June 2016

Modified September 2016

USEPA Approved Report

Total Maximum Daily Loads for the Tygart Valley River Watershed, West Virginia

Prepared for

West Virginia Department of Environmental Protection
Division of Water and Waste Management
Watershed Protection 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
AD	Acid Deposition
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
BPH	[West Virginia] Bureau for Public Health
CFR	Code of Federal Regulations
CSGP	Construction Stormwater General Permit
CSO	combined sewer overflow
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
µg/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
OOG	[WVDEP] Office of Oil and Gas
POTW	publicly owned treatment works
SI	stressor identification
SMCRA	Surface Mining Control and Reclamation Act
SRF	State Revolving Fund
SSO	sanitary sewer overflow
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
WVDOH	West Virginia Division of Highways
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 Tygart Valley River Watershed refers to the tributary streams that ultimately drain to the Tygart Valley River, except for Tygart Lake and its unimpaired tributaries (**Figure I-1**). Tygart Lake occurs where the Tygart River is dammed upstream of the City of Grafton in Taylor County. However, Tygart Lake was not considered 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 Tygart Valley 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 251 impaired streams contained within 84 TMDL watersheds in the Tygart Valley 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 84 TMDL watersheds have been subdivided into 520 modeled subwatersheds. Pollutant sources, allocations and reductions are presented at the subwatershed scale to facilitate future permitting actions and TMDL implementation.

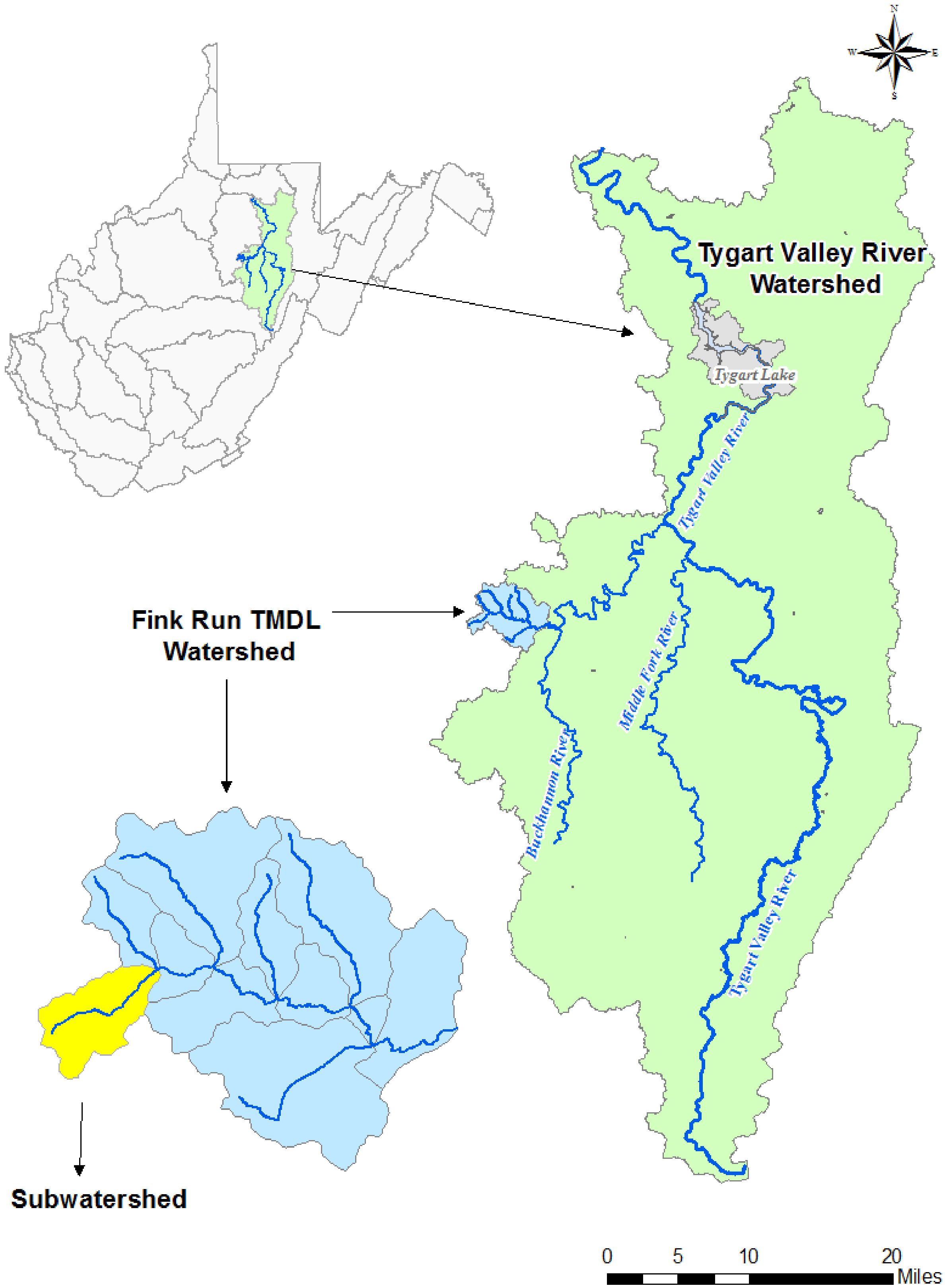


Figure I-1. Examples of a watershed, TMDL watershed, and subwatershed

EXECUTIVE SUMMARY

This report includes Total Maximum Daily Loads (TMDLs) for 251 impaired streams in the Tygart Valley watershed. This project was organized into 84 TMDL watersheds, which account for all streams draining to the Tygart, except for unimpaired tributaries draining to the Tygart Lake.

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 at 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 2012 Section 303(d) List or draft 2014 Section 303(d) List. Documented impairments are related to numeric water quality criteria for total iron, dissolved aluminum, total beryllium, pH, dissolved oxygen, and fecal coliform bacteria.

The narrative water quality criterion of 47 CSR 2–3.2.i prohibits the presence of wastes in state waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, and biological components of aquatic ecosystems. Historically, WVDEP based assessment of biological integrity on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index (WVSCI). WVSCI-based "biological impairments" were included on West Virginia Section 303(d) lists from 2002 through 2010.

Recent 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, 51 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 recent USEPA oversight activities relative to Clean Water Act Section 303(d) and the relationship of the pollutant-specific TMDLs developed herein to WVSCI-based biological impacts.

Impaired waters were organized into 84 TMDL watersheds. For hydrologic modeling purposes, impaired and unimpaired streams in these 84 TMDL watersheds were further divided into 520 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, iron, beryllium, pH, and aluminum. 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, and stormwater discharges from Municipal Separate Storm Sewer Systems (MS4s). The presence of individual source categories and their relative significance varies by subwatershed.

There are 6 dissolved oxygen impairments in 5 TMDL watersheds. In general, sources contributing to dissolved oxygen impairments are the same as those for fecal coliform. Because of the effect of reducing organic loadings, the fecal coliform TMDLs developed by WVDEP are appropriate surrogates for the dissolved oxygen impairment for these streams.

Iron impairments are also attributable to both point and nonpoint sources. Nonpoint sources of iron include abandoned mine lands (AML), roads, oil and gas operations, timbering, agriculture, urban/residential land disturbance and streambank erosion. Iron point sources include the permitted discharges from mining activities, bond forfeiture sites, and stormwater contributions from MS4 and construction sites. The presence of individual source categories and their relative significance also varies by subwatershed. Because iron is a naturally-occurring element that is present in soils, the iron loading from many of the identified sources is associated with sediment contributions.

The pH and dissolved aluminum impairments in the watershed are attributable to two separate source categories, acid precipitation and legacy mining (including abandoned mine lands and permitted bond forfeited sites). In certain watersheds with low buffering capacity, acidic precipitation decreases pH below the pH criterion. Decreased pH may in turn increase the portion of aluminum in solution and result in exceedances of the dissolved aluminum criterion. Legacy mine land sources (seeps) are a source of dissolved aluminum and acidity resulting in criteria impairments. In most cases the acidic pH impairments coincide with overlapping metals impairments and the TMDLs for pH impairments were developed using an approach where instream metal (iron and aluminum) concentrations were reduced for attainment of iron and aluminum water quality criteria coupled with direct pollutant reductions to offset acid load from acid precipitation and legacy mine sources. Pollutant reductions are measured and expressed in the amount of alkalinity needed to offset the acid load.

Four beryllium impaired streams in 3 TMDL watersheds are addressed in this report. Beryllium exceedances were only detected in streams when the pH was less than 5 and in watersheds where legacy mining influences were prevalent and the most likely source of beryllium and acidity. The most elevated beryllium exceedances were observed during low flow conditions. Acidity abatement pursuant to the pH TMDLs will create instream pH conditions that limit the solubility of beryllium to the point where the beryllium water quality criterion will be attained. Thus the pH TMDL serve as surrogates for beryllium water quality criterion nonattainment.

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

In 2001 USEPA, with support from WVDEP developed TMDLs for pH and metals impaired streams in the Tygart Valley River Watershed (USEPA, 2001). In 1998, USEPA developed metals and pH TMDLs for the Buckhannon River, and iron and aluminum TMDLs for Tenmile Creek of the Buckhannon River (USEPA, 1998a; USEPA, 1998b). In this project, all impaired streams for which TMDLs were developed in 2001 and 1998 have been re-evaluated and new TMDLs, consistent with currently effective water quality criteria, are presented for all current identified impairments. Upon approval, all of the TMDLs presented herein shall supersede those developed previously. Re-evaluation also determined that certain impairments for which TMDLs were developed are no longer effective due to West Virginia water quality standard revisions and new water quality monitoring. All previously developed total aluminum and manganese TMDLs are not effective because of water quality criteria revision.

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. The TMDL modeling is among the most sophisticated 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 10** of this report. The accompanying spreadsheets provide TMDLs and allocations of loads to categories of point and nonpoint sources that achieve the total TMDL. Also provided is the 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

This report describes the overall total maximum daily load (TMDL) development process for select streams in the Tygart Valley River Watershed, identifies impaired streams, and outlines the source assessment for all pollutants for which TMDLs are presented. It also describes the modeling and allocation processes and lists measures that will be taken to ensure that the TMDLs are met. The applicable TMDLs are displayed in **Section 10** of this report. The report is supported by an ArcGIS Viewer Project that provides 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 2014 TMDLs should be pursued in Hydrologic Group B, which includes the Tygart Valley River Watershed. **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.

In 2001 USEPA, with support from WVDEP developed TMDLs for pH and metals impaired streams in the Tygart Valley River Watershed (USEPA, 2001). Before that, in 1998, USEPA developed metals and pH TMDLs for the Buckhannon River, and iron and aluminum TMDLs for Tenmile Creek of the Buckhannon River (USEPA, 1998a; USEPA, 1998b). The older TMDLs were developed by USEPA in 2001 and 1998 with a less robust stream monitoring and source tracking dataset and a lower resolution modeling approach. While pursuing TMDL development for other impairments, WVDEP obtained more comprehensive data and developed new TMDLs under a more refined modeling approach. Upon approval, the TMDLs presented herein shall supersede those developed previously.

Appendix A of the Technical Report indicates the previous TMDLs for which new TMDLs are developed and describes previous TMDLs that are no longer effective.

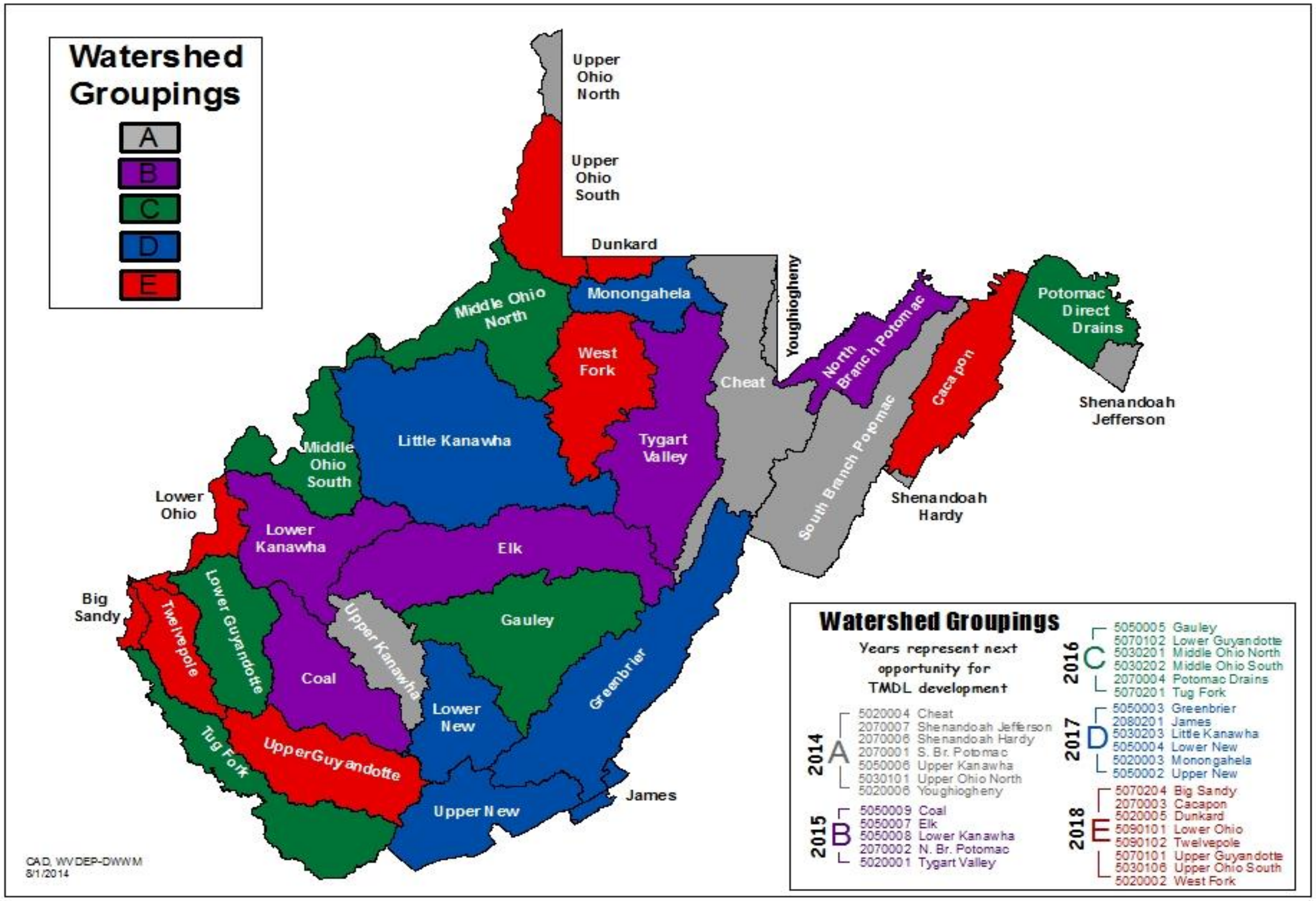


Figure 2-1. Hydrologic groupings of West Virginia's watersheds

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 at 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 include: propagation and maintenance of aquatic life in warmwater fisheries and troutwaters, water contact recreation, and public water supply. In various streams in the Tygart Valley River Watershed, warmwater fishery aquatic life use impairments have been determined pursuant to exceedances of total iron, dissolved aluminum, dissolved oxygen and/or pH numeric water quality criteria. Troutwater aquatic life use impairments have been determined pursuant to exceedances of total iron, dissolved aluminum, dissolved oxygen and/or pH numeric water quality criteria. Water contact recreation and/or public water supply use impairments have also been determined in various waters pursuant to exceedances of numeric water quality criteria for fecal coliform bacteria, pH, total beryllium, dissolved oxygen, 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]	
Aluminum, dissolved (µg/L)	750	750	750	87	--
Iron, total (mg/L)	--	1.5	--	1.0	1.5
Beryllium, total (µg/L)	130		130		4 (µg/L)
Dissolved oxygen	Not less than 5 mg/L at any time	Not less than 5 mg/L at any time	Not less than 6 mg/L at any time	Not less than 6 mg/L at any time	Not less than 5 mg/L at any time
pH	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0
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 Tygart Valley River is a major tributary of the Monongahela River, which is a major tributary of the Ohio River that joins the Mississippi and flows to the Gulf of Mexico. The Tygart Watershed consists of land draining to the Tygart Valley River, which begins as a mountain headwater stream in Pocahontas County, and ends where the Tygart and the West Fork rivers converge to form the Monongahela River at Fairmont. This river is approximately 140 miles (226 km) long, and its watershed encompasses 1,375 square miles (3,561 km^2). The Tygart Valley River is dammed above the City of Grafton in Taylor County to make Tygart Lake. Of the 1,375 total square miles in the watershed, only 1,350 square miles were modeled under this TMDL effort, because the Tygart Lake and its un-impaired tributaries were not modeled.

The Tygart Valley River Watershed lies within the high Allegheny Mountains of north-central West Virginia, and occupies large portions of Randolph, Upshur, Barbour and Taylor counties (**Figure 3-1**). The watershed also falls within small portions of Preston, Pocahontas, Tucker, Monongalia, and Marion counties. Cities and towns in the vicinity of the area of study are Elkins, Buckhannon, Philippi, Grafton, and Fairmont. The highest point in the modeled portion of the Tygart Watershed is 4,746 feet above sea level on Cheat Mountain, 3 miles west of Cass, WV. The lowest point in the modeled portion of the watershed is 863 feet at the confluence of the Tygart and West Fork rivers in Fairmont. The average elevation in the modeled portion of the watershed is 1,994 feet. The total population living in the subject watersheds of this report is estimated to be 85,000 people.

Major tributaries of the Tygart Valley River include the Buckhannon River, Middle Fork River, Teter Creek, and Three Fork Creek. This project was organized into 84 TMDL watersheds. **Figure 3-2** displays the extent of the Tygart Valley River Watershed and the TMDL watersheds associated with this project.

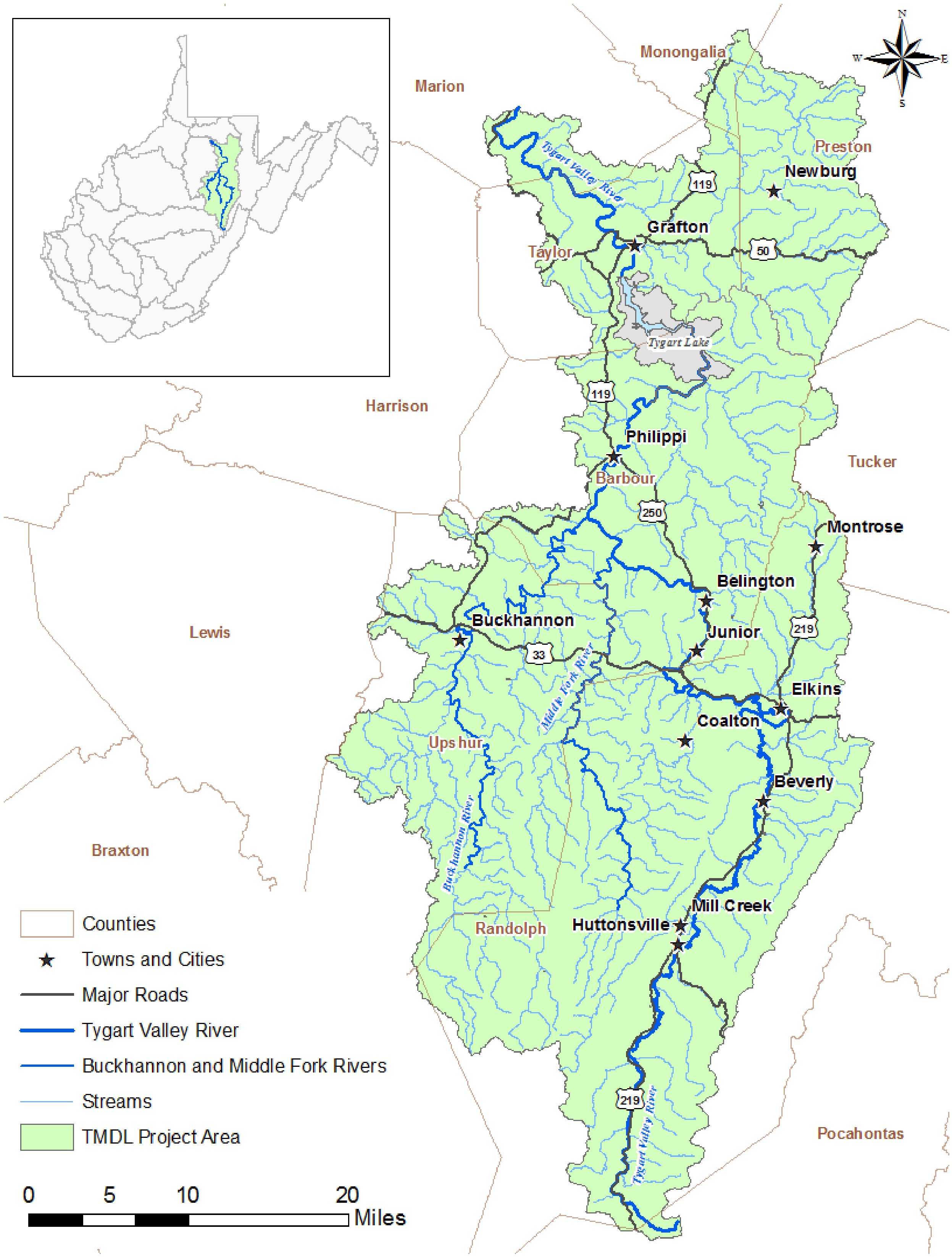


Figure 3-1. Location of the Tygart Valley River Watershed TMDL Project Area in West Virginia

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 2011 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 74.21 percent of the total landuse area. Other important modeled landuse types are forestry (5.50 percent), grassland (5.24 percent), agricultural (cropland/pasture, 5.47 percent combined), urban/residential (6.64 percent), and mining/quarry (1.15 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 Tygart Valley TMDL watersheds

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
Abandoned Mine Lands	1,307.95	2.04	0.15%
Barren	2,363.60	3.69	0.27%
Cropland	20,467.14	31.98	2.37%
Forest	641,173.63	1001.83	74.21%
Forestry	47,507.64	74.23	5.50%
Grassland	45,286.40	70.76	5.24%
Mining/Quarry	9,952.62	15.55	1.15%
Oil and Gas	7,064.96	11.04	0.82%
Pasture	26,761.35	41.81	3.10%
Urban/Residential	57,352.03	89.61	6.64%
Water	4,797.93	7.50	0.56%
Total	864,035.23	1350.06	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 2011 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	2011 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 Tygart Valley River Watershed from 2012 through 2013. 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 84 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.

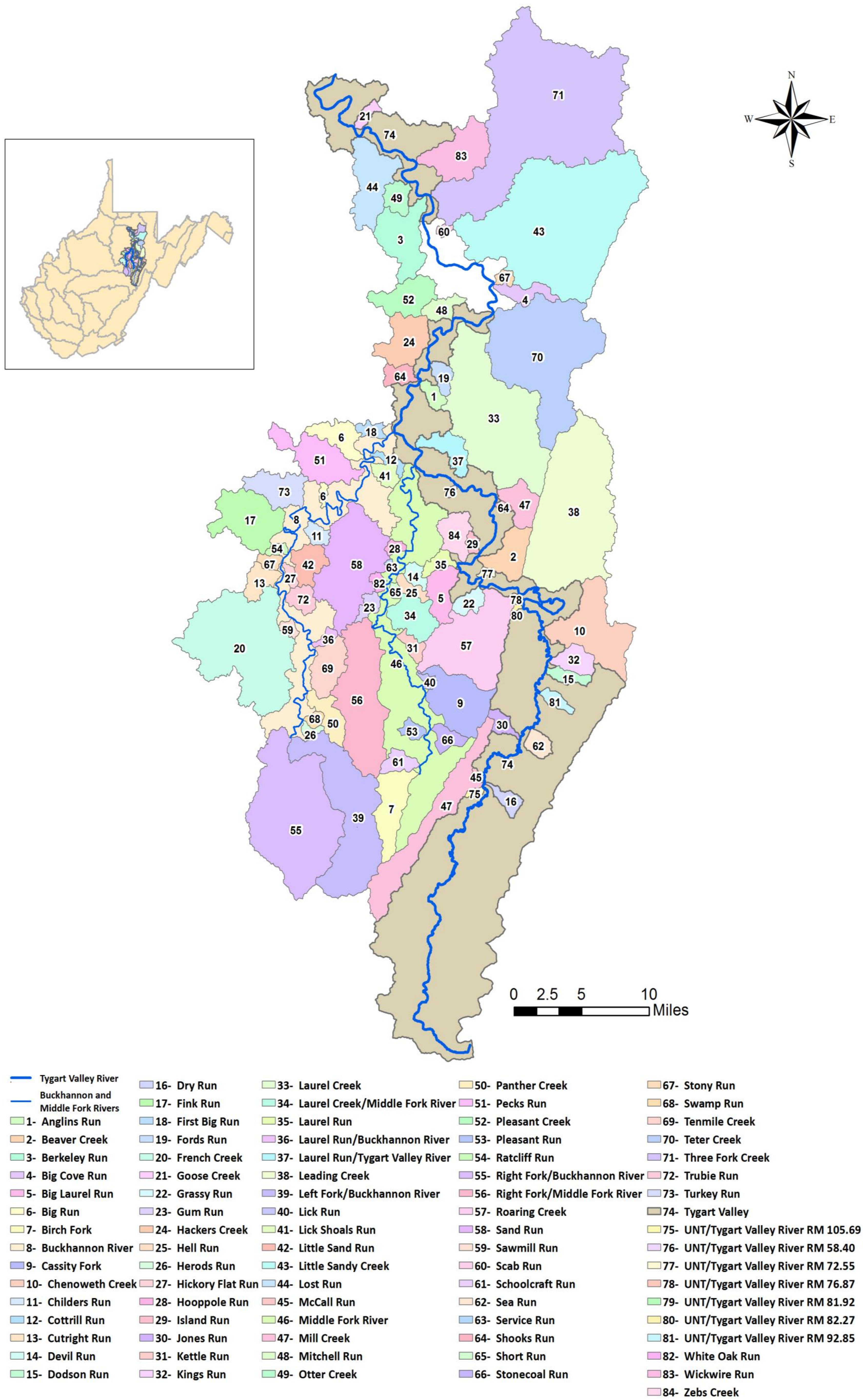


Figure 3-2. Tygart Valley TMDL Watersheds

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

Subwatershed	Stream Name	NHD Code	Trout	pH	Al	DO	Fe	Be	FC
Tygart Valley	Tygart Valley River	WV-MT	X*				X		X
Island Run	Island Run	WV-MT-108					M		
Beaver Creek	Beaver Creek	WV-MT-109		X	X		M		
Beaver Creek	UNT/Beaver Creek RM 2.02	WV-MT-109-D		M	M		M		
Goose Creek	Goose Creek	WV-MT-11		X	X		X		X
Zebs Creek	Zebs Creek	WV-MT-112	X				M		X
Laurel Run	Laurel Run	WV-MT-114	X				M		
Big Laurel Run	Big Laurel Run	WV-MT-115	X				M		
Big Laurel Run	Little Laurel Run	WV-MT-115-B	X	X	X		M		
Tygart Valley	UNT/Tygart Valley River RM 71.66	WV-MT-116					M		
UNT/Tygart Valley River RM 72.55	UNT/Tygart Valley River RM 72.55	WV-MT-117		X	X		X		
Grassy Run	Grassy Run	WV-MT-119		X	X		X		
Grassy Run	UNT/Grassy Run RM 0.45	WV-MT-119-A		M	M				
Lost Run	Lost Run	WV-MT-12					M		X
Roaring Creek	Roaring Creek	WV-MT-120		X	X		M		
Roaring Creek	UNT/Roaring Creek RM 4.09	WV-MT-120-I		X	X		X		
Roaring Creek	Laurel Run	WV-MT-120-L					M		
Roaring Creek	Flatbush Fork	WV-MT-120-U	X	X	X		M		
Roaring Creek	UNT/Flatbush Fork RM 0.78	WV-MT-120-U-3		X	X		M		
Roaring Creek	UNT/Flatbush Fork RM 1.80	WV-MT-120-U-4		X	X		M		
Roaring Creek	UNT/Roaring Creek RM 10.51	WV-MT-120-X		M	M		M		
Roaring Creek	UNT/Roaring Creek RM 11.0	WV-MT-120-Y		X					
UNT/Tygart Valley River RM 76.87	UNT/Tygart Valley River RM 76.87	WV-MT-122					X		X
Leading Creek	Leading Creek	WV-MT-125					X		X
Leading Creek	UNT/Leading Creek RM 0.47	WV-MT-125-A					M		
Leading Creek	Cherry Fork	WV-MT-125-AC					M		
Leading Creek	Laurel Run	WV-MT-125-AN					M		X
Leading Creek	Craven Run	WV-MT-125-B					M		X
Leading Creek	Claylick Run	WV-MT-125-D					M		
Leading Creek	Pearcy Run	WV-MT-125-L					M		
Leading Creek	Stalnaker Run	WV-MT-125-M					M		

Subwatershed	Stream Name	NHD Code	Trout	pH	Al	DO	Fe	Be	FC
Leading Creek	Davis Lick	WV-MT-125-S					X		X
UNT/Tygart Valley River RM 81.92	UNT/Tygart Valley River RM 81.92	WV-MT-136					X		
UNT/Tygart Valley River RM 82.27	UNT/Tygart Valley River RM 82.27	WV-MT-137					X		X
Chenoweth Creek	Chenoweth Creek	WV-MT-146	X				M		X
Chenoweth Creek	Isner Creek	WV-MT-146-F							X
Chenoweth Creek	Left Fork/Chenoweth Creek	WV-MT-146-Q					M		
Tygart Valley	Whitman Run	WV-MT-148					M		
Tygart Valley	Beaver Creek	WV-MT-151	X				M		
Kings Run	Kings Run	WV-MT-152					M		X
Dodson Run	Dodson Run	WV-MT-153							X
Tygart Valley	Files Creek	WV-MT-157	X				M		
Tygart Valley	Right Fork/Files Creek	WV-MT-157-D	X				M		
Tygart Valley	Left Fork/Files Creek	WV-MT-157-E	X				M		
UNT/Tygart Valley River RM 92.85	UNT/Tygart Valley River RM 92.85	WV-MT-159					X		X
Tygart Valley	Glady Creek	WV-MT-16					M		
Tygart Valley	Plum Run	WV-MT-17					M		
Sea Run	Sea Run	WV-MT-171							X
Jones Run	Jones Run	WV-MT-177					M		X
Wickwire Run	Wickwire Run	WV-MT-18					M		X
Wickwire Run	Dog Run	WV-MT-18-C					M		
Wickwire Run	UNT/Wickwire Run RM 4.39	WV-MT-18-D					M		
Wickwire Run	UNT/Wickwire Run RM 5.22	WV-MT-18-E					M		
Otter Creek	Otter Creek	WV-MT-20					M		X
McCall Run	McCall Run	WV-MT-205							X
Dry Run	Dry Run	WV-MT-206					M		X
Mill Creek	Mill Creek	WV-MT-207	X*				M		X
Mill Creek	Right Fork/Mill Creek	WV-MT-207-A					M		X
Mill Creek	Meatbox Run	WV-MT-207-N	X	X	X				
Mill Creek	Potatohole Fork	WV-MT-207-P	X	X	X		M		
UNT/Tygart Valley River RM 105.69	UNT/Tygart Valley River RM 105.69	WV-MT-208					X		X
Berkeley Run	Berkeley Run	WV-MT-24					X		X
Tygart Valley	Stewart Run	WV-MT-243	X				M		

Subwatershed	Stream Name	NHD Code	Trout	pH	Al	DO	Fe	Be	FC
Berkeley Run	Shelby Run	WV-MT-24-A					M		X
Berkeley Run	Long Run	WV-MT-24-B					X		X
Berkeley Run	Berry Run	WV-MT-24-B-2					X		X
Three Fork Creek	Three Fork Creek	WV-MT-25		X	M		M		X
Tygart Valley	Conley Run	WV-MT-254	X				M		
Tygart Valley	Ralston Run	WV-MT-258	X				M		
Tygart Valley	Windy Run	WV-MT-259	X				M		
Three Fork Creek	Martins Run	WV-MT-25-AA							X
Three Fork Creek	Lick Run	WV-MT-25-AD		X	X		M		
Three Fork Creek	Birds Creek	WV-MT-25-AE		X	X		M	X	
Three Fork Creek	Squires Creek	WV-MT-25-AE-1		X	X		X	X	
Three Fork Creek	UNT/Squires Creek RM 2.40	WV-MT-25-AE-1-B		X	X		X		
Three Fork Creek	UNT/Birds Creek RM 0.64	WV-MT-25-AE-2		X	X		X		
Three Fork Creek	UNT/Birds Creek RM 2.57	WV-MT-25-AE-4		M	X				
Three Fork Creek	Fields Creek	WV-MT-25-AF	X	X	X		X		X
Three Fork Creek	Stony Run	WV-MT-25-AF-1					M		
Three Fork Creek	Brains Creek	WV-MT-25-AF-3	X				M		X
Three Fork Creek	UNT/Three Fork Creek RM 2.02	WV-MT-25-C					M		X
Three Fork Creek	Rocky Branch	WV-MT-25-E							X
Three Fork Creek	Little Laurel Run	WV-MT-25-N					M		
Three Fork Creek	Raccoon Creek	WV-MT-25-R		X	X		X		
Three Fork Creek	Cooks Run	WV-MT-25-R-2		M	M		M		
Three Fork Creek	Little Raccoon Creek	WV-MT-25-R-5					M		X
Three Fork Creek	Laurel Run	WV-MT-25-V	X				M		X
Scab Run	Scab Run	WV-MT-26					M		X
Tygart Valley	Logan Run	WV-MT-264	X				M		
Tygart Valley	Big Run	WV-MT-268	X				M		
Pleasant Creek	Pleasant Creek	WV-MT-30					M		X
Little Sandy Creek	Sandy Creek	WV-MT-34					M		X
Little Sandy Creek	Swamp Run	WV-MT-34-D					M		
Little Sandy Creek	Glade Run	WV-MT-34-G					M		
Little Sandy Creek	Little Cove Run	WV-MT-34-H					M		X
Little Sandy Creek	Little Sandy Creek	WV-MT-34-J		X	X		X		
Little Sandy Creek	York Run	WV-MT-34-J-13					M		X
Little Sandy Creek	Right Fork/Little Sandy Creek	WV-MT-34-J-18	X				M		
Little Sandy Creek	Tibbs Run	WV-MT-34-J-18-B					M		

Subwatershed	Stream Name	NHD Code	Trout	pH	Al	DO	Fe	Be	FC
Little Sandy Creek	Left Fork/Little Sandy Creek	WV-MT-34-J-19		X	X		X	X	
Little Sandy Creek	Maple Run	WV-MT-34-J-8		X	X		X		
Little Sandy Creek	Oldroad Run	WV-MT-34-K					M		
Little Sandy Creek	Left Fork/Sandy Creek	WV-MT-34-L					M		X
Little Sandy Creek	UNT/Left Fork RM 4.58/Sandy Creek	WV-MT-34-L-10					M		X
Little Sandy Creek	UNT/Sandy Creek RM 10.47	WV-MT-34-N					M		X
Little Sandy Creek	UNT/UNT RM 0.56/Sandy Creek RM 10.47	WV-MT-34-N-1		X			M		
Stony Run	Stony Run	WV-MT-38							X
Big Cove Run	Big Cove Run	WV-MT-39					M		X
Teter Creek	Teter Creek	WV-MT-43	X				M		X
Teter Creek	Glade Run	WV-MT-43-B					M		X
Teter Creek	Raccoon Creek	WV-MT-43-C					M		X
Teter Creek	Stony Run	WV-MT-43-C-5					M		X
Teter Creek	Brushy Fork	WV-MT-43-H	X*				M		X
Teter Creek	Mill Run	WV-MT-43-L	X				M		X
Teter Creek	Jimmy Run	WV-MT-43-M		X			M		
Teter Creek	Mill Run	WV-MT-43-S	X				M		
Laurel Creek	Laurel Creek	WV-MT-46	X				M		
Laurel Creek	Moats Hollow	WV-MT-46-B					M		
Laurel Creek	Frost Run	WV-MT-46-C					M		X
Laurel Creek	Sugar Creek	WV-MT-46-J				X	M		X
Laurel Creek	Bills Creek	WV-MT-46-J-10					M		
Laurel Creek	Hunter Fork	WV-MT-46-J-24							X
Laurel Creek	Long Run	WV-MT-46-J-25							X
Laurel Creek	Glady Creek	WV-MT-46-J-3					X		X
Laurel Creek	UNT/Glady Creek RM 3.68	WV-MT-46-J-3-F					M		
Laurel Creek	Whitman Run	WV-MT-46-J-7					M		X
Laurel Creek	Bonica Run	WV-MT-46-K					M		X
Mitchell Run	Mitchell Run	WV-MT-48					M		X
Hackers Creek	Hackers Creek	WV-MT-50					X		X
Hackers Creek	Taylor Drain	WV-MT-50-A					X		X
Hackers Creek	Foxgrape Run	WV-MT-50-B					X		X
Hackers Creek	Little Hackers Creek	WV-MT-50-C					X		X
Fords Run	Fords Run	WV-MT-51		X	X		X		X
Shooks Run	Shooks Run	WV-MT-53					M		X

Subwatershed	Stream Name	NHD Code	Trout	pH	Al	DO	Fe	Be	FC
Anglins Run	Anglins Run	WV-MT-54							X
Tygart Valley	Little Laurel Run	WV-MT-56					M		
Buckhannon River	Buckhannon River	WV-MT-62	X*				M		X
Big Run	Big Run	WV-MT-62-AA					X		X
Childers Run	Childers Run	WV-MT-62-AB					M		X
Turkey Run	Turkey Run	WV-MT-62-AE					M		X
Turkey Run	Sugar Run	WV-MT-62-AE-3					M		X
Fink Run	Fink Run	WV-MT-62-AH					X		X
Fink Run	Bridge Run	WV-MT-62-AH-10				X	X		X
Fink Run	Sauls Run	WV-MT-62-AH-12					M		
Fink Run	Brushy Fork	WV-MT-62-AH-4					X		X
Fink Run	Mud Lick	WV-MT-62-AH-5					X		X
Fink Run	Wash Run	WV-MT-62-AH-8					M		X
Little Sand Run	Little Sand Run	WV-MT-62-AN				X	M		X
Little Sand Run	Left Fork/Little Sand Run	WV-MT-62-AN-2							X
Ratcliff Run	Ratcliff Run	WV-MT-62-AO					M		X
Stony Run	Stony Run	WV-MT-62-AP					M		X
Hickory Flat Run	Hickory Flat Run	WV-MT-62-AR					M		X
Cutright Run	Cutright Run	WV-MT-62-AS					X		X
Cutright Run	Lick Run	WV-MT-62-AS-5					X		X
French Creek	French Creek	WV-MT-62-AV					X		X
French Creek	Laurel Fork	WV-MT-62-AV-12	X				M		X
French Creek	Queens Fork	WV-MT-62-AV-12-H					M		
French Creek	Grassy Creek	WV-MT-62-AV-12-J					M		
French Creek	Kittle Run	WV-MT-62-AV-14					M		
French Creek	Morgan Run	WV-MT-62-AV-15					X		X
French Creek	Grub Hollow	WV-MT-62-AV-16					X		X
French Creek	Brush Run	WV-MT-62-AV-17					M		X
French Creek	Little Brush Run	WV-MT-62-AV-17-A					M		
French Creek	Slab Camp Fork	WV-MT-62-AV-19					X		X
French Creek	Left Fork/French Creek	WV-MT-62-AV-24					M		X
French Creek	Bull Run	WV-MT-62-AV-7				X	X		X
French Creek	Blacklick Run	WV-MT-62-AV-7-B		X	X		X		
French Creek	Mudlick Run	WV-MT-62-AV-7-C				X	X		X
French Creek	Grand Camp Run	WV-MT-62-AV-9	X	M	X		M		X
Trubie Run	Trubie Run	WV-MT-62-AW					M		X
Sawmill Run	Sawmill Run	WV-MT-62-BA					X		X

Subwatershed	Stream Name	NHD Code	Trout	pH	Al	DO	Fe	Be	FC
Buckhannon River	Grassy Run	WV-MT-62-BD					M		
Buckhannon River	Little Laurel Run	WV-MT-62-BF					M		
Laurel Run/ Buckhannon River	Laurel Run	WV-MT-62-BG					M		X
Tenmile Creek	Tenmile Creek	WV-MT-62-BH	X				M		
Tenmile Creek	Right Fork/Tenmile Creek	WV-MT-62-BH-1	X*				M		X
Panther Creek	Panther Creek	WV-MT-62-BN	X*	X			M		
Buckhannon River	Big Run	WV-MT-62-BR	X*				M		
Swamp Run	Swamp Run	WV-MT-62-CB		X	M		M		
Herods Run	Herods Run	WV-MT-62-CC		X	M		M		
Right Fork/ Buckhannon River	Right Fork/Buckhannon River	WV-MT-62-CE	X				M		
Right Fork/ Buckhannon River	Marsh Fork	WV-MT-62-CE-21	X				M		
Right Fork/ Buckhannon River	UNT/Right Fork RM 12.18/Buckhannon River	WV-MT-62-CE-22		X					
Right Fork/ Buckhannon River	Millsite Run	WV-MT-62-CE-6	X				M		
Right Fork/ Buckhannon River	Left Fork/Right Fork/Buckhannon River	WV-MT-62-CE-8	X				M		
Right Fork/ Buckhannon River	Middle Fork/Right Fork/Buckhannon River	WV-MT-62-CE-9					M		
Left Fork/ Buckhannon River	Left Fork/Buckhannon River	WV-MT-62-CF	X				M		
Left Fork/ Buckhannon River	Beech Run	WV-MT-62-CF-16	X				M		
Left Fork/ Buckhannon River	Smooth Rock Lick Run	WV-MT-62-CF-3		X			M		
Left Fork/ Buckhannon River	Bearcamp Run	WV-MT-62-CF-7	X	X			M		
First Big Run	First Big Run	WV-MT-62-E					M		X
Cottrill Run	Cottrill Run	WV-MT-62-J					X		X
Big Run	Big Run	WV-MT-62-L					X		X
Lick Shoals Run	Lick Shoals Run	WV-MT-62-N					M		X
Pecks Run	Pecks Run	WV-MT-62-P					X		X
Pecks Run	Mud Run	WV-MT-62-P-11							X
Pecks Run	UNT/Pecks Run RM 2.24	WV-MT-62-P-2					M		X
Pecks Run	Little Pecks Run	WV-MT-62-P-6					M		X
Buckhannon River	Handy Camp Run	WV-MT-62-U					M		
Sand Run	Sand Run	WV-MT-62-V					M		X
Sand Run	Laurel Fork	WV-MT-62-V-2					M		X
Sand Run	Little Laurel Fork	WV-MT-62-V-2-A					M		
Sand Run	Left Fork/Sand Run	WV-MT-62-V-9					M		X

Subwatershed	Stream Name	NHD Code	Trout	pH	Al	DO	Fe	Be	FC
Laurel Run/ Tygart Valley River	Laurel Run	WV-MT-68					M		X
Tygart Valley	Guyses Run	WV-MT-7					M		
Middle Fork River	Middle Fork River	WV-MT-72	X*				X		
White Oak Run	White Oak Run	WV-MT-72-AA		X			M		
White Oak Run	UNT/White Oak Run RM 0.44	WV-MT-72-AA-1		X	X		M		
Gum Run	Gum Run	WV-MT-72-AB							X
Gum Run	UNT/Gum Run RM 1.18	WV-MT-72-AB-2					M		X
Laurel Creek/ Middle Fork River	Laurel Creek	WV-MT-72-AE	X				M		X
Laurel Creek/Middle Fork River	Brook Run	WV-MT-72-AE-1	X	X	X		M		X
Right Fork/Middle Fork River	Right Fork/Middle Fork River	WV-MT-72-AH	X				X		X
Right Fork/ Middle Fork River	Osborne Run	WV-MT-72-AH-1					M		
Right Fork/ Middle Fork River	Jackson Fork	WV-MT-72-AH-12	X				M		
Right Fork/ Middle Fork River	Jenks Fork	WV-MT-72-AH-13	X	X			M		
Right Fork/ Middle Fork River	Laurel Run	WV-MT-72-AH-5					M		
Right Fork/ Middle Fork River	Laurel Run	WV-MT-72-AH-7					M		
Kettle Run	Kettle Run	WV-MT-72-AK		X	X				
Middle Fork River	Long Run	WV-MT-72-AL	X				M		
Lick Run	Lick Run	WV-MT-72-AT		X			M		
Cassity Fork	Cassity Fork	WV-MT-72-AU	X*	X	X		X	X	
Cassity Fork	Panther Run	WV-MT-72-AU-3	X*	M	X		X		
Cassity Fork	UNT/Panther Run RM 0.62	WV-MT-72-AU-3-A	X	X	X		M		
Cassity Fork	Mulberry Fork	WV-MT-72-AU-5		X			M		
Middle Fork River	Three Forks Run	WV-MT-72-AV	X				M		
Stonecoal Run	Stonecoal Run	WV-MT-72-BA	X	X	X		M		
Pleasant Run	Pleasant Run	WV-MT-72-BC	X	X			M		
Middle Fork River	Laurel Run	WV-MT-72-BD	X				M		
Middle Fork River	Laurel Branch	WV-MT-72-BE	X				M		
Middle Fork River	Spice Run	WV-MT-72-BG	X				M		
Schoolcraft Run	Schoolcraft Run	WV-MT-72-BH	X				M		
Schoolcraft Run	Birch Fork	WV-MT-72-BH-2	X	X	X		M		
Birch Fork	Birch Fork	WV-MT-72-BI	X				M		
Birch Fork	Rocky Run	WV-MT-72-BI-2	X	X	X		M		
Middle Fork River	Kittle Creek	WV-MT-72-BJ	X				M		

Subwatershed	Stream Name	NHD Code	Trout	pH	Al	DO	Fe	Be	FC
Middle Fork River	Mitchell Lick Fork	WV-MT-72-BJ-1	X				M		
Middle Fork River	Hanging Run	WV-MT-72-O	X				M		
Middle Fork River	Laurel Run	WV-MT-72-Q					M		
Hooppole Run	Hooppole Run	WV-MT-72-T					X		
Devil Run	Devil Run	WV-MT-72-V	X	X	M		M		
Service Run	Service Run	WV-MT-72-W		X					
Hell Run	Hell Run	WV-MT-72-X	X	X	X		M		
Short Run	Short Run	WV-MT-72-Z	X	X	X		M		
Tygart Valley	UNT/Tygart Valley River RM 55.89	WV-MT-77					M		
Tygart Valley	Gower Run	WV-MT-78					M		
UNT/Tygart Valley River RM 58.40	UNT/Tygart Valley River RM 58.40	WV-MT-83					X		
Tygart Valley	Big Run	WV-MT-94					M		
Mill Creek	Mill Creek	WV-MT-96	X			X	X		X
Mill Creek	UNT/Mill Creek RM 2.11	WV-MT-96-E					M		
Shooks Run	Shooks Run	WV-MT-97					M		X

Note:
RM river mile
UNT unnamed tributary
Trout X = entire length, X*= segment is designated trout. See Technical Report Appendix A for details.
pH acidity impairment
DO dissolved oxygen impairment
Fe iron impairment
Al aluminum impairment
Be beryllium impairment
FC fecal coliform bacteria impairment
M Impairment determined via modeling

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. This 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. Although this project does not include "biological impairment" TMDLs, SI results are presented for 51 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. The SI process demonstrated that biological stress would be resolved in 28 of those streams through the implementation of numeric criterion TMDLs developed in this project (**Table 4.1**).

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. A SI process was implemented to identify the significant stressors associated with identified impacts. Streams with WVSCI scores less than 68 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) causes toxicity
3. Basic (high pH >9) causes toxicity
4. Increased ionic strength causes toxicity
5. Organic enrichment (e.g. sewage discharges and agricultural runoff cause habitat alterations
6. Increased metals flocculation and deposition causes habitat alterations (e.g., embeddedness)
7. Increased total suspended solids (TSS)/erosion and altered hydrology cause sedimentation and other 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.

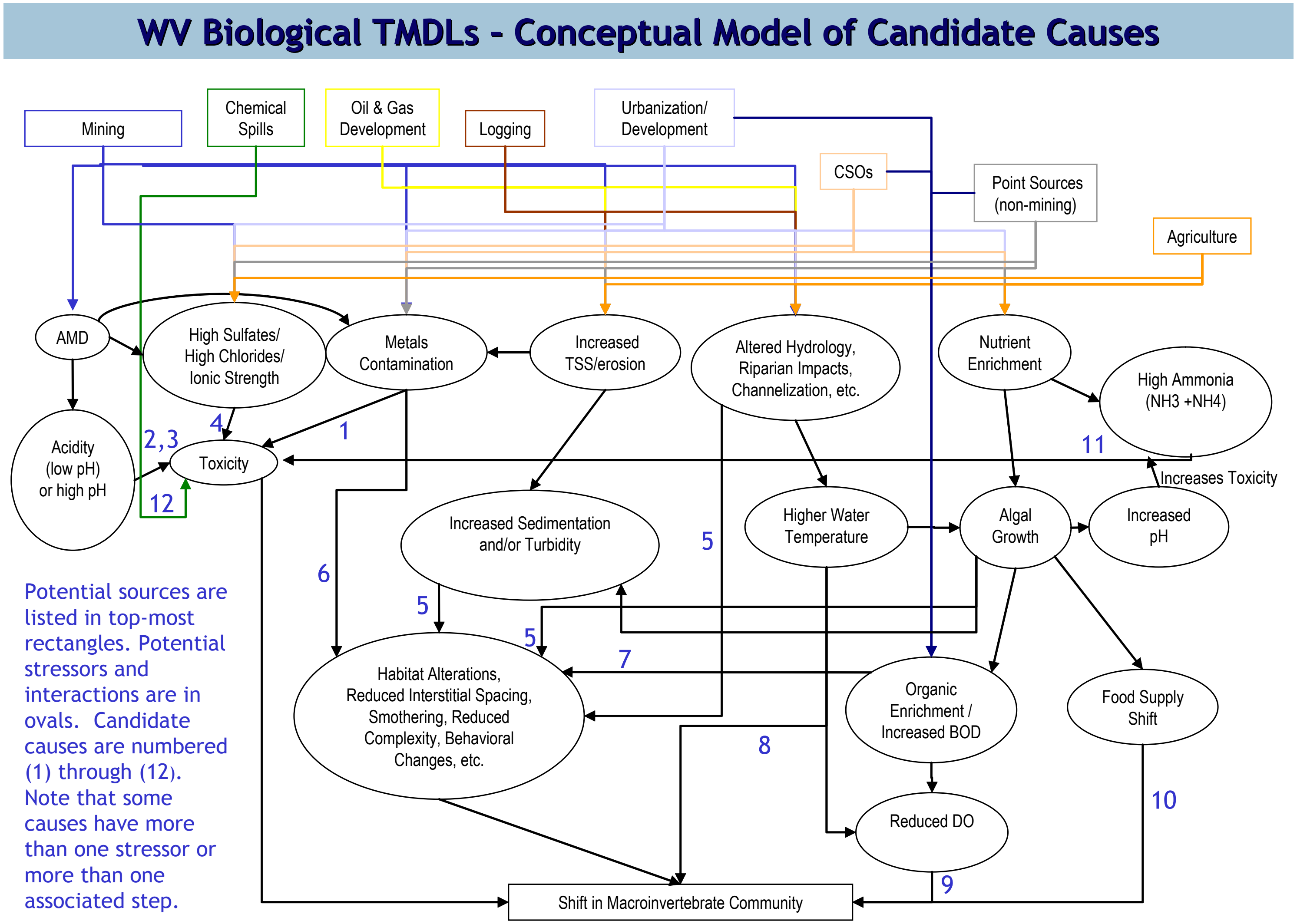


Figure 4-1. Conceptual model of candidate causes and potential biological effects

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 Tygart Valley River Watershed:

- Aluminum toxicity
- pH toxicity
- Increased metals flocculation and deposition causes habitat alterations (e.g., embeddedness)
- Organic enrichment (the combined effects of oxygen-demanding pollutants, nutrients, and the resultant algal and habitat alteration)
- Sedimentation
- Increased ionic strength causes toxicity

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

The SI process identified aluminum and pH toxicity as significant biological stressors in waters that also demonstrated violations of the aluminum and pH water quality criteria for protection of aquatic life. WVDEP determined that the implementation of those pollutant-specific TMDLs would address those stressors.

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 23 streams for which the SI process did not indicate that TMDLs for numeric criteria would resolve the biological impacts. Reference **Appendix K** of the Technical Report for complete SI results.

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

Stream Name	NHD-Code	Significant Stressors	TMDLs Developed
Tygart Valley River	WV-MT	organic enrichment	Fecal coliform
Wickwire Run	WV-MT-18	organic enrichment, sedimentation	Fecal coliform, iron
Sandy Creek	WV-MT-34	sedimentation, organic enrichment	Fecal coliform, iron
Little Sandy Creek	WV-MT-34-J	pH, dissolved metals, metal flocculation/deposition, sedimentation	Iron, dissolved aluminum, pH
Right Fork/Little Sandy Creek	WV-MT-34-J-18	sedimentation	Iron
Left Fork/Sandy Creek	WV-MT-34-L	sedimentation, organic enrichment	Fecal coliform, iron
UNT/UNT RM 0.56/Sandy Creek RM 10.47	WV-MT-34-N-1	pH	pH, iron
Mill Run	WV-MT-43-L	organic enrichment	Fecal coliform
Mill Run	WV-MT-43-S	organic enrichment	Fecal coliform
Sugar Creek	WV-MT-46-J	sedimentation, organic enrichment	Fecal coliform, iron
Long Run	WV-MT-46-J-25	organic enrichment	Fecal coliform
Mitchell Run	WV-MT-48	organic enrichment	Fecal coliform
Big Run	WV-MT-62-AA	sedimentation, organic enrichment	Fecal coliform, iron
Childers Run	WV-MT-62-AB	sedimentation, organic enrichment	Fecal coliform, iron
Wash Run	WV-MT-62-AH-8	organic enrichment, sedimentation	Fecal coliform, iron
Bull Run	WV-MT-62-AV-7	organic enrichment, sedimentation	Fecal coliform, iron
Swamp Run	WV-MT-62-CB	pH, dissolved metals	pH, dissolved aluminum, iron
First Big Run	WV-MT-62-E	organic enrichment, sedimentation	Fecal coliform, iron
Middle Fork River	WV-MT-72	sedimentation	Iron
Brook Run	WV-MT-72-AE-1	organic enrichment	Fecal coliform
Cassity Fork	WV-MT-72-AU	pH, dissolved metals, metal flocculation/deposition, sedimentation	pH, dissolved aluminum, iron
Hoophole Run	WV-MT-72-T	metal flocculation/deposition	iron
Mill Creek	WV-MT-96	sedimentation, organic enrichment	Fecal coliform, iron
Shooks Run	WV-MT-97	sedimentation, organic enrichment	Fecal coliform, iron
Zebs Creek	WV-MT-112	organic enrichment	Fecal coliform
Craven Run	WV-MT-125-B	sedimentation, organic enrichment	Fecal coliform, iron
Davis Lick	WV-MT-125-S	sedimentation, organic enrichment	Fecal coliform, iron
Chenoweth Creek	WV-MT-146	organic enrichment, sedimentation	Fecal coliform, iron

5.0 METALS SOURCE ASSESSMENT

This section identifies and examines the potential sources of metals impairments (i.e., iron, aluminum, and beryllium) in the Tygart Valley River Watershed. Sources can be classified as point (permitted) or nonpoint (non-permitted) sources. For the sake of consistency, the same modeled landuse setup was used for all metals nonpoint sources. Mining and non-mining point sources were also modeled consistently in terms of drainage area and flow, although chemical concentrations were configured specifically for each pollutant modeled.

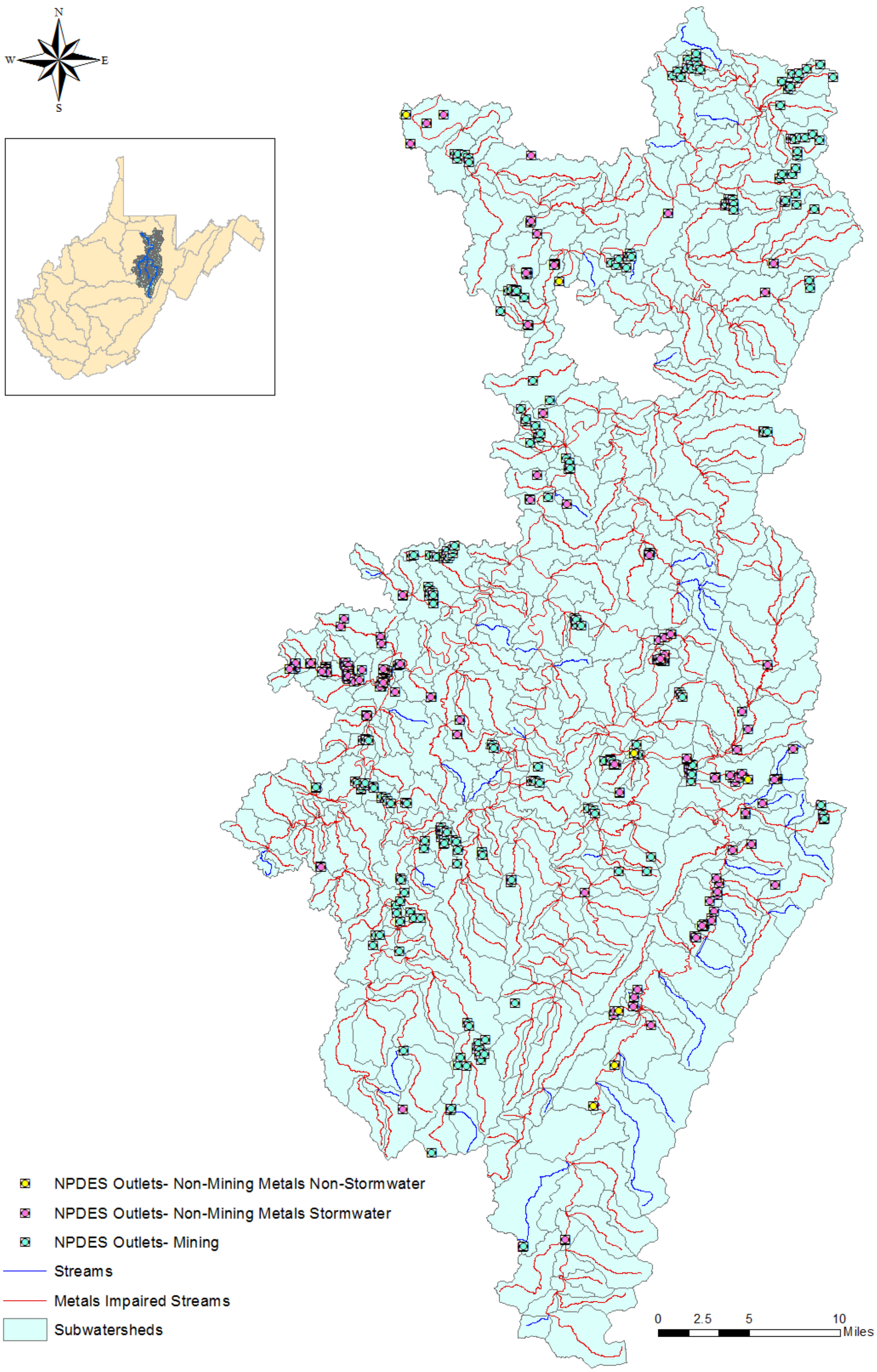
A point source, according to 40 CFR 122.3, is any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, and vessel 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. 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 AML. The assignment of LAs to AML 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 AML drainage 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 mining- and non-mining-related 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: permits in close proximity appear to overlap in the figure)

Figure 5-1. Point sources in the Tygart Valley River Watershed

5.1.1 Mining Point Sources

The Surface Mining Control and Reclamation Act of 1977 (SMCRA, Public Law 95-87) and its subsequent revisions were enacted to establish a nationwide program to protect the beneficial uses of land or water resources, protect public health and safety from the adverse effects of current surface coal mining operations, and promote the reclamation of mined areas left without adequate reclamation prior to August 3, 1977. SMCRA requires a permit for development of new, previously mined, or abandoned sites for the purpose of surface mining. Permittees are required to post a performance bond that will be sufficient to ensure the completion of reclamation requirements by a regulatory authority in the event that the applicant forfeits its permit. Mines that ceased operations before the effective date of SMCRA (often called "pre-law" mines) are not subject to the requirements of the SMCRA.

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

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

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

There are 48 mining-related NPDES permits, with 187 associated outlets in the metals impaired watersheds of the Tygart Valley River Watershed. Some permits include multiple outlets with discharges to more than one TMDL watershed. A complete list of the permits and outlets is provided in **Appendix F** of the Technical Report. **Figure 5-1** illustrates the extent of the mining NPDES outlets in the watershed.

5.1.2 SMCRA Bond Forfeiture Sites

Facilities subject to the Surface Mining Control and Reclamation Act of 1977 (SMCRA, Public Law 95-87) during active operations are required to post a performance bond to ensure the completion of reclamation requirements. Bond forfeited sites and abandoned operations can be a significant source of metals. When a bond is forfeited, WVDEP assumes the responsibility for the reclamation requirements. The Office of Special Reclamation in WVDEP's Division of Land Restoration provided bond forfeiture site locations and information regarding the status of land reclamation and water treatment activities. Sites with unreclaimed land disturbance and unresolved water quality impacts were represented, as were sites with ongoing water treatment activities. There are19 such bond forfeiture site (49 outlets) located in the metals impaired TMDL watersheds. In addition to permitted outlets, there are 16 acid mine discharges (seeps) associated with bond forfeiture sites and represented as point sources.

In past TMDLs, bond forfeiture sites were classified as nonpoint sources. A judicial decision (West Virginia Highlands Conservancy, Inc., and West Virginia Rivers Coalition, Inc. v. Randy Huffman, Secretary, West Virginia Department of Environmental Protection. [1:07CV87]. 2009) requires WVDEP to obtain an NPDES permit for discharges from forfeited sites. As such, this TMDL project classifies bond forfeiture sites as point sources and provides WLAs.

5.1.3 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 230 industrial wastewater discharges in the watersheds of metals impaired streams in the Tygart Valley 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 or aluminum 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.

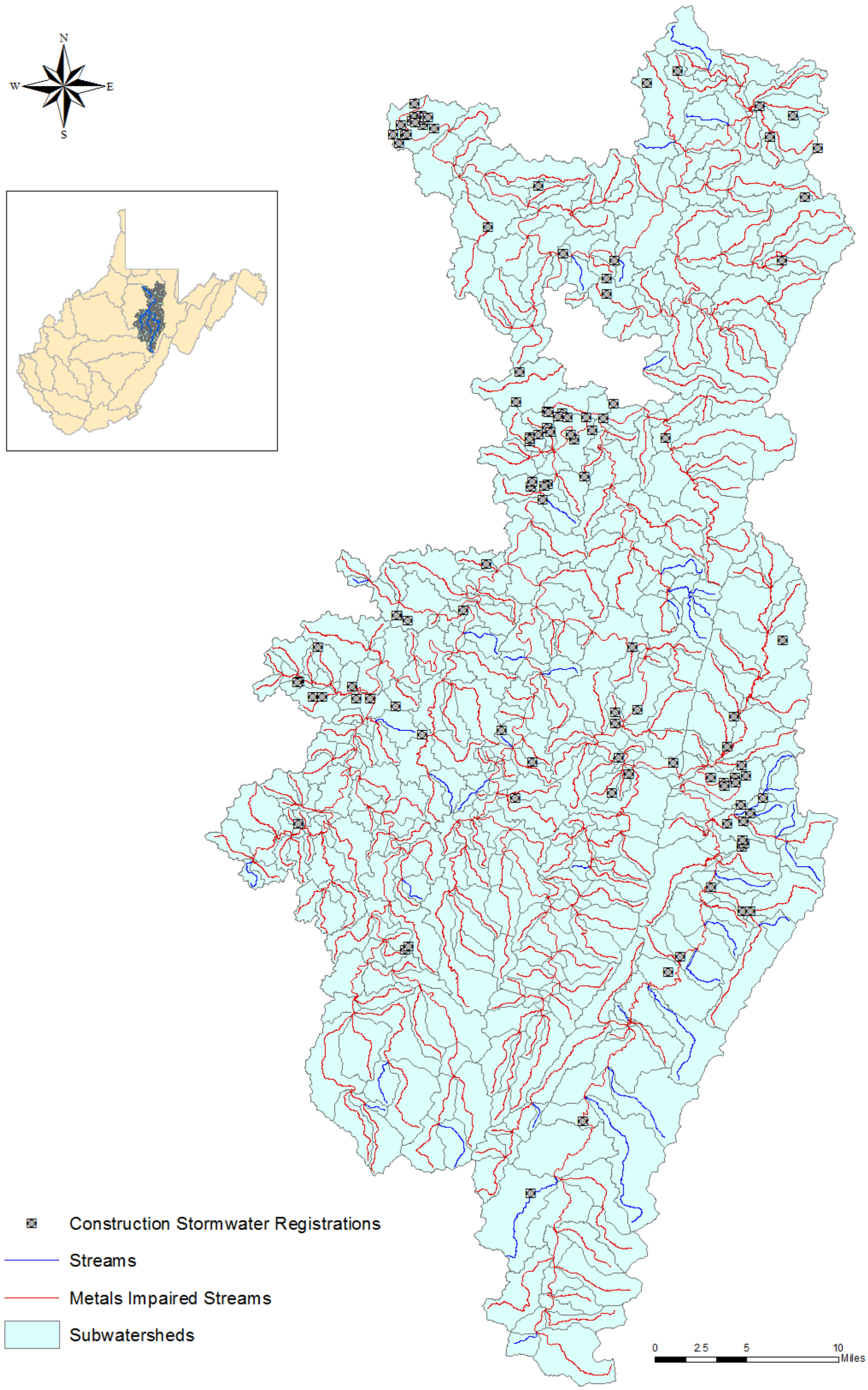
There are 230 modeled non-mining NPDES permitted outlets (7 water treatment plant discharges, 19 industrial stormwater discharges regulated by an individual permit, 162 storm water industrial general permit discharges, 1 solid waste landfill discharge, 38 WV DOH stormwater discharges, and 3 POTW stormwater discharges) in the watersheds of 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.

5.1.4 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 and aluminum. WVDEP issues a General NPDES Permit (permit WV0115924) to regulate stormwater discharges associated with construction activities with a land disturbance greater than one acre. 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, 112 active construction sites with a total disturbed acreage of 1,296.27 acres registered under the Construction Stormwater General Permit (CSGP) were represented in the watersheds of metals impaired waters (**Figure 5-2**). Specific WLAs are not prescribed for individual sites. Instead, subwatershed-based allocations are provided for concurrently disturbed area registered under the permits as described in **Sections 9.7.1** and **11.0**.



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

Figure 5-2. Construction stormwater permits in the Tygart Valley River Watershed

5.1.5 Municipal Separate Storm Sewer Systems (MS4)

Runoff from residential and urbanized areas during storm events can be a significant sediment source. USEPA's stormwater permitting regulations require public entities to obtain NPDES permit coverage for stormwater discharges from MS4s in specified urbanized areas. As such, their stormwater discharges are considered point sources and are prescribed WLAs. The MS4 entities are registered under the MS4 General Permit (WV0116025). Individual registration numbers for the MS4 entities are City of Fairmont (WVR030038) and the West Virginia Division of Highways (WVDOH) (WVR030004).

The City of Fairmont MS4 permit area falls within the established city limits. WVDOH MS4 area occurs inside and on the southern periphery of the City of Fairmont municipal area.

MS4 source representation was based upon precipitation and runoff from landuses determined from the modified NLCD 2011 landuse data, the jurisdictional boundary of the city, and the transportation-related drainage areas for which WVDOH has MS4 responsibility. The representation also includes streambank erosion loads for the portions of streams within the MS4 boundaries. WVDEP consulted with the City of Fairmont and obtained information to determine drainage areas to the respective systems and best represent MS4 pollutant loadings. The location and extent of the MS4 jurisdiction are shown in **Figure 5-3**.

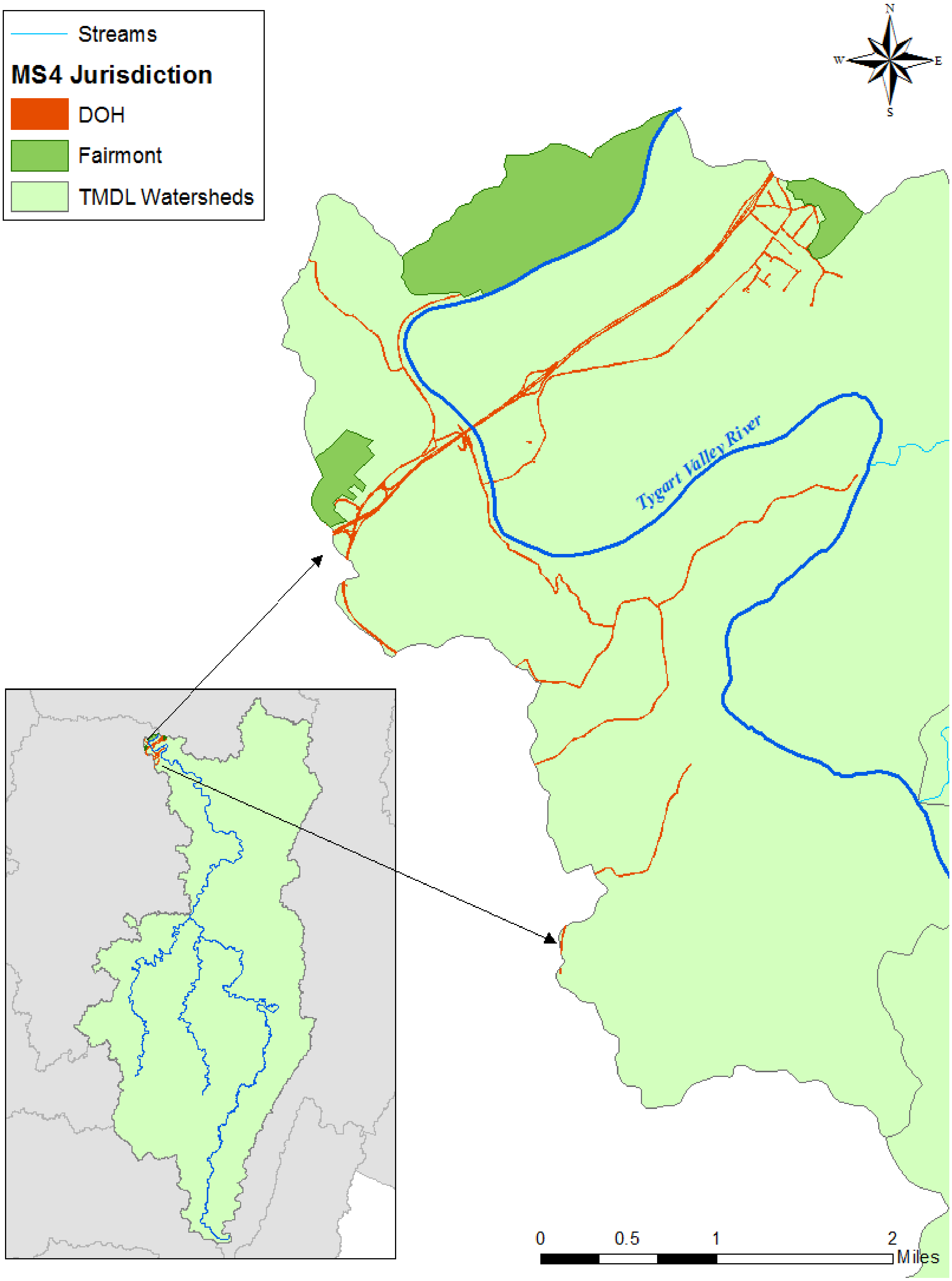


Figure 5-3. MS4 jurisdictions in the Tygart Valley River Watershed

5.2 Metals Nonpoint Sources

In addition to point sources, nonpoint sources can contribute to water quality impairments related to metals. AML may contribute acid mine drainage (AMD), which produces low pH and high metals concentrations in surface and subsurface water. Also, land disturbing activities that introduce excess sediment are considered nonpoint sources of metals.

5.2.1 Abandoned Mine Lands

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

The Office of AML&R identified locations of AML in the Tygart Valley River Watershed from their records. In addition, source tracking efforts by WVDEP DWWM and AML&R identified additional AML sources (discharges, seeps, portals, and refuse piles). Field data, such as GPS locations, water samples, and flow measurements, were collected to represent these sources and characterize their impact on water quality. Based on this work, AML represent a significant source of metals in certain metals impaired streams for which TMDLs are presented. In TMDL watersheds with metals impairments, a total of 164.45 miles (calculated as 1307.95 acres using a standard width) of AML highwall and 197 seeps associated with legacy mine practices at AML sites, were incorporated into the TMDL model (**Figure 5-4**).

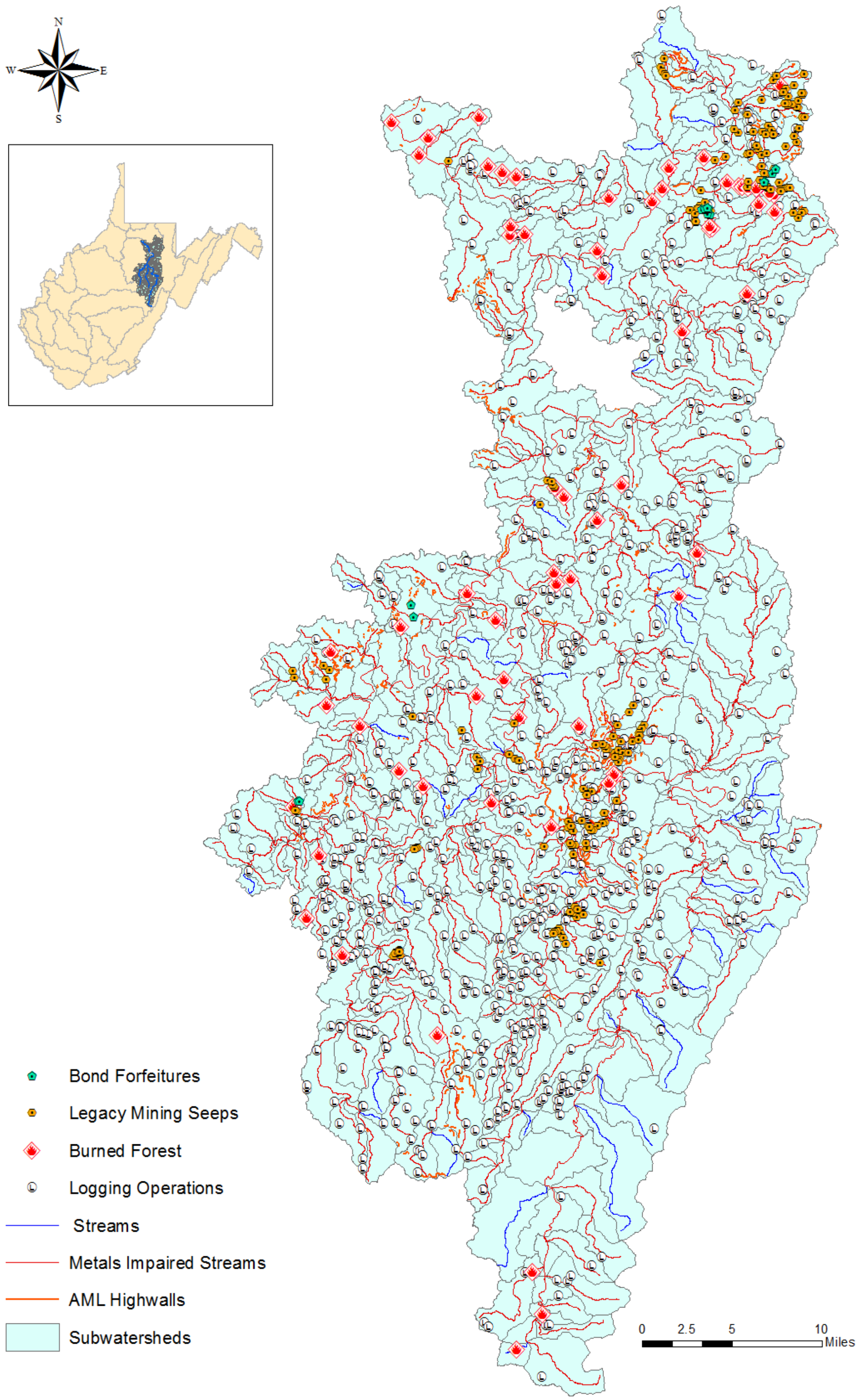


Figure 5-4. Nonpoint sources in the Tygart Valley River Watershed

5.2.2 Sediment Sources

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

Forestry

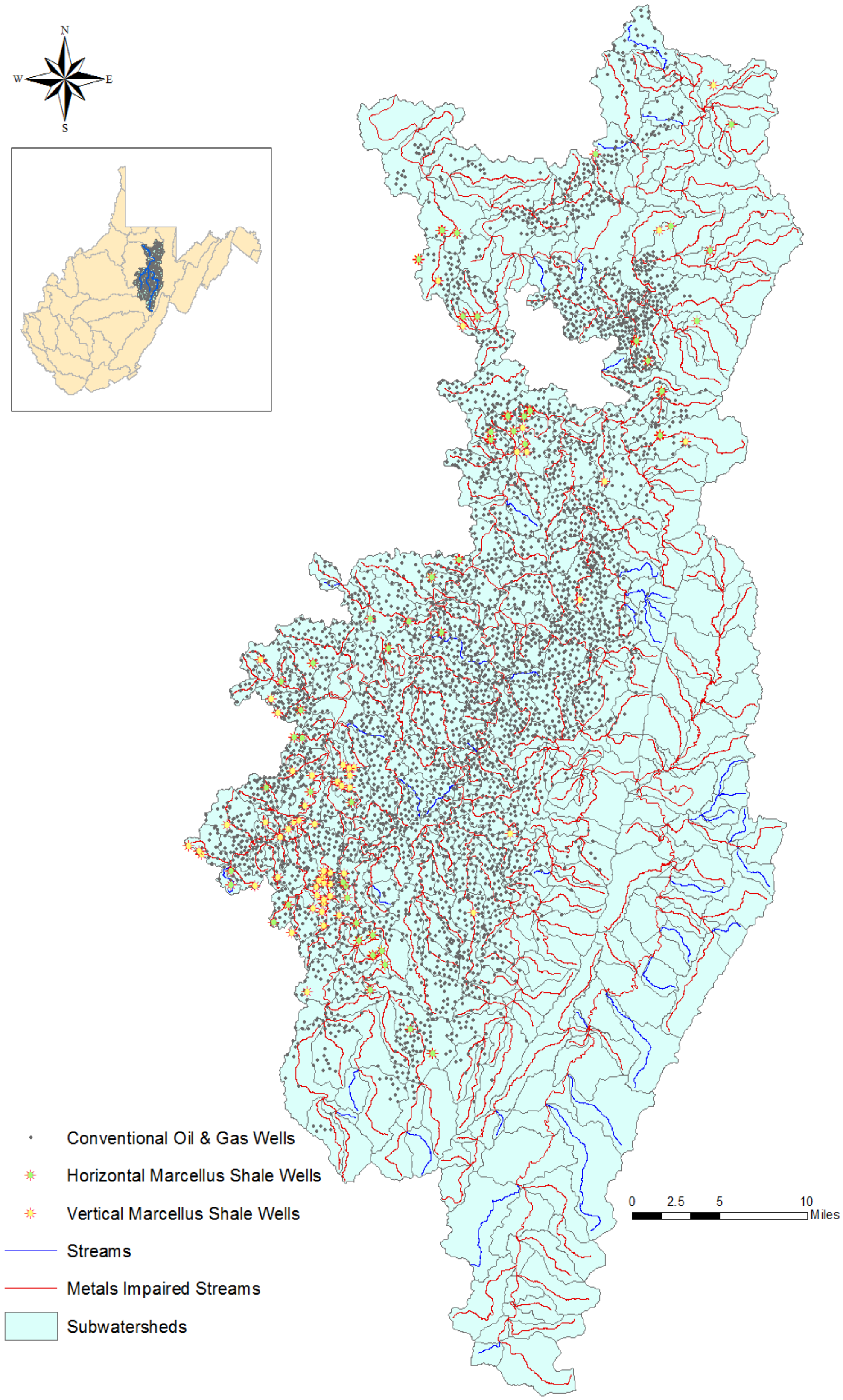
West Virginia recognizes the water quality issues posed by sediment from logging sites. In 1992, the West Virginia Legislature passed the Logging Sediment Control Act. The act requires the use of BMPs to reduce sediment loads to nearby waterbodies. Without properly installed BMPs, logging and associated 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 51,665 acres of harvested area within the TMDL impaired streams watersheds, of which subset of land disturbed by roads and landings is 4157.36 acres. In addition, 187.9 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 has 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 4577 conventional active oil and gas wells (represented as 6,316.26 acres), 60 vertical Marcellus wells (represented as 185.68 acres), and 165 horizontal Marcellus wells (represented as 563.02 acres) represented in the metals impaired TMDL watersheds addressed in this report. Runoff from unpaved access roads to these wells and the disturbed areas around the wells contribute sediment to adjacent streams (**Figure 5-5**).



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

Figure 5-5. Oil and Gas Well locations in the Tygart Valley 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 2011 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 or indirectly by calculating areas as described in the technical report.

Agriculture

Agricultural landuses account for 5.47 percent of the modeled land area in metals impaired TMDL watersheds. 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 outside of MS4 areas.

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 (abandoned mine lands, mining permits, etc.). The remainder is represented as a specific nonpoint source category in the model.

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

5.3 Beryllium Source Assessment

Four streams in this TMDL project have been listed in the draft 2014 303(d) list pursuant to the water quality criteria for both beryllium and pH, based on pre-TMDL data collected by WVDEP from 2012- 2013.

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

An analysis of the WAB data in Tygart Valley River Watershed determined that all occurrences of beryllium water quality criterion exceedances were associated with pH less than 5 (**Figure 5-6**). Beryllium exceedances occurred in watersheds where legacy mining influences were prevalent and the most likely source of beryllium and acidity. The most elevated beryllium exceedances were observed during low flow conditions during which the continuous flow acid sources are dominant. Particulate beryllium is not expected to occur in the water column in concentrations that result in criterion exceedances when solids become transient during precipitation induced flow conditions.

Acidity abatement pursuant to the pH TMDLs will create instream pH conditions that limit the solubility of beryllium resulting in precipitation and settling of particulate compounds (i.e., bound to metals hydroxides). Thus the pH TMDLs serve as surrogates for beryllium water quality criterion nonattainment. **Figure 5-7** displays the extent of the beryllium impaired watersheds.

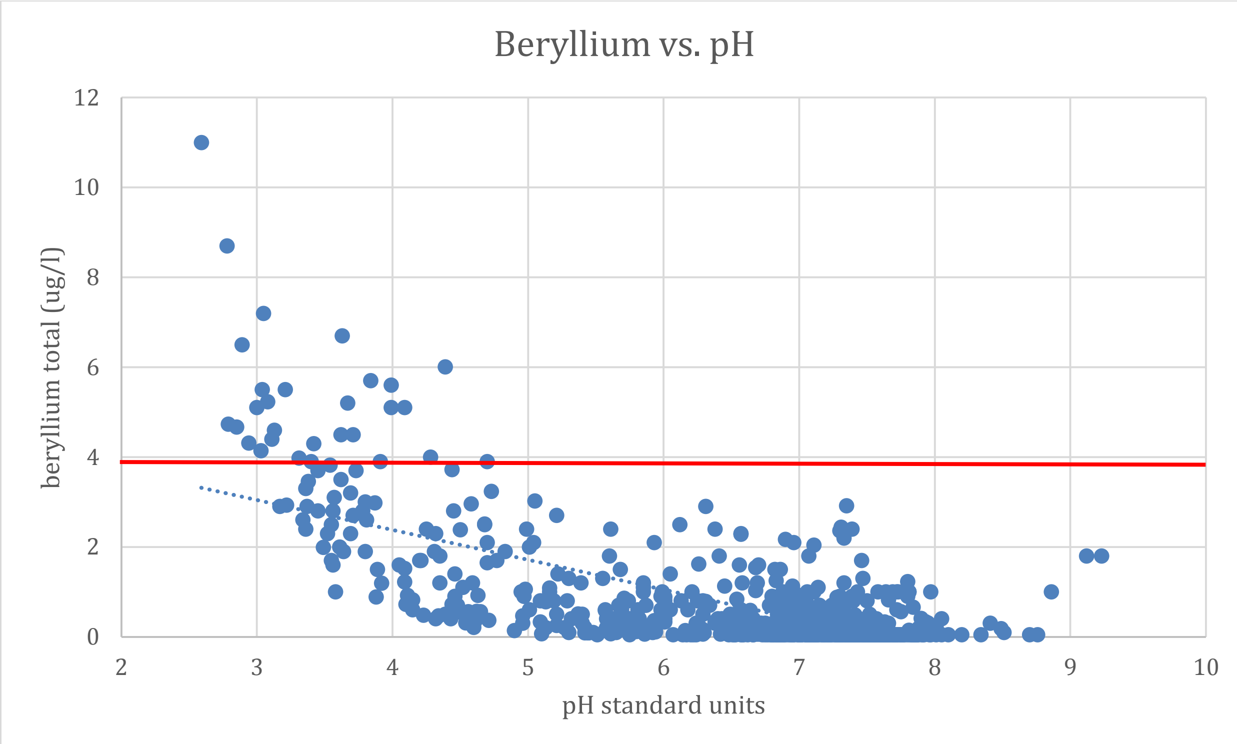
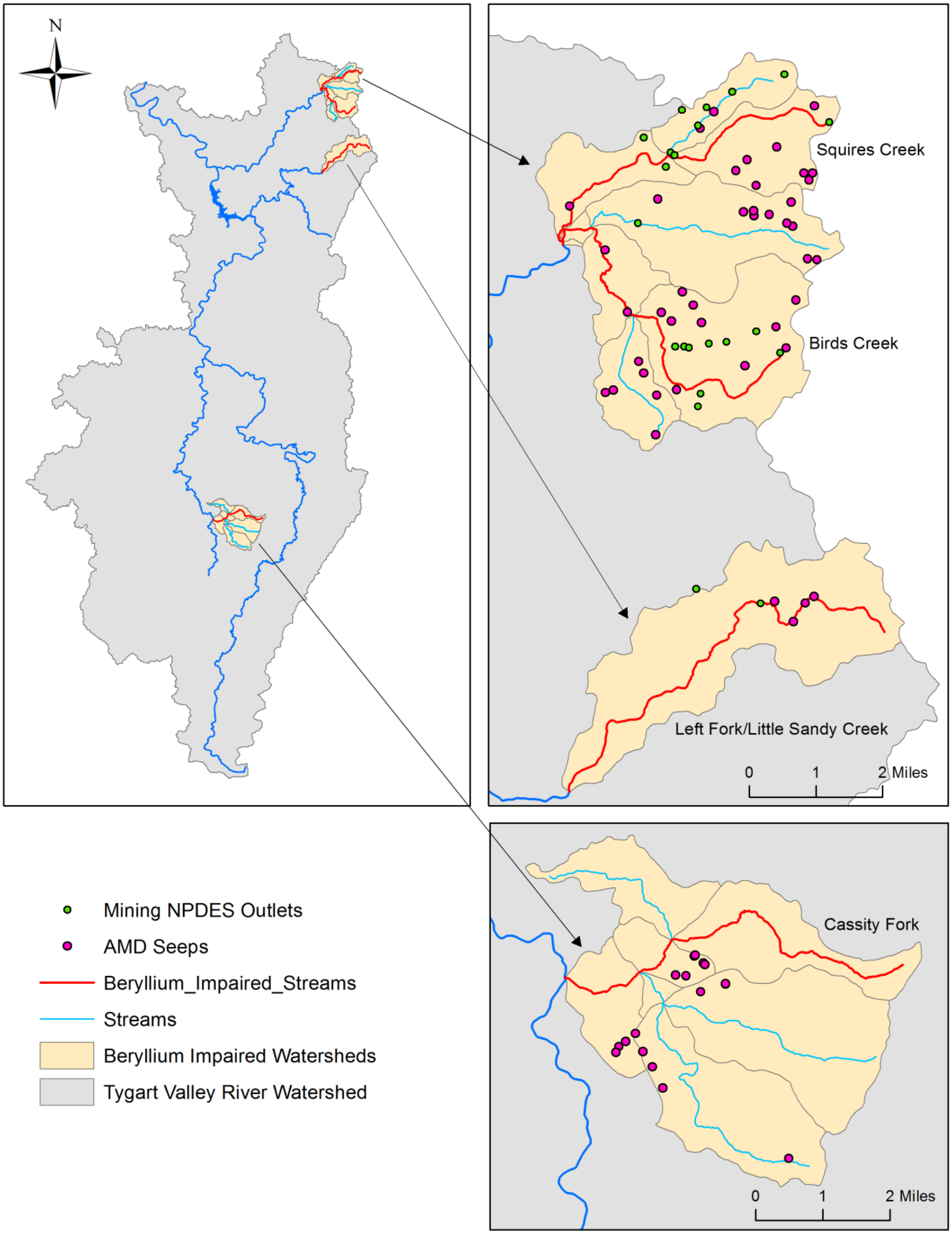


Figure 5-6: Beryllium and pH for water quality data from monitoring stations in the Tygart Valley River Watershed.



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

Figure 5-7. Beryllium impaired watersheds in the Tygart Valley River Watershed

6.0 pH SOURCE ASSESSMENT

pH impairments in the study area are caused by acidity introduced generally by legacy mining activities and acid depostion. WVDEP source tracking and pre-TMDL water quality monitoring were used to determine the causative sources.

6.1 Acid Deposition

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

The majority of the acid deposition occurs in the eastern United States. In March 2005, the USEPA issued the Clean Air Interstate Rule (CAIR), which places caps on emissions for sulfur dioxide and nitrogen dioxides for the eastern United States. It is expected that CAIR will reduce sulfur dioxide emissions by over 70 percent and nitrogen oxides emissions by over 60 percent from the 2003 emission levels (USEPA, 2005c). Since the pollution is highly mobile in the atmosphere, reductions based on CAIR in West Virginia, Ohio, and Pennsylvania will likely improve the quality of precipitation in the watershed.

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

Weekly wet/dry deposition data were retrieved from WV18/PAR107-parsons in Tucker County from 2000 to the most recent data 2014 January national atmospheric deposition program. Clean Air Status and Trends Network (CASTNET) was accessed to retrieve the dry deposition data.

6.2 pH – Natural Influences

The natural conditions may result in lowered pH levels due to the lack of buffering capacity in soils and certain geologic formations. Acidic soils (e.g., Delkalb, Ernest, and Gilpin) and the Conemaugh (contents of marine limestone) , Pottsville, Allegheny formation (very low buffering capacity) existing in Tygart River basin are known to influence the pH conditions.

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

Additionally, natural conditions such as wetlands/bogs reduce the pH levels and buffering capacity downstream. Bogs receive most of their water from precipitation, which is naturally acidic, and pH may be decreased from the natural decomposition of organic materials (MDE 2003).

6.3 Alkalinity Sources

Although the buffering capacity provided by underlying geology within the watershed is limited, the Conemaugh formation could be some source of alkalinity in the basin. Dissolution of carbonate rocks neutralizes the excessive acidity from atmospheric precipitation and provides natural loading of alkalinity to the streams. As a result, near neutral pH levels are commonly observed in the streams from geologic formations of carbonate rocks.

To restore water quality and protect fisheries in streams affected by acid deposition, selected acidic streams in the Tygart Valley River Watershed are treated with instream applications of fine-grained limestone or limestone slurry addition using water-powered limestone grinding stations. The location of liming stations and dosages in the Tygart Valley River Watershed were provided by the WVDEP and included data recorded by the West Virginia Division of Natural Resources. The applied dosage information for these remediation methods were included for calibration purposes.

7.0 FECAL COLIFORM SOURCE ASSESSMENT

7.1 Fecal Coliform Point Sources

Publicly and privately owned sewage treatment facilities and home aeration units are point sources of fecal coliform bacteria. Combined sewer overflows (CSOs) and discharges from MS4s are additional point sources that may contribute loadings of fecal coliform bacteria to receiving streams. The following sections discuss the specific types of fecal coliform point sources that were identified in the Tygart Valley River Watershed.

7.1.1 Individual NPDES Permits

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

In the subject watersheds of this report, 10 individually permitted POTWs discharge treated effluent at ten (10) outlets (Buckhannon, Elkins, Grafton, Philippi, Newburg, Belington, Colfax, Junior, Huttonsville PSD, and Beverly). There are also three (3) permitted stormwater discharges from wastewater treatment plants sites at Buckhannon (2 outlets) and Elkins (1 outlet). One additional individually permitted non-POTW wastewater treatment plant

(Huttonsville Correctional Center) discharges from one outlet. Nine (9) mining bathhouse permits discharge to TMDL streams in the Tygart Valley River TMDL watersheds via nine (9) outlets.

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

7.1.2 Overflows

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

In the subject watersheds, there were a total of 56 CSO outlets associated with POTW collection systems operated by the City of Fairmont (1), City of Grafton (17), City of Philippi (13), the City of Buckhannon (4), the City of Belington (7), and the City of Elkins (14). No significant SSO discharges were represented in the model.

7.1.3 Municipal Separate Storm Sewer Systems (MS4)

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

MS4 entities and their areas of responsibility are described in **Section 5.1.5** and displayed in **Figure 5-3**. MS4 source representation is based upon precipitation and runoff from landuses determined from the modified NLCD 2011 landuse data, the jurisdictional boundary of the cities, and the transportation-related drainage areas for which WVDOH has MS4 responsibility. In certain areas, urban/residential stormwater runoff may drain to both CSO and MS4 systems. WVDEP consulted with local governments and obtained information to determine drainage areas to the respective systems and best represent MS4 pollutant loadings.

7.1.4 General Sewage Permits

General sewage permits are designed to cover like discharges from numerous individual owners and facilities throughout the state. General Permit WV0103110 regulates small, privately owned sewage treatment plants ("package plants") that have a design flow of 50,000 gallons per day (gpd) or less. General Permit WV0107000 regulates home aeration units (HAUs). HAUs are small sewage treatment plants primarily used by individual residences where site considerations preclude typical septic tank and leach field installation. Both general permits contain fecal coliform effluent limitations identical to those in individual NPDES permits for sewage treatment facilities. In the areas draining to streams for which fecal coliform TMDLs have been developed, 39 facilities are registered under the "package plant" general permit, and 522 are registered under the HAU general permit.

7.2 Fecal Coliform Nonpoint Sources

7.2.1 On-site Treatment Systems

Failing septic systems and straight pipes are significant nonpoint sources of fecal coliform bacteria. Information collected during source tracking efforts by WVDEP yielded an estimate of 10,179 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 three percent to 24 percent.

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 7-1** shows the fecal coliform counts per year represented in the model from failing septic systems relative to the total stream length in meters for each subwatershed.

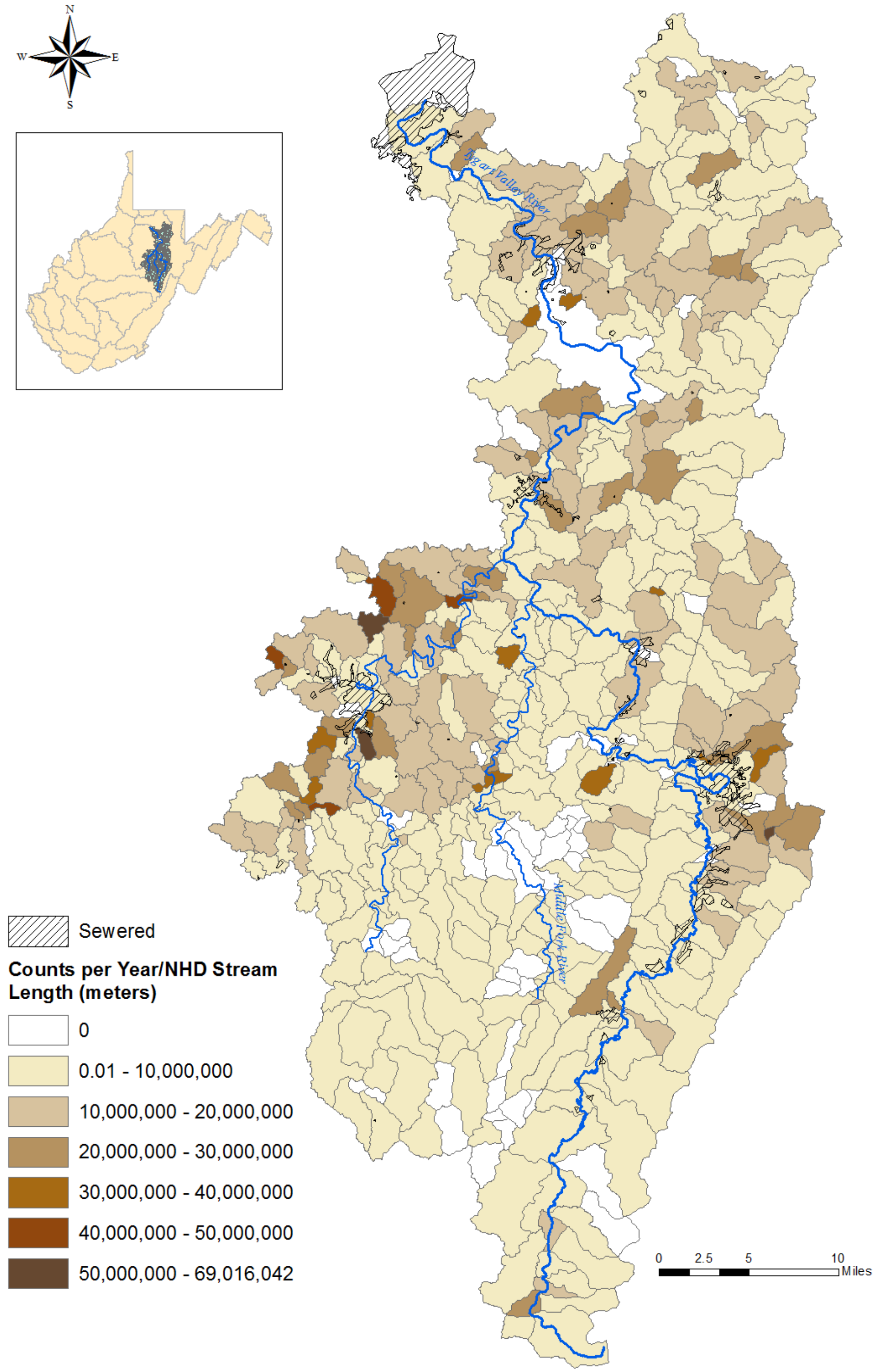


Figure 7-1. Fecal coliform counts attributed to failing septic systems per year relative to the stream lengths (meters) in the Tygart Valley River Watershed as represented in modeling.

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. This concentration 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. Additional details of the failing septic analyses are elucidated in the Technical Report.

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

7.2.2 Urban/Residential Runoff

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

7.2.3 Agriculture

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

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

7.2.4 Natural Background (Wildlife)

A certain "natural background" contribution of fecal coliform bacteria can be attributed to deposition by wildlife in forested areas. Accumulation rates for fecal coliform bacteria in forested areas were developed using reference numbers from past TMDLs, 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. These results were used during the model calibration process. On the basis of the low fecal accumulation rates for forested areas, the storm water sampling results, and model simulations, wildlife is not considered to be a significant nonpoint source of fecal coliform bacteria in the watershed.

8.0 DISSOLVED OXYGEN SOURCE ASSESSMENT

As noted in **Table 3-3**, there are 6 streams that are impaired for dissolved oxygen and fecal coliform bacteria, both commonly associated with organic enrichment. Excessive amounts of organic matter increase fecal coliform bacteria counts and reduce dissolved oxygen levels. Generally, point and non-point sources contributing to dissolved oxygen impairments are the same as those for fecal coliform. Streams impaired for both dissolved oxygen and fecal coliform are listed below:

- Sugar Creek WV-MT-46-J
- Bridge Run WV-MT-62-AH-10
- Little Sand Run WV-MT-62-AN
- Bull Run WV-MT-62-AV-7
- Mudlick Run WV-MT-62-AV-7-C
- Mill Creek WV-MT-96

Sugar Creek

Over 12 miles long with 8 named tributaries, Sugar Creek is the largest of the DO impaired streams in the Tygart basin. DEP had four pre-TMDL monitoring points on the Sugar Creek mainstem and five of the tributaries were monitored. Of those 100 samples (44 on Sugar Creek mainstem), only two had a DO level less than 5.0 mg/l. These were both located at MP 5.8 of Sugar Creek. The stream channel is much more meandering in this section of Sugar Creek than in any other and aerial photographs indicate the presence of wetlands. These natural conditions of the stream channel and gradient contribute to depressed oxygen levels.

There are also elevated fecal coliform loads attributed to pasture runoff and failing septic systems upstream of this point, with cattle access occurring upstream in the two uppermost subwatersheds (2068 and 2069). Implementation of the fecal coliform TMDL for Sugar Creek will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

Bridge Run

DO violations occurred at MP 0.1 during low flow months (July and September). Above this monitoring point, Bridge Run flows through a fairly large wetland area. Above MP 0.7, agriculture becomes prominent in the watershed. Cattle have access to the creek along the UNT/Bridge Run RM 0.83, and to a lesser extent, portions of Bridge Run upstream of the UT. Agricultural runoff is the most likely source of fecal coliform violations. There are also elevated fecal coliform loads attributed to failing septic systems.

The DO violations in Bridge Run are attributed to organic loading associated with agricultural runoff and potential failing septic systems. Implementation of the fecal coliform TMDL for Bridge Run will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

Little Sand Run

Two DO violations occurred on Little Sand Run at MP 0.2 in June & July 2013, about 3 weeks apart. One violation occurred on Sand Run at MP 0.5 in July 2013. No DO violations were reported from monitoring on the Left Fork of Sand Run, which enters just below MP 0.5. Organic loading associated with agricultural runoff and cattle access, particularly in the lower portion of the stream reach, causes the DO violations in Little Sand Run. Implementation of the fecal coliform TMDL for Little Sand Run will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

Bull Run

DO violations were observed in Bull Run. Bull Run is also impaired for fecal coliform. The DO violations again are attributable to fecal coliform sources (agricultural and failing septic systems) and low gradient and wetland conditions present in the watershed. Implementation of the fecal coliform TMDL will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

Mudlick Run

Mudlick Run is a small watershed, approximately 300 acres. While much of the subwatershed is cleared, no cattle were observed by WVDEP. Fecal coliform concentrations were consistently high in lower flow periods and did not show any elevation when monitoring occurred during higher runoff events. The source of the fecal coliform appears likely to be failing septic systems. Implementation of the fecal coliform TMDL will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

Mill Creek

DO and fecal coliform violations were observed in Mill Creek. Low DO in Mill Creek is attributable to organic enrichment originating from pasture with cattle access to the stream. Implementation of the fecal coliform TMDL will reduce the organic loads from these sources and will resolve the dissolved oxygen impairment in the stream.

9.0 MODELING PROCESS

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

9.1 Model Selection

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

- Scale of analysis
- Point and nonpoint sources
- Metals and fecal coliform bacteria impairments are temporally variable and occur at low, average, and high flow conditions
- Dissolved aluminum and beryllium impairments are related to pH water quality
- Total iron and total aluminum 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, aluminum, beryllium, dissolved oxygen, pH, 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 Tygart Valley 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 AMD seeps and 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, dissolved aluminum, pH, and fecal coliform bacteria were modeled using the MDAS.

9.2 Model Setup

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

9.2.1 General MDAS Configuration

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

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

PRISM daily weather data and NLDAS-2 hourly precipitation data were obtained and processed to create a time series for each 4 km x 4 km grid cell that intersected modeled TMDL watersheds. Using the precipitation and temperature time series, a model weather input file was developed for each PRISM grid cell. Given that slight variability was observed between the grid cells at the12-digit Hydrologic Unit Code (HUC) scale and in order to allow more feasibility when executing the models, one centrally located weather input file per HUC was identified as representative of the weather in the area. Model subwatersheds falling within each 12-digit HUC were then assigned the appropriate weather input file for hydrologic modeling purposes.

The 84 TMDL watersheds were broken into 520 separate subwatershed units, based on the groupings of impaired streams shown in **Figure 3-2**. The TMDL watersheds were divided to allow evaluation of water quality and flow at pre-TMDL monitoring stations. This subdivision process also ensures a proper stream network configuration within the basin.

9.2.2 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. abandoned mine lands, harvested forest and skid roads, oil and gas operations, paved and unpaved roads, and active mining). 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 (active deep mine discharges, water treatment plant backwash discharges, industrial discharges, solid waste landfill leachates) 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 9-1**). The erodible wetted perimeter is equal to the difference between the actual wetted perimeter and wetted perimeter during threshold flow conditions. The bank erosion rate per unit area was multiplied by the erodible perimeter and the reach length to obtain an estimate of sediment mass eroded corresponding to the stream segment.

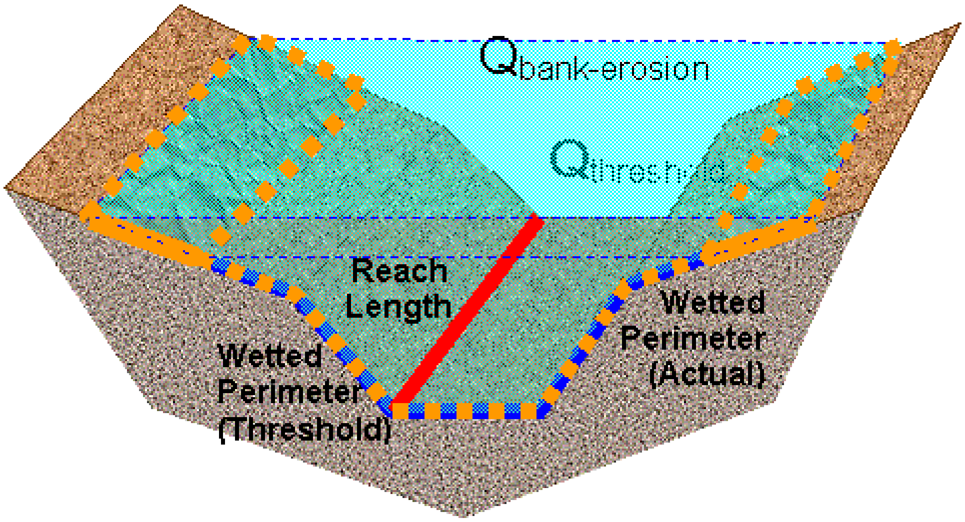


Figure 9-1. Conceptual diagram of stream channel components used in the bank erosion model

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

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

9.2.3 Aluminum, and pH Configuration

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

Pollutant Source Configuration

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

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

In order to represent the effects of acid precipitation, soil type parameters were selected using the literature and refined based on site data ranges. The concentrations of the wet deposition data were assigned to rainfall events. The dry deposition was assumed to accumulate daily and wash off during the precipitation events and was assumed to be included implicitly in the loads being generated at the surface. Weekly wet/dry deposition data were retrieved from WV18/PAR107-parsons in Tucker County from 2000 to the most recent data 2014 January national atmospheric deposition program. Clean Air Status and Trends Network (CASTNET) was accessed to retrieve the dry deposition data. Adjustment and verification of these parameters occurred by examining water quality data in streams where watersheds did not include legacy mine discharges or alkalinity mitigation. This aspect of the model provided the link between atmospheric deposition and soil buffering capacity.

Instream Chemical Reaction

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

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

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

9.2.4 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, straight pipes, and discharges from sewage treatment facilities, were modeled as direct, continuous-flow sources in the model.

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

9.3 Hydrology Calibration

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

- USGS 03056250 Three Fork Creek Near Grafton, WV
- USGS 03054500 Tygart Valley River At Philippi, WV
- USGS 03053500 Buckhannon River At Hall, WV
- USGS 03052500 Sand Run Near Buckhannon, WV
- USGS 03052000 Middle Fork River At Audra, WV
- USGS 03051000 Tygart Valley River At Belington, WV
- USGS 03050000 Tygart Valley River Near Dailey, 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, 2004 to December 30, 2013. 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 Tygart Valley 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.

9.4 Water Quality Calibration

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

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

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

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.

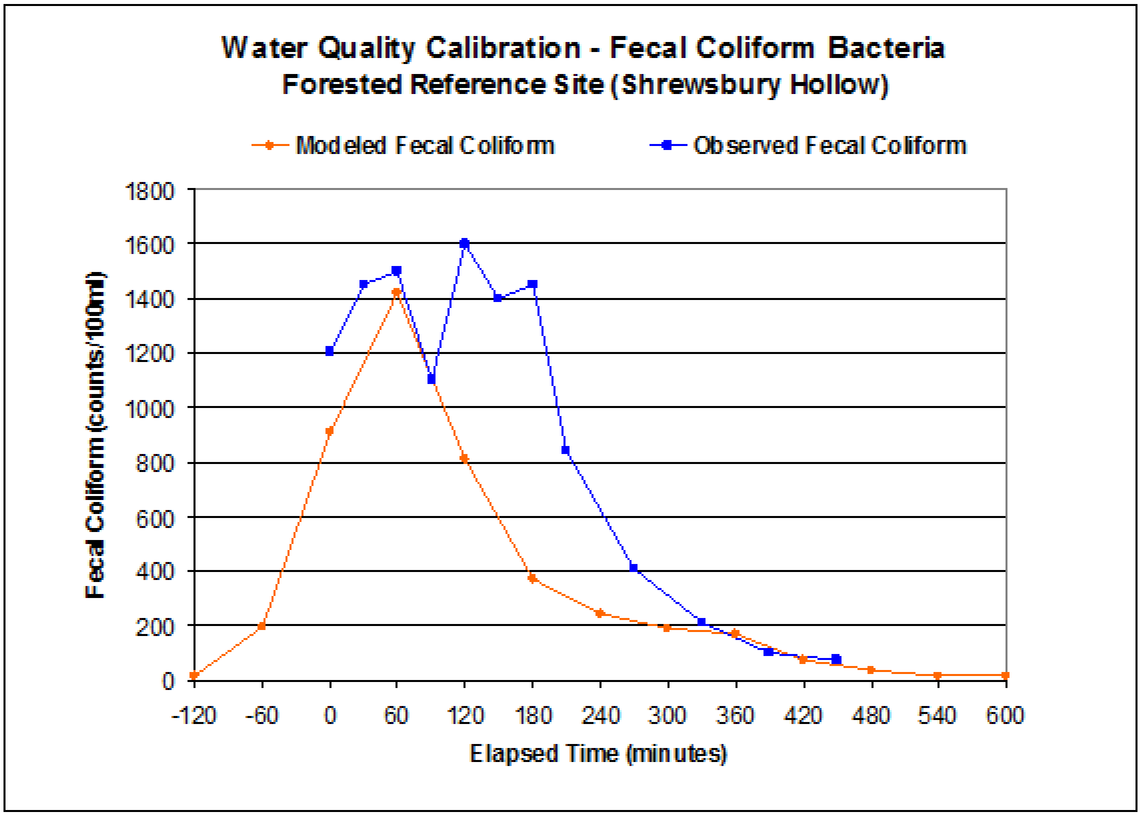


Figure 9-2. Shrewsbury Hollow fecal coliform observed data

9.5 Modeling Technique for Biological Impacts with Sedimentation Stressors

The SI process discussed in **Section 4** identified sedimentation as a significant biological stressor in some of the streams. 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.

9.6 Allocation Strategy

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

TMDL = sum of WLAs + sum of LAs + MOS

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

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

9.6.1 TMDL Endpoints

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

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

An explicit MOS was not applied for total iron TMDLs in certain subwatersheds where mining point sources create an effluent dominated scenario and/or the regulated mining activity encompasses a large percentage of the watershed area. Within these scenarios, WLAs are established at the value of the criteria and little uncertainty is associated with the source/water quality linkage.

Table 9-1. 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)
Dissolved Aluminum	Aquatic Life, warmwater fisheries	0.75 mg/L (1-hour average)	0.7125 mg/L (1-hour average)
pH	Aquatic Life	6.00 Standard Units (Minimum)	6.02 Standard Units (Minimum)
Fecal Coliform	Water Contact Recreation and Public Water Supply	200 counts / 100 mL (Monthly Geometric Mean)	190 counts / 100 mL (Monthly Geometric Mean)

Water Quality Criterion	Designated Use	Criterion Value	TMDL Endpoint
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.

9.6.2 Baseline Conditions and Source Loading Alternatives

The calibrated model provides the basis for performing the allocation analysis. The first step is to simulate baseline conditions, which represent existing nonpoint source loadings and point sources loadings at permit limits. 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, 2008 through December 31, 2013). The precipitation experienced over this period was applied to the landuses and pollutant sources as they existed at the time of TMDL development. Predicted instream concentrations were compared directly with the TMDL endpoints. This comparison allowed for the evaluation of the magnitude and frequency of exceedances under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods. **Figure 9-3** presents the annual rainfall totals for the years 2002 through 2014 at the Ekins-Randolph County Airport (WBAN 13729) weather station in West Virginia. The years 2008 to 2013 are highlighted to indicate the range of precipitation conditions used for TMDL development in the Tygart Valley River Watershed.

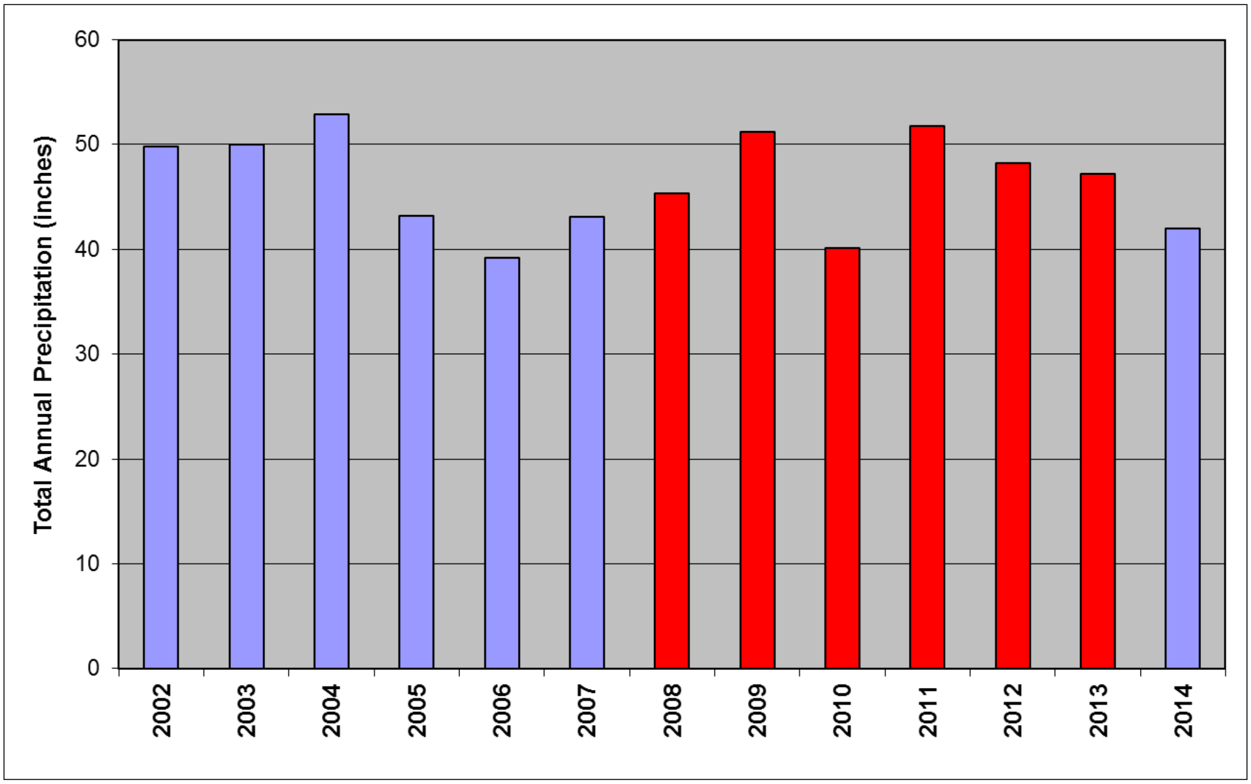


Figure 9-3. Annual precipitation totals for the Ekins-Randolph County Airport (WBAN 13729) weather station

NPDES permits contain effluent limitations for iron, and aluminum concentrations. In the baseline condition, mining discharges that are influenced by precipitation were represented using precipitation and drainage area. For non-precipitation-induced mining discharges, available flow and/or pump capacity information was used. 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. These concentrations accurately represent existing WLAs for the majority of mining discharges. In the limited instances where existing effluent limitations vary from the displayed values, the outlets were represented at next higher condition. For example, existing iron effluent limits between 1.5 and 3.2 mg/L were represented at 3.2 mg/L. For aluminum, discharges are not necessarily compliant with interim limits and the permits allow pursuit of aluminum translators that may result in less stringent final limits. Baseline total aluminum concentrations were set at the 95^{th} percentile of maximum values from Discharge Monitoring Reports (1.39 mg/l).

Certain non-mining discharges (stormwater associated with non-construction, industrial activity) were represented using precipitation, drainage area, and the stormwater benchmark iron value of 1.0 mg/L.

Based upon guidance from WVDEP's permitting program, 2.5 percent of the total subwatershed area was allotted for concurrent construction activity under the CSGP. 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.

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

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

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

Source Loading Alternatives

Simulating baseline conditions allowed for the evaluation of each stream's response to variations in source contributions under a variety of hydrologic conditions. 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 9-4 shows an example of model output for a baseline condition and a successful TMDL scenario.

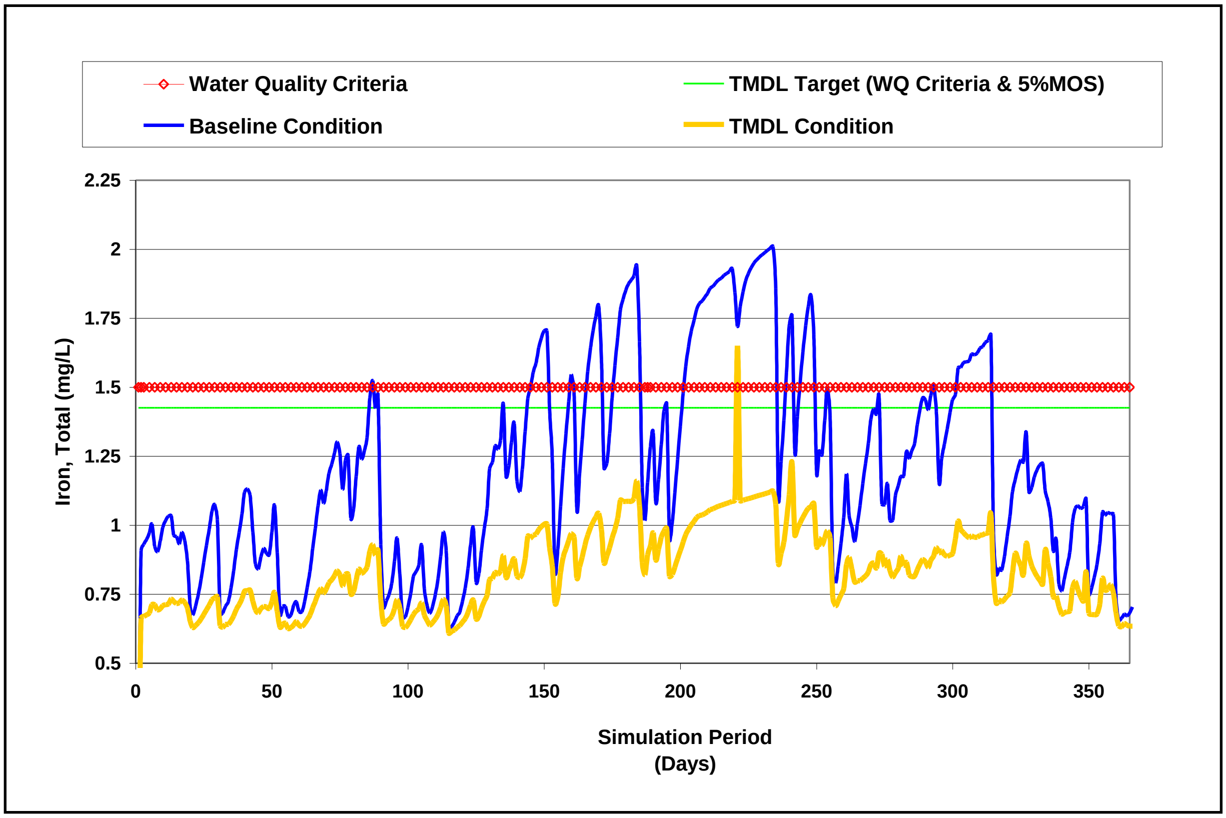


Figure 9-4. Example of baseline and TMDL conditions for total iron

9.7 TMDLs and Source Allocations

9.7.1 Total Iron TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the iron impaired streams of the Tygart Valley 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
3. Harvested Forest and Skid Roads were reduced to the sediment and iron loading associated with Forest.

4. AMD seeps were reduced to water quality criterion end of pipe (1.5 mg/L iron).
5. Active mining permits and other point sources were reduced to water quality criterion end of pipe (1.5 mg/L iron) in subwatersheds where the model indicated non-attainment after reductions associated with Steps 1-4.

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

After executing the above provisions, model output was evaluated to determine the criterion attainment status at all subwatershed pour points. Where the model indicated non-attainment with the total iron criterion for trout streams, iron loading from AMD seeps and active mining permits were reduced as necessary to trout water quality criterion end of pipe (1.0 mg/L iron) on a subwatershed basis.

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, MS4 facilities, and facilities registered under the General NPDES permit for construction stormwater.

Active Mining Operations

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

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

In certain instances, prescribed WLAs may be less stringent than existing effluent limitations. However, the TMDLs are not intended to relax effluent limitations that were developed under the alternative basis of WVDEP's implementation of the antidegradation provisions of the Water Quality Standards, which may result in more stringent allocations than those resulting from the TMDL process. Whereas TMDLs prescribe allocations that minimally achieve water quality criteria (i.e. 100 percent use of a stream's assimilative capacity), the antidegradation provisions of the standards are designed to maintain the existing quality of high-quality waters. Antidegradation provisions may result in more stringent allocations that limit the use of remaining assimilative capacity. Also, water quality-based effluent limitations developed in the NPDES permitting process may dictate more stringent effluent limitations for discharge locations that are upstream of those considered in the TMDLs. TMDL allocations reflect pollutant loadings that are necessary to achieve water quality criteria at distinct locations (i.e., the pour points of delineated subwatersheds). In contrast, effluent limitation development in the permitting process is based on the achievement/maintenance of water quality criteria at the point of discharge.

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

Bond Forfeiture Sites

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

Discharges regulated by the Multi Sector Stormwater Permit

Certain registrations under the general permit for stormwater associated with industrial activity implement TSS and/or iron benchmark values. Facilities that are compliant with such limitations are not considered to be significant sources of sediment or iron. Facilities that are present in the watersheds of iron-impaired streams are assigned WLAs that allow for continued discharge under existing permit conditions.

Municipal Separate Storm Sewer System (MS4)

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

- City of Fairmont WVR030038
- West Virginia Division of Highways WVR030004

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

Construction Stormwater

Specific WLAs for activity under the CSGP are provided at the subwatershed scale and are described in **Section 9.6.2**. An allocation of 2.5 percent of undeveloped subwatershed area was provided with loadings based upon precipitation and runoff and an assumption that required BMPs, if properly installed and maintained, will achieve a TSS benchmark value of 100 mg/L. In certain areas, the existing level of activity under the CSGP does not conform to the subwatershed allocations. In these instances the WVDEP, DWWM permitting program will require stabilization and permit termination in the shortest time possible. Thereafter the program will maintain concurrently disturbed area as allocated or otherwise control future activity through provisions described in **Section 11**.

Other Non-mining Point Sources

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

Load Allocations (LAs)

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

- AML: loading from abandoned mine lands, including loads from highwalls, deep mine discharges and seeps
- Sediment sources: loading associated with sediment contributions from barren land, harvested forest, 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)

9.7.2 Dissolved Aluminum and pH TMDLs

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

As general steps of the allocation process, substantive sources (e.g., seeps) of total iron were reduced first as described in **Section 9.7.1**. This step was taken because, depending on the stream's buffering capacity, existing instream dissolved iron concentrations could significantly reduce pH. Once the model results indicated the achievement of the iron criterion, dissolved aluminum and pH model results were evaluated under the reduced iron loadings condition. If model results predicted non-attainment of the pH and dissolved aluminum criteria, alkalinity additions were prescribed and total aluminum were reduced from specific sources. The following methodology was used to predict necessary alkalinity additions and total aluminum reductions in the model simulation:

- Initially, the baseline metal and hydrogen acidity loadings from sources (i.e., seeps, AML lands, and non-mining land uses) were used to estimate the required alkalinity necessary to achieve improved water quality conditions for pH. Aluminum concentrations anticipated to improve water quality were predicted based on pre-TMDL water quality monitoring data observed in conditions of pH of 6 or greater. MINTEQ was used to verify these estimates and predictions.
- Results from MINTEQ were applied to the seeps in the MDAS allocation scenario. If criteria were not met, remaining acidity sources (i.e., AML lands and non-mining land uses affected by acid precipitation) were evaluated and prioritized per subwatershed based on the source loading magnitude. Alkalinity was applied to offset the pollutant loads from the land uses to achieve the pH criterion.
- In some instances, acidity released from instream metal precipitation lowered the pH and resulted in re-suspension of dissolved aluminum. If these reactions resulted in non-attainment of pH and/or dissolved aluminum criteria additional alkalinity was prescribed to seeps and then land uses sources of acidity.

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

Wasteload Allocations (WLAs)

WLAs were developed for active mining point source discharges regulated by NPDES permits effluent limitations. The WLAs for active mining operations consider the functional characteristics of the permitted outlets (i.e. precipitation driven, pumped continuous flow, gravity continuous flow, commingled) and their respective impacts at high- and low-flow conditions. The dissolved aluminum concentration for mining outlets was set at 1.39 mg/l in baseline conditions and no reductions were made in the allocations. Similarly, no acidity reduction was prescribed for active mining operations because no increase to the alkalinity associated with attainment of existing pH effluent limitations was found to be necessary.

Certain legacy mining discharges (seeps) have been classified as point sources. Aluminum allocations for untreated seeps occurring on bond forfeiture sites are captured in permitted outlets for which wasteload allocations are provided. Net acidity reductions to the existing untreated acid loadings are also prescribed, but can be assumed to be achieved if the permitted outlets comply with pH permit effluent limitations in the 6.0 – 9.0 range.

Baseline loadings from non-mining point sources, including facilities registered under the MS4, and Construction Stormwater General Permits were represented to properly account for aluminum associated with sediment sources. Negligible amounts of acidity or dissolved aluminum are attributed to these sources, thus no reductions were necessary and aluminum-specific control actions are not prescribed.

Load Allocations (LAs)

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

- AML: loading from abandoned mine lands, including loads from highwalls, deep mine discharges and seeps.
- Other nonpoint sources: loading associated with acid precipitation influences from background sources, including barren land, harvested forest, oil and gas well operations, agriculture, undisturbed forest and grasslands, and residential/urban/road landuses.

All sources were represented and provided allocations in terms of the total aluminum and net acidity loadings. With respect to load allocations for nonpoint sources that result from precipitation and runoff, any reductions associated with aluminum allocations represent the conversion of dissolved aluminum to particulate aluminum and subsequent settling that would result from alkalinity additions. For abandoned mine sources, aluminum allocations are similarly calculated for abandoned mine lands, but the load allocation presented includes the reduced loads associated with seep discharges.

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

The alkalinity additions associated with existing fine-grained limestone applications in the watershed by the WVDEP and WVDNR were considered in model calibration but were not represented in baseline or allocated conditions because continued operation is not legally mandated. Although these restoration activities are currently resulting in partial or full attainment of TMDL allocations, cessation of operation will result in non-attainment conditions evidenced by upstream monitoring results.

9.7.3 Fecal Coliform Bacteria TMDLs

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

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

Combined Sewer Overflows

In TMDL watersheds there are a total of 56 CSO outlets associated with POTWs operated by the municipalities or sanitary districts listed below (**Table 9-2**). These systems have Long Term

Control Plans, but currently experience frequent stormwater-related CSO discharges, and do not have systems in place to store or treat CSO discharges.

Table 9-2. Combined sewer overflows in the Tygart Valley River Watershed

City	Modeled Sub-watershed	Receiving Stream	Receiving Stream Code	Permit ID	Outlet
Belington	5014	Tygart Valley River	WV-MT	WV0029289	C002
Belington	5012	Tygart Valley River	WV-MT	WV0029289	C003
Belington	5009	Mill Creek	WV-MT-96	WV0029289	C004
Belington	5012	Tygart Valley River	WV-MT	WV0029289	C005
Belington	5007	Big Run	WV-MT-94	WV0029289	C006
Belington	5008	Tygart Valley River	WV-MT	WV0029289	C007
Belington	5008	Tygart Valley River	WV-MT	WV0029289	C008
Buckhannon	3038	Buckhannon River	WV-MT-62	WV0032336	C003
Buckhannon	3050	Buckhannon River	WV-MT-62	WV0032336	C004
Buckhannon	3050	Buckhannon River	WV-MT-62	WV0032336	C005
Buckhannon	3050	Buckhannon River	WV-MT-62	WV0032336	C006
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C002
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C003
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C004
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C005
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C006
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C007
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C008
Elkins	5056	Craven Run	WV-MT-125-B	WV0020028	C009
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C011
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C016
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C017
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C018
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C019
Elkins	5070	Tygart Valley River	WV-MT	WV0020028	C020
Fairmont	1001	Tygart Valley River	WV-MT	WV0023353	C045
Grafton	1023	Tygart Valley River	WV-MT	WV0021822	C005
Grafton	1023	Tygart Valley River	WV-MT	WV0021822	C007
Grafton	1024	Berkeley Run	WV-MT-24	WV0021822	C008
Grafton	1023	Tygart Valley River	WV-MT	WV0021822	C009
Grafton	1023	Tygart Valley River	WV-MT	WV0021822	C010
Grafton	1023	Tygart Valley River	WV-MT	WV0021822	C011
Grafton	1023	Tygart Valley River	WV-MT	WV0021822	C012

City	Modeled Sub-watershed	Receiving Stream	Receiving Stream Code	Permit ID	Outlet
Grafton	1071	Tygart Valley River	WV-MT	WV0021822	C013
Grafton	1071	Tygart Valley River	WV-MT	WV0021822	C020
Grafton	1031	Three Fork Creek	WV-MT-25	WV0021822	C024
Grafton	1031	Three Fork Creek	WV-MT-25	WV0021822	C025
Grafton	1031	Three Fork Creek	WV-MT-25	WV0021822	C028
Grafton	1031	Three Fork Creek	WV-MT-25	WV0021822	C030
Grafton	1023	Tygart Valley River	WV-MT	WV0021822	C031
Grafton	1033	Three Fork Creek	WV-MT-25	WV0021822	C034
Grafton	1033	Three Fork Creek	WV-MT-25	WV0021822	C035
Grafton	1023	Tygart Valley River	WV-MT	WV0021822	C040
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C002
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C003
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C004
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C005
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C006
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C007
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C008
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C009
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C010
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C011
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C012
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C013
Philippi	2082	Tygart Valley River	WV-MT	WV0021857	C014

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

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

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

Municipal Separate Storm Sewer System (MS4)

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

Load Allocations (LAs)

Fecal coliform LAs are assigned to the following source categories:

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

9.7.4 Seasonal Variation

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

9.7.5 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). Also, AMD seeps (categorized as nonpoint sources but represented as continuous flow discharges) often have an associated low-flow critical condition, particularly where such sources are located on small receiving waters.

9.7.6 TMDL Presentation

The TMDLs for all impairments are shown in **Section 10** of this report. The TMDLs for iron, and aluminum and are presented as average daily loads, in pounds per day. The dissolved aluminum TMDLs are based on a dissolved aluminum TMDL endpoint; however, components and allocations are provided in the form of total metal. The pH TMDLs are presented as average daily loads of net acidity, 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, and aluminum WLAs for active mining operations and bond forfeitures are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are the operable allocations and are to be implemented by conversion to monthly average and daily maximum effluent limitations using USEPA's Technical Support Document for Water Quality-based Toxics Control (USEPA, 1991). The iron WLAs for Construction Stormwater General Permit registrations are presented as both annual average loads, for comparison with other sources, and equivalent area registered under the permit. The registered area is the operable allocation. The iron WLAs for non-construction sectors registered under the Multi Sector Stormwater Permit are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are operable, and because they are equivalent to existing effluent limitations/benchmark values, they are to be directly implemented.

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

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

10.0 TMDL RESULTS

Table 10-1. Dissolved aluminum TMDLs

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	WLA (lbs/day)	Margin of Safety (lbs/day)	Dis Al TMDL (lbs/day)
Goose Creek	WV-MT-11	Goose Creek	1.38	0.13	0.08	1.58
Three Fork Creek	WV-MT-25	Three Fork Creek	115.55	56.55	9.06	181.16
Three Fork Creek	WV-MT-25-R	Raccoon Creek	28.18	6.46	1.82	36.47
Three Fork Creek	WV-MT-25-R-2	Cooks Run	4.56	0.00	0.24	4.80
Three Fork Creek	WV-MT-25-AD	Lick Run	1.39	0.00	0.07	1.46
Three Fork Creek	WV-MT-25-AE	Birds Creek	25.92	4.85	1.62	32.40
Three Fork Creek	WV-MT-25-AE-1	Squires Creek	10.50	1.90	0.65	13.05
Three Fork Creek	WV-MT-25-AE-1-B	UNT/Squires Creek RM 2.40	1.43	0.54	0.10	2.08
Three Fork Creek	WV-MT-25-AE-2	UNT/Birds Creek RM 0.64	4.98	0.12	0.27	5.37
Three Fork Creek	WV-MT-25-AE-4	UNT/Birds Creek RM 2.57	3.42	0.03	0.18	3.63
Three Fork Creek	WV-MT-25-AF	Fields Creek	16.41	3.62	1.05	21.08
Sandy Creek	WV-MT-34-J	Little Sandy Creek	47.11	0.50	2.51	50.12
Sandy Creek	WV-MT-34-J-8	Maple Run	8.98	0.44	0.50	9.91
Sandy Creek	WV-MT-34-J-19	Left Fork/Little Sandy Creek	13.70	0.03	0.72	14.45
Fords Run	WV-MT-51	Fords Run	3.14	0.17	0.17	3.49
French Creek	WV-MT-62-AV-7-B	Blacklick Run	0.13	2.08	0.12	2.33
French Creek	WV-MT-62-AV-9	Grand Camp Run	7.10	0.00	0.37	7.47
Swamp Run	WV-MT-62-CB	Swamp Run	1.49	0.03	0.08	1.60
Herods Run	WV-MT-62-CC	Herods Run	0.93	0.02	0.05	1.00
Devil Run	WV-MT-72-V	Devil Run	1.65	0.06	0.09	1.80
Hell Run	WV-MT-72-X	Hell Run	2.00	0.00	0.11	2.11
Short Run	WV-MT-72-Z	Short Run	0.74	0.00	0.04	0.78
White Oak Run	WV-MT-72-AA-1	UNT/White Oak Run RM 0.44	2.84	0.00	0.15	2.99

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	WLA (lbs/day)	Margin of Safety (lbs/day)	Dis Al TMDL (lbs/day)
Laurel Creek/Middle Fork River	WV-MT-72-AE-1	Brook Run	1.45	0.14	0.08	1.67
Kettle Run	WV-MT-72-AK	Kettle Run	2.22	0.00	0.12	2.33
Cassity Fork	WV-MT-72-AU	Cassity Fork	24.00	0.00	1.26	25.27
Cassity Fork	WV-MT-72-AU-3	Panther Run	13.05	0.00	0.69	13.73
Cassity Fork	WV-MT-72-AU-3-A	UNT/Panther Run RM 0.62	6.79	0.00	0.36	7.15
Stonecoal Run	WV-MT-72-BA	Stonecoal Run	3.07	0.00	0.16	3.23
Schoolcraft Run	WV-MT-72-BH-2	Birch Fork	0.80	0.00	0.04	0.84
Birch Fork	WV-MT-72-BI-2	Rocky Run	2.83	0.00	0.15	2.98
Beaver Creek	WV-MT-109	Beaver Creek	11.26	0.08	0.60	11.94
Beaver Creek	WV-MT-109-D	UNT/Beaver Creek RM 2.02	1.32	0.00	0.07	1.39
Big Laurel Run	WV-MT-115-B	Little Laurel Run	2.02	0.00	0.11	2.13
UNT/Tygart Valley River RM 72.55	WV-MT-117	UNT/Tygart Valley River RM 72.55	2.20	0.00	0.12	2.32
Grassy Run	WV-MT-119	Grassy Run	4.87	0.09	0.26	5.22
Grassy Run	WV-MT-119-A	UNT/Grassy Run RM 0.45	0.63	0.06	0.04	0.72
Roaring Creek	WV-MT-120	Roaring Creek	44.73	0.92	2.40	48.06
Roaring Creek	WV-MT-120-I	UNT/Roaring Creek RM 4.09	6.55	0.00	0.34	6.89
Roaring Creek	WV-MT-120-U	Flatbush Fork	7.44	0.60	0.42	8.47
Roaring Creek	WV-MT-120-U-3	UNT/Flatbush Fork RM 0.78	1.72	0.60	0.12	2.44
Roaring Creek	WV-MT-120-U-4	UNT/Flatbush Fork RM 1.80	1.51	0.00	0.08	1.59
Roaring Creek	WV-MT-120-X	UNT/Roaring Creek RM 10.51	2.03	0.00	0.11	2.14
Mill Creek	WV-MT-207-N	Meatbox Run	0.46	0.00	0.02	0.49
Mill Creek	WV-MT-207-P	Potatohole Fork	1.36	0.00	0.07	1.43

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

Table 10-2. Iron TMDLs

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Tygart Valley	WV-MT	Tygart Valley River (Below Lake)	7619.02	465.78	425.52	8510.32
Tygart Valley	WV-MT	Tygart Valley River (Above Lake)	11190.52	983.01	640.71	12814.25
Island Run	WV-MT-108	Island Run	4.48	0.81	0.28	5.58
Beaver Creek	WV-MT-109	Beaver Creek	36.82	6.28	2.27	45.37
Beaver Creek	WV-MT-109-D	UNT/Beaver Creek RM 2.02	7.38	1.60	0.47	9.46
Goose Creek	WV-MT-11	Goose Creek	4.62	4.52	0.48	9.62
Zebs Creek	WV-MT-112	Zebs Creek	25.37	4.00	1.55	30.92
Laurel Run	WV-MT-114	Laurel Run	9.88	1.73	0.61	12.21
Big Laurel Run	WV-MT-115	Big Laurel Run	15.14	2.77	0.94	18.85
Big Laurel Run	WV-MT-115-B	Little Laurel Run	4.68	0.93	0.30	5.90
Tygart Valley	WV-MT-116	UNT/Tygart Valley River RM 71.66	3.25	2.74	0.32	6.30
UNT/Tygart Valley River RM 72.55	WV-MT-117	UNT/Tygart Valley River RM 72.55	3.67	0.41	0.21	4.30
Grassy Run	WV-MT-119	Grassy Run	8.34	1.36	0.51	10.21
Lost Run	WV-MT-12	Lost Run	37.30	5.19	2.24	44.72
Roaring Creek	WV-MT-120	Roaring Creek	100.61	26.79	6.71	134.11
Roaring Creek	WV-MT-120-I	UNT/Roaring Creek RM 4.09	8.23	0.64	0.47	9.33
Roaring Creek	WV-MT-120-L	Laurel Run	7.45	3.31	0.57	11.33
Roaring Creek	WV-MT-120-U	Flatbush Fork	17.89	10.94	1.52	30.34
Roaring Creek	WV-MT-120-U-3	UNT/Flatbush Fork RM 0.78	3.31	8.89	0.64	12.85
Roaring Creek	WV-MT-120-U-4	UNT/Flatbush Fork RM 1.80	2.89	0.48	0.18	3.54
Roaring Creek	WV-MT-120-X	UNT/Roaring Creek RM 10.51	5.46	1.06	0.34	6.86
UNT/Tygart Valley River RM 76.87	WV-MT-122	UNT/Tygart Valley River RM 76.87	0.63	1.73	0.12	2.49
Leading Creek	WV-MT-125	Leading Creek	288.41	29.38	16.73	334.51
Leading Creek	WV-MT-125-A	UNT/Leading Creek RM 0.47	4.35	0.73	0.27	5.35
Leading Creek	WV-MT-125-AC	Cherry Fork	11.50	1.79	0.70	13.99

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Leading Creek	WV-MT-125-AN	Laurel Run	5.47	1.01	0.34	6.82
Leading Creek	WV-MT-125-B	Craven Run	12.63	2.23	0.78	15.64
Leading Creek	WV-MT-125-D	Claylick Run	14.66	2.89	0.92	18.47
Leading Creek	WV-MT-125-L	Pearcy Run	11.67	2.12	0.73	14.51
Leading Creek	WV-MT-125-M	Stalnaker Run	14.72	2.84	0.92	18.49
Leading Creek	WV-MT-125-S	Davis Lick	11.26	1.60	0.68	13.54
UNT/Tygart Valley River RM 81.92	WV-MT-136	UNT/Tygart Valley River RM 81.92	0.04	1.39	0.08	1.51
UNT/Tygart Valley River RM 82.27	WV-MT-137	UNT/Tygart Valley River RM 82.27	0.13	1.90	0.11	2.14
Chenoweth Creek	WV-MT-146	Chenoweth Creek	50.97	12.59	3.35	66.91
Chenoweth Creek	WV-MT-146-Q	Left Fork/Chenoweth Creek	6.81	6.29	0.69	13.79
Tygart Valley	WV-MT-148	Whitman Run	5.64	1.08	0.35	7.08
Tygart Valley	WV-MT-151	Beaver Creek	17.35	3.32	1.09	21.76
Kings Run	WV-MT-152	Kings Run	15.64	2.92	0.98	19.55
Tygart Valley	WV-MT-157	Files Creek	69.31	11.87	4.27	85.44
Tygart Valley	WV-MT-157-D	Right Fork/Files Creek	35.55	6.75	2.23	44.53
Tygart Valley	WV-MT-157-E	Left Fork/Files Creek	19.17	3.85	1.21	24.23
UNT/Tygart Valley River RM 92.85	WV-MT-159	UNT/Tygart Valley River RM 92.85	5.74	0.85	0.35	6.93
Tygart Valley	WV-MT-16	Glady Creek	17.38	2.74	1.06	21.18
Tygart Valley	WV-MT-17	Plum Run	4.47	0.68	0.27	5.41
Jones Run	WV-MT-177	Jones Run	8.06	1.58	0.51	10.14
Wickwire Run	WV-MT-18	Wickwire Run	57.73	8.13	3.47	69.32
Wickwire Run	WV-MT-18-C	Dog Run	8.42	1.19	0.51	10.12
Wickwire Run	WV-MT-18-D	UNT/Wickwire Run RM 4.39	3.05	0.62	0.19	3.86
Wickwire Run	WV-MT-18-E	UNT/Wickwire Run RM 5.22	11.72	1.74	0.71	14.17
Otter Creek	WV-MT-20	Otter Creek	12.12	1.64	0.72	14.48
Dry Run	WV-MT-206	Dry Run	10.79	1.92	0.67	13.38

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Mill Creek	WV-MT-207	Mill Creek	74.90	12.24	4.59	91.72
Mill Creek	WV-MT-207-A	Right Fork/Mill Creek	16.29	3.29	1.03	20.61
Mill Creek	WV-MT-207-P	Potatohole Fork	3.57	0.65	0.22	4.44
UNT/Tygart Valley River RM 105.69	WV-MT-208	UNT/Tygart Valley River RM 105.69	3.11	0.30	0.18	3.58
Berkeley Run	WV-MT-24	Berkeley Run	30.38	7.22	1.98	39.57
Tygart Valley	WV-MT-243	Stewart Run	21.89	3.81	1.35	27.05
Berkeley Run	WV-MT-24-A	Shelby Run	7.46	3.68	0.59	11.73
Berkeley Run	WV-MT-24-B	Long Run	8.22	1.74	0.52	10.48
Berkeley Run	WV-MT-24-B-2	Berry Run	1.58	0.22	0.09	1.90
Three Fork Creek	WV-MT-25	Three Fork Creek	425.15	137.67	29.62	592.44
Tygart Valley	WV-MT-254	Conley Run	8.64	1.37	0.53	10.54
Tygart Valley	WV-MT-258	Ralston Run	16.85	2.38	1.01	20.24
Tygart Valley	WV-MT-259	Windy Run	12.62	2.04	0.77	15.44
Three Fork Creek	WV-MT-25-AD	Lick Run	3.03	0.51	0.19	3.72
Three Fork Creek	WV-MT-25-AE	Birds Creek	50.39	25.89	4.02	80.30
Three Fork Creek	WV-MT-25-AE-1	Squires Creek	16.62	14.43	1.63	32.69
Three Fork Creek	WV-MT-25-AE-1-B	UNT/Squires Creek RM 2.40	2.24	7.75	0.53	10.51
Three Fork Creek	WV-MT-25-AE-2	UNT/Birds Creek RM 0.64	8.83	2.04	0.57	11.44
Three Fork Creek	WV-MT-25-AF	Fields Creek	49.46	10.52	3.16	63.13
Three Fork Creek	WV-MT-25-AF-1	Stony Run	11.15	1.48	0.66	13.29
Three Fork Creek	WV-MT-25-AF-3	Brains Creek	10.58	4.94	0.82	16.33
Three Fork Creek	WV-MT-25-C	UNT/Three Fork Creek RM 2.02	1.68	30.89	1.71	34.28
Three Fork Creek	WV-MT-25-N	Little Laurel Run	7.48	1.28	0.46	9.22
Three Fork Creek	WV-MT-25-R	Raccoon Creek	60.43	22.96	4.39	87.78
Three Fork Creek	WV-MT-25-R-2	Cooks Run	9.60	1.47	0.58	11.65
Three Fork Creek	WV-MT-25-R-5	Little Raccoon Creek	4.73	1.08	0.31	6.11
Three Fork Creek	WV-MT-25-V	Laurel Run	27.62	4.08	1.67	33.37
Scab Run	WV-MT-26	Scab Run	1.18	0.19	0.07	1.44

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Tygart Valley	WV-MT-264	Logan Run	4.88	0.76	0.30	5.93
Tygart Valley	WV-MT-268	Big Run	7.05	1.15	0.43	8.64
Pleasant Creek	WV-MT-30	Pleasant Creek	21.47	45.01	3.50	69.98
Little Sandy Creek	WV-MT-34	Sandy Creek	444.26	49.87	26.01	520.13
Little Sandy Creek	WV-MT-34-D	Swamp Run	9.45	1.19	0.56	11.21
Little Sandy Creek	WV-MT-34-G	Glade Run	12.15	2.06	0.75	14.96
Little Sandy Creek	WV-MT-34-H	Little Cove Run	26.74	3.52	1.59	31.84
Little Sandy Creek	WV-MT-34-J	Little Sandy Creek	149.06	22.94	9.05	181.05
Little Sandy Creek	WV-MT-34-J-13	York Run	12.01	2.11	0.74	14.87
Little Sandy Creek	WV-MT-34-J-18	Right Fork/Little Sandy Creek	42.29	7.44	2.62	52.35
Little Sandy Creek	WV-MT-34-J-18-B	Tibbs Run	8.59	1.69	0.54	10.83
Little Sandy Creek	WV-MT-34-J-19	Left Fork/Little Sandy Creek	22.39	4.20	1.40	27.99
Little Sandy Creek	WV-MT-34-J-8	Maple Run	17.75	4.07	1.15	22.97
Little Sandy Creek	WV-MT-34-K	Oldroad Run	4.43	0.71	0.27	5.42
Little Sandy Creek	WV-MT-34-L	Left Fork/Sandy Creek	28.93	8.99	2.00	39.91
Little Sandy Creek	WV-MT-34-L-10	UNT/Left Fork RM 4.58/Sandy Creek	4.41	0.78	0.27	5.47
Little Sandy Creek	WV-MT-34-N	UNT/Sandy Creek RM 10.47	16.38	2.26	0.98	19.62
Little Sandy Creek	WV-MT-34-N-1	UNT/UNT RM 0.56/Sandy Creek RM 10.47	11.14	1.71	0.68	13.53
Big Cove Run	WV-MT-39	Big Cove Run	17.24	2.55	1.04	20.84
Teter Creek	WV-MT-43	Teter Creek	172.91	29.79	10.67	213.36
Teter Creek	WV-MT-43-B	Glade Run	9.75	1.30	0.58	11.64
Teter Creek	WV-MT-43-C	Raccoon Creek	27.07	4.54	1.66	33.27
Teter Creek	WV-MT-43-C-5	Stony Run	4.50	0.66	0.27	5.44
Teter Creek	WV-MT-43-H	Brushy Fork	34.33	12.80	2.48	49.61
Teter Creek	WV-MT-43-L	Mill Run	7.08	1.16	0.43	8.67
Teter Creek	WV-MT-43-M	Jimmy Run	4.67	0.86	0.29	5.83
Teter Creek	WV-MT-43-S	Mill Run	6.53	1.39	0.42	8.34
Laurel Creek	WV-MT-46	Laurel Creek	257.08	28.78	15.05	300.90

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Laurel Creek	WV-MT-46-B	Moats Hollow	2.85	0.51	0.18	3.54
Laurel Creek	WV-MT-46-C	Frost Run	4.06	0.75	0.25	5.07
Laurel Creek	WV-MT-46-J	Sugar Creek	192.65	23.96	11.40	228.01
Laurel Creek	WV-MT-46-J-10	Bills Creek	24.19	4.13	1.49	29.81
Laurel Creek	WV-MT-46-J-3	Glady Creek	34.75	4.61	2.07	41.43
Laurel Creek	WV-MT-46-J-3-F	UNT/Glady Creek RM 3.68	10.46	1.25	0.62	12.32
Laurel Creek	WV-MT-46-J-7	Whitman Run	15.53	2.23	0.94	18.70
Laurel Creek	WV-MT-46-K	Bonica Run	8.70	1.27	0.52	10.49
Mitchell Run	WV-MT-48	Mitchell Run	13.92	2.27	0.85	17.04
Hackers Creek	WV-MT-50	Hackers Creek	22.78	66.13	4.68	93.59
Hackers Creek	WV-MT-50-A	Taylor Drain	3.58	0.62	0.22	4.42
Hackers Creek	WV-MT-50-B	Foxgrape Run	4.95	39.44	2.34	46.72
Hackers Creek	WV-MT-50-C	Little Hackers Creek	0.72	24.97	1.35	27.04
Fords Run	WV-MT-51	Fords Run	5.54	6.07	0.61	12.22
Shooks Run	WV-MT-53	Shooks Run	6.84	0.87	0.41	8.12
Tygart Valley	WV-MT-56	Little Laurel Run	11.64	1.72	0.70	14.06
Buckhannon River	WV-MT-62	Buckhannon River	3022.30	529.75	186.95	3739.00
Big Run	WV-MT-62-AA	Big Run	2.42	0.33	0.14	2.89
Childers Run	WV-MT-62-AB	Childers Run	5.63	0.93	0.35	6.90
Turkey Run	WV-MT-62-AE	Turkey Run	34.44	5.83	2.12	42.39
Turkey Run	WV-MT-62-AE-3	Sugar Run	5.93	1.05	0.37	7.35
Fink Run	WV-MT-62-AH	Fink Run	50.46	10.18	3.19	63.83
Fink Run	WV-MT-62-AH-10	Bridge Run	6.15	1.07	0.38	7.60
Fink Run	WV-MT-62-AH-12	Sauls Run	3.30	1.07	0.23	4.60
Fink Run	WV-MT-62-AH-4	Brushy Fork	9.13	1.30	0.55	10.98
Fink Run	WV-MT-62-AH-5	Mud Lick	7.26	2.39	0.51	10.16
Fink Run	WV-MT-62-AH-8	Wash Run	3.22	0.79	0.21	4.22
Little Sand Run	WV-MT-62-AN	Little Sand Run	16.61	1.92	0.98	19.51

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Ratcliff Run	WV-MT-62-AO	Ratcliff Run	3.46	0.52	0.21	4.19
Stony Run	WV-MT-62-AP	Stony Run	6.62	0.80	0.39	7.81
Hickory Flat Run	WV-MT-62-AR	Hickory Flat Run	3.85	0.57	0.23	4.66
Cutright Run	WV-MT-62-AS	Cutright Run	15.99	22.23	2.01	40.24
Cutright Run	WV-MT-62-AS-5	Lick Run	5.16	0.69	0.31	6.16
French Creek	WV-MT-62-AV	French Creek	229.66	50.71	14.76	295.12
French Creek	WV-MT-62-AV-12	Laurel Fork	41.65	6.28	2.52	50.46
French Creek	WV-MT-62-AV-12-H	Queens Fork	7.33	1.30	0.45	9.09
French Creek	WV-MT-62-AV-12-J	Grassy Creek	8.94	1.14	0.53	10.61
French Creek	WV-MT-62-AV-14	Kittle Run	2.41	0.37	0.15	2.93
French Creek	WV-MT-62-AV-15	Morgan Run	2.00	0.26	0.12	2.38
French Creek	WV-MT-62-AV-16	Grub Hollow	2.34	0.30	0.14	2.78
French Creek	WV-MT-62-AV-17	Brush Run	19.02	2.79	1.15	22.96
French Creek	WV-MT-62-AV-17-A	Little Brush Run	7.38	1.11	0.45	8.94
French Creek	WV-MT-62-AV-19	Slab Camp Fork	18.92	2.79	1.14	22.85
French Creek	WV-MT-62-AV-24	Left Fork/French Creek	8.57	1.33	0.52	10.42
French Creek	WV-MT-62-AV-7	Bull Run	13.87	23.72	1.98	39.58
French Creek	WV-MT-62-AV-7-B	Blacklick Run	0.50	22.06	1.19	23.74
French Creek	WV-MT-62-AV-7-C	Mudlick Run	1.02	0.16	0.06	1.24
French Creek	WV-MT-62-AV-9	Grand Camp Run	17.51	2.82	1.07	21.41
Trubie Run	WV-MT-62-AW	Trubie Run	9.67	1.59	0.59	11.85
Sawmill Run	WV-MT-62-BA	Sawmill Run	1.92	56.29	3.06	61.28
Buckhannon River	WV-MT-62-BD	Grassy Run	15.87	38.52	2.86	57.25
Buckhannon River	WV-MT-62-BF	Little Laurel Run	3.66	0.59	0.22	4.47
Laurel Run/Buckhannon River	WV-MT-62-BG	Laurel Run	3.94	0.63	0.24	4.82
Tenmile Creek	WV-MT-62-BH	Tenmile Creek	17.25	37.47	2.88	57.60
Tenmile Creek	WV-MT-62-BH-1	Right Fork/Tenmile Creek	11.53	5.06	0.87	17.46
Panther Creek	WV-MT-62-BN	Panther Creek	13.75	9.16	1.21	24.12

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Buckhannon River	WV-MT-62-BR	Big Run	9.66	2.25	0.63	12.54
Swamp Run	WV-MT-62-CB	Swamp Run	4.30	1.54	0.31	6.15
Herods Run	WV-MT-62-CC	Herods Run	3.33	1.04	0.23	4.60
Right Fork/Buckhannon River	WV-MT-62-CE	Right Fork/Buckhannon River	192.25	133.49	17.14	342.88
Right Fork/Buckhannon River	WV-MT-62-CE-21	Marsh Fork	11.05	1.92	0.68	13.65
Right Fork/Buckhannon River	WV-MT-62-CE-6	Millsite Run	6.94	1.15	0.43	8.51
Right Fork/Buckhannon River	WV-MT-62-CE-8	Left Fork/Right Fork/Buckhannon River	57.44	116.44	9.15	183.03
Right Fork/Buckhannon River	WV-MT-62-CE-9	Middle Fork/Right Fork/Buckhannon River	18.33	3.13	1.13	22.59
Left Fork/Buckhannon River	WV-MT-62-CF	Left Fork/Buckhannon River	164.79	47.94	11.20	223.92
Left Fork/Buckhannon River	WV-MT-62-CF-16	Beech Run	19.61	5.10	1.30	26.01
Left Fork/Buckhannon River	WV-MT-62-CF-3	Smooth Rock Lick Run	4.89	0.78	0.30	5.97
Left Fork/Buckhannon River	WV-MT-62-CF-7	Bearcamp Run	10.04	1.65	0.62	12.30
First Big Run	WV-MT-62-E	First Big Run	7.48	1.24	0.46	9.17
Cottrill Run	WV-MT-62-J	Cottrill Run	2.49	0.39	0.15	3.04
Big Run	WV-MT-62-L	Big Run	14.95	19.53	1.82	36.30
Lick Shoals Run	WV-MT-62-N	Lick Shoals Run	4.57	0.71	0.28	5.56
Pecks Run	WV-MT-62-P	Pecks Run	53.51	19.39	3.84	76.74
Pecks Run	WV-MT-62-P-2	UNT/Pecks Run RM 2.24	1.15	0.15	0.07	1.37
Pecks Run	WV-MT-62-P-6	Little Pecks Run	6.83	1.19	0.42	8.44
Buckhannon River	WV-MT-62-U	Handy Camp Run	10.14	1.77	0.63	12.55
Sand Run	WV-MT-62-V	Sand Run	97.91	14.96	5.94	118.81
Sand Run	WV-MT-62-V-2	Laurel Fork	36.29	6.53	2.25	45.07
Sand Run	WV-MT-62-V-2-A	Little Laurel Fork	8.90	1.92	0.57	11.39
Sand Run	WV-MT-62-V-9	Left Fork/Sand Run	16.85	3.11	1.05	21.01
Laurel Run/Tygart Valley River	WV-MT-68	Laurel Run	18.38	2.55	1.10	22.03
Tygart Valley	WV-MT-7	Guyses Run	6.80	1.14	0.42	8.36

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Middle Fork River	WV-MT-72	Middle Fork River	849.74	87.43	49.32	986.49
White Oak Run	WV-MT-72-AA	White Oak Run	5.84	2.87	0.46	9.17
White Oak Run	WV-MT-72-AA-1	UNT/White Oak Run RM 0.44	1.94	0.24	0.11	2.29
Gum Run	WV-MT-72-AB-2	UNT/Gum Run RM 1.18	0.58	0.07	0.03	0.68
Laurel Creek/Middle Fork River	WV-MT-72-AE	Laurel Creek	15.86	3.64	1.03	20.53
Laurel Creek/Middle Fork River	WV-MT-72-AE-1	Brook Run	5.16	2.08	0.38	7.62
Right Fork/Middle Fork River	WV-MT-72-AH	Right Fork/Middle Fork River	109.31	22.40	6.93	138.64
Right Fork/Middle Fork River	WV-MT-72-AH-1	Osborne Run	4.63	0.90	0.29	5.83
Right Fork/Middle Fork River	WV-MT-72-AH-12	Jackson Fork	7.47	1.42	0.47	9.36
Right Fork/Middle Fork River	WV-MT-72-AH-13	Jenks Fork	18.37	3.39	1.15	22.91
Right Fork/Middle Fork River	WV-MT-72-AH-5	Laurel Run	3.57	2.30	0.31	6.18
Right Fork/Middle Fork River	WV-MT-72-AH-7	Laurel Run	5.18	2.36	0.40	7.93
Middle Fork River	WV-MT-72-AL	Long Run	25.28	4.77	1.58	31.64
Lick Run	WV-MT-72-AT	Lick Run	2.00	0.34	0.12	2.46
Cassity Fork	WV-MT-72-AU	Cassity Fork	59.62	7.69	3.54	70.86
Cassity Fork	WV-MT-72-AU-3	Panther Run	29.39	4.77	1.80	35.95
Cassity Fork	WV-MT-72-AU-3-A	UNT/Panther Run RM 0.62	14.36	2.60	0.89	17.85
Cassity Fork	WV-MT-72-AU-5	Mulberry Fork	3.89	0.62	0.24	4.74
Middle Fork River	WV-MT-72-AV	Three Forks Run	4.25	0.71	0.26	5.22
Stonecoal Run	WV-MT-72-BA	Stonecoal Run	6.78	1.15	0.42	8.35
Pleasant Run	WV-MT-72-BC	Pleasant Run	3.82	0.71	0.24	4.77
Middle Fork River	WV-MT-72-BD	Laurel Run	5.12	0.90	0.32	6.34
Middle Fork River	WV-MT-72-BE	Laurel Branch	7.53	1.30	0.46	9.30
Middle Fork River	WV-MT-72-BG	Spice Run	5.20	0.90	0.32	6.41
Schoolcraft Run	WV-MT-72-BH	Schoolcraft Run	10.68	1.67	0.65	13.00
Schoolcraft Run	WV-MT-72-BH-2	Birch Fork	2.10	0.36	0.13	2.59

TMDL Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Birch Fork	WV-MT-72-BI	Birch Fork	38.30	18.53	2.99	59.82
Birch Fork	WV-MT-72-BI-2	Rocky Run	11.68	2.11	0.73	14.51
Middle Fork River	WV-MT-72-BJ	Kittle Creek	19.10	3.12	1.17	23.38
Middle Fork River	WV-MT-72-BJ-1	Mitchell Lick Fork	3.33	0.59	0.21	4.13
Middle Fork River	WV-MT-72-O	Hanging Run	11.81	1.59	0.71	14.10
Middle Fork River	WV-MT-72-Q	Laurel Run	4.13	0.53	0.25	4.90
Hooppole Run	WV-MT-72-T	Hooppole Run	2.56	0.34	0.15	3.06
Devil Run	WV-MT-72-V	Devil Run	4.27	0.63	0.26	5.16
Hell Run	WV-MT-72-X	Hell Run	3.79	0.58	0.23	4.60
Short Run	WV-MT-72-Z	Short Run	2.16	0.38	0.13	2.68
Tygart Valley	WV-MT-77	UNT/Tygart Valley River RM 55.89	3.96	0.77	0.25	4.98
Tygart Valley	WV-MT-78	Gower Run	3.51	9.00	0.66	13.16
UNT/Tygart Valley River RM 58.40	WV-MT-83	UNT/Tygart Valley River RM 58.40	0.79	0.12	0.05	0.96
Tygart Valley	WV-MT-94	Big Run	8.26	1.34	0.51	10.11
Mill Creek	WV-MT-96	Mill Creek	16.92	2.74	1.03	20.69
Mill Creek	WV-MT-96-E	UNT/Mill Creek RM 2.11	2.55	0.54	0.16	3.25
Shooks Run	WV-MT-97	Shooks Run	2.64	0.55	0.17	3.36

UNT = unnamed tributary; RM = river mile.

Table 10-3. pH TMDLs

TMDL Watershed	Stream Code	Stream Name	LA Average Daily Net Acidity Load (lbs as CaCO3/day)	WLA Average Daily Net Acidity Load (lbs as CaCO3/day)	MOS Average Daily Net Acidity Load (lbs as CaCO3/day)	TMDL Average Daily Net Acidity Load (lbs as CaCO3/day)
Goose Creek	MT-11	Goose Creek	-356.19	0.00	-18.75	-374.94
Three Fork Creek	MT-25	Three Fork Creek	-15810.79	-1564.20	-914.47	-18289.47
Three Fork Creek	MT-25-R	Raccoon Creek	-3575.97	-368.68	-207.61	-4152.26

TMDL Watershed	Stream Code	Stream Name	LA Average Daily Net Acidity Load (lbs as CaCO3/day)	WLA Average Daily Net Acidity Load (lbs as CaCO3/day)	MOS Average Daily Net Acidity Load (lbs as CaCO3/day)	TMDL Average Daily Net Acidity Load (lbs as CaCO3/day)
Three Fork Creek	MT-25-R-2	Cooks Run	-367.72	0.00	-19.35	-387.07
Three Fork Creek	MT-25-AD	Lick Run	-291.64	0.00	-15.35	-306.99
Three Fork Creek	MT-25-AE	Birds Creek	-2872.00	-20.64	-152.24	-3044.88
Three Fork Creek	MT-25-AE-1	Squires Creek	-1784.02	-6.71	-94.25	-1884.97
Three Fork Creek	MT-25-AE-1-B	UNT/Squires Creek RM 2.40	-58.29	0.00	-3.07	-61.36
Three Fork Creek	MT-25-AE-2	UNT/Birds Creek RM 0.64	-88.25	0.00	-4.64	-92.90
Three Fork Creek	MT-25-AE-4	UNT/Birds Creek RM 2.57	-65.95	0.00	-3.47	-69.42
Three Fork Creek	MT-25-AF	Fields Creek	-2815.16	-1.27	-148.23	-2964.66
Little Sandy Creek	MT-34-J	Little Sandy Creek	-10824.58	-85.16	-574.20	-11483.94
Little Sandy Creek	MT-34-J-8	Maple Run	-1458.34	-85.16	-81.24	-1624.74
Little Sandy Creek	MT-34-J-19	Left Fork/Little Sandy Creek	-3031.95	0.00	-159.58	-3191.52
Little Sandy Creek	MT-34-N-1	UNT/UNT RM 0.56/Sandy Creek RM 10.47	-1331.10	0.00	-70.06	-1401.16
Teter Creek	MT-43-M	Jimmy Run	-672.81	0.00	-35.41	-708.22
Fords Run	MT-51	Fords Run	-747.70	0.00	-39.35	-787.06
French Creek	MT-62-AV-7-B	Blacklick Run	-233.74	-77.37	-16.37	-327.49
French Creek	MT-62-AV-9	Grand Camp Run	-1040.17	0.00	-54.75	-1094.92
Panther Creek	MT-62-BN	Panther Creek	-1616.08	0.00	-85.06	-1701.14
Swamp Run	MT-62-CB	Swamp Run	-435.57	0.00	-22.92	-458.50
Herods Run	MT-62-CC	Herods Run	-359.56	0.00	-18.92	-378.48
Right Fork/Buckhannon River	MT-62-CE-22	UNT/Right Fork RM 12.18/Buckhannon River	-219.39	0.00	-11.55	-230.94
Left Fork/Buckhannon River	MT-62-CF-3	Smooth Rock Lick Run	-482.75	0.00	-25.41	-508.16
Left Fork/Buckhannon River	MT-62-CF-7	Bearcamp Run	-1279.65	0.00	-67.35	-1347.00
Devil Run	MT-72-V	Devil Run	-405.27	0.00	-21.33	-426.60
Service Run	MT-72-W	Service Run	-143.41	0.00	-7.55	-150.96
Hell Run	MT-72-X	Hell Run	-365.41	0.00	-19.23	-384.64
Short Run	MT-72-Z	Short Run	-176.03	0.00	-9.26	-185.29

TMDL Watershed	Stream Code	Stream Name	LA Average Daily Net Acidity Load (lbs as CaCO3/day)	WLA Average Daily Net Acidity Load (lbs as CaCO3/day)	MOS Average Daily Net Acidity Load (lbs as CaCO3/day)	TMDL Average Daily Net Acidity Load (lbs as CaCO3/day)
White Oak Run	MT-72-AA	White Oak Run	-558.87	-2.49	-29.54	-590.90
White Oak Run	MT-72-AA-1	UNT/White Oak Run RM 0.44	-246.18	0.00	-12.96	-259.13
Laurel Creek/Middle Fork River	MT-72-AE-1	Brook Run	-832.99	0.00	-43.84	-876.83
Right Fork/Middle Fork River	MT-72-AH-13	Jenks Fork	-2109.97	0.00	-111.05	-2221.02
Kettle Run	MT-72-AK	Kettle Run	-761.51	0.00	-40.08	-801.59
Lick Run	MT-72-AT	Lick Run	-251.15	0.00	-13.22	-264.37
Cassity Fork	MT-72-AU	Cassity Fork	-3250.02	0.00	-171.05	-3421.07
Cassity Fork	MT-72-AU-3	Panther Run	-730.24	0.00	-38.43	-768.67
Cassity Fork	MT-72-AU-3-A	UNT/Panther Run RM 0.62	-375.27	0.00	-19.75	-395.02
Cassity Fork	MT-72-AU-5	Mulberry Fork	-576.12	0.00	-30.32	-606.44
Stonecoal Run	MT-72-BA	Stonecoal Run	-1078.55	0.00	-56.77	-1135.32
Pleasant Run	MT-72-BC	Pleasant Run	-748.40	0.00	-39.39	-787.79
Schoolcraft Run	MT-72-BH-2	Birch Fork	-382.49	0.00	-20.13	-402.62
Birch Fork	MT-72-BI-2	Rocky Run	-759.95	0.00	-40.00	-799.95
Beaver Creek	MT-109	Beaver Creek	-1188.92	0.00	-62.57	-1251.49
Beaver Creek	MT-109-D	UNT/Beaver Creek RM 2.02	-238.08	0.00	-12.53	-250.61
Big Laurel Run	MT-115-B	Little Laurel Run	-449.40	0.00	-23.65	-473.06
UNT/Tygart Valley River RM 72.55	MT-117	UNT/Tygart Valley River RM 72.55	-200.50	0.00	-10.55	-211.05
Grassy Run	MT-119	Grassy Run	-416.28	0.00	-21.91	-438.19
Grassy Run	MT-119-A	UNT/Grassy Run RM 0.45	-159.35	0.00	-8.39	-167.74
Roaring Creek	MT-120	Roaring Creek	-6670.30	0.00	-351.07	-7021.37
Roaring Creek	MT-120-I	UNT/Roaring Creek RM 4.09	-3296.56	0.00	-173.50	-3470.06
Roaring Creek	MT-120-U	Flatbush Fork	-1121.45	0.00	-59.02	-1180.47
Roaring Creek	MT-120-U-3	UNT/Flatbush Fork RM 0.78	-146.44	0.00	-7.71	-154.15
Roaring Creek	MT-120-U-4	UNT/Flatbush Fork RM 1.80	-223.80	0.00	-11.78	-235.58

TMDL Watershed	Stream Code	Stream Name	LA Average Daily Net Acidity Load (lbs as CaCO3/day)	WLA Average Daily Net Acidity Load (lbs as CaCO3/day)	MOS Average Daily Net Acidity Load (lbs as CaCO3/day)	TMDL Average Daily Net Acidity Load (lbs as CaCO3/day)
Roaring Creek	MT-120-X	UNT/Roaring Creek RM 10.51	-480.96	0.00	-25.31	-506.28
Roaring Creek	MT-120-Y	UNT/Roaring Creek RM 11.0	-199.66	0.00	-10.51	-210.17
Mill Creek	MT-207-N	Meatbox Run	-189.49	0.00	-9.97	-199.46
Mill Creek	MT-207-P	Potatohole Fork	-524.01	0.00	-27.58	-551.59

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

Table 10-4. Fecal Coliform Bacteria TMDLs

TMDL Watershed	Stream Code	Stream Name	Load Allocations (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Tygart Valley River	WV-MT	Tygart Valley River (Below Lake)	9.30E+11	2.55E+10	5.03E+10	1.01E+12
Tygart Valley River	WV-MT	Tygart Valley River (Above Lake)	4.01E+12	7.66E+10	2.15E+11	4.31E+12
Goose Creek	WV-MT-11	Goose Creek	9.26E+09	1.36E+07	4.88E+08	9.76E+09
Zebs Creek	WV-MT-112	Zebs Creek	2.58E+10	9.09E+06	1.36E+09	2.72E+10
Lost Run	WV-MT-12	Lost Run	6.04E+10	4.77E+07	3.18E+09	6.37E+10
UNT/Tygart Valley River RM 76.87	WV-MT-122	UNT/Tygart Valley River RM 76.87	1.42E+09	0.00E+00	7.48E+07	1.50E+09
Leading Creek	WV-MT-125	Leading Creek	2.45E+11	1.27E+08	1.29E+10	2.58E+11
Leading Creek	WV-MT-125-AN	Laurel Run	7.06E+09	0.00E+00	3.72E+08	7.43E+09
Leading Creek	WV-MT-125-B	Craven Run	1.60E+10	1.24E+07	8.45E+08	1.69E+10
Leading Creek	WV-MT-125-S	Davis Lick	1.11E+10	0.00E+00	5.85E+08	1.17E+10
UNT/Tygart Valley River RM 82.27	WV-MT-137	UNT/Tygart Valley River Rm 82.27	6.23E+08	0.00E+00	3.28E+07	6.56E+08
Chenoweth Creek	WV-MT-146	Chenoweth Creek	9.07E+10	6.74E+07	4.77E+09	9.55E+10
Chenoweth Creek	WV-MT-146-F	Isner Creek	3.16E+10	2.42E+07	1.67E+09	3.33E+10
Kings Run	WV-MT-152	Kings Run	1.90E+10	9.09E+06	9.98E+08	2.00E+10
Dodson Run	WV-MT-153	Dodson Run	8.73E+09	4.55E+06	4.60E+08	9.19E+09
UNT/Tygart Valley River RM 92.85	WV-MT-159	UNT/Tygart Valley River RM 92.85	1.75E+10	4.62E+07	9.22E+08	1.84E+10
Sea Run	WV-MT-171	Sea Run	1.25E+10	0.00E+00	6.58E+08	1.32E+10

TMDL Watershed	Stream Code	Stream Name	Load Allocations (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Jones Run	WV-MT-177	Jones Run	8.83E+09	0.00E+00	4.65E+08	9.30E+09
Wickwire Run	WV-MT-18	Wickwire Run	5.41E+10	6.74E+07	2.85E+09	5.70E+10
Otter Creek	WV-MT-20	Otter Creek	2.83E+10	2.20E+07	1.49E+09	2.98E+10
McCall Run	WV-MT-205	McCall Run	1.90E+09	0.00E+00	1.00E+08	2.01E+09
Dry Run	WV-MT-206	Dry Run	9.21E+09	0.00E+00	4.84E+08	9.69E+09
Mill Creek	WV-MT-207	Mill Creek	8.61E+10	0.00E+00	4.53E+09	9.06E+10
Mill Creek	WV-MT-207-A	Right Fork/Mill Creek	2.09E+10	0.00E+00	1.10E+09	2.20E+10
UNT/Tygart Valley River RM 105.69	WV-MT-208	UNT/Tygart Valley River RM 105.69	4.44E+09	0.00E+00	2.34E+08	4.67E+09
Berkeley Run	WV-MT-24	Berkeley Run	5.56E+10	2.05E+07	2.93E+09	5.86E+10
Berkeley Run	WV-MT-24-A	Shelby Run	1.52E+10	4.55E+06	7.99E+08	1.60E+10
Berkeley Run	WV-MT-24-B	Long Run	1.45E+10	0.00E+00	7.61E+08	1.52E+10
Berkeley Run	WV-MT-24-B-2	Berry Run	3.77E+09	0.00E+00	1.98E+08	3.96E+09
Three Fork Creek	WV-MT-25	Three Fork Creek	3.94E+11	1.43E+09	2.08E+10	4.17E+11
Three Fork Creek	WV-MT-25-AA	Martins Run	1.14E+10	4.55E+06	6.00E+08	1.20E+10
Three Fork Creek	WV-MT-25-AF	Fields Creek	7.33E+10	6.11E+08	3.89E+09	7.78E+10
Three Fork Creek	WV-MT-25-AF-3	Brains Creek	1.48E+10	9.09E+06	7.81E+08	1.56E+10
Three Fork Creek	WV-MT-25-C	UNT/Three Fork Creek RM 2.02	5.43E+09	0.00E+00	2.86E+08	5.72E+09
Three Fork Creek	WV-MT-25-E	Rocky Branch	6.49E+09	3.74E+07	3.43E+08	6.87E+09
Three Fork Creek	WV-MT-25-R-5	Little Raccoon Creek	9.85E+09	0.00E+00	5.19E+08	1.04E+10
Three Fork Creek	WV-MT-25-V	Laurel Run	4.59E+10	2.52E+08	2.43E+09	4.86E+10
Scab Run	WV-MT-26	Scab Run	2.90E+09	0.00E+00	1.52E+08	3.05E+09
Pleasant Creek	WV-MT-30	Pleasant Creek	3.61E+10	0.00E+00	1.90E+09	3.80E+10
Little Sandy Creek	WV-MT-34	Sandy Creek	3.37E+11	1.42E+08	1.77E+10	3.55E+11
Little Sandy Creek	WV-MT-34-H	Little Cove Run	1.55E+10	4.55E+06	8.15E+08	1.63E+10
Little Sandy Creek	WV-MT-34-J-13	York Run	1.67E+10	3.79E+06	8.79E+08	1.76E+10
Little Sandy Creek	WV-MT-34-L	Left Fork/Sandy Creek	5.16E+10	0.00E+00	2.72E+09	5.43E+10
Little Sandy Creek	WV-MT-34-L-10	UNT/Left Fork RM 4.58/Sandy Creek	9.68E+09	0.00E+00	5.10E+08	1.02E+10
Little Sandy Creek	WV-MT-34-N	UNT/Sandy Creek RM 10.47	2.67E+10	0.00E+00	1.40E+09	2.81E+10
Stony Run	WV-MT-38	Stony Run	5.79E+09	0.00E+00	3.04E+08	6.09E+09
Big Cove Run	WV-MT-39	Big Cove Run	1.57E+10	0.00E+00	8.25E+08	1.65E+10

TMDL Watershed	Stream Code	Stream Name	Load Allocations (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Teter Creek	WV-MT-43	Teter Creek	1.95E+11	4.09E+07	1.03E+10	2.06E+11
Teter Creek	WV-MT-43-B	Glade Run	1.24E+10	8.33E+06	6.51E+08	1.30E+10
Teter Creek	WV-MT-43-C	Raccoon Creek	3.17E+10	1.97E+07	1.67E+09	3.34E+10
Teter Creek	WV-MT-43-C-5	Stony Run	5.26E+09	0.00E+00	2.77E+08	5.54E+09
Teter Creek	WV-MT-43-H	Brushy Fork	4.51E+10	0.00E+00	2.38E+09	4.75E+10
Teter Creek	WV-MT-43-L	Mill Run	1.56E+10	0.00E+00	8.20E+08	1.64E+10
Laurel Creek	WV-MT-46-C	Frost Run	4.17E+09	0.00E+00	2.20E+08	4.39E+09
Laurel Creek	WV-MT-46-J	Sugar Creek	1.68E+11	1.82E+07	8.85E+09	1.77E+11
Laurel Creek	WV-MT-46-J-24	Hunter Fork	2.30E+10	0.00E+00	1.21E+09	2.42E+10
Laurel Creek	WV-MT-46-J-25	Long Run	2.46E+09	0.00E+00	1.29E+08	2.59E+09
Laurel Creek	WV-MT-46-J-3	Glady Creek	4.23E+10	4.55E+06	2.23E+09	4.45E+10
Laurel Creek	WV-MT-46-J-7	Whitman Run	1.61E+10	0.00E+00	8.46E+08	1.69E+10
Laurel Creek	WV-MT-46-K	Bonica Run	1.06E+10	4.55E+06	5.58E+08	1.12E+10
Mitchell Run	WV-MT-48	Mitchell Run	1.54E+10	7.58E+06	8.10E+08	1.62E+10
Hackers Creek	WV-MT-50	Hackers Creek	3.98E+10	4.53E+08	2.12E+09	4.24E+10
Hackers Creek	WV-MT-50-A	Taylor Drain	8.16E+09	0.00E+00	4.30E+08	8.59E+09
Hackers Creek	WV-MT-50-B	Foxgrape Run	1.19E+10	3.18E+08	6.43E+08	1.29E+10
Hackers Creek	WV-MT-50-C	Little Hackers Creek	4.39E+09	0.00E+00	2.31E+08	4.62E+09
Fords Run	WV-MT-51	Fords Run	1.01E+10	0.00E+00	5.29E+08	1.06E+10
Shooks Run	WV-MT-53	Shooks Run	1.63E+10	0.00E+00	8.60E+08	1.72E+10
Anglins Run	WV-MT-54	Anglins Run	9.47E+09	1.14E+07	4.99E+08	9.99E+09
Buckhannon River	WV-MT-62	Buckhannon River	1.30E+12	2.12E+10	6.97E+10	1.39E+12
Big Run	WV-MT-62-AA	Big Run	3.96E+09	7.58E+06	2.09E+08	4.18E+09
Childers Run	WV-MT-62-AB	Childers Run	1.16E+10	4.24E+07	6.15E+08	1.23E+10
Turkey Run	WV-MT-62-AE	Turkey Run	3.64E+10	5.45E+07	1.92E+09	3.83E+10
Turkey Run	WV-MT-62-AE-3	Sugar Run	6.77E+09	1.67E+07	3.57E+08	7.14E+09
Fink Run	WV-MT-62-AH	Fink Run	7.35E+10	1.36E+08	3.88E+09	7.75E+10
Fink Run	WV-MT-62-AH-10	Bridge Run	1.09E+10	7.58E+06	5.76E+08	1.15E+10
Fink Run	WV-MT-62-AH-4	Brushy Fork	1.53E+10	2.27E+07	8.07E+08	1.61E+10
Fink Run	WV-MT-62-AH-5	Mud Lick	8.52E+09	0.00E+00	4.49E+08	8.97E+09
Fink Run	WV-MT-62-AH-8	Wash Run	3.95E+09	3.79E+06	2.08E+08	4.16E+09
Little Sand Run	WV-MT-62-AN	Little Sand Run	2.86E+10	7.73E+07	1.51E+09	3.02E+10

TMDL Watershed	Stream Code	Stream Name	Load Allocations (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Little Sand Run	WV-MT-62-AN-2	Left Fork/Little Sand Run	1.51E+10	2.35E+07	7.96E+08	1.59E+10
Ratcliff Run	WV-MT-62-AO	Ratcliff Run	7.02E+09	0.00E+00	3.70E+08	7.39E+09
Stony Run	WV-MT-62-AP	Stony Run	1.47E+10	0.00E+00	7.72E+08	1.54E+10
Hickory Flat Run	WV-MT-62-AR	Hickory Flat Run	5.79E+09	1.67E+08	3.13E+08	6.27E+09
Cutright Run	WV-MT-62-AS	Cutright Run	2.30E+10	4.62E+07	1.22E+09	2.43E+10
Cutright Run	WV-MT-62-AS-5	Lick Run	8.03E+09	3.79E+06	4.23E+08	8.46E+09
French Creek	WV-MT-62-AV	French Creek	2.12E+11	2.30E+08	1.12E+10	2.23E+11
French Creek	WV-MT-62-AV-12	Laurel Fork/French Creek	4.69E+10	3.79E+06	2.47E+09	4.94E+10
French Creek	WV-MT-62-AV-15	Morgan Run	3.24E+09	7.58E+06	1.71E+08	3.42E+09
French Creek	WV-MT-62-AV-16	Grub Hollow	4.04E+09	3.79E+06	2.13E+08	4.26E+09
French Creek	WV-MT-62-AV-17	Brush Run	1.52E+10	3.79E+06	8.00E+08	1.60E+10
French Creek	WV-MT-62-AV-19	Slab Camp Fork	2.71E+10	3.79E+06	1.43E+09	2.85E+10
French Creek	WV-MT-62-AV-24	Left Fork/French Creek	1.01E+10	7.80E+07	5.36E+08	1.07E+10
French Creek	WV-MT-62-AV-7	Bull Run	2.28E+10	3.48E+07	1.20E+09	2.40E+10
French Creek	WV-MT-62-AV-7-C	Mudlick Run	1.65E+09	0.00E+00	8.69E+07	1.74E+09
French Creek	WV-MT-62-AV-9	Grand Camp Run	2.07E+10	0.00E+00	1.09E+09	2.17E+10
Trubie Run	WV-MT-62-AW	Trubie Run	1.36E+10	3.56E+07	7.17E+08	1.43E+10
Sawmill Run	WV-MT-62-BA	Sawmill Run	4.37E+09	4.41E+08	2.53E+08	5.06E+09
Laurel Run/Buckhannon River	WV-MT-62-BG	Laurel Run/Buckhannon River	5.63E+09	3.79E+06	2.96E+08	5.93E+09
Tenmile Creek	WV-MT-62-BH-1	Right Fork/Tenmile Creek	1.50E+10	0.00E+00	7.92E+08	1.58E+10
First Big Run	WV-MT-62-E	First Big Run	6.94E+09	3.79E+06	3.66E+08	7.31E+09
Cottrill Run	WV-MT-62-J	Cottrill Run	5.79E+09	0.00E+00	3.05E+08	6.10E+09
Big Run	WV-MT-62-L	Big Run	2.86E+10	7.65E+07	1.51E+09	3.02E+10
Lick Shoals Run	WV-MT-62-N	Lick Shoals Run	1.10E+10	4.55E+06	5.80E+08	1.16E+10
Pecks Run	WV-MT-62-P	Pecks Run	5.85E+10	6.40E+07	3.08E+09	6.16E+10
Pecks Run	WV-MT-62-P-11	Mud Run	1.56E+09	0.00E+00	8.22E+07	1.64E+09
Pecks Run	WV-MT-62-P-2	UNT/Pecks Run RM 2.24	2.38E+09	0.00E+00	1.25E+08	2.50E+09
Pecks Run	WV-MT-62-P-6	Little Pecks Run	7.15E+09	1.93E+07	3.78E+08	7.55E+09
Sand Run	WV-MT-62-V	Sand Run	9.24E+10	1.08E+08	4.87E+09	9.74E+10
Sand Run	WV-MT-62-V-2	Laurel Fork/Sand Run	2.78E+10	3.79E+06	1.47E+09	2.93E+10
Sand Run	WV-MT-62-V-9	Left Fork/Sand Run	1.29E+10	2.27E+07	6.80E+08	1.36E+10

TMDL Watershed	Stream Code	Stream Name	Load Allocations (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Laurel Run/Tygart Valley River	WV-MT-68	Laurel Run/Tygart Valley River	2.67E+10	4.24E+07	1.41E+09	2.81E+10
Gum Run	WV-MT-72-AB	Gum Run	9.58E+09	1.29E+07	5.05E+08	1.01E+10
Gum Run	WV-MT-72-AB-2	UNT/Gum Run RM 1.18	1.21E+09	8.33E+06	6.42E+07	1.28E+09
Laurel Creek/Middle Fork River	WV-MT-72-AE	Laurel Creek/Middle Fork River	3.65E+10	3.79E+06	1.92E+09	3.84E+10
Laurel Creek/Middle Fork River	WV-MT-72-AE-1	Brook Run	1.05E+10	3.79E+06	5.53E+08	1.11E+10
Right Fork/Middle Fork River	WV-MT-72-AH	Right Fork/Middle Fork River	1.11E+11	2.83E+07	5.83E+09	1.17E+11
Mill Creek	WV-MT-96	Mill Creek	3.05E+10	2.88E+07	1.61E+09	3.21E+10
Shooks Run	WV-MT-97	Shooks Run	4.96E+09	0.00E+00	2.61E+08	5.23E+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 $\times 10^4$ or 1.0492E+4.

11.0 FUTURE GROWTH

11.1 Iron, Aluminum, and pH

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 and pH TMDLs have been developed. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits must be "consistent with the assumptions and requirements of any available WLAs for the discharge...." In addition, the federal regulations generally prohibit issuance of a permit to a new discharger "if the discharge from its construction or operation will cause or contribute to the violation of water quality standards." A discharge permit for a new discharger could be issued under the following scenarios:

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

- NPDES permitting rules mandate effluent limitations for metals to be prescribed in the total recoverable form. West Virginia water quality criteria for iron are in total recoverable form and may be directly implemented.

- Because aluminum water quality criteria are in dissolved form, a dissolved/total pollutant translator is needed to determine total aluminum effluent limitations. In aluminum impaired warmwater fisheries, a new facility could be permitted if total aluminum effluent limitations are based on the dissolved aluminum, acute, aquatic life protection criterion and a dissolved/total aluminum translation equal to 1.0. In aluminum impaired troutwaters, a new facility could be permitted if total aluminum effluent limitations are based on the dissolved aluminum, chronic, aquatic life protection criterion and a dissolved/total aluminum translation equal to 1.0. For new discharges to unimpaired troutwater segments of impaired warmwater fisheries, permits should include case by case effluent limits as necessary to ensure attainment of troutwater dissolved aluminum criteria but limits must be capped at the future growth provisions for aluminum impaired warmwater fisheries.

- 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.

- Lands associated with the MS4, Construction Stormwater and Multi-sector Stormwater General Permits are not significant or causative sources of dissolved aluminum, or pH or impairments. New registrations may be permitted in the watersheds of impaired streams without specific wasteload allocations for those parameters.

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

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

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

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

11.2 Fecal Coliform Bacteria

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

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

12.0 PUBLIC PARTICIPATION

12.1 Public Meetings

Informational public meetings were held on May 9, 2012 in Elkins, WV; and May 10, 2012 in Grafton, 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. Two project status update meeting was held, one in Elkins on May 18, 2015 and one in Grafton on May 19, 2015. Public meetings will held to present the draft TMDLs on October 13, 2015 in Elkins, WV and October 14, 2015 in Grafton, WV. Both meetings start at 6:30 PM and will provide information to stakeholders intended to facilitate comments on the draft TMDLs.

12.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised in various local newspapers beginning on October 2, 2015. Interested parties were invited to submit comments during the public comment period, which began on October 2, 2015 and ended on November 2, 2015. The electronic documents were also posted on the WVDEP's internet site at www.dep.wv.gov/tmdl.

12.3 Response Summary

WVDEP did not receive any written comments on the Draft TMDLs.

13.0 REASONABLE ASSURANCE

Reasonable assurance for maintenance and improvement of water quality in the affected watershed rests primarily with two programs. The NPDES permitting program is implemented by WVDEP to control point source discharges. 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.

13.1 NPDES Permitting

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

Both the permitting and TMDL development processes have been synchronized with the Watershed Management Framework cycle, such that TMDLs are completed just before the permit expiration/reissuance time frames. Permits for existing nonmining facilities in the Tygart Valley River Watershed will be reissued beginning in July 2016 and the reissuance of mining permits will begin January 1, 2017.

The MS4 permitting program is being implemented to address stormwater impacts from urbanized areas. West Virginia has developed a General NPDES Permit for MS4 discharges (WV0110625). All of the cities with MS4 permits in subject waters of this report, plus the West Virginia Department of Transportation, WVDOH are registered under the permit. The permit is based upon national guidance and is non-traditional in that it does not contain numeric effluent limitations, but instead proposes Best Management Practices that must be implemented. At permit reissuance, registrants will be expected to specifically describe management practices intended for implementation that will achiever the WLAs prescribed in applicable TMDLs. A mechanism to assess the effectiveness of the BMPs in achieving the WLAs must also be provided. The TMDLs are not intended to mandate imposition of numerical effluent limitations and/or discharge monitoring requirements for MS4s. Reasonable alternative methodologies may be employed for targeting and assessing BMP effectiveness in relation to prescribed WLAs. The "MS4 WLA Detailed" tabs on the allocation spreadsheets WLAs provide drainage areas of various land use types represented in the baseline condition (without BMPs) for each MS4 entity at the subwatershed scale. Through consideration of anticipated removal efficiencies of selected BMPs and their areas of application, it is anticipated that this information will allow MS4 permittees to make meaningful predictions of performance under the permit.

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

13.2 Watershed 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, Martin Christ (Martin.J.Christ@wv.gov)

There are several active citizen-based watershed associations representing the Tygart mainstem and several of its tributaries in the Tygart Valley River Watershed. These groups include the Save the Tygart Watershed Association, Buckhannon River Watershed Association, Laurel Run Watershed Association, and the Laurel Mountain/Fellowsville Area Watershed Association For additional information concerning the associations, contact the above mentioned Basin Coordinator or visit http://www.dep.wv.gov/WWE/getinvolved/WSA_Support/Documents/WVWatershedAssoc.PDF

13.3 Public Sewer Projects

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

13.4 AML Projects

Within WVDEP, the Office of Abandoned Mine Lands and Reclamation (AML&R) manages the reclamation of lands and waters affected by mining prior to the passage of the Surface Mining Control and Reclamation Act (SMCRA) in 1977. Title IV of the act addresses adverse impacts associated with abandoned mine lands. Funding for reclamation activities is derived from fees placed on coal mined which are placed in a fund and annually distributed to state and tribal agencies.

Various abandoned mine land reclamation activities are addressed by the program as necessary to protect public health, safety, and property from past coal mining and to enhance the environment through the reclamation and restoration of land and water resources. Portions of the annual grant are also used to repair or replace drinking water supplies that were substantially damaged by pre-SMCRA coal mining and to administer the program.

In December 2006, Congress passed legislation amending SMCRA and the Title IV program and in November 2008, the Office of Surface Mining finalized rules to implement the amendments. After an initial ramp-up period, AML&R will realize significant increases in its annual reclamation funding and the flexibility to direct a larger portion of those funds to address water resource impacts from abandoned mine drainage (AMD).

Title IV now contains a "30% AMD set-aside" provision that allows a state to use up to 30% of its annual grant to address AMD problems. In determining the amount of money to set-aside, AML&R must balance its multiple areas of responsibility under the program and ensure that funding is available for perpetual operation and maintenance of treatment facilities. In regard to water resource impacts, project prioritization will consider treatment practicability and sustainability and will be accomplished under a methodology that provides for the efficient application of funds to maximize restoration of fisheries across AML impacted areas of the State.

14.0 MONITORING PLAN

The following monitoring activities are recommended:

14.1 NPDES Compliance

WVDEP's DWWM and DMR have the responsibility to ensure that NPDES permits contain effluent limitations as prescribed by the TMDL WLAs and to assess and compel compliance. 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.

14.2 Nonpoint Source Project Monitoring

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

14.3 TMDL Effectiveness Monitoring

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

15.0 REFERENCES

Atkins, John T. Jr., Jeffery B. Wiley, Katherine S. Paybins. 2005. Calibration Parameters Used to Simulate Streamflow from Application of the Hydrologic Simulation Program-FORTRAN Model (HSPF) to Mountainous Basins Containing Coal Mines in West Virginia. Scientific Investigations Report 2005-5099. U.S. Department of the Interior, U.S. Geological Survey.

Cormier, S., G. Sutter, and S.B. Norton. 2000. *Stressor Identification: Technical Guidance Document*. USEPA-822B-00-25. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

CCREM. 1987. Canadian water quality guidelines. Canadian Council of Ministers of Resources and Environment. Ottawa, Ontario.

Drury, JS; Shriner, CR; Lewis, EB; et al. (1978) Reviews of the environmental effects of pollutants: VI. Beryllium. Prepared under IAG-D5-0403 by Oak Ridge National Laboratory, Union Carbide Corp., Oak Ridge, TN. EPA 600/1-78-028. NTIS PB-290966.

Gerritsen, J., J. Burton, and M.T. Barbour. 2000. *A Stream Condition Index for West Virginia Wadeable Streams*. Tetra Tech, Inc., Owings Mills, MD.

IPCS (2001) Beryllium and beryllium compounds. Geneva, World Health Organization, International Programme on Chemical Safety (Concise International Chemical Assessment Document 32; http://www.inchem.org/documents/cicads/cicads/cicad32.htm). (Accessed July 2015).

MDE (Maryland Department of the Environment). 2003. *Total Maximum Daily Loads to Address Low pH in Cherry Creek in the Deep Creek Watershed Garrett County, Maryland*. Maryland Department of the Environment. Baltimore, MD.

Novotny, V., and H. Olem. 1994. Water Quality: Prevention, Identification, and Management of Diffuse Pollution. Van Nostrand Reinhold, New York, NY.

PADEP (Pennsylvania Department of Environmental Protection). 2000. *Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania*. Pennsylvania Department of Environmental Protection, Harrisburg, PA.

Scientific notation. Dictionary.com. *The American Heritage® Dictionary of the English Language, Fourth Edition*. Houghton Mifflin Company, 2004. http://dictionary.reference.com/browse/scientific notation (accessed: May 22, 2007).

USEPA (U.S. Environmental Protection Agency). 1991. *Technical Support Document for Water Quality-based Toxics Control*. USEPA/505/2-90-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 1998a. *Metals TMDL for Buckhannon River, West Virginia.* U.S. Environmental Protection Agency Region 3, 1650 Arch Street, Philadelphia, PA.

USEPA (U.S. Environmental Protection Agency). 1998b. *TMDL for Tenmmile Creek, West Virginia.* U.S. Environmental Protection Agency Region 3, 1650 Arch Street, Philadelphia, PA.

USEPA (U.S. Environmental Protection Agency). 2001. *Metals and pH TMDLs for the Tygart Valley River Watershed, West Virginia.* U.S. Environmental Protection Agency Region 3, 1650 Arch Street, Philadelphia, PA.

USEPA (U.S. Environmental Protection Agency). 2005. *Technical Support Document for the Final Clean Air Interstate Rule – Air Quality Modeling*. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. https://archive.epa.gov/airmarkets/programs/cair/web/pdf/finaltech02.pdf (Accessed in July 2016.)

USGS (United States Geological Survey). 2011. National Land Cover Database. Multi-Resolution Land Characteristics Consortium. Sioux Falls, SD. Remote Sensing Image.

Walsh, C.J., and J. Kunapo. 2009. The importance of upland flow paths in determining urban effects on stream ecosystems. *Journal of the North American Benthological Society*, 28(4):977-990.

WVDEP (West Virginia Department of Environmental Protection) 2001. *TMDLs for Select Streams in the Tygart Valley River Watershed, West Virginia*. West Virginia Department of Environmental Protection, Division of Water and Waste Management, Charleston, WV. http://www.dep.wv.gov/WWE/watershed/TMDL/grpb/Documents/Tygart/3016_complete_tygart_tmdl.pdf (Accessed July 2016)

WVGES (West Virginia Geological and Economic Survey). 2002. Trace Elements in West Virginia Coals. Beryllium (Be). Morgantown, WV. Electronic resource. http://www.wvgs.wvnet.edu/www/datastat/te/Bemap.htm (accessed July, 2015).