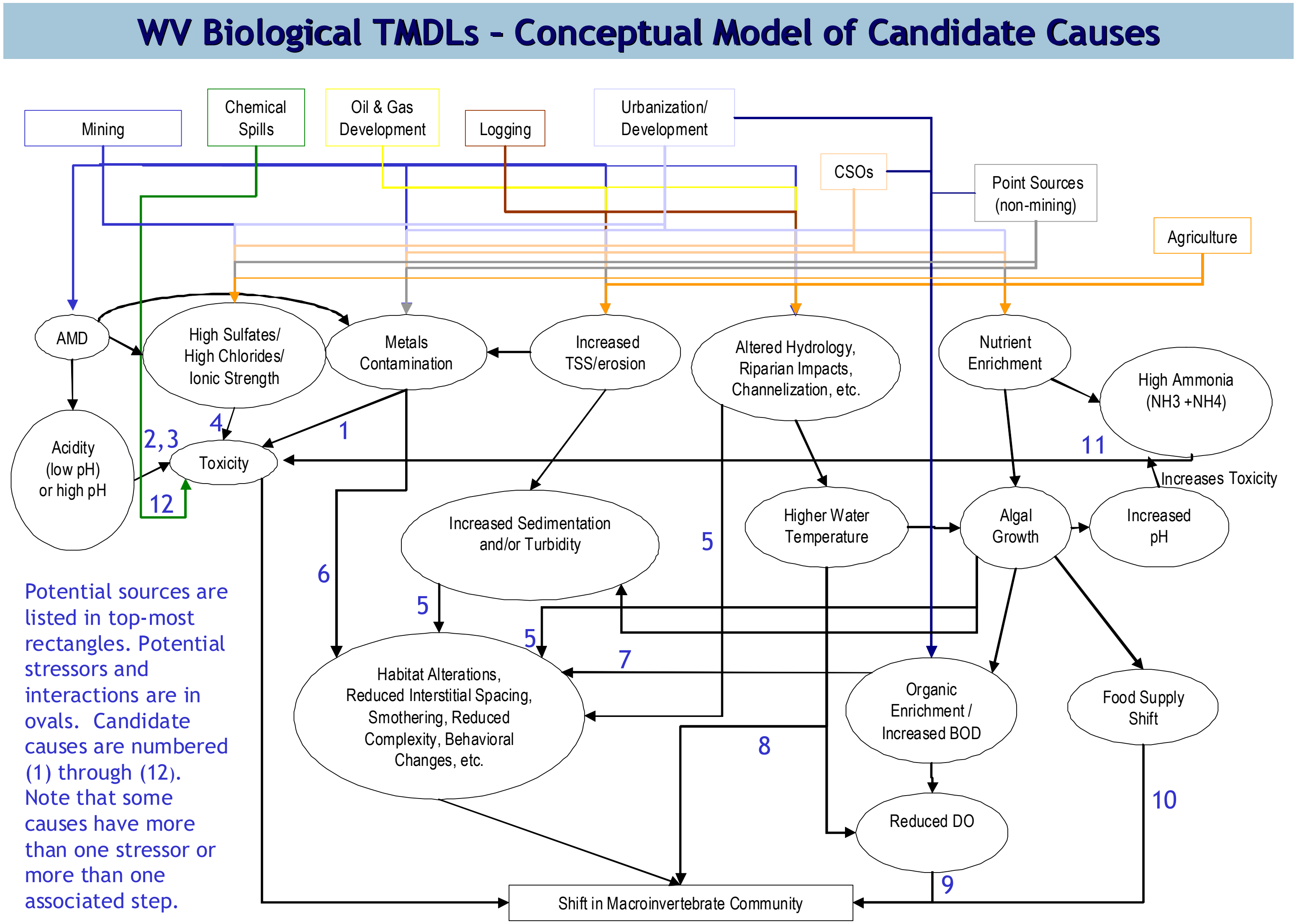


Figure 4-1. Conceptual model of candidate causes and potential biological effects

4.4 Stressor Identification Results

The SI process identified significant biological stressors for each stream. Biological impact was linked to a single stressor in some cases and multiple stressors in others. The SI process identified the following stressors to be present in the impacted waters in the Hughes River Watershed:

- Organic enrichment (the combined effects of oxygen-demanding pollutants, nutrients, and the resultant algal and habitat alteration)
- Sedimentation

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.

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 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 4 streams for which the SI process did not indicate that TMDLs for numeric criteria would resolve the biological impacts. These streams are Goose Creek (WV-OLK-31-E), Nutter Fork (WV-OLK-31-E-25), Big Run (WV-OLK-31-L-23), and Hushers Run (WV-OLK-31-L-30-B).

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

Stream Name	NHD-Code	WV Code	Significant Stressors	TMDLs Developed
Lyda Run	WV-OLK-31-C	WVLKH-2	organic enrichment, sedimentation	Fecal coliform, Iron
Gooseneck Run	WV-OLK-31-D	WVLKH-3	sedimentation	Iron
Brushy Fork	WV-OLK-31-E-31	WVLKH-4-N	organic enrichment, sedimentation	Fecal coliform, Iron
Layfields Run	WV-OLK-31-E-36	WVLKH-4-O	organic enrichment, sedimentation	Fecal coliform, Iron
South Fork/Hughes River	WV-OLK-31-K	WVLKH-9	organic enrichment, sedimentation	Fecal coliform, Iron
Dutchman Run	WV-OLK-31-K-16	WVLKH-9-H	organic enrichment, sedimentation	Fecal coliform, Iron
Spruce Creek	WV-OLK-31-K-44	WVLKH-9-R	organic enrichment, sedimentation	Fecal coliform, Iron
Left Fork/Spruce Creek	WV-OLK-31-K-44-T	WVLKH-9-R-9	organic enrichment, sedimentation	Fecal coliform, Iron
Long Run	WV-OLK-31-K-46	WVLKH-9-S	organic enrichment, sedimentation	Fecal coliform, Iron
Bone Creek	WV-OLK-31-K-62	WVLKH-9-X	organic enrichment, sedimentation	Fecal coliform, Iron
Upper Run	WV-OLK-31-K-73-M	WVLKH-9-AA-6	organic enrichment, sedimentation	Fecal coliform, Iron
Sheep Run	WV-OLK-31-K-88	WVLKH-9-GG	organic enrichment, sedimentation	Iron, See note*
North Fork/Hughes River	WV-OLK-31-L	WVLKH-10	organic enrichment, sedimentation	Fecal coliform, Iron
Buffalo Run	WV-OLK-31-L-1	WVLKH-10-A	organic enrichment, sedimentation	Fecal coliform, Iron
Rush Run	WV-OLK-31-L-19	WVLKH-10-K	organic enrichment, sedimentation	Fecal coliform, Iron
Beech Run	WV-OLK-31-L-30-K-5	WVLKH-10-R-4-A	organic enrichment, sedimentation	Fecal coliform, Iron
Whiskey Run	WV-OLK-31-L-30-O	WVLKH-10-R-5	organic enrichment, sedimentation	Fecal coliform, Iron
Big Knot Run	WV-OLK-31-L-30-AE	WVLKH-10-R-7	organic enrichment, sedimentation	Fecal coliform, Iron
Back Run	WV-OLK-31-L-37-B	WVLKH-10-T-1	organic enrichment, sedimentation	Fecal coliform, Iron
Cunningham Run	WV-OLK-31-L-42	WVLKH-10-W	organic enrichment, sedimentation	Fecal coliform, Iron

Stream Name	NHD-Code	WV Code	Significant Stressors	TMDLs Developed
Rockcamp Run	WV-OLK-31-L-44	WVLKH-10-X	organic enrichment, sedimentation	Iron, See note*
Bunnell Run	WV-OLK-31-L-45	WVLKH-10-Y	organic enrichment, sedimentation	Fecal coliform, Iron
Beason Run	WV-OLK-31-L-51	WVLKH-10-AA	organic enrichment, sedimentation	Fecal coliform, Iron
Spring Run	WV-OLK-31-L-52	WVLKH-10-BB	organic enrichment, sedimentation	Fecal coliform, Iron
Lynncamp Run	WV-OLK-31-L-56	WVLKH-10-DD	organic enrichment, sedimentation	Fecal coliform, Iron
Cabin Run	WV-OLK-31-L-62	WVLKH-10-EE	organic enrichment, sedimentation	Fecal coliform, Iron
Leason Run	WV-OLK-31-L-62-J	WVLKH-10-EE-1	organic enrichment, sedimentation	Fecal coliform, Iron
Dotson Run	WV-OLK-31-L-63	WVLKH-10-FF	organic enrichment, sedimentation	Fecal coliform, Iron
Gnat Run	WV-OLK-31-L-69	WVLKH-10-HH	organic enrichment, sedimentation	Iron, See note*
Poplarlick Run	WV-OLK-31-L-72	WVLKH-10-II	organic enrichment, sedimentation	Fecal coliform, Iron
Haddox Run	WV-OLK-31-L-73	WVLKH-10-JJ	organic enrichment, sedimentation	Iron, See note*
Burton Run	WV-OLK-31-L-76	WVLKH-10-KK	organic enrichment, sedimentation	Fecal coliform, Iron
Marsh Run	WV-OLK-31-L-79	WVLKH-10-LL	organic enrichment, sedimentation	Fecal coliform, Iron

*Note: Although a fecal coliform TMDL was not developed for this stream, reductions to fecal coliform sources in this watershed that were necessary to attain State water quality standards in downstream water bodies were prescribed.

5.0 METALS SOURCE ASSESSMENT

This section identifies and examines the potential sources of metals impairments (i.e., iron) in the Hughes River Watershed. Sources can be classified as point (permitted) or nonpoint (non-permitted) 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 .

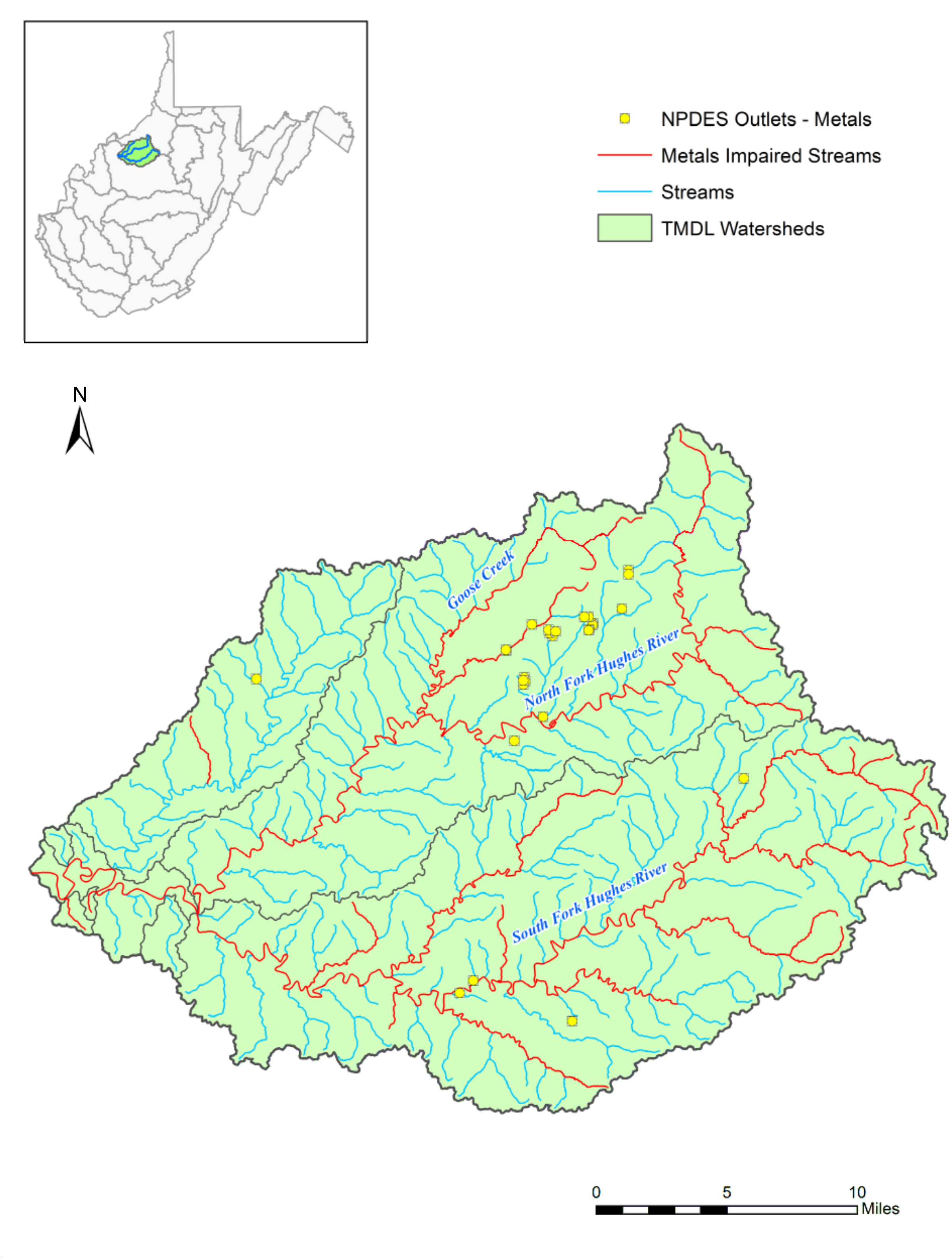
A point source, according to 40 CFR 122.3, is any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, and vessel 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 points 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 (OOG). The assignment of LAs to OOG 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 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 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 Hughes River Watershed

5.1.1 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 28 industrial wastewater discharges in the watersheds of metals impaired streams in the Hughes Watershed.

In the Hughes River 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 28 modeled non-mining NPDES permitted outlets (1 industrial stormwater discharge regulated by an individual permit, 19 storm water industrial general permit discharges, and 8 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. A complete list of the permits and outlets is provided in **Appendix F** of the Technical Report.

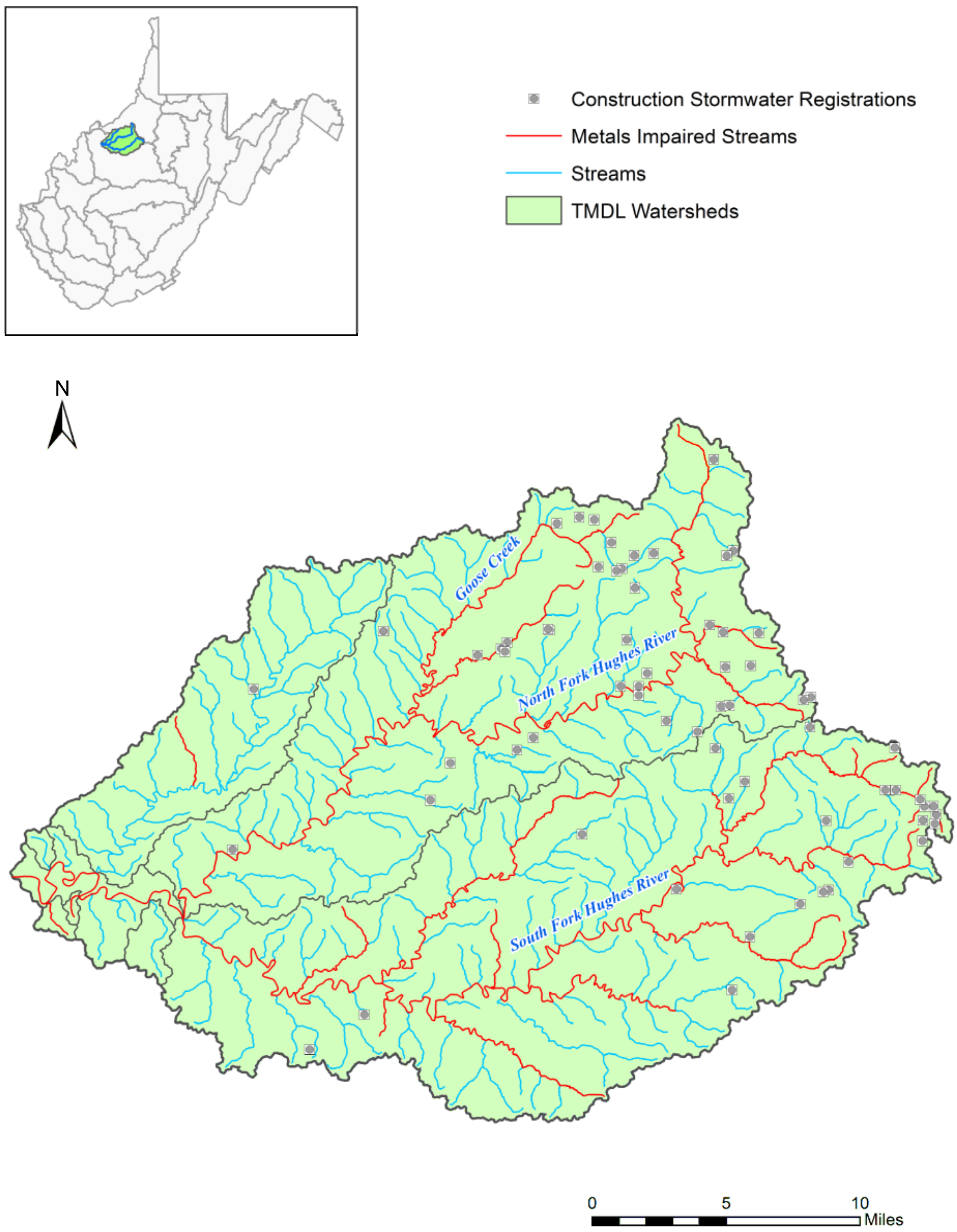
5.1.2 Construction Stormwater Permits

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. Individual registration under the General Permit is usually limited to less than one year.

At the time of model set-up, 22 active construction sites with a total disturbed area of 133.42 acres registered under the CSGP were represented in the Hughes River Watershed. Fifty-three registrations under the OGCSGP were represented in the model with a total disturbance of 1,617.41 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 7.7.1** and **9.0**.



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

Figure 5-2. Construction stormwater permits in the Hughes River 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. **Figure 5-3** displays modeled metals nonpoint sources.

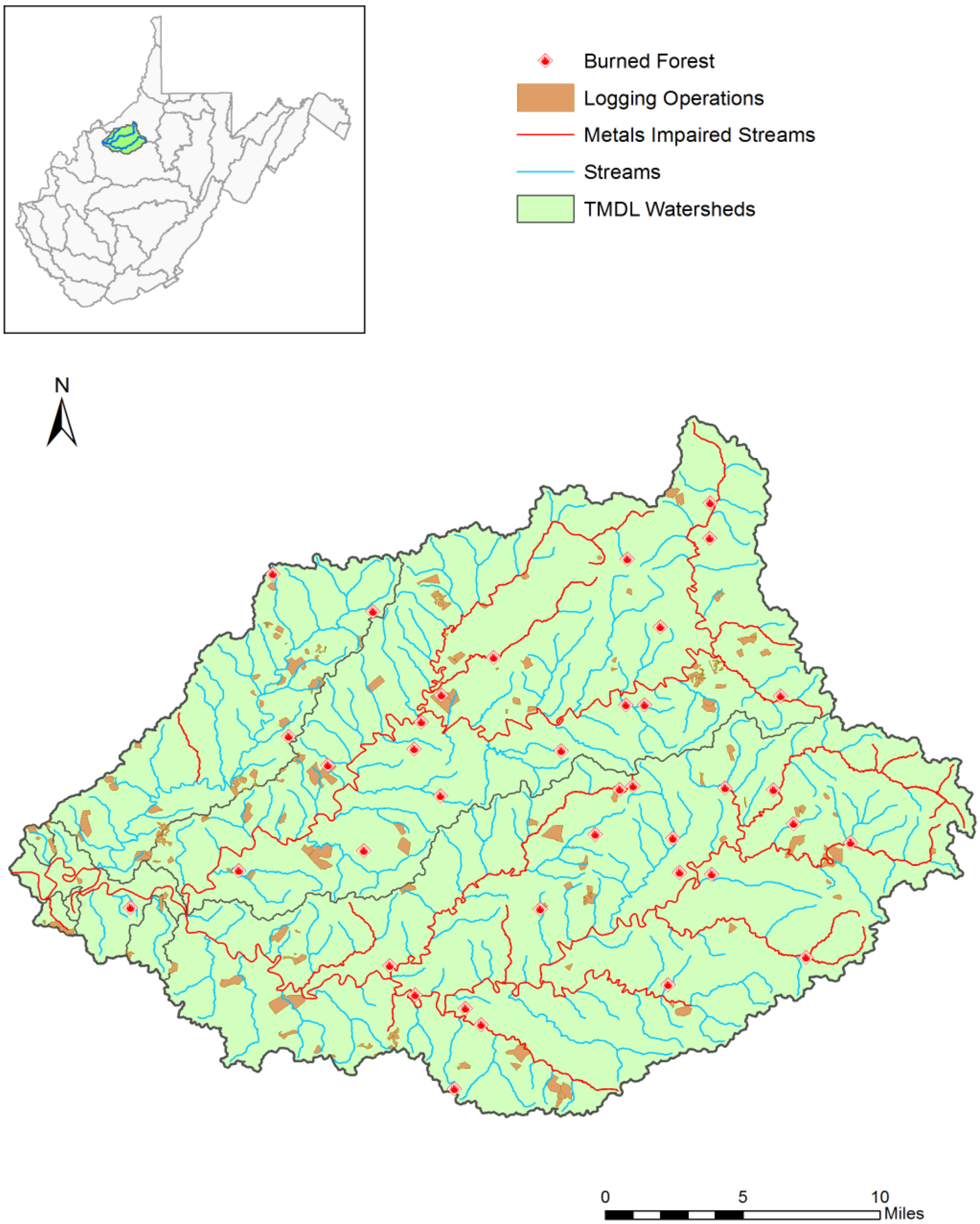


Figure 5-3. Nonpoint sources in the Hughes River Watershed

5.2.1 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 areas. Additionally, streambank erosion represents a significant sediment source throughout the watershed. Upland sediment nonpoint sources are summarized below.

Forestry

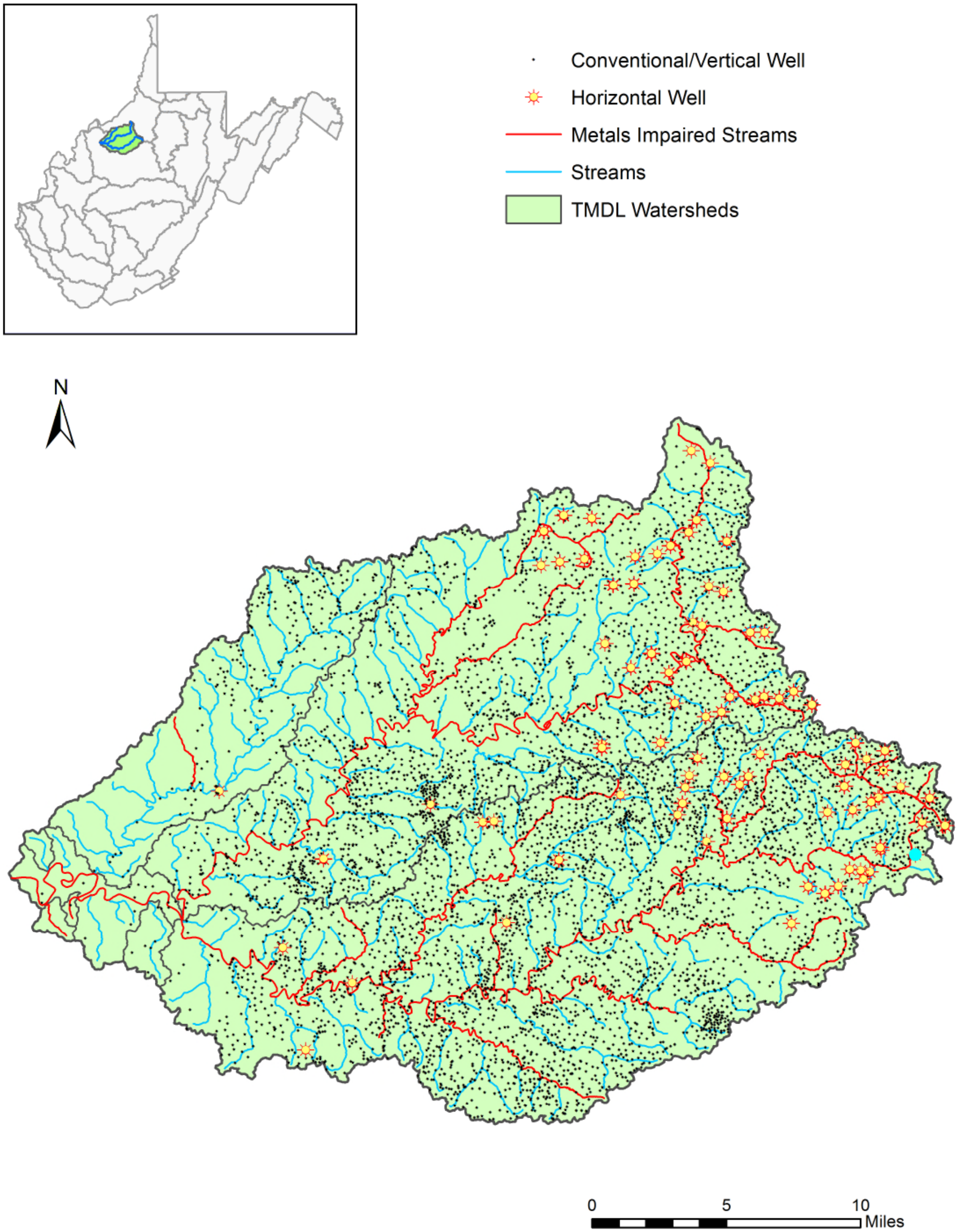
West Virginia recognizes the water quality issues posed by sediment from logging sites. In 1992, the West Virginia Legislature passed the Logging Sediment Control Act. The act requires the use of BMPs to reduce sediment loads to nearby waterbodies. Without properly installed BMPs, logging and associated 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 7,536 acres of harvested area within the TMDL impaired streams watersheds, of which subset of land disturbed by roads and landings is 603 acres. In addition, 185 acres of burned forest were reported and included as disturbed land for calibration purposes only.

Oil and Gas

The WVDEP Office of Oil and Gas (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 have increased in the watershed with the development of new hydraulic fracturing techniques. Because of the different drilling techniques, the overall amount of land disturbance can be significantly higher for Marcellus wells than for 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 site 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 6,771 active conventional and vertical oil and gas wells (represented as 9,344 acres), and 471 horizontal wells (represented as 2,026 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 5-4**).



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

Figure 5-4. Oil and Gas Well locations in the Hughes River 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.

Information on roads was obtained from various sources, including the 2015 TIGER/Line shapefiles from the US Census Bureau and the WV Roads GIS coverage prepared by WVU. Additional areas of unpaved roads that were not included in either GIS coverage were derived directly by digitizing aerial photography.

Agriculture

Agricultural landuses account for 4 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. 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 neighboring 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.

6.0 FECAL COLIFORM SOURCE ASSESSMENT

6.1 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 Hughes River Watershed.

6.1.1 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, 4 individually permitted POTWs discharge treated effluent at 4 outlets, Cairo (WV0084212), Ellenboro-Lamberton PSD (WV0027308), Harrisville (WV0022357), and Pennsboro (WV0025739). One additional individually permitted non-POTW wastewater treatment plant, Alfab, Inc. Industrial (WV0111911) discharges from one outlet.

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.

6.1.2 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, 4 facilities are registered under the "package plant" general permit, and 24 are registered under the HAU general permit. Modeled point source locations are shown on **Figure 6-1.**

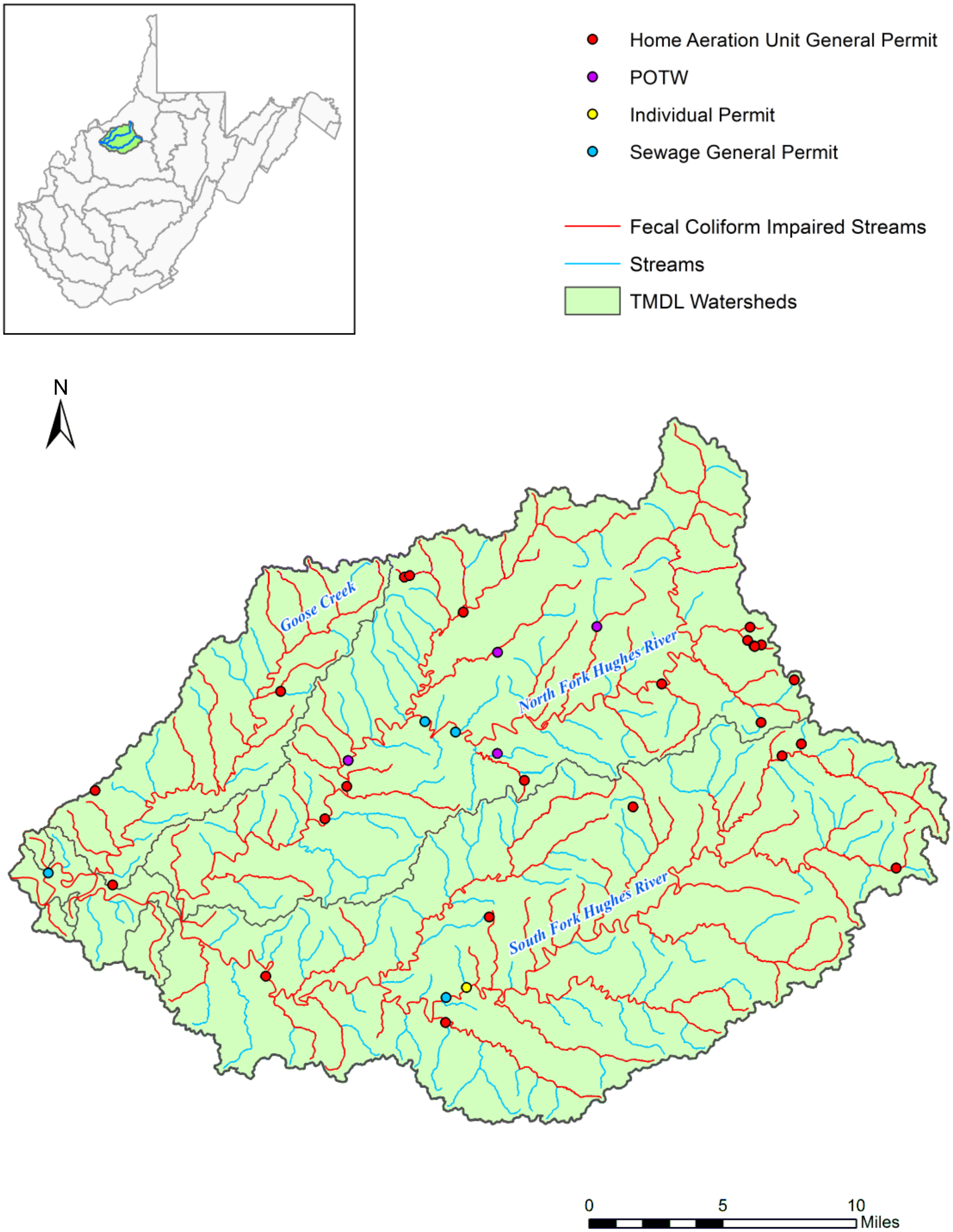


Figure 6-1. Fecal coliform point sources

6.2 Fecal Coliform Nonpoint Sources

6.2.1 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 2,220 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 7 percent to 24 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 four 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 6-2** 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.

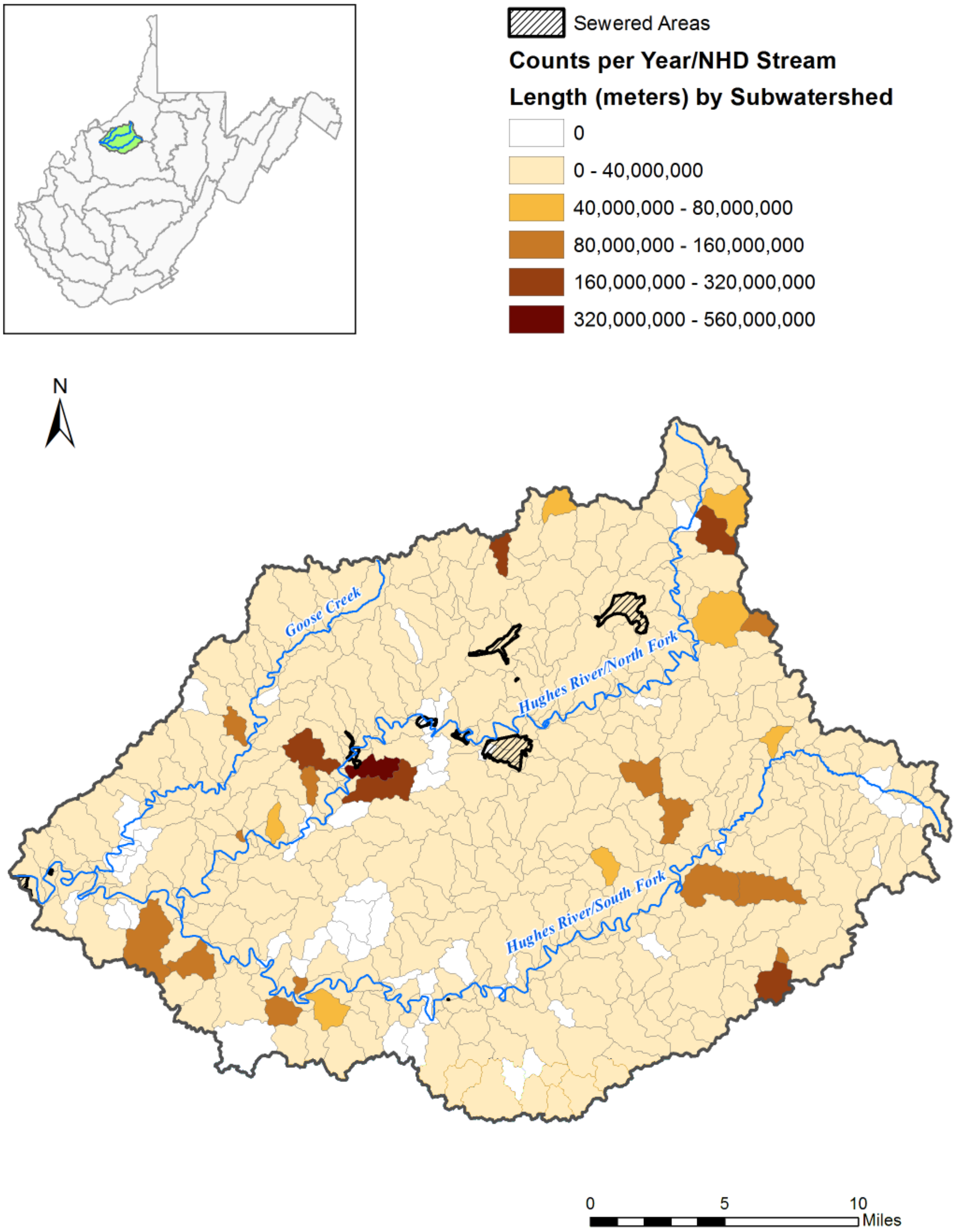


Figure 6-2. Fecal coliform counts attributed to failing septic systems per year relative to the stream lengths (meters) in each subwatershed in the Hughes River Watershed as represented in modeling.

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.

6.2.2 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.

6.2.3 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.

6.2.4 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, incorporating 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.

7.0 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 Hughes River Watershed.

7.1 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
- 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 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). 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 Hughes River 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, and fecal coliform bacteria were modeled using the MDAS.

7.2 Model Setup

Model setup consisted of configuring the following two separate MDAS models: iron/sediment; and fecal coliform bacteria.

7.2.1 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 nineteen 12-digit HUCs in the Hughes River 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 8 TMDL watersheds were broken into 447 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.

7.2.2 Iron 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 (i.e. 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 (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 in-stream sediment and iron metals concentrations. The results were then applied to the sediment from sediment-producing landuses and bank erosion to calculate the iron loads delivered to the streams.

Generation of upland sediment loads depends on the intensity of surface runoff. It also 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 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. 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 threshold.

The wetted perimeter and reach length represent ground area covered by water (**Figure 7-1**). 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.

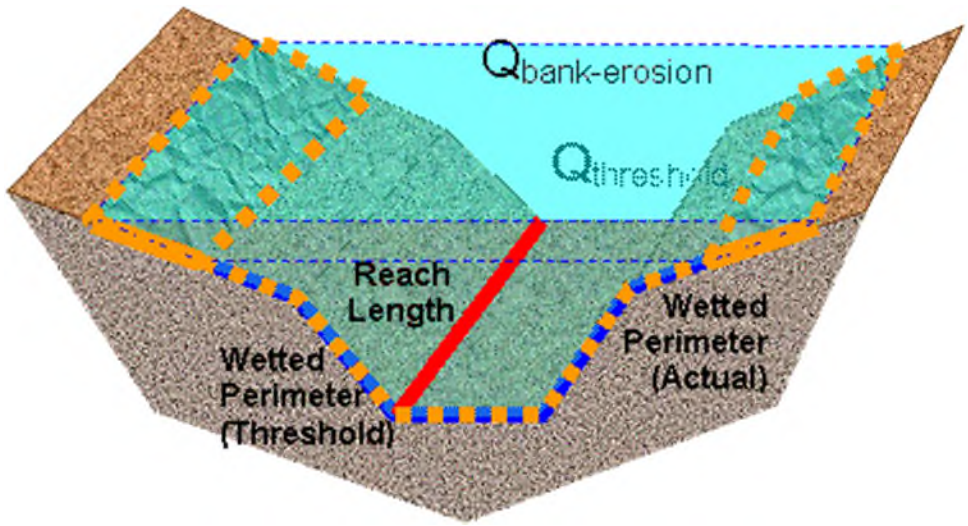


Figure 7-1. Conceptual diagram of stream channel components used in the bank erosion model

Another important variable in the prediction of sediment yield is bank stability as defined by coefficient for scour of the bank matrix soil (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.

7.2.3 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 6.2.1** describes the process of assigning flow and fecal coliform concentrations to failing septic systems.

7.3 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 station located in Hughes River watershed had adequate recorded data for model hydrology calibration:

- USGS 03155220 South Fork Hughes River below Macfarlan, 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, 2010 to September 30, 2016. 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 Hughes River 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**.

7.4 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 7-2**.

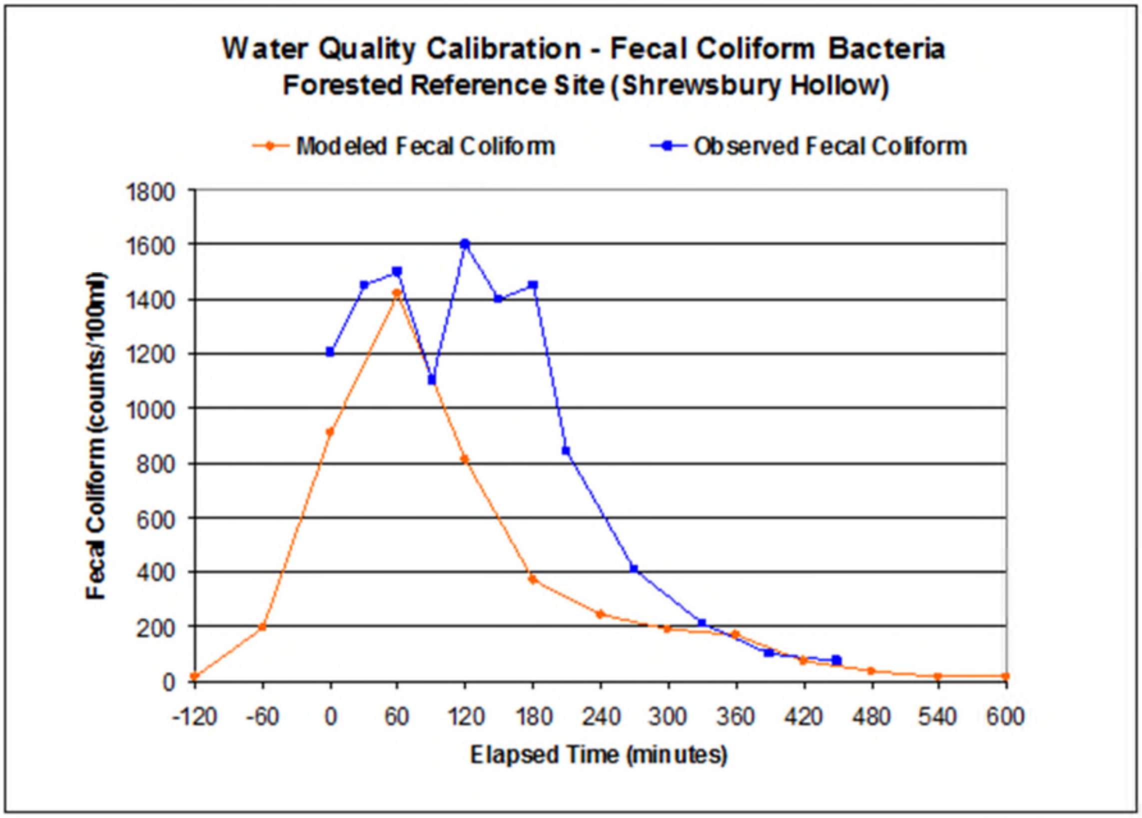


Figure 7-2. Shrewsbury Hollow fecal coliform observed data

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.

7.5 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. Three reference watersheds were 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.

7.6 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:

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

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
- Determine the TMDL and source allocations

7.6.1 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 7-1**.

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.

Table 7-1. TMDL endpoints

Water Quality Criterion	Designated Use	Criterion Value	TMDL Endpoint
Total Iron	Aquatic Life, warmwater fisheries	1.5 mg/L (4-day average)	1.425 mg/L (4-day average)
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)

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.

7.6.2 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 source 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, 2010 through December 31, 2015). 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 7-3** presents the annual rainfall totals for the years 2006 through 2016 at the Mid-Ohio Valley Regional Airport (WBAN 03804) weather station near Parkersburg, West Virginia. The years 2010 to 2015 are highlighted to indicate the range of precipitation conditions used for TMDL development in the Hughes River Watershed.

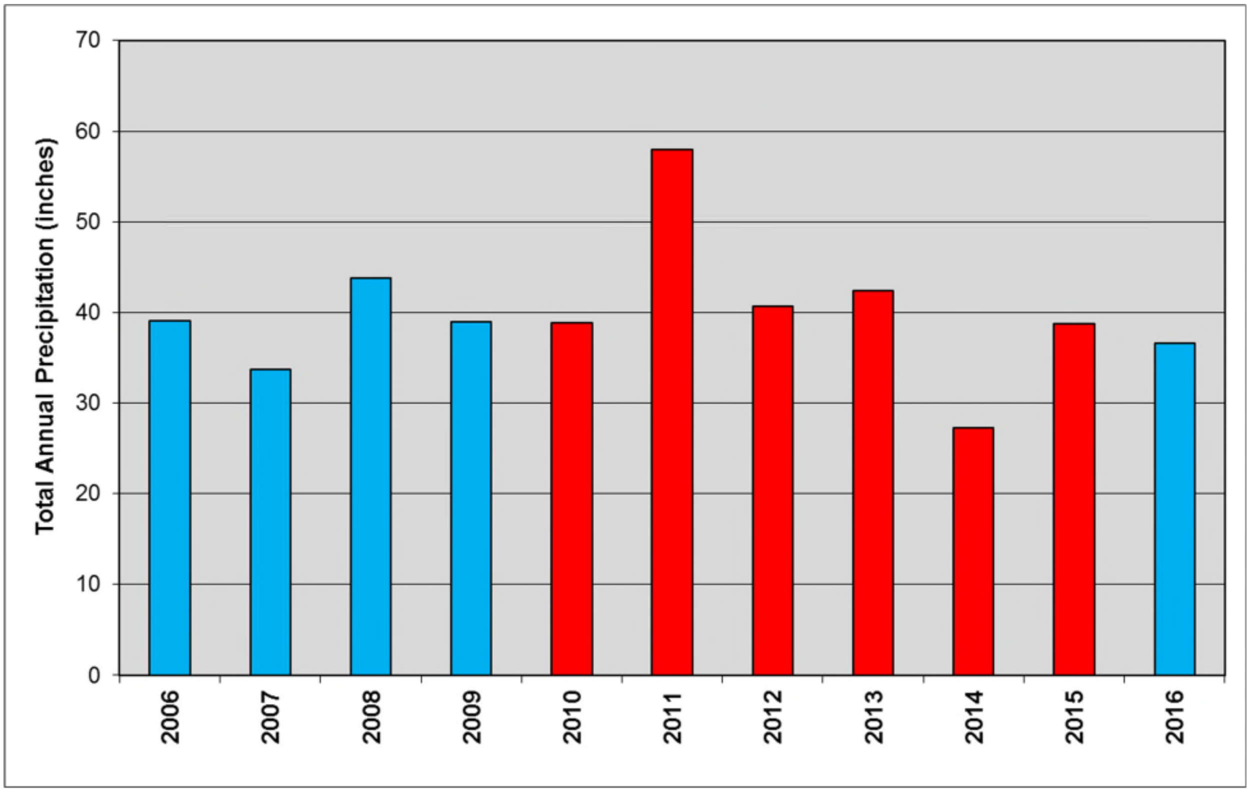


Figure 7-3. Annual precipitation totals for the Mid-Ohio Valley Regional Airport (WBAN 03804) weather station

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 (3.2 mg/l) or water quality based (1.5 mg/l) concentrations, as applicable to each permit.

Based upon guidance from WVDEP's permitting program, between 2.6 and 6 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 TSS benchmark value of 100 mg/L. In certain subwatersheds where planned construction activities are predicted to exceed 4 percent, the allowance was increased to a maximum of 6 percent.

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.

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; 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 7-4** shows an example of model output for a baseline condition and a successful TMDL scenario.

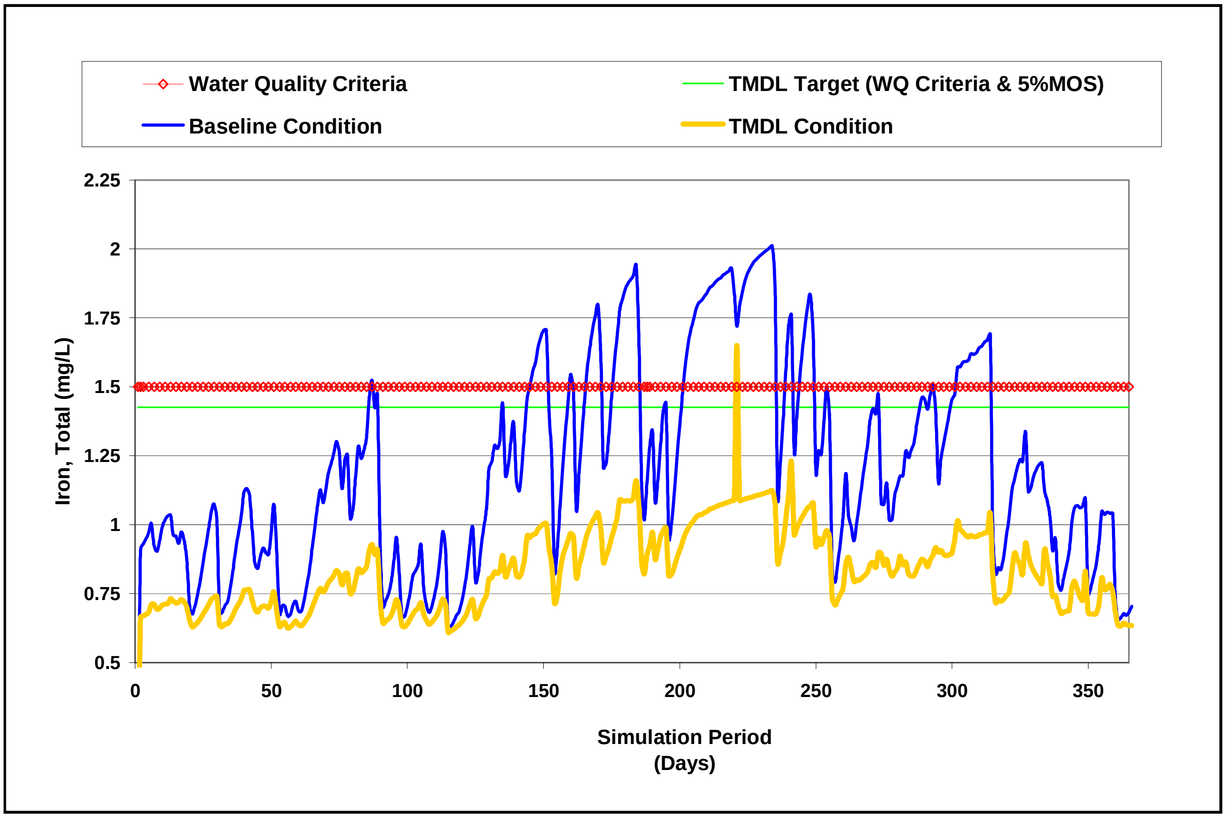


Figure 7-4. Example of baseline and TMDL conditions for total iron

7.7 TMDLs and Source Allocations

7.7.1 Total Iron TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the iron impaired streams of the Hughes River Watersheds. In order to meet iron criterion and allow for equitable allocations, reductions to existing sources were first assigned using the following general rules:

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. Four percent of the subwatershed area was allocated for activity in almost all subwatersheds to account for future growth. Where the iron criteria could not be met by implementing steps 1-3 above, the CSGP activity allowance was reduced to 2.5%. In certain subwatersheds where construction activities planned under the OGCSGP are predicted to exceed 4 percent, the allowance was increased to a maximum of 6 percent. Ten percent of the OGCSGP disturbed area represented in the model during calibration was converted to unpaved roads in the allocation scenario to account for ongoing maintenance in the utility rights-of-way. The remaining 90 percent of pipeline area was converted to grassland. Grassland was the determined to be the appropriate landuse assuming that a permanent 50 to 75 foot right of way for the pipeline would be maintained for the foreseeable future.

After executing the above provisions, model output was evaluated to determine the criterion attainment status at all subwatershed pour points.

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.

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.

Construction Stormwater

Specific WLAs for activity under the CSGP are provided at the subwatershed scale and are described in **Section 7.6.2**. With several exceptions, an allocation of 4 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 9**.

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. 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:

- 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 and other nonpoint sources: loading from undisturbed forest and grasslands (loadings associated with this category were represented but not reduced)

7.7.2 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
- If further reduction was necessary, non-point source loadings from agricultural lands and residential areas were subsequently reduced until in-stream 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.

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
- Background and Other Nonpoint Sources — loading associated with wildlife sources from all other landuses (contributions/loadings from wildlife sources were not reduced)

7.7.3 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.

7.7.4 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).

7.7.5 TMDL Presentation

The TMDLs for all impairments are shown in **Section 8** of this report. The TMDLs for iron are presented as average daily loads, in pounds per day. The TMDLs for fecal coliform bacteria are presented in average number of colonies per day. 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.

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 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.

8.0 TMDL RESULTS

Table 8-1. Iron TMDLs

TMDL Watershed	NHD Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Hughes River	WV-OLK-31	Hughes River	WVLKH	2701.20	328.35	159.45	3189.01
Hughes River	WV-OLK-31-B	Silver Run	WVLKH-1	3.01	1.19	0.22	4.43
Hughes River	WV-OLK-31-C	Lyda Run	WVLKH-2	1.34	0.51	0.10	1.95
Gooseneck Run	WV-OLK-31-D	Gooseneck Run	WVLKH-3	1.73	0.59	0.12	2.44
Goose Creek	WV-OLK-31-E	Goose Creek	WVLKH-4	146.47	29.55	9.26	185.28
Goose Creek	WV-OLK-31-E-1	Fox Run	WVLKH-4-0.5A	1.18	0.48	0.09	1.75
Goose Creek	WV-OLK-31-E-2	Lick Run	WVLKH-4-A	2.49	1.03	0.19	3.71
Goose Creek	WV-OLK-31-E-4	Combs Run	WVLKH-4-C	2.15	0.90	0.16	3.21
Goose Creek	WV-OLK-31-E-7	Pigeonroost Run	WVLKH-4-E	2.35	0.91	0.17	3.43
Goose Creek	WV-OLK-31-E-11	Oil Spring Run	WVLKH-4-G	4.50	1.75	0.33	6.58
Goose Creek	WV-OLK-31-E-14	Lynn Run	WVLKH-4-H.5	5.53	1.65	0.38	7.55
Goose Creek	WV-OLK-31-E-17	Long Run	WVLKH-4-I	1.12	0.40	0.08	1.59
Goose Creek	WV-OLK-31-E-25	Nutter Fork	WVLKH-4-L	4.29	1.54	0.31	6.14
Goose Creek	WV-OLK-31-E-25-A	UNT/Nutter Fork RM 0.91	WVLKH-4-L-1	3.30	1.14	0.23	4.67
Goose Creek	WV-OLK-31-E-31	Brushy Fork	WVLKH-4-N	0.78	0.37	0.06	1.21
Goose Creek	OLK-31-E-36	Layfields Run	WVLKH-4-O	1.50	0.64	0.11	2.25
Hughes River	WV-OLK-31-F	Rock Run	WVLKH-5	0.63	0.24	0.05	0.91
South Fork/Hughes River	WV-OLK-31-K	South Fork/Hughes River	WVLKH-9	1043.73	149.48	62.80	1256.00
South Fork/Hughes River	WV-OLK-31-K-6	Bear Run	WVLKH-9-D	1.48	0.51	0.10	2.09
South Fork/Hughes River	WV-OLK-31-K-7	Louthers Run	WVLKH-9-E	0.88	0.37	0.07	1.32
South Fork/Hughes River	WV-OLK-31-K-8	UNT/South Fork RM 5.98/Hughes River	WVLKH-9-E.3	9.34	3.77	0.69	13.80
South Fork/Hughes River	WV-OLK-31-K-13	Laurel Run	WVLKH-9-F	3.15	1.42	0.24	4.80

TMDL Watershed	NHD Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
South Fork/Hughes River	WV-OLK-31-K-13-B	UNT/Laurel Run RM 1.57	WVLKH-9-F-2	13.31	4.49	0.94	18.74
South Fork/Hughes River	WV-OLK-31-K-15	Macfarlan Creek	WVLKH-9-G	4.13	1.63	0.30	6.06
South Fork/Hughes River	WV-OLK-31-K-15-A	Left Fork/Macfarlan Creek	WVLKH-9-G-1	2.13	0.66	0.15	2.93
South Fork/Hughes River	WV-OLK-31-K-15-F	UNT/Macfarlan Creek RM 4.21	WVLKH-9-G-1.8	8.46	3.38	0.62	12.46
South Fork/Hughes River	WV-OLK-31-K-16	Dutchman Run	WVLKH-9-H	2.61	1.08	0.19	3.89
South Fork/Hughes River	WV-OLK-31-K-16-C	Left Fork/Dutchman Run	WVLKH-9-H-1	70.92	16.44	4.60	91.96
South Fork/Hughes River	WV-OLK-31-K-20	Indian Creek	WVLKH-9-J	0.65	0.20	0.04	0.90
South Fork/Hughes River	WV-OLK-31-K-20-A	UNT/Indian Creek RM 0.06	WVLKH-9-J-0.3	1.29	0.35	0.09	1.73
South Fork/Hughes River	WV-OLK-31-K-20-L	Little Indian Run	WVLKH-9-J-7	2.29	0.58	0.15	3.01
South Fork/Hughes River	WV-OLK-31-K-20-O	King Knob Run	WVLKH-9-J-9	1.18	0.40	0.08	1.66
South Fork/Hughes River	WV-OLK-31-K-20-U	Dog Run	WVLKH-9-J-11	2.19	0.67	0.15	3.00
South Fork/Hughes River	WV-OLK-31-K-20-U-2	UNT/Dog Run RM 1.39	WVLKH-9-J-11-B	1.40	0.53	0.10	2.03
South Fork/Hughes River	WV-OLK-31-K-20-Z	Chevaux de Frise Run	WVLKH-9-J-12	5.29	1.50	0.36	7.15
South Fork/Hughes River	WV-OLK-31-K-20-Z-2	Davy Cain Run	WVLKH-9-J-12-A	1.52	0.47	0.10	2.09
South Fork/Hughes River	WV-OLK-31-K-20-Z-5	Twolick Run	WVLKH-9-J-12-B	10.75	2.94	0.72	14.41
South Fork/Hughes River	WV-OLK-31-K-20-Z-6	Adds Run	WVLKH-9-J-12-C	1.61	0.62	0.12	2.34
South Fork/Hughes River	WV-OLK-31-K-20-AB	Moyers Run	WVLKH-9-J-13	0.83	0.28	0.06	1.17
South Fork/Hughes River	WV-OLK-31-K-20-AC	Den Run	WVLKH-9-J-14	0.90	0.32	0.06	1.28
South Fork/Hughes River	WV-OLK-31-K-20-AK	Bearwallow Run	WVLKH-9-J-16	1.24	0.51	0.09	1.84
South Fork/Hughes River	WV-OLK-31-K-21	Lick Run	WVLKH-9-J.5	2.86	1.14	0.21	4.21
South Fork/Hughes River	WV-OLK-31-K-26	Crab Run	WVLKH-9-K	27.85	8.80	1.93	38.58
South Fork/Hughes River	WV-OLK-31-K-31	Leatherbark Creek	WVLKH-9-M	3.30	1.34	0.24	4.88
South Fork/Hughes River	WV-OLK-31-K-31-C	Road Fork	WVLKH-9-M-1	7.29	2.78	0.53	10.59
South Fork/Hughes River	WV-OLK-31-K-31-J	Middle Fork/Leatherbark Creek	WVLKH-9-M-2	2.13	0.77	0.15	3.06
South Fork/Hughes River	WV-OLK-31-K-31-J-3	Wolfpen Fork	WVLKH-9-M-2-A	1.26	0.41	0.09	1.75
South Fork/Hughes River	WV-OLK-31-K-31-N	UNT/Leatherbark Creek RM 5.44	WVLKH-9-M-2.7	1.97	0.62	0.14	2.72
South Fork/Hughes River	WV-OLK-31-K-31-Q	Rocklick Run	WVLKH-9-M-3	1.37	0.49	0.10	1.96
South Fork/Hughes River	WV-OLK-31-K-31-T	Lynncamp Run	WVLKH-9-M-4	1.10	0.27	0.07	1.44

TMDL Watershed	NHD Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
South Fork/Hughes River	WV-OLK-31-K-32	UNT/South Fork RM 21.06/Hughes River	WVLKH-9-M.4	1.33	0.35	0.09	1.76
South Fork/Hughes River	WV-OLK-31-K-36	Owl Run	WVLKH-9-O	5.39	1.69	0.37	7.45
South Fork/Hughes River	WV-OLK-31-K-39	Lamb Run	WVLKH-9-P	26.24	8.00	1.80	36.04
South Fork/Hughes River	WV-OLK-31-K-40	Grass Run	WVLKH-9-Q	4.82	1.14	0.31	6.27
South Fork/Hughes River	WV-OLK-31-K-40-J	UNT/Grass Run RM 5.65	WVLKH-9-Q-7	0.85	0.28	0.06	1.19
South Fork/Hughes River	WV-OLK-31-K-41	UNT/South Fork RM 25.95/Hughes River	WVLKH-9-Q.5	66.19	17.32	4.40	87.91
South Fork/Hughes River	WV-OLK-31-K-44	Spruce Creek	WVLKH-9-R	0.95	0.38	0.07	1.40
South Fork/Hughes River	WV-OLK-31-K-44-B	Rock Run	WVLKH-9-R-1	3.52	1.20	0.25	4.97
South Fork/Hughes River	WV-OLK-31-K-44-D	Dry Run	WVLKH-9-R-2	4.08	1.77	0.31	6.16
South Fork/Hughes River	WV-OLK-31-K-44-K	Straight Fork	WVLKH-9-R-4	4.12	1.24	0.28	5.64
South Fork/Hughes River	WV-OLK-31-K-44-M	Laurel Fork	WVLKH-9-R-5	1.68	0.60	0.12	2.41
South Fork/Hughes River	WV-OLK-31-K-44-N	Leatherbark Run	WVLKH-9-R-6	17.34	5.40	1.20	23.95
South Fork/Hughes River	WV-OLK-31-K-44-T	Left Fork/Spruce Creek	WVLKH-9-R-9	7.36	2.08	0.50	9.94
South Fork/Hughes River	WV-OLK-31-K-44-U	Right Fork/Spruce Creek	WVLKH-9-R-8	6.64	1.97	0.45	9.07
South Fork/Hughes River	WV-OLK-31-K-46	Long Run	WVLKH-9-S	3.57	1.26	0.25	5.08
South Fork/Hughes River	WV-OLK-31-K-49	Jesse Cain Run	WVLKH-9-T	1.52	0.70	0.12	2.33
South Fork/Hughes River	WV-OLK-31-K-51	Cain Run	WVLKH-9-U	2.13	0.88	0.16	3.18
South Fork/Hughes River	WV-OLK-31-K-53	Smith Run	WVLKH-9-V	30.06	9.87	2.10	42.03
South Fork/Hughes River	WV-OLK-31-K-55	Slab Creek	WVLKH-9-W	3.46	1.26	0.25	4.97
South Fork/Hughes River	WV-OLK-31-K-55-B	Wolfpen Run	WVLKH-9-W-1	1.45	0.58	0.11	2.14
South Fork/Hughes River	WV-OLK-31-K-55-B-1	UNT/Wolfpen Run RM 0.51	WVLKH-9-W-1-A	3.45	1.38	0.25	5.08
South Fork/Hughes River	WV-OLK-31-K-55-F	Isaac Fork	WVLKH-9-W-2	1.65	0.68	0.12	2.44
South Fork/Hughes River	WV-OLK-31-K-55-I	Straight Fork	WVLKH-9-W-3	10.99	3.58	0.77	15.34
South Fork/Hughes River	WV-OLK-31-K-55-J	Left Fork/Slab Creek	WVLKH-9-W-4	2.53	0.77	0.17	3.48
South Fork/Hughes River	WV-OLK-31-K-55-J-3	Star Fork	WVLKH-9-W-4-B	2.44	0.94	0.18	3.55
South Fork/Hughes River	WV-OLK-31-K-55-K	Right Fork/Slab Creek	WVLKH-9-W-5	10.28	4.30	0.77	15.35
South Fork/Hughes River	WV-OLK-31-K-62	Bone Creek	WVLKH-9-X	33.50	9.50	2.26	45.26

TMDL Watershed	NHD Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
South Fork/Hughes River	WV-OLK-31-K-62-S	Left Fork/Bone Creek	WVLKH-9-X-6	5.14	1.59	0.35	7.08
South Fork/Hughes River	WV-OLK-31-K-62-T	Right Fork/Bone Creek	WVLKH-9-X-5	5.73	1.67	0.39	7.79
South Fork/Hughes River	WV-OLK-31-K-69	Otterslide Creek	WVLKH-9-Y	6.23	2.21	0.44	8.89
South Fork/Hughes River	WV-OLK-31-K-72	Turtle Run	WVLKH-9-Z	1.65	0.64	0.12	2.41
South Fork/Hughes River	WV-OLK-31-K-73	Middle Fork/South Fork/Hughes River	WVLKH-9-AA	2.87	1.09	0.21	4.16
South Fork/Hughes River	WV-OLK-31-K-73-E	Bear Run	WVLKH-9-AA-2	47.35	13.80	3.22	64.36
South Fork/Hughes River	WV-OLK-31-K-73-I	Brush Run	WVLKH-9-AA-3.5	3.39	1.30	0.25	4.93
South Fork/Hughes River	WV-OLK-31-K-73-J	Straight Fork	WVLKH-9-AA-4	1.58	0.57	0.11	2.25
South Fork/Hughes River	WV-OLK-31-K-73-L	Lower Run	WVLKH-9-AA-5	6.82	2.84	0.51	10.17
South Fork/Hughes River	WV-OLK-31-K-73-M	Upper Run	WVLKH-9-AA-6	2.73	0.66	0.18	3.57
South Fork/Hughes River	WV-OLK-31-K-73-M-2	Jims Run	WVLKH-9-AA-6-A	3.91	1.31	0.27	5.49
South Fork/Hughes River	WV-OLK-31-K-73-R	Mudlick Run	WVLKH-9-AA-9	1.15	0.39	0.08	1.63
South Fork/Hughes River	WV-OLK-31-K-75	White Oak Creek	WVLKH-9-BB	1.16	0.38	0.08	1.63
South Fork/Hughes River	WV-OLK-31-K-75-A	Little White Oak Creek	WVLKH-9-BB-1	20.85	5.46	1.38	27.70
South Fork/Hughes River	WV-OLK-31-K-75-B	Right Fork/White Oak Creek	WVLKH-9-BB-3	2.70	1.09	0.20	3.99
South Fork/Hughes River	WV-OLK-31-K-75-C	Left Fork/White Oak Creek	WVLKH-9-BB-2	9.41	2.35	0.62	12.38
South Fork/Hughes River	WV-OLK-31-K-76	Poverty Hollow	WVLKH-9-CC	5.91	1.42	0.39	7.72
South Fork/Hughes River	WV-OLK-31-K-82	Sugar Run	WVLKH-9-DD	1.39	0.54	0.10	2.04
South Fork/Hughes River	WV-OLK-31-K-84	Clevenger Hollow	WVLKH-9-DD.5	0.69	0.23	0.05	0.97
South Fork/Hughes River	WV-OLK-31-K-85	Taylor Drain	WVLKH-9-EE	1.97	0.76	0.14	2.87
South Fork/Hughes River	WV-OLK-31-K-87	Freds Run	WVLKH-9-FF	1.14	0.43	0.08	1.65
South Fork/Hughes River	WV-OLK-31-K-88	Sheep Run	WVLKH-9-GG	1.07	0.36	0.07	1.50
South Fork/Hughes River	WV-OLK-31-K-93	Holt Run	WVLKH-9-GG.5	2.08	0.41	0.13	2.62
South Fork/Hughes River	WV-OLK-31-K-94	Big Run	WVLKH-9-HH	1.59	0.62	0.12	2.32
South Fork/Hughes River	WV-OLK-31-K-103	Cain Run	WVLKH-9-OO	0.57	0.28	0.04	0.89
South Fork/Hughes River	WV-OLK-31-K-105	UNT/South Fork RM 55.73/Hughes River	WVLKH-9-PP	1.83	0.67	0.13	2.64
North Fork/Hughes River	WV-OLK-31-L	North Fork/Hughes River	WVLKH-10	1042.28	139.17	62.18	1243.63

TMDL Watershed	NHD Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
North Fork/Hughes River	WV-OLK-31-L-1	Buffalo Run	WVLKH-10-A	3.72	1.42	0.27	5.41
North Fork/Hughes River	WV-OLK-31-L-4	Gillespie Run	WVLKH-10-C	1.06	0.45	0.08	1.59
North Fork/Hughes River	WV-OLK-31-L-7	Cabin Run	WVLKH-10-E	1.97	0.83	0.15	2.95
North Fork/Hughes River	WV-OLK-31-L-7-A	UNT/Cabin Run RM 0.52	WVLKH-10-E-1	16.99	5.99	1.21	24.19
North Fork/Hughes River	WV-OLK-31-L-10	UNT/North Fork RM 7.87/Hughes River	WVLKH-10-F.3	2.51	1.08	0.19	3.78
North Fork/Hughes River	WV-OLK-31-L-11	Cow Run	WVLKH-10-F.5	1.52	0.66	0.12	2.30
North Fork/Hughes River	WV-OLK-31-L-13	Devilhole Creek	WVLKH-10-G	4.34	1.97	0.33	6.64
North Fork/Hughes River	WV-OLK-31-L-13-F	UNT/Devilhole Creek RM 2.47	WVLKH-10-G.7	1.42	0.62	0.11	2.14
North Fork/Hughes River	WV-OLK-31-L-13-I	UNT/Devilhole Creek RM 4.03	WVLKH-10-G-2	8.90	3.48	0.65	13.04
North Fork/Hughes River	WV-OLK-31-L-14	Sheep Run	WVLKH-10-H	2.59	1.07	0.19	3.86
North Fork/Hughes River	WV-OLK-31-L-14-A	UNT/Sheep Run RM 0.63	WVLKH-10-H-1	0.47	0.18	0.03	0.69
North Fork/Hughes River	WV-OLK-31-L-16	Elm Run	WVLKH-10-I	9.40	3.15	0.66	13.21
North Fork/Hughes River	WV-OLK-31-L-16-B	UNT/Elm Run RM 1.92	WVLKH-10-I-4	1.72	0.61	0.12	2.46
North Fork/Hughes River	WV-OLK-31-L-17	Slaughterhouse Run	WVLKH-10-I.5	2.94	0.83	0.20	3.97
North Fork/Hughes River	WV-OLK-31-L-18	Addis Run	WVLKH-10-J	2.79	1.24	0.21	4.25
North Fork/Hughes River	WV-OLK-31-L-18-F	UNT/Addis Run RM 2.63	WVLKH-10-J-2	4.75	1.93	0.35	7.03
North Fork/Hughes River	WV-OLK-31-L-19	Rush Run	WVLKH-10-K	4.30	2.08	0.34	6.71
North Fork/Hughes River	WV-OLK-31-L-20	Silver Run	WVLKH-10-L	2.67	1.15	0.20	4.02
North Fork/Hughes River	WV-OLK-31-L-23	Big Run	WVLKH-10-N	6.78	2.37	0.48	9.63
North Fork/Hughes River	WV-OLK-31-L-25	Buky Run	WVLKH-10-O	120.21	32.30	8.03	160.54
North Fork/Hughes River	WV-OLK-31-L-26	Low Gap Run	WVLKH-10-P	2.26	0.37	0.14	2.77
North Fork/Hughes River	WV-OLK-31-L-29	Bear Run	WVLKH-10-Q	1.56	0.69	0.12	2.37
North Fork/Hughes River	WV-OLK-31-L-30	Bonds Creek	WVLKH-10-R	1.66	0.75	0.13	2.53
North Fork/Hughes River	WV-OLK-31-L-30-B	Hushers Run	WVLKH-10-R-1	3.51	0.88	0.23	4.62
North Fork/Hughes River	WV-OLK-31-L-30-B-21	UNT/Hushers Run RM 6.82	WVLKH-10-R-1-B.5	26.93	10.38	1.96	39.27
North Fork/Hughes River	WV-OLK-31-L-30-D	Painter Run	WVLKH-10-R-3	2.75	1.44	0.22	4.41
North Fork/Hughes River	WV-OLK-31-L-30-G	Wolfpen Run	WVLKH-10-R-3.5	3.68	1.48	0.27	5.43

TMDL Watershed	NHD Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
North Fork/Hughes River	WV-OLK-31-L-30-K	Comfort Run	WVLKH-10-R-4	2.55	1.20	0.20	3.95
North Fork/Hughes River	WV-OLK-31-L-30-K-3	UNT/Comfort Run RM 0.97	WVLKH-10-R-4-0.5A	9.58	2.80	0.65	13.03
North Fork/Hughes River	WV-OLK-31-L-30-K-5	Beech Run	WVLKH-10-R-4-A	0.91	0.39	0.07	1.37
North Fork/Hughes River	WV-OLK-31-L-30-O	Whiskey Run	WVLKH-10-R-5	2.92	1.03	0.21	4.16
North Fork/Hughes River	WV-OLK-31-L-30-X	McGregor Run	WVLKH-10-R-6	9.90	2.97	0.68	13.54
North Fork/Hughes River	WV-OLK-31-L-30-AE	Big Knot Run	WVLKH-10-R-7	0.71	0.27	0.05	1.03
North Fork/Hughes River	WV-OLK-31-L-30-AF	Blacks Run	WVLKH-10-R-8	0.86	0.36	0.06	1.29
North Fork/Hughes River	WV-OLK-31-L-30-AK	Charleys Run	WVLKH-10-R-9	6.06	2.07	0.43	8.55
North Fork/Hughes River	WV-OLK-31-L-30-AN	Long Bottom	WVLKH-10-R-10	17.81	3.73	1.13	22.68
North Fork/Hughes River	WV-OLK-31-L-31	UNT/North Fork RM 22.26/Hughes River	WVLKH-10-R.5	11.47	1.99	0.71	14.17
North Fork/Hughes River	WV-OLK-31-L-35	Lost Run	WVLKH-10-S	3.42	0.54	0.21	4.17
North Fork/Hughes River	WV-OLK-31-L-37	Third Run	WVLKH-10-T	2.14	0.47	0.14	2.75
North Fork/Hughes River	WV-OLK-31-L-37-B	Back Run	WVLKH-10-T-1	10.29	3.10	0.71	14.10
North Fork/Hughes River	WV-OLK-31-L-37-B-1	UNT/Back Run RM 0.88	WVLKH-10-T-1-A	9.39	3.17	0.66	13.23
North Fork/Hughes River	WV-OLK-31-L-37-B-3	UNT/Back Run RM 2.48	WVLKH-10-T-1-C	1.72	0.46	0.11	2.30
North Fork/Hughes River	WV-OLK-31-L-41	Stewart Run	WVLKH-10-V	0.72	0.32	0.05	1.09
North Fork/Hughes River	WV-OLK-31-L-41-B	UNT/Stewart Run RM 0.51	WVLKH-10-V-2	2.00	0.61	0.14	2.74
North Fork/Hughes River	WV-OLK-31-L-41-G	UNT/Stewart Run RM 2.17	WVLKH-10-V-7	6.67	2.34	0.47	9.48
North Fork/Hughes River	WV-OLK-31-L-42	Cunningham Run	WVLKH-10-W	20.32	6.60	1.42	28.34
North Fork/Hughes River	WV-OLK-31-L-44	Rockcamp Run	WVLKH-10-X	3.21	1.31	0.24	4.76
North Fork/Hughes River	WV-OLK-31-L-45	Bunnell Run	WVLKH-10-Y	1.96	0.76	0.14	2.85
North Fork/Hughes River	WV-OLK-31-L-45-I	Horner Run	WVLKH-10-Y-9	7.77	2.93	0.56	11.27
North Fork/Hughes River	WV-OLK-31-L-46	Goose Run	WVLKH-10-Z	1.38	0.59	0.10	2.07
North Fork/Hughes River	WV-OLK-31-L-51	Beason Run	WVLKH-10-AA	1.67	0.77	0.13	2.57
North Fork/Hughes River	WV-OLK-31-L-51-B	Little Beason Run	WVLKH-10-AA-0.7	8.93	2.13	0.58	11.64
North Fork/Hughes River	WV-OLK-31-L-51-D	Davis Run	WVLKH-10-AA-2	3.45	0.96	0.23	4.65
North Fork/Hughes River	WV-OLK-31-L-52	Spring Run	WVLKH-10-BB	0.53	0.23	0.04	0.80

TMDL Watershed	NHD Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
North Fork/Hughes River	WV-OLK-31-L-52-B	Long Run	WVLKH-10-BB-1	14.08	3.25	0.91	18.24
North Fork/Hughes River	WV-OLK-31-L-54	Bear Run	WVLKH-10-CC	3.24	0.76	0.21	4.21
North Fork/Hughes River	WV-OLK-31-L-56	Lynncamp Run	WVLKH-10-DD	26.00	6.80	1.73	34.53
North Fork/Hughes River	WV-OLK-31-L-56-B	Buzzard Run	WVLKH-10-DD-1	4.31	1.21	0.29	5.81
North Fork/Hughes River	WV-OLK-31-L-62	Cabin Run	WVLKH-10-EE	1.04	0.46	0.08	1.58
North Fork/Hughes River	WV-OLK-31-L-62-J	Leason Run	WVLKH-10-EE-1	2.65	0.82	0.18	3.65
North Fork/Hughes River	WV-OLK-31-L-62-K	UNT/Cabin Run RM 2.68	WVLKH-10-EE-2	4.17	0.61	0.25	5.03
North Fork/Hughes River	WV-OLK-31-L-62-N	UNT/Cabin Run RM 3.58	WVLKH-10-EE-4	11.29	3.37	0.77	15.43
North Fork/Hughes River	WV-OLK-31-L-62-Q	UNT/Cabin Run RM 4.57	WVLKH-10-EE-7	2.11	0.58	0.14	2.83
North Fork/Hughes River	WV-OLK-31-L-63	Dotson Run	WVLKH-10-FF	1.63	0.48	0.11	2.23
North Fork/Hughes River	WV-OLK-31-L-63-I	UNT/Dotson Run RM 2.17	WVLKH-10-FF-9	5.35	1.94	0.38	7.67
North Fork/Hughes River	WV-OLK-31-L-65	UNT/North Fork RM 44.47/Hughes River	WVLKH-10-FF.5	1.80	0.71	0.13	2.65
North Fork/Hughes River	WV-OLK-31-L-68	Buck Run	WVLKH-10-GG	3.12	1.27	0.23	4.62
North Fork/Hughes River	WV-OLK-31-L-69	Gnat Run	WVLKH-10-HH	4.61	1.75	0.33	6.70
North Fork/Hughes River	WV-OLK-31-L-72	Poplarlick Run	WVLKH-10-II	3.25	0.86	0.22	4.33
North Fork/Hughes River	WV-OLK-31-L-73	Haddox Run	WVLKH-10-JJ	4.01	1.22	0.28	5.50
North Fork/Hughes River	WV-OLK-31-L-76	Burton Run	WVLKH-10-KK	3.35	1.29	0.24	4.89
North Fork/Hughes River	WV-OLK-31-L-79	Marsh Run	WVLKH-10-LL	1.17	0.53	0.09	1.79
North Fork/Hughes River	WV-OLK-31-L-80	Lizzies Roost Run	WVLKH-10-MM	2.33	0.82	0.17	3.31

UNT = unnamed tributary; RM = river mile.

Table 8-2. Fecal Coliform Bacteria TMDLs

TMDL Watershed	Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Hughes River	WV-OLK-31	Hughes River	WVLKH	9.01E+11	5.95E+09	4.77E+10	9.55E+11
Hughes River	WV-OLK-31-B	Silver Run	WVLKH-1	1.70E+09		8.96E+07	1.79E+09
Hughes River	WV-OLK-31-C	Lyda Run	WVLKH-2	1.29E+09		6.77E+07	1.35E+09
Goose Creek	WV-OLK-31-E	Goose Creek	WVLKH-4	8.18E+10	1.14E+07	4.31E+09	8.61E+10
Goose Creek	WV-OLK-31-E-2	Lick Run	WVLKH-4-A	3.14E+09		1.65E+08	3.30E+09
Goose Creek	WV-OLK-31-E-3	Second Big Run	WVLKH-4-B	2.43E+09	3.79E+06	1.28E+08	2.56E+09
Goose Creek	WV-OLK-31-E-11	Oil Spring Run	WVLKH-4-G	2.56E+09		1.35E+08	2.69E+09
Goose Creek	WV-OLK-31-E-13	Myers Fork	WVLKH-4-H	5.72E+09		3.01E+08	6.02E+09
Goose Creek	WV-OLK-31-E-17	Long Run	WVLKH-4-I	2.61E+09		1.38E+08	2.75E+09
Goose Creek	WV-OLK-31-E-18	Short Run	WVLKH-4-J	8.22E+08		4.33E+07	8.65E+08
Goose Creek	WV-OLK-31-E-25	Nutter Fork	WVLKH-4-L	6.36E+09	3.79E+06	3.35E+08	6.69E+09
Goose Creek	WV-OLK-31-E-31	Brushy Fork	WVLKH-4-N	4.40E+09		2.32E+08	4.64E+09
Goose Creek	WV-OLK-31-E-36	Layfields Run	WVLKH-4-O	3.46E+09		1.82E+08	3.64E+09
Goose Creek	WV-OLK-31-E-41	Douglas Run	WVLKH-4-Q	4.04E+09		2.13E+08	4.25E+09
Hughes River	WV-OLK-31-F	Rock Run	WVLKH-5	7.15E+08		3.76E+07	7.52E+08
Hughes River	WV-OLK-31-J	Flint Run	WVLKH-8	4.08E+09		2.15E+08	4.30E+09
South Fork/Hughes River	WV-OLK-31-K	South Fork/Hughes River	WVLKH-9	4.24E+11	5.38E+07	2.23E+10	4.47E+11
South Fork/Hughes River	WV-OLK-31-K-4	Big Island Run	WVLKH-9-C	6.89E+09		3.63E+08	7.26E+09
South Fork/Hughes River	WV-OLK-31-K-13	Laurel Run	WVLKH-9-F	5.72E+09		3.01E+08	6.02E+09
South Fork/Hughes River	WV-OLK-31-K-15	MacFarlan Creek	WVLKH-9-G	1.45E+10		7.64E+08	1.53E+10
South Fork/Hughes River	WV-OLK-31-K-16	Dutchman Run	WVLKH-9-H	7.47E+09		3.93E+08	7.86E+09
South Fork/Hughes River	WV-OLK-31-K-20	Indian Creek	WVLKH-9-J	5.87E+10		3.09E+09	6.18E+10
South Fork/Hughes River	WV-OLK-31-K-20-Z	Chevaux De Frise Run	WVLKH-9-J-12	1.21E+10		6.36E+08	1.27E+10
South Fork/Hughes River	WV-OLK-31-K-31	Leatherbark Creek	WVLKH-9-M	2.68E+10	4.55E+06	1.41E+09	2.82E+10
South Fork/Hughes River	WV-OLK-31-K-36	Owl Run	WVLKH-9-O	1.01E+09		5.31E+07	1.06E+09

TMDL Watershed	Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
South Fork/Hughes River	WV-OLK-31-K-39	Lamb Run	WVLKH-9-P	3.94E+09	3.79E+06	2.07E+08	4.15E+09
South Fork/Hughes River	WV-OLK-31-K-40	Grass Run	WVLKH-9-Q	1.45E+10		7.61E+08	1.52E+10
South Fork/Hughes River	WV-OLK-31-K-44	Spruce Creek	WVLKH-9-R	3.96E+10		2.08E+09	4.17E+10
South Fork/Hughes River	WV-OLK-31-K-44-T	Left Fork/Spruce Creek	WVLKH-9-R-9	8.82E+09		4.64E+08	9.28E+09
South Fork/Hughes River	WV-OLK-31-K-44-U	Right Fork/Spruce Creek	WVLKH-9-R-8	4.81E+09		2.53E+08	5.06E+09
South Fork/Hughes River	WV-OLK-31-K-46	Long Run	WVLKH-9-S	7.66E+09		4.03E+08	8.06E+09
South Fork/Hughes River	WV-OLK-31-K-49	Jesse Cain Run	WVLKH-9-T	2.79E+09		1.47E+08	2.93E+09
South Fork/Hughes River	WV-OLK-31-K-53	Smith Run	WVLKH-9-V	1.85E+09		9.72E+07	1.94E+09
South Fork/Hughes River	WV-OLK-31-K-55	Slab Creek	WVLKH-9-W	2.12E+10	3.79E+06	1.11E+09	2.23E+10
South Fork/Hughes River	WV-OLK-31-K-55-B	Wolfpen Run	WVLKH-9-W-1	4.08E+09		2.15E+08	4.29E+09
South Fork/Hughes River	WV-OLK-31-K-55-J	Left Fork/Slab Creek	WVLKH-9-W-4	5.43E+09	3.79E+06	2.86E+08	5.72E+09
South Fork/Hughes River	WV-OLK-31-K-55-K	Right Fork/Slab Creek	WVLKH-9-W-5	2.28E+09		1.20E+08	2.40E+09
South Fork/Hughes River	WV-OLK-31-K-62	Bone Creek	WVLKH-9-X	3.31E+10		1.74E+09	3.48E+10
South Fork/Hughes River	WV-OLK-31-K-62-R	Big Run	WVLKH-9-X-4	2.26E+09		1.19E+08	2.38E+09
South Fork/Hughes River	WV-OLK-31-K-62-S	Left Fork/Bone Creek	WVLKH-9-X-6	5.09E+09		2.68E+08	5.36E+09
South Fork/Hughes River	WV-OLK-31-K-62-T	Right Fork/Bone Creek	WVLKH-9-X-5	4.62E+09		2.43E+08	4.86E+09
South Fork/Hughes River	WV-OLK-31-K-69	Otterslide Creek	WVLKH-9-Y	6.77E+09		3.56E+08	7.12E+09
South Fork/Hughes River	WV-OLK-31-K-72	Turtle Run	WVLKH-9-Z	2.63E+09		1.38E+08	2.76E+09
South Fork/Hughes River	WV-OLK-31-K-73	Middle Fork/South Fork/Hughes River	WVLKH-9-AA	4.18E+10	3.79E+06	2.20E+09	4.40E+10
South Fork/Hughes River	WV-OLK-31-K-73-E	Bear Run	WVLKH-9-AA-2	3.46E+09		1.82E+08	3.64E+09
South Fork/Hughes River	WV-OLK-31-K-73-J	Straight Fork	WVLKH-9-AA-4	5.29E+09		2.78E+08	5.56E+09
South Fork/Hughes River	WV-OLK-31-K-73-M	Upper Run	WVLKH-9-AA-6	5.50E+09		2.89E+08	5.79E+09
South Fork/Hughes River	WV-OLK-31-K-75	White Oak Creek	WVLKH-9-BB	1.50E+10		7.90E+08	1.58E+10
South Fork/Hughes River	WV-OLK-31-K-76	Poverty Hollow	WVLKH-9-CC	1.27E+09		6.66E+07	1.33E+09
South Fork/Hughes River	WV-OLK-31-K-84	Clevenger Hollow	WVLKH-9-DD.5	1.19E+09		6.28E+07	1.26E+09
South Fork/Hughes River	WV-OLK-31-K-93	Holt Run	WVLKH-9-GG.5	5.85E+08		3.08E+07	6.16E+08

TMDL Watershed	Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
South Fork/Hughes River	WV-OLK-31-K-103	Cain Run	WVLKH-9-OO	1.79E+09		9.43E+07	1.89E+09
South Fork/Hughes River	WV-OLK-31-K-105	UNT/South Fork RM 55.73/Hughes River	WVLKH-9-PP	8.62E+08		4.54E+07	9.07E+08
North Fork/Hughes River	WV-OLK-31-L	North Fork/Hughes River	WVLKH-10	3.70E+11	5.87E+09	1.98E+10	3.96E+11
North Fork/Hughes River	WV-OLK-31-L-1	Buffalo Run	WVLKH-10-A	3.50E+09		1.84E+08	3.68E+09
North Fork/Hughes River	WV-OLK-31-L-4	Gillespie Run	WVLKH-10-C	9.84E+09		5.18E+08	1.04E+10
North Fork/Hughes River	WV-OLK-31-L-7	Cabin Run	WVLKH-10-E	2.80E+09		1.47E+08	2.95E+09
North Fork/Hughes River	WV-OLK-31-L-10	UNT/North Fork RM 7.87/Hughes River	WVLKH-10-F.3	9.91E+08		5.21E+07	1.04E+09
North Fork/Hughes River	WV-OLK-31-L-14	Sheep Run	WVLKH-10-H	3.08E+09		1.62E+08	3.25E+09
North Fork/Hughes River	WV-OLK-31-L-17	Slaughterhouse Run	WVLKH-10-I.5	8.21E+08		4.32E+07	8.64E+08
North Fork/Hughes River	WV-OLK-31-L-18	Addis Run	WVLKH-10-J	8.03E+09		4.23E+08	8.45E+09
North Fork/Hughes River	WV-OLK-31-L-19	Rush Run	WVLKH-10-K	2.30E+09		1.21E+08	2.42E+09
North Fork/Hughes River	WV-OLK-31-L-20	Silver Run	WVLKH-10-L	2.90E+09		1.52E+08	3.05E+09
North Fork/Hughes River	WV-OLK-31-L-21	Wildcat Run	WVLKH-10-M	1.57E+09		8.27E+07	1.65E+09
North Fork/Hughes River	WV-OLK-31-L-23	Big Run	WVLKH-10-N	5.18E+09		2.73E+08	5.45E+09
North Fork/Hughes River	WV-OLK-31-L-30	Bonds Creek	WVLKH-10-R	7.37E+10	9.58E+08	3.93E+09	7.86E+10
North Fork/Hughes River	WV-OLK-31-L-30-B	Hushers Run	WVLKH-10-R-1	2.25E+10	9.47E+08	1.24E+09	2.47E+10
North Fork/Hughes River	WV-OLK-31-L-30-K	Comfort Run	WVLKH-10-R-4	7.04E+09	7.58E+06	3.71E+08	7.42E+09
North Fork/Hughes River	WV-OLK-31-L-30-K-5	Beech Run	WVLKH-10-R-4-A	2.86E+09	7.58E+06	1.51E+08	3.02E+09
North Fork/Hughes River	WV-OLK-31-L-30-O	Whiskey Run	WVLKH-10-R-5	6.79E+09		3.58E+08	7.15E+09
North Fork/Hughes River	WV-OLK-31-L-30-U	UNT/Bonds Creek RM 11.47	WVLKH-10-R-5.7	9.66E+08		5.08E+07	1.02E+09
North Fork/Hughes River	WV-OLK-31-L-30-X	McGregor Run	WVLKH-10-R-6	7.12E+08		3.75E+07	7.50E+08
North Fork/Hughes River	WV-OLK-31-L-30-AE	Big Knot Run	WVLKH-10-R-7	1.26E+09		6.63E+07	1.33E+09
North Fork/Hughes River	WV-OLK-31-L-30-AF	Blacks Run	WVLKH-10-R-8	1.16E+09		6.11E+07	1.22E+09
North Fork/Hughes River	WV-OLK-31-L-37-B	Back Run	WVLKH-10-T-1	1.24E+10	2.47E+09	7.80E+08	1.56E+10
North Fork/Hughes River	WV-OLK-31-L-41	Stewart Run	WVLKH-10-V	1.06E+10		5.59E+08	1.12E+10

TMDL Watershed	Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
North Fork/Hughes River	WV-OLK-31-L-42	Cunningham Run	WVLKH-10-W	1.78E+09		9.35E+07	1.87E+09
North Fork/Hughes River	WV-OLK-31-L-45	Bunnell Run	WVLKH-10-Y	1.48E+10	1.89E+09	8.77E+08	1.75E+10
North Fork/Hughes River	WV-OLK-31-L-51	Beason Run	WVLKH-10-AA	9.82E+09		5.17E+08	1.03E+10
North Fork/Hughes River	WV-OLK-31-L-52	Spring Run	WVLKH-10-BB	8.15E+09		4.29E+08	8.58E+09
North Fork/Hughes River	WV-OLK-31-L-56	Lynncamp Run	WVLKH-10-DD	7.93E+09		4.18E+08	8.35E+09
North Fork/Hughes River	WV-OLK-31-L-62	Cabin Run	WVLKH-10-EE	1.68E+10	8.33E+06	8.85E+08	1.77E+10
North Fork/Hughes River	WV-OLK-31-L-62-J	Leason Run	WVLKH-10-EE-1	3.03E+09		1.60E+08	3.19E+09
North Fork/Hughes River	WV-OLK-31-L-63	Dotson Run	WVLKH-10-FF	8.96E+09	1.89E+07	4.72E+08	9.45E+09
North Fork/Hughes River	WV-OLK-31-L-63-I	UNT/Dotson Run RM 2.17	WVLKH-10-FF-9	1.57E+09	3.79E+06	8.30E+07	1.66E+09
North Fork/Hughes River	WV-OLK-31-L-68	Buck Run	WVLKH-10-GG	5.19E+09		2.73E+08	5.46E+09
North Fork/Hughes River	WV-OLK-31-L-72	Poplarlick Run	WVLKH-10-II	5.69E+09		2.99E+08	5.98E+09
North Fork/Hughes River	WV-OLK-31-L-76	Burton Run	WVLKH-10-KK	2.82E+09		1.49E+08	2.97E+09
North Fork/Hughes River	WV-OLK-31-L-79	Marsh Run	WVLKH-10-LL	2.79E+09		1.47E+08	2.94E+09
North Fork/Hughes River	WV-OLK-31-L-80	Lizzies Roost Run	WVLKH-10-MM	2.12E+09		1.11E+08	2.23E+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 1.0492×10^4 or 1.0492E+4.

9.0 FUTURE GROWTH

9.1 Iron

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.
- 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. 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.

- 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.

9.2 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.

10.0 PUBLIC PARTICIPATION

10.1 Public Meetings

An informational public meeting was held on May 15, 2014 at North Bend State Park near Harrisville, 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. A public meeting was held to present the draft TMDLs on June 5, 2018 at the General Thomas M. Harris School Museum at 217 West Main Street, Harrisville, WV 26362 . The meeting provided information to stakeholders was intended to facilitate comments on the draft TMDLs.

10.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised in various local newspapers beginning on May 22, 2018. Interested parties were invited to submit comments during the public comment period, which began on May 22, 2018 and ended on June 22, 2018. At the request of the local watershed association, the comment period was extended to July 6, 2018. The extension was communicated directly to the watershed association; via email notifications sent to those who have requested to receive WVDEP Public Notices; and on the WVDEP website. The electronic documents were also posted on the WVDEP's internet site at www.dep.wv.gov/tmdl.

10.3 Response Summary

The West Virginia Department of Environmental Protection received written comments on the draft TMDL from the Friends of Hughes Watershed Association. Comments have been compiled and responded to in this response summary. Comments and comment summaries are in boldface and italic. Agency responses appear in plain text.

The commenter expressed concern regarding the deterioration of the Hughes River due to development related to the extraction of oil and gas from the watershed. The commenter referred to instances of permit and water quality standard violations and included a WVDEP Order issued to the Antero Midstream LLC facility (Order No. MM-16-04) in February 2016 as an example. The commenter asked that enforcement and fines be increased so that protecting water quality and abiding by the permit is less expensive than paying fines. The commenter referred to evidence of sedimentation described in the TMDL and recommended the DEP use that evidence to begin to mitigate in the Hughes River watershed. He suggested there is a need for proper training to install best management practices (BMPs) and amend soil to ensure that vegetation will grow on disturbed sites.

DEP appreciates the contributions of the Friends of Hughes Watershed. As evidenced through the DEP monitoring and modeling efforts to develop the TMDL for impaired waters in the Hughes River watershed, sedimentation contributes to numeric water quality standard violations for total iron and to conditions not allowable for aquatic life use throughout the watershed. Among other sources of total iron and sedimentation, oil and gas well pads, access roads, pipelines and facilities are represented in the TMDL and prescribed reductions for total iron load allocations. As described in Section 7.7.1, the TMDL scenario assumes total iron loading from existing land disturbing sources are those associated with 100 mg/L TSS. Adhering to the total iron TMDL load allocation by controlling runoff to meet 100 mg/L TSS will result in a commensurate reduction of sediment from the oil and gas related sources.

The TMDL also addresses future oil and gas related construction activities authorized by the OGCSGP (see Section 5.1.2 for a description of activities) by assigning subwatershed-based area allocations for the amount of disturbance from which specific waters can assimilate stormwater runoff with a concentration of 100 mg/L TSS. Adherence to the future growth allocation is expected to protective of the total iron water quality standards in stream. See Section 9.1 for complete details regarding future growth provisions in the TMDL.

The commenter expressed concern that BMPs are not being properly installed and maintained at sites being logged. He acknowledged that DEP does not have authority for forestry sites but requested that DEP communicate issues to the proper agencies to insure timbering companies are licensed and that BMPs are protective of water quality.

The commenter also expressed concern that legislation written to protect source of drinking water specifically related to spill reporting were not being adhered to in the Hughes River watershed, also contributing to deterioration.

The comments regarding oversight of forestry sites and spill reporting are beyond the purview of this TMDL**.**

11.0 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. The West Virginia Watershed Network is a cooperative nonpoint source control effort involving many state and federal agencies, whose task is protection and/or restoration of water quality.

11.1 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 9**.

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. Permits for existing non-mining facilities in the Hughes River Watershed will be reissued beginning in July 2018.

11.2 Watershed Management Framework Process

The Watershed Management Framework is a tool used to identify priority watersheds and coordinate efforts of state and federal agencies with the goal of developing and implementing watershed management strategies through a cooperative, long-range planning effort.

The West Virginia Watershed Network is an informal association of state and federal agencies, and nonprofit organizations interested in the watershed movement in West Virginia. Membership is voluntary and everyone is invited to participate. The Network uses the Framework to coordinate existing programs, local watershed associations, and limited resources. This coordination leads to the development of Watershed Based Plans to implement TMDLs and document environmental results.

The principal area of focus of watershed management through the Framework process is correcting problems related to nonpoint source pollution. Network partners have placed a greater emphasis on identification and correction of nonpoint source pollution. The combined resources of the partners are used to address all different types of nonpoint source pollution through both public education and on-the-ground projects.

Among other things, the Framework includes a management schedule for integration and implementation of TMDLs. In 2000, the schedule for TMDL development under Section 303(d) was merged with the Framework process. The Framework identifies a six-step process for developing integrated management strategies and action plans for achieving the state's water quality goals. Step 3 of that process includes "identifying point source and/or nonpoint source management strategies - or Total Maximum Daily Loads - predicted to best meet the needed [pollutant] reduction." Following development of the TMDL, Steps 5 and 6 provide for preparation, finalization, and implementation of a Watershed Based Plan to improve water quality.

Each year, the Framework is included on the agenda of the Network to evaluate the restoration potential of watersheds within a certain Hydrologic Group. This evaluation includes a review of TMDL recommendations for the watersheds under consideration. Development of Watershed Based Plans is based on the efforts of local project teams. These teams are composed of Network members and stakeholders having interest in or residing in the watershed. Team formation is based on the type of impairment(s) occurring or protection(s) needed within the watershed. In addition, teams have the ability to use the TMDL recommendations to help plan future activities. Additional information regarding upcoming Network activities can be obtained from the Watershed Improvement Branch Basin Coordinator, Tomi Bergstrom (Tomi.M.Bergstrom@wv.gov)

There is one active citizen-based watershed association representing the Hughes River Watershed: Friends of the Hughes. For additional information concerning the association, contact the above mentioned Basin Coordinator or visit https://dep.wv.gov/WWE/getinvolved/WSA_Support/Pages/WGs.aspx

11.3 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.

12.0 MONITORING PLAN

The following monitoring activities are recommended:

12.1 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. Compliance schedules may be implemented that achieve compliance as soon as possible while providing the time necessary to accomplish corrective actions. 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.

12.2 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.

12.3 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.

13.0 REFERENCES

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