

April 2014

USEPA Approved Report

Total Maximum Daily Loads for Selected Streams in the Monongahela 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
Top Middle: West Ru (WV-M-7). Special thanks to West Virginia Water Research Institute

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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. In this report, the Monongahela River and its drainage area which begins as the source confluences of the West Fork River and the Tygart Valley River join together at the City of Fairmont, West Virginia and where it meets the Stateline near the outlet of Camp Run is referred to as the Monongahela River Watershed. Throughout this report, the Monongahela River Watershed refers to the tributary streams that eventually drain to the Monongahela River (**Figure I-1**). The term "watershed" is also used more generally to refer to the land area that contributes precipitation runoff that eventually drains to this segment of the Monongahela 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 153 impaired streams contained within 28 TMDL watersheds in the Monongahela 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 28 TMDL watersheds have been subdivided into 370 modeled subwatersheds. Pollutant sources, allocations and reductions are presented at the subwatershed scale to facilitate future permitting actions and TMDL implementation.

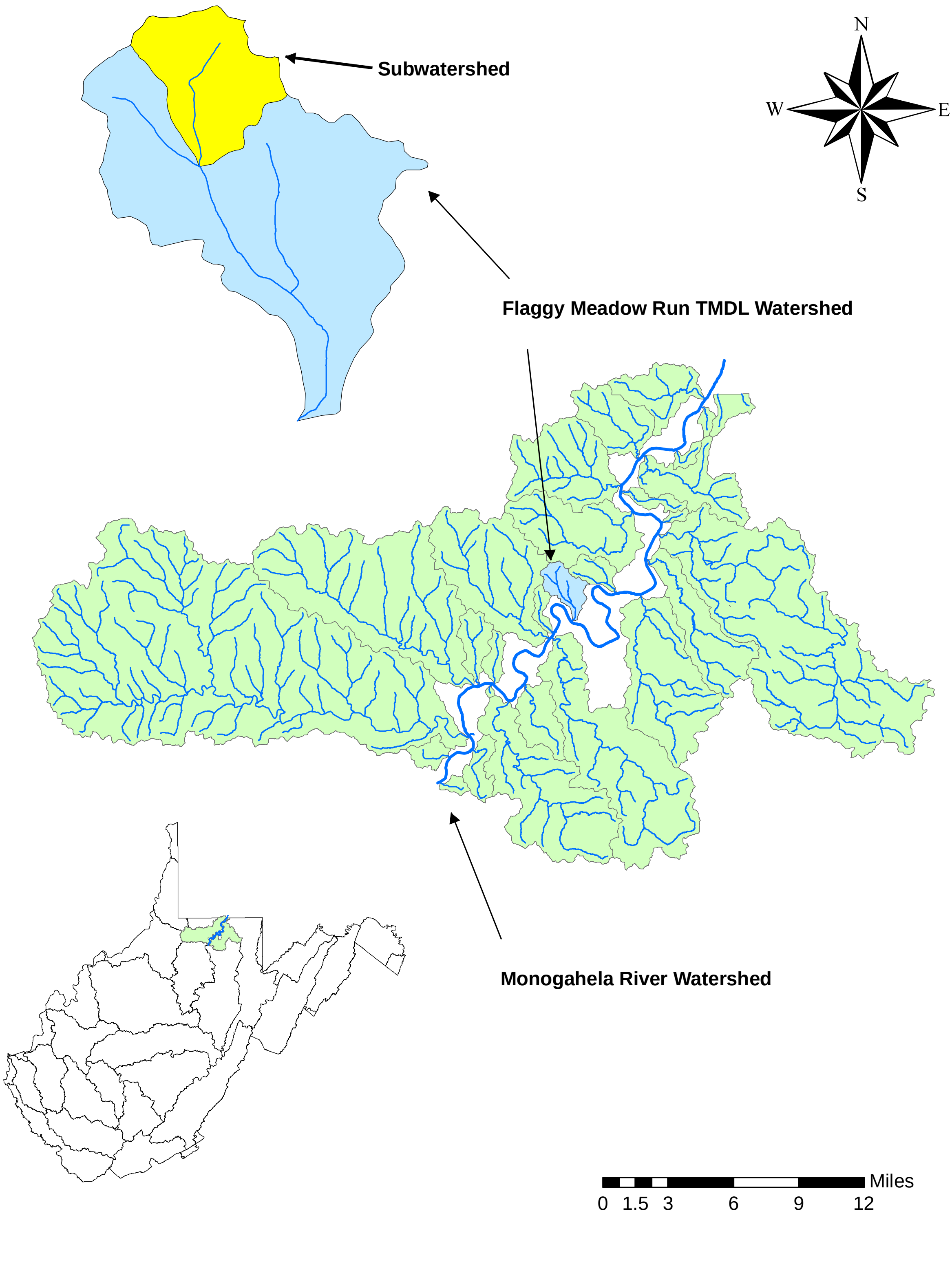


Figure I-1. Examples of a watershed, TMDL watershed, and subwatersheds

EXECUTIVE SUMMARY

This report includes Total Maximum Daily Loads (TMDLs) for 153 impaired streams in the Monongahela River Watershed from the outlet of UNT/Monongahela River RM 128 downstream to the outlet of Camp Run.

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.

The subject impaired streams are included on West Virginia's 2012 Section 303(d) List. Documented impairments are related to numeric water quality criteria for total iron, total manganese, dissolved aluminum, total selenium, pH, dissolved oxygen, chloride, 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. The original scope of work for this project included approximately 20 biological impairments for which TMDLs were to be developed. A separate project addressing an additional 30 impacted streams was funded and initiated by the Environmental Protection Agency Region III. The latter project focused on streams with elevated dissolved solids concentrations for which significant ionic stress to the benthic community was presumed.

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 did not add new WVSCI-based biological impairments to the 2012 303(d) list that was submitted to the USEPA for approval on December 21, 2012. WVDEP has also 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, all of the 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 displayed in Chapter 4. Chapter 4 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 28 TMDL watersheds. For hydrologic modeling purposes, impaired and unimpaired streams in these 28 TMDL watersheds were further divided into 370 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, chloride, manganese, 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.

Point and nonpoint sources contribute to the fecal coliform bacteria impairments in the watershed. Failing on-site systems, direct discharges of untreated sewage, and precipitation runoff from agricultural and residential areas are significant nonpoint sources of fecal coliform bacteria. Point sources of fecal coliform bacteria include the effluents of sewage treatment facilities, collection system overflows (CSOs) from publicly owned treatment works (POTWs), and stormwater discharges from Municipal Separate Storm Sewer Systems (MS4s).

There are dissolved oxygen impairments in Deckers Creek (WV-M-14) and Mod Run (WV-M-54-T). The Deckers Creek DO impairment limited to a 2 mile segment upstream of UNT/Deckers Creek RM 18.48 to pond outlet at RM 20.5. In general, point and non-point 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, construction sites and non-mining industrial facilities. The presence of individual source categories and their relative significance 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.

Most often, chloride impairments in the watershed are caused by certain point source discharges associated with mining activities. For two streams, UNT/Mon River RM 99.49 (Popenoe Run, WV-M-11) and UNT/West Run RM 0.91 (WV-M-7-A), impairments were attributed to deicing runoff in subwatersheds where urban impervious surfaces constitute a large percentage of land cover.

The overlapping pH and dissolved aluminum impairments are caused by acidity introduced by legacy mining activities. Atmospheric acid deposition was additionally represented in the model as was the aluminum loading from permitted point sources. Atmospheric deposition was not found to be a causative source of impairment as effects are mitigated by available watershed buffering capacity. All active mining sources were represented and prescribed WLAs were not more stringent than existing NPDES permit limits. The TMDLs for pH and dissolved aluminum impairments were developed using an iterative approach where alkalinity additions to offset acid load from legacy mining sources were coupled with total iron and aluminum reductions until attainment of both criteria were predicted.

The only total manganese impaired stream in the Monongahela River Watershed is Brand Run. The impairment is solely attributed to discharges associated with legacy mining activities in the watershed.

Arnett Run is the only selenium impaired stream in the Monongahela River Watershed addressed in this report. Reclaimed and active mining, as well as flyash disposal areas from a coal burning power plant are dominant landuses for the Arnett Run watershed and presumed to be the contributing sources of selenium.

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 2002, USEPA, with support from WVDEP, developed the metals and pH TMDLs for the Monongahela River Watershed (USEPA, 2002). In this project, all streams/impairments for which TMDLs were developed in 2002 have been re-evaluated and new TMDLs, consistent with currently effective water quality criteria, are presented for all 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 in 2002 are no longer effective due to West Virginia water quality standard revisions and new water quality monitoring. All total aluminum TMDLs developed in 2002 are not effective because of water quality criteria revision from total to dissolved. Previously developed total manganese TMDLs are also not effective in streams where the water quality criterion does not apply. In limited instances this re-evaluation determined that impairments no longer exist. All such TMDLs are no longer effective.

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 11** 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 Monongahela 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 11** 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 2012 TMDLs should be pursued in Hydrologic Group D, which includes the Monongahela 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 2002, USEPA, with support from WVDEP, developed the metals and pH TMDLs for the Monongahela River Watershed (USEPA, 2002). Significant aluminum and manganese water quality criterion revisions have been enacted since USEPA approval of the 2002 TMDL project rendering the existing TMDLs obsolete. The form of the aluminum criteria was changed from total to dissolved and the chronic criterion value for warmwater fisheries was revised. The manganese water quality standard revision now limits applicability of the criterion to five mile stream segments upstream of existing public water supplies. The goal for this project is to produce TMDLs for the Monongahela River Watershed that are consistent with effective water quality criteria. All streams/impairments for which TMDLs were developed in 2002 have been re-evaluated.

Upon approval, the TMDLs presented herein shall supersede those developed previously. All total aluminum TMDLs developed for 36 streams in 2002 are no longer effective because of the criteria revisions. However, new dissolved aluminum TMDLs are presented for 19 of the 36 original streams. The remaining 17 streams for which total aluminum TMDLs were developed in 2002, attain the dissolved aluminum criterion. Additional dissolved aluminum impairments are also addressed. Previously developed total manganese TMDLs are no longer effective in 32 of the original 33 TMDL streams, because the manganese criterion is not applicable to those waters. A revised manganese TMDL is presented only for Brand Run (WV-M-20). Total iron TMDLs were previously presented for 35 streams. These streams were determined to be impaired and new TMDLs are presented. Appendix A of the Technical Report lists the 2002 TMDLs for total iron, total aluminum, and total manganese, describes why the TMDLs are no longer effective, and indicates those streams for which new TMDLs are presented.

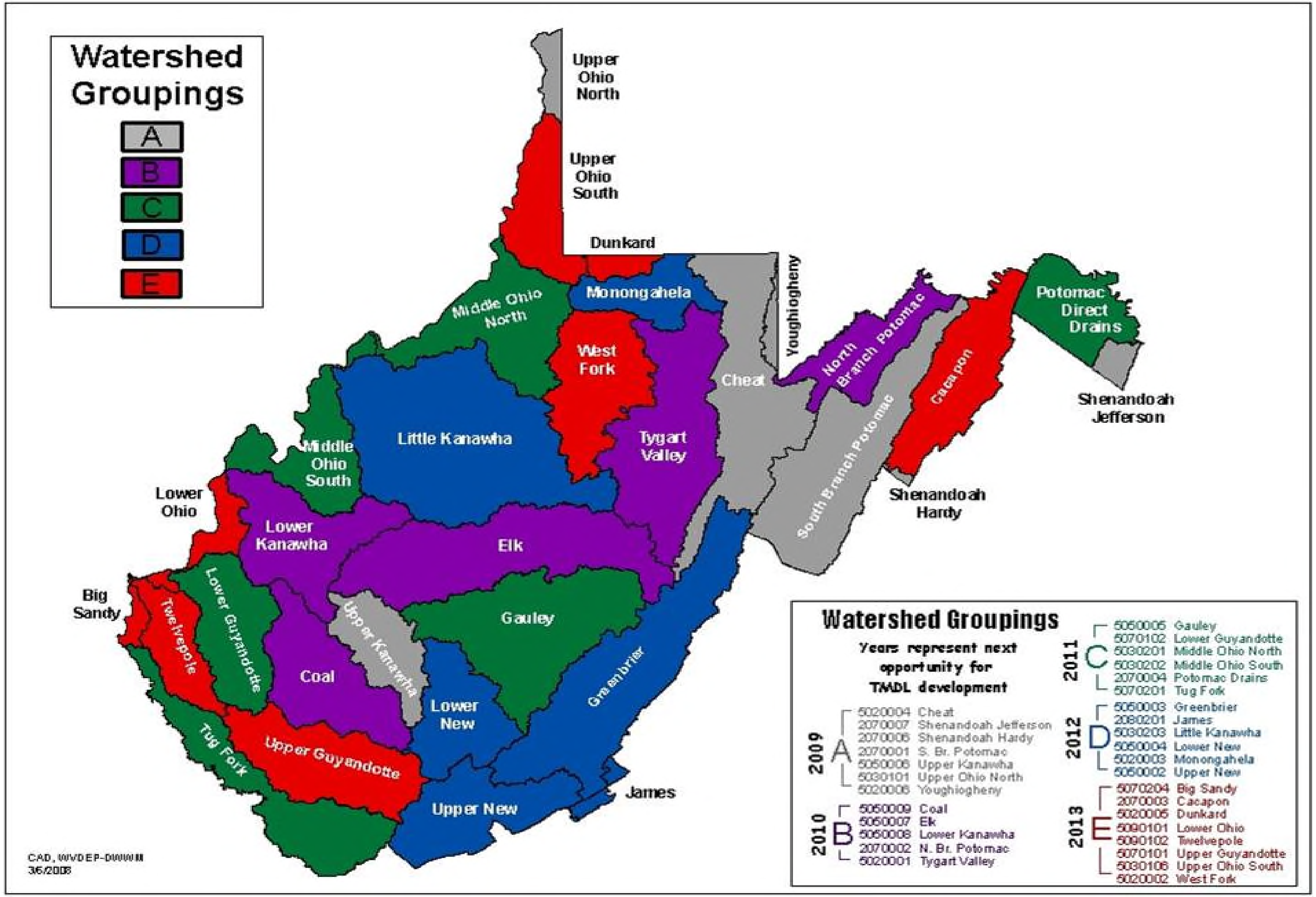


Figure 2-1. Hydrologic groupings of West Virginia's watersheds

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 Monongahela River Watershed, warmwater and troutwater fishery aquatic life use impairments have been determined pursuant to exceedances of iron, dissolved aluminum, dissolved oxygen, selenium, chloride 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, dissolved oxygen, pH, chloride, manganese, and total iron.

The manganese water quality criterion is applicable to five-mile zones upstream of known public or private water supply intakes used for human consumption. Based upon known intake locations, WVDEP delineated five-mile distances in an upstream direction along watercourses to determine streams within the zone of applicability of the criterion. WVDEP then assessed compliance with the criterion by reviewing available water quality monitoring results from streams within the zone and evaluated the base condition portrayed by the TMDL model. The evaluation determined that the manganese criterion is exceeded in Brand Run.

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**.

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
Selenium, total (µg/L)	20	5	20	5	50
Manganese, total (mg/L)	--	--	--	--	1.0[c]
Chloride (mg/L)	860	230	860	230	250
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.

[b] Four-day average concentration not to be exceeded more than once every 3 years on the average.

[c] Not to exceed 1.0 mg/L within the five-mile zone upstream of known public or private water supply intakes used for human consumption.

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

The TMDL Project includes direct tributaries of the Monongahela River, identified as the U.S. Geological Survey [USGS] 8-digit hydrologic unit code 05020003 and for the purposes of this document is referred collectively as the Monongahela River Watershed. Other 8-digit hydrologic units within the Monongahela River Watershed, such as the West Fork River, Tygart Valley River, Cheat River, and Dunkard Creek are not included in this TMDL development effort (Figure 3-1). The TMDL project watershed encompasses nearly 464 square miles in northern West Virginia. It extends from the City of Fairmont north to southern Pennsylvania, and lies in portions of Monongalia, Marion, Preston, and Taylor Counties in West Virginia, and a small portion of Greene County in Pennsylvania. Outside West Virginia, the Monongahela River continues northward through Pennsylvania to the City of Pittsburgh, although areas draining to that portion of the river are not discussed in this report. Major tributaries within West Virginia are Buffalo Creek, Deckers Creek, Paw Paw Creek, and Scotts Run. Cities and towns in the vicinity of the area of study include Morgantown, Fairmont, Barrackville, and Farmington.

The average elevation in the watershed is 1,292 feet. The highest point is 2,427 feet on an unnamed ridge west of Kingwood, WV in the headwaters of the Kanes Creek watershed. The minimum elevation is 793 feet, which is the normal pool elevation of the Monongahela River at the West Virginia state line. The total population living in the subject watersheds of this report is estimated to be 75,000 people.

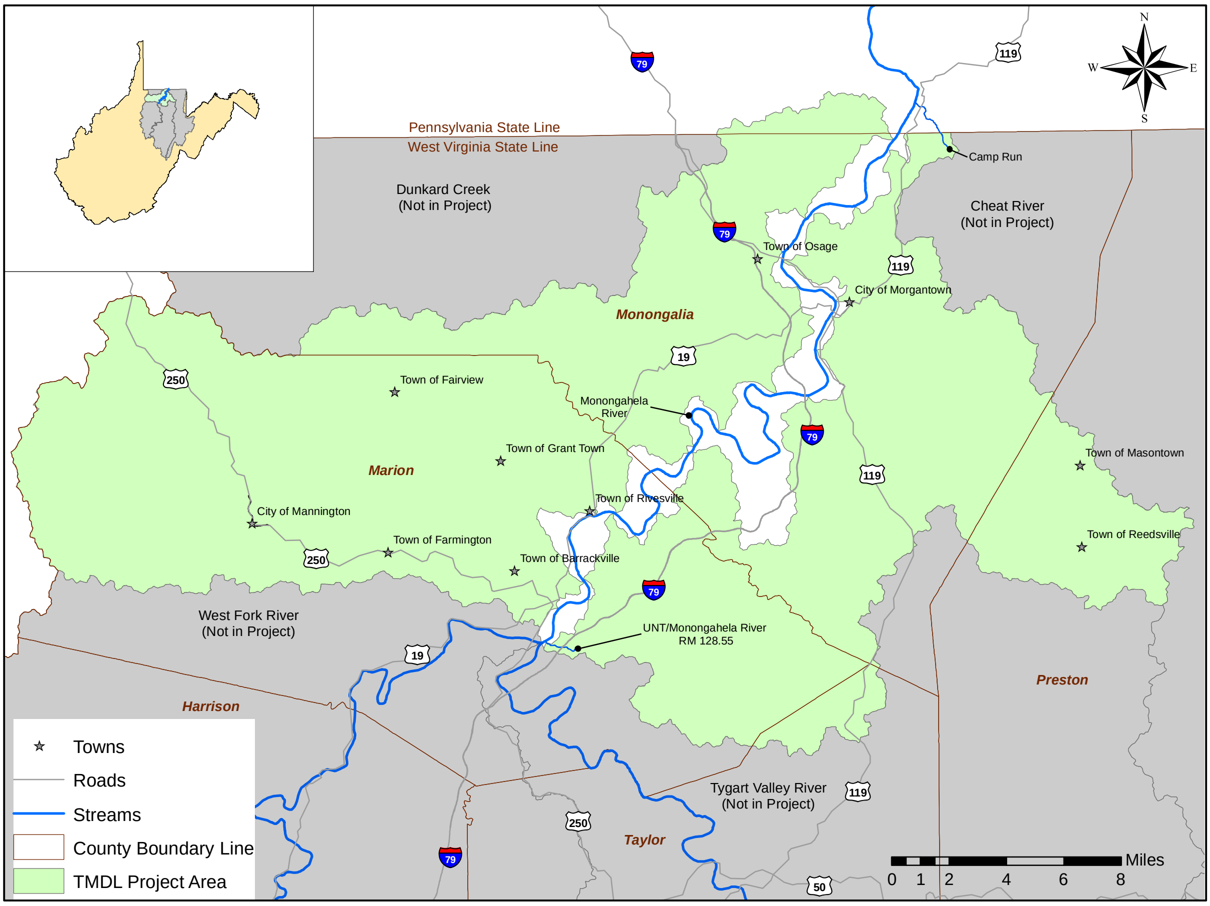


Figure 3-1. Location of the Monongahela River Watershed in West Virginia

Landuse and land cover estimates were originally obtained from vegetation data gathered from the National Land Cover Dataset (NLCD) 2006. 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 early 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 2003 aerial photography with 1-meter resolution. Additional information regarding the NLCD spatial database is provided in Appendix C of the Technical Report.

Table 3-1 displays the landuse distribution for the 370 modeled subwatersheds in the Monongahela River Watershed, derived from NLCD as described above. The dominant landuse is forest, which constitutes 72.2 percent of the total landuse area. Other important modeled landuse types are urban/residential (9.7 percent), grassland (6.7 percent), agriculture (5.9 percent), mine/quarry (2.33 percent) and forestry (2.2 percent). Individually, all other land cover types compose less than one percent of the total watershed area.

Table 3-1. Modified landuse for the Monongahela TMDL watershed

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
AML	233	0.36	0.09%
Barren	211	0.33	0.08%
Cropland	7,806	12.20	2.90%
Forest	194,794	304.37	72.25%
Forestry	6,023	9.41	2.23%
Grassland	18,043	28.19	6.69%
Mining/Quarry	6,293	9.83	2.33%
Oil and Gas	763	1.19	0.28%
Pasture	8,216	12.84	3.05%
Urban/Residential	26,328	41.14	9.77%
Water	884	1.38	0.33%
Total	269,606	421.26	100.0%

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 K. 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 2006 (NLCD)
	2003 Aerial Photography (1-meter resolution)	WVDEP
	Counties	U.S. Census Bureau
	Cities/populated places	U.S. Census Bureau
	Soils	State Soil Geographic Database (STATSGO) U.S. Department of Agriculture (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	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 Monongahela River Watershed from July 2009 through June 2010. 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 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 28 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.

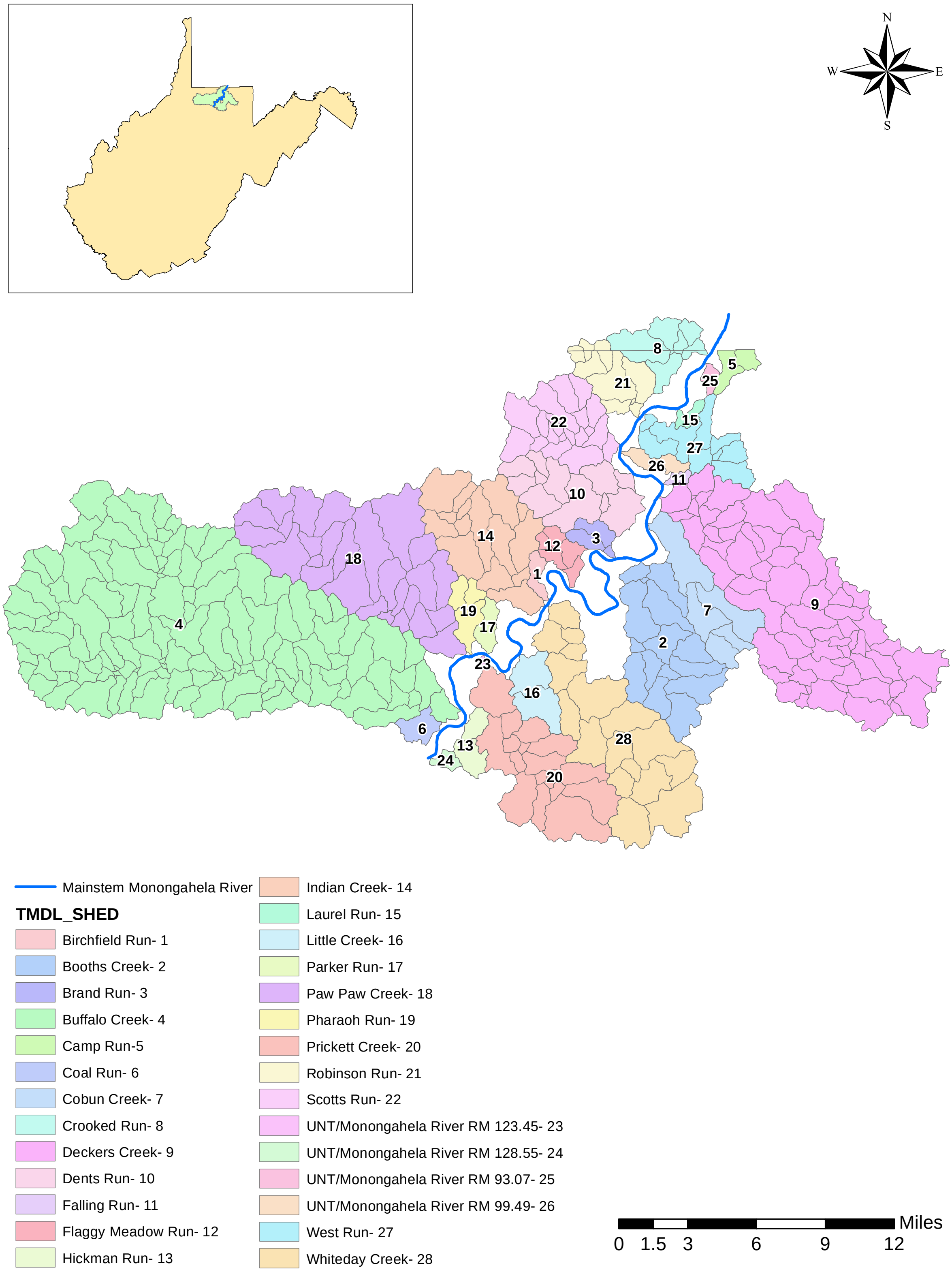


Figure 3-2. Monongahela TMDL Watersheds

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

TMDL Watershed	Stream Name	NHD_Code	Trout	pH	DO	Fe	Al	Cl	Se	Mn	FC
Camp Run	Camp Run	WV-M-1		X		X	X				
Camp Run	UNT/Camp Run RM 0.79	WV-M-1-A		X		X	X				
Crooked Run	Crooked Run	WV-M-2		X		X	X				X
Crooked Run	UNT/Crooked Run RM 2.27	WV-M-2-B				X					X
Crooked Run	UNT/Crooked Run RM 2.42	WV-M-2-C				M					
UNT/Monongahela River RM 93.07	UNT/Monongahela River RM 93.07	WV-M-3		X		X	X				
Laurel Run	Laurel Run	WV-M-5				M					
West Run	West Run	WV-M-7		X		X	X				X
West Run	UNT/West Run RM 0.91	WV-M-7-A				M		X			X
West Run	UNT/West Run RM 3.79	WV-M-7-D		X		X	X				X
West Run	UNT/West Run RM 4.84	WV-M-7-F				M					
West Run	UNT/West Run RM 5.19	WV-M-7-G				M					
Robinson Run	Robinson Run	WV-M-8				X					X
Robinson Run	Crafts Run	WV-M-8-A		X		X	X				
Robinson Run	UNT/Robinson Run RM 1.09	WV-M-8-B		X		X	X				
Robinson Run	UNT/Robinson Run RM 2.91	WV-M-8-E				M					
Robinson Run	UNT/Robinson Run RM 4.09	WV-M-8-F				M					
Scotts Run	Scotts Run	WV-M-10				X					X
Scotts Run	UNT/Scotts Run RM 1.36	WV-M-10-A				M					
Scotts Run	Wades Run	WV-M-10-C				X					X
Scotts Run	UNT/Wades Run RM 0.49	WV-M-10-C-1				M					
Scotts Run	UNT/Wades Run RM 1.34	WV-M-10-C-2				M					
Scotts Run	Guston Run	WV-M-10-D				X					X
Scotts Run	UNT/Scotts Run RM 3.23	WV-M-10-E				M					
Scotts Run	UNT/Scotts Run RM 3.58	WV-M-10-F				X					
Scotts Run	UNT/Scotts Run RM 4.17	WV-M-10-G				X					
Scotts Run	UNT/Scotts Run RM 4.79	WV-M-10-H				X					X
UNT/Monongahela River RM 99.49	UNT/Monongahela River RM 99.49	WV-M-11						X			X

TMDL Watershed	Stream Name	NHD_Code	Trout	pH	DO	Fe	Al	Cl	Se	Mn	FC
Dents Run	Dents Run	WV-M-12				M					X
Dents Run	Flaggy Meadow Run	WV-M-12-A									X
Dents Run	UNT/Dents Run RM 3.60	WV-M-12-C		X		X	X				
Dents Run	UNT/Dents Run RM 5.82	WV-M-12-H				M					
Dents Run	UNT/Dents Run RM 7.26	WV-M-12-K				M					
Falling Run	Falling Run	WV-M-13									X
Deckers Creek	Deckers Creek	WV-M-14			X*	X					X
Deckers Creek	Hartman Run	WV-M-14-A				M					X
Deckers Creek	UNT/Deckers Creek RM 21.95	WV-M-14-AB				M					
Deckers Creek	Aaron Creek	WV-M-14-B				M					X
Deckers Creek	Knocking Run	WV-M-14-C									X
Deckers Creek	UNT/Deckers Creek RM 3.63	WV-M-14-D				M					
Deckers Creek	UNT/Deckers Creek RM 5.70	WV-M-14-E				M					X
Deckers Creek	Tibbs Run	WV-M-14-G				M					X
Deckers Creek	Dry Run	WV-M-14-N				M					
Deckers Creek	Falls Run	WV-M-14-O				M					
Deckers Creek	Glady Run	WV-M-14-P		X		X	X				
Deckers Creek	Slabcamp Run	WV-M-14-R		X		X	X				
Deckers Creek	Dillan Creek	WV-M-14-S		X		X	X				X
Deckers Creek	UNT/Dillan Creek RM 0.30	WV-M-14-S-1				M					
Deckers Creek	UNT/Dillan Creek RM 1.02	WV-M-14-S-2				M					
Deckers Creek	Swamp Run	WV-M-14-S-3				M					
Deckers Creek	Laurel Run/Deckers Creek	WV-M-14-T		X		X	X				
Deckers Creek	UNT/Laurel Run RM 1.62	WV-M-14-T-1				M					
Deckers Creek	UNT/Deckers Creek RM 17.28	WV-M-14-U				M					
Deckers Creek	Kanes Creek	WV-M-14-V		X		X	X				
Deckers Creek	UNT/Kanes Creek RM 2.36	WV-M-14-V-0.9		X		X	X				
Deckers Creek	UNT/Kanes Creek RM 2.49	WV-M-14-V-1		X		X	X				
Deckers Creek	UNT/Deckers Creek RM 18.48	WV-M-14-W				M					

TMDL Watershed	Stream Name	NHD_Code	Trout	pH	DO	Fe	Al	Cl	Se	Mn	FC
Deckers Creek	UNT/Deckers Creek RM 20.48	WV-M-14-Y				M					
Deckers Creek	UNT/Deckers Creek RM 20.63	WV-M-14-Z				M					
Cobun Creek	Cobun Creek	WV-M-15									X
Booths Creek	Booths Creek	WV-M-17		X		X	Re				
Booths Creek	Jolliet Run	WV-M-17-B				M					
Booths Creek	Bloody Run	WV-M-17-C				M					
Booths Creek	Owl Creek	WV-M-17-G		X		X	X				
Booths Creek	UNT/Owl Creek RM 1.66	WV-M-17-G-2				M					
Booths Creek	Mays Run	WV-M-17-H		X		M	Re				
Booths Creek	UNT/Booths Creek RM 6.27	WV-M-17-I		X		M	X				
Booths Creek	UNT/Booths Creek RM 7.43	WV-M-17-L				M					X
Brand Run	Brand Run	WV-M-20		X		X	X			X	
Brand Run	UNT/Brand Run RM 0.72	WV-M-20-A				M					
Flaggy Meadow Run	Flaggy Meadow Run	WV-M-30				X		X			X
Flaggy Meadow Run	UNT/Flaggy Meadow Run RM 1.07	WV-M-30-B				M					
Flaggy Meadow Run	UNT/Flaggy Meadow Run RM 2.15	WV-M-30-D				M		X			
Birchfield Run	Birchfield Run	WV-M-31		X		X	X				
Whiteday Creek	Whiteday Creek	WV-M-32	Yes			X					
Whiteday Creek	UNT/Whiteday Creek RM 1.68	WV-M-32-C				M					X
Whiteday Creek	UNT/Whiteday Creek RM 3.49	WV-M-32-E				M					
Whiteday Creek	Laurel Run	WV-M-32-H				M					
Whiteday Creek	Lick Run	WV-M-32-M				M					
Whiteday Creek	Laurel Run/Whiteday Creek	WV-M-32-P				M					X
Whiteday Creek	Maple Run	WV-M-32-U				M					
Whiteday Creek	Cherry Run	WV-M-32-W				M					
Indian Creek	Indian Creek	WV-M-33									X
Indian Creek	Little Indian Creek	WV-M-33-E									X
Indian Creek	UNT/Indian Creek RM 7.23	WV-M-33-P									X
Little Creek	Little Creek	WV-M-42				M					

TMDL Watershed	Stream Name	NHD_Code	Trout	pH	DO	Fe	Al	Cl	Se	Mn	FC
Prickett Creek	Prickett Creek	WV-M-44				M					X
Prickett Creek	Scratchers Run	WV-M-44-H				M					X
Prickett Creek	Reuben Run	WV-M-44-I				M					
Prickett Creek	Piney Run	WV-M-44-K				M					
Prickett Creek	Grassy Run	WV-M-44-M									X
Prickett Creek	Long Run	WV-M-44-N				M					
Prickett Creek	Mudlick Run	WV-M-44-P				M					
Parker Run	Parker Run	WV-M-45		X		X	X				X
UNT/Monongahela River RM 123.45	UNT/Monongahela River RM 123.45	WV-M-46		X		X	X				
Pharaoh Run	Pharaoh Run	WV-M-47				X					X
Paw Paw Creek	Paw Paw Creek	WV-M-49				M		X			X
Paw Paw Creek	Little Paw Paw Creek	WV-M-49-D				M					X
Paw Paw Creek	Ministers Run	WV-M-49-D-2				M					
Paw Paw Creek	Chunk Run	WV-M-49-D-4				M					
Paw Paw Creek	Arnett Run	WV-M-49-G				X			X		
Paw Paw Creek	Tarney Run	WV-M-49-H				M					
Paw Paw Creek	Panther Lick Run	WV-M-49-I				M					
Paw Paw Creek	Robinson Run	WV-M-49-K				M					
Paw Paw Creek	Laurel Run	WV-M-49-O				M					
Paw Paw Creek	Rush Run	WV-M-49-Q				M					
Paw Paw Creek	Bennefield Prong	WV-M-49-R				M					X
Paw Paw Creek	Sugar Run	WV-M-49-W				M					X
Paw Paw Creek	Harvey Run	WV-M-49-X				M					
Buffalo Creek	Buffalo Creek	WV-M-54				X					X
Buffalo Creek	Whetstone Run	WV-M-54-AA				M					X
Buffalo Creek	Joes Run	WV-M-54-AC				M					X
Buffalo Creek	Price Run	WV-M-54-AD				M					
Buffalo Creek	Long Drain	WV-M-54-AE				M					
Buffalo Creek	UNT/Buffalo Creek RM 23.53	WV-M-54-AF						X			

TMDL Watershed	Stream Name	NHD_Code	Trout	pH	DO	Fe	Al	Cl	Se	Mn	FC
Buffalo Creek	Huey Run	WV-M-54-AH				M					
Buffalo Creek	Owen Davy Fork	WV-M-54-AI				M					X
Buffalo Creek	Laurel Run	WV-M-54-AI-3				M					
Buffalo Creek	Camp Run	WV-M-54-AI-4				M					
Buffalo Creek	Bartholomew Fork	WV-M-54-AK				M					X
Buffalo Creek	Warrior Fork	WV-M-54-AM				M					X
Buffalo Creek	Evans Run	WV-M-54-AM-2				M					X
Buffalo Creek	Ices Run	WV-M-54-C				M					
Buffalo Creek	Finchs Run	WV-M-54-D				M					X
Buffalo Creek	UNT/Finchs Run RM 1.15	WV-M-54-D-2				X					X
Buffalo Creek	Moody Run	WV-M-54-E									X
Buffalo Creek	Dunkard Mill Run	WV-M-54-I				X					X
Buffalo Creek	Bethel Run	WV-M-54-I-1				M					X
Buffalo Creek	UNT/Bethel Run RM 0.80	WV-M-54-I-1-A									X
Buffalo Creek	Little Laurel Run	WV-M-54-J				X					X
Buffalo Creek	East Run	WV-M-54-O				M					
Buffalo Creek	Plum Run	WV-M-54-R				X					X
Buffalo Creek	Carberry Run	WV-M-54-R-1				M					
Buffalo Creek	UNT/Plum Run RM 3.81	WV-M-54-R-4				M					
Buffalo Creek	Mod Run	WV-M-54-T			X**	X					X
Buffalo Creek	Little Mod Run	WV-M-54-T-1				M					
Buffalo Creek	Mahan Run	WV-M-54-U				M					X
Buffalo Creek	Salt Lick Run	WV-M-54-V				M					
Buffalo Creek	Flaggy Meadow Run	WV-M-54-W				M					X
Buffalo Creek	Fleming Fork	WV-M-54-W-2				M					X
Buffalo Creek	Pyles Fork	WV-M-54-X				M					X
Buffalo Creek	Big Run	WV-M-54-X-10				M					
Buffalo Creek	Beechlick Run	WV-M-54-X-14				M					
Buffalo Creek	Flat Run	WV-M-54-X-3				M		X			X

TMDL Watershed	Stream Name	NHD_Code	Trout	pH	DO	Fe	Al	Cl	Se	Mn	FC
Buffalo Creek	Llewellyn Run	WV-M-54-X-3-A				M		X			
Buffalo Creek	State Road Fork	WV-M-54-X-7				M					X
Buffalo Creek	Campbell Run	WV-M-54-X-9				M					X
Buffalo Creek	Messer Run	WV-M-54-X-9-A				M					
Buffalo Creek	Left Fork/Campbell Run	WV-M-54-X-9-B				M					
Buffalo Creek	Dents Run	WV-M-54-Z				X					X
Hickman Run	Hickman Run	WV-M-55				X					X
Coal Run	Coal Run	WV-M-56									X
UNT/Monongahela River RM 128.55	UNT/Monongahela River RM 128.55	WV-M-57				X					X

Note:

RM	river mile
UNT	unnamed tributary
Trout	indicates a designated trout stream
pH	acidity impairment
DO	dissolved oxygen impairment
Fe	iron impairment
Al	aluminum impairment
Cl	chloride impairment
Se	selenium impairment
Mn	manganese impairment
FC	fecal coliform bacteria impairment
M	Modeled Iron
X*	Deckers Creek DO impairment limited to two mile segment upstream of UNT/Deckers Creek RM 18.48 to pond outlet at RM 20.5; FC surrogate possible
X**	Fecal coliform surrogate possible for Mod Run DO TMDL

4.0 BIOLOGICAL IMPAIRMENTS 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. The original scope of work for this project included approximately 20 biological impairments for which TMDLs were to be developed. A separate project addressing an additional 30 impacted streams was funded and initiated by USEPA Region III. The latter project focused on streams with elevated dissolved solids concentrations for which significant ionic stress to the benthic community was presumed.

Three years into this TMDL process, 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 did not add new WVSCI-based biological impairments to the 2012 303(d) list that was submitted to EPA for approval on December 21, 2012. WVDEP has also suspended biological impairment TMDL development pending legislative approval of the new assessment methodology.

On March 25, 2013, EPA partially approved and partially disapproved West Virginia's 2012 Section 303(d) list submittal. EPA disapproved West Virginia's failure to list multiple waters for which available biological information would have been deemed impairment pursuant to 47 CSR 2 §3.2.i if assessed using the WVSCI methodology as in past listing cycles. On April 8, 2013 EPA published a notice in the *Federal Register* of its proposal to add 255 waters to West Virginia's 2012 303(d) list and opened a 30-day public comment period regarding the same. Information regarding the public notice, the public comments received, and EPA's response to the same may be viewed in their entirety at: http://www.epa.gov/reg3wapd/tmdl/303list.html

On May 8, 2013, WVDEP submitted comments to EPA that expressed general disagreement with the proposed over-list action and provided technical considerations regarding proposed specific stream listings. EPA considered WVDEP's comments and altered their final action based on those comments, by removing eight streams that EPA initially proposed to add, adding one stream, and revising the segmentation of four streams. The final EPA action also delisted twelve streams that WVDEP included on its draft list. However, EPA declined to follow

WVDEP's suggestion regarding waters for which WVDEP deemed the biological results uncertain based on the WVSCI methodology (i.e. WVSCI scores between 60.6 and 68). WVDEP did not historically assess such waters as biologically impaired, and EPA approved those assessments. However, in the instant Section 303(d) list, the EPA final action includes listing those streams as impaired. EPA contends that the previous uncertainty consideration is statistically unsupported. WVDEP disagrees with that contention and maintains that streams that are assessed to be in the "grey area" need not be listed on Section 303(d) lists as biologically impaired.

The above notwithstanding, all of the potentially impacted streams were subjected to the biological stressor identification process described in this Chapter. Independent of their fate on the 303(d) list, 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, stressor identification results are presented 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 through the implementation of TMDLs developed in this project pursuant to effective numeric water quality criteria for the streams identified in **Table 4-1**. **Table 4-2** identifies the potentially biologically impacted streams that are not affected by this TMDL development project.

4.1 Introduction

Impact to benthic macroinvertebrate communities were rated using a multimetric index developed for use in the wadeable streams of West Virginia. The West Virginia Stream Condition Index (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 Stressor Identification (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 2** of the Technical Report discusses the stressor identification (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 2006 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.

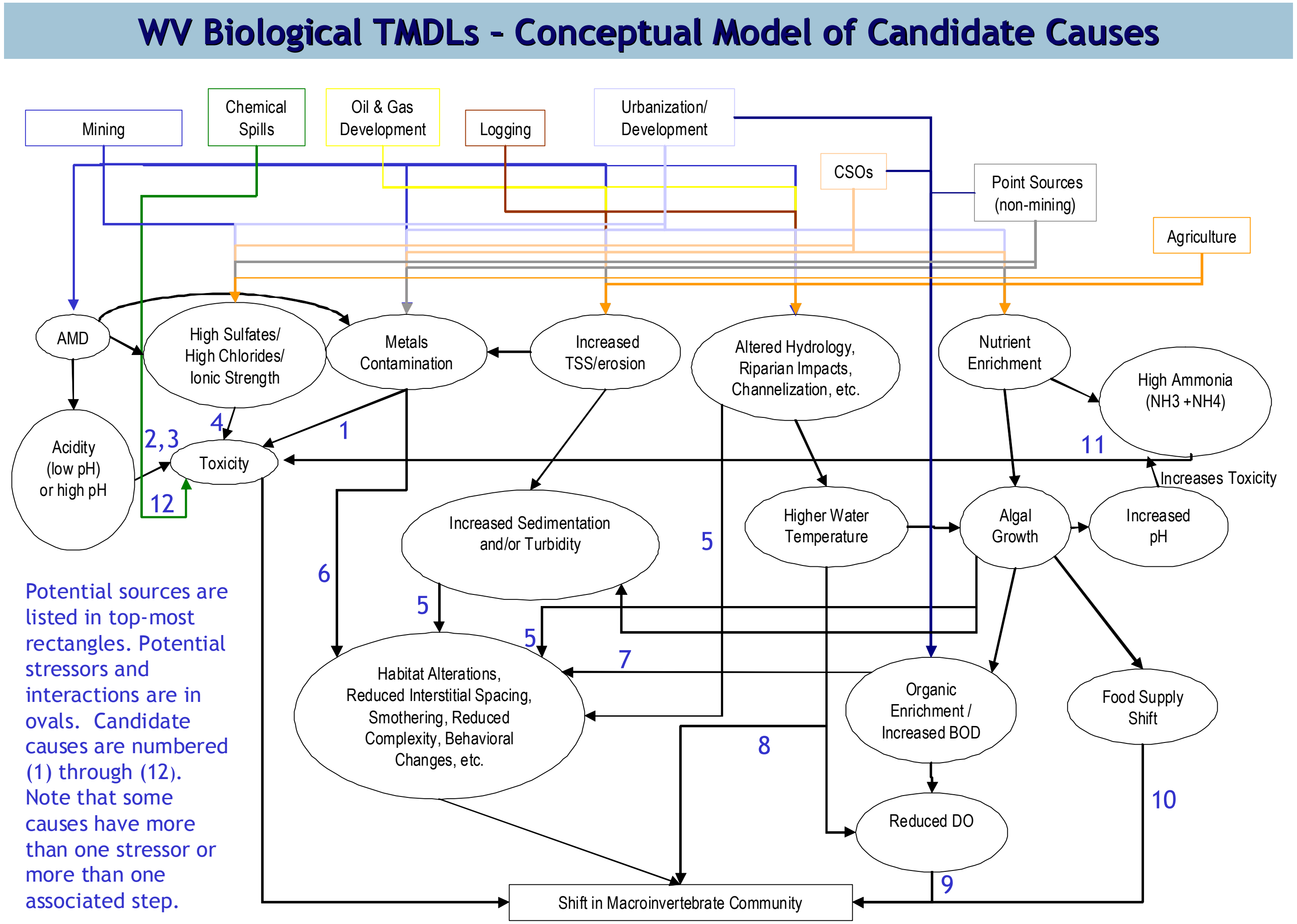


Figure 4-1. Conceptual model of candidate causes and potential biological effects

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 Monongahela River Watershed:

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

All of the 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 each stream, 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. Implentation of the iron TMDLs will resolve biological stress from sedimentation.

Little Paw Paw Creek (WV-M-49-D) was selected as the achievable reference stream as it shares similar landuse, ecoregion and geomorphologic characteristics with the sediment impaired streams. The location of Little Paw Paw Creek is shown in **Figure 4-2**.

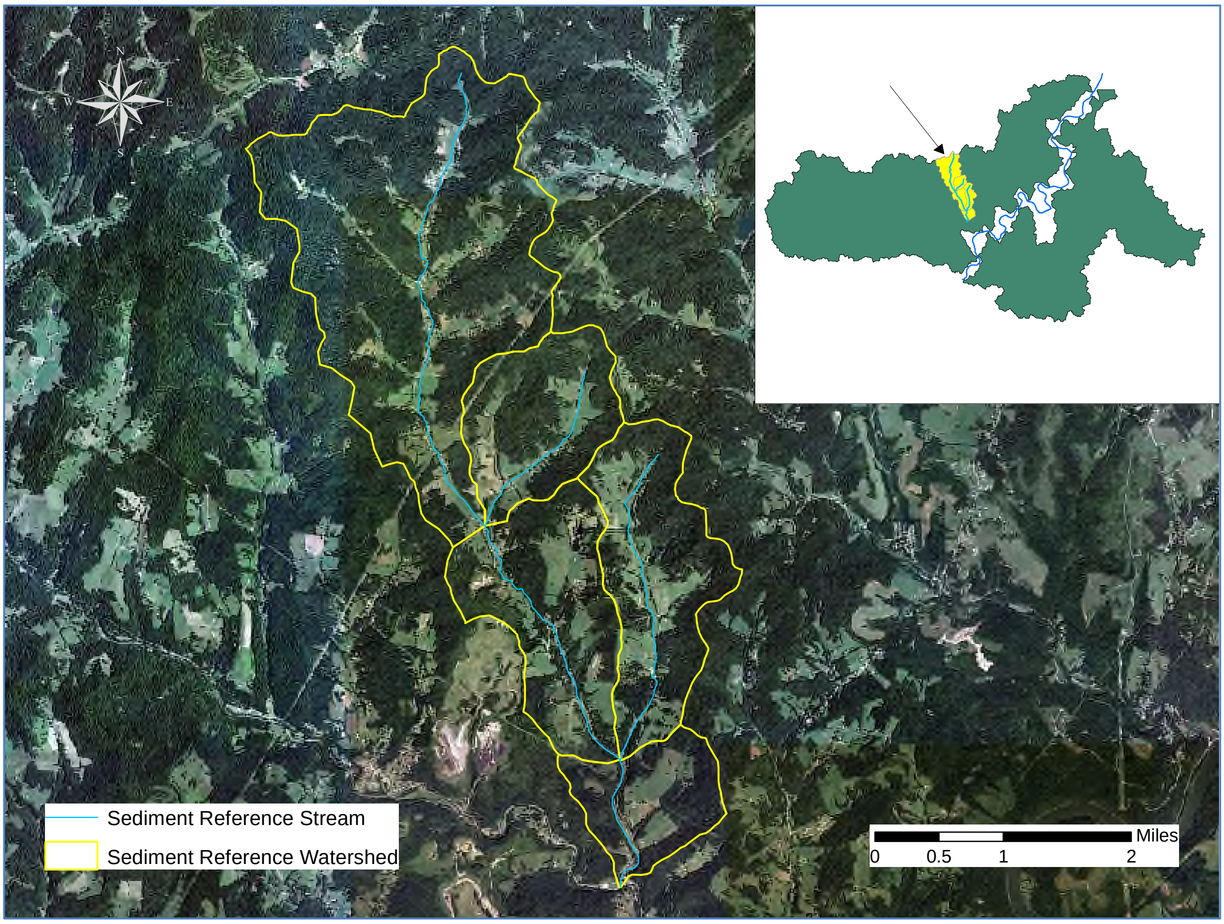


Figure 4-2. Location of the sediment reference stream, Little Paw Paw Creek (WV-M-49-D)

See **Section 10.5** for further description of the correlation between sedimentation and iron.

The streams for which biological stress would be resolved through the implementation of the pollutant-specific TMDLs developed in this project are presented in **Table 4-1**. **Table 4-2** presents streams for which the SI process identified the presence of significant stressors that would not be positively addressed by TMDLs based on effective numeric water quality criteria.

Table 4-1. Significant stressors of biologically impacted streams in the Monongahela River Watershed and pollutant TMDL to be developed.

Stream Name	NHD-Code	Significant Stressors	TMDLs Developed
UNT/Crooked Run RM 2.27	WV-M-2-B	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Deckers Creek	WV-M-14	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Aaron Creek	WV-M-14-B	Sedimentation	Total Iron
UNT/Deckers Creek RM 5.70	WV-M-14-E	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Glady Run	WV-M-14-P	pH Toxicity, Metals Toxicity, Metal Hydroxides	pH, Total Iron, Dissolved Aluminum

Stream Name	NHD-Code	Significant Stressors	TMDLs Developed
Booths Creek	WV-M-17	pH Toxicity, Aluminum Toxicity	pH, Dissolved Aluminum
Brand Run	WV-M-20	pH Toxicity, Aluminum Toxicity, Iron Toxicity	pH, Dissolved Aluminum, Total Iron
Little Creek	WV-M-42	Sedimentation	Total Iron
Prickett Creek	WV-M-44	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Scratchers Run	WV-M-44-H	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Robinson Run	WV-M-49-K	Sedimentation	Total Iron
UNT/Finchs Run RM 1.15	WV-M-54-D-2	Sedimentation	Total Iron
UNT/Bethel Run RM 0.80	WV-M-54-I-1-A	Organic Enrichment	Fecal Coliform
Mod Run	WV-M-54-T	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Mahan Run	WV-M-54-U	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Flaggy Meadow Run	WV-M-54-W	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
State Road Fork	WV-M-54-X-7	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Campbell Run	WV-M-54-X-9	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Dents Run	WV-M-54-Z	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Joes Run	WV-M-54-AC	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Owen Davy Fork	WV-M-54-AI	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Bartholomew Fork	WV-M-54-AK	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron
Warrior Fork	WV-M-54-AM	Sedimentation, Organic Enrichment	Fecal Coliform, Total Iron
Hickman Run	WV-M-55	Organic Enrichment, Sedimentation	Fecal Coliform, Total Iron

Note:
RM is River Mile
UNT is unnamed tributary.

Table 4-2: Significant stressors of biologically impacted streams in the Monongahela River Watershed not entirely addressed by TMDLs based on effective numeric water quality criteria presented herein.

Stream Name	NHD-Code	Significant Stressors
Camp Run	WV-M-1	pH Toxicity, Aluminum Toxicity, Iron Toxicity, Ionic Stress, Metal Hydroxides
Scotts Run	WV-M-10	Ionic Stress, Organic Enrichment
Wades Run	WV-M-10-C	Ionic Stress
Guston Run	WV-M-10-D	Ionic Stress
Dents Run	WV-M-12	Organic Enrichment, Sedimentation, Ionic Stress
Flaggy Meadow Run	WV-M-12-A	Organic Enrichment, Ionic Stress
UNT/Dents Run RM 5.82	WV-M-12-H	Ionic Stress
Hartman Run	WV-M-14-A	Ionic Stress

Stream Name	NHD-Code	Significant Stressors
Owl Creek	WV-M-17-G	pH Toxicity, Aluminum Toxicity, Ionic Stress, Metal Hydroxides
UNT/Booths Creek RM 7.43	WV-M-17-L	Inconclusive
UNT/Camp Run RM 0.79	WV-M-1-A	pH Toxicity, Aluminum Toxicity, Iron Toxicity, Ionic Stress, Metal Hydroxides
Crooked Run	WV-M-2	pH Toxicity, Aluminum Toxicity, Ionic Stress, Metal Hydroxides
Flaggy Meadow Run	WV-M-30	Ionic Stress
UNT/Flaggy Meadow Run RM 2.15	WV-M-30-D	Ionic Stress
Indian Creek	WV-M-33	Ionic Stress
Little Indian Creek	WV-M-33-E	Ionic Stress
Snider Run	WV-M-33-E-2	Ionic Stress
UNT/Little Indian Creek RM 3.19	WV-M-33-E-6	Ionic Stress
UNT/Indian Creek RM 7.23	WV-M-33-P	Ionic Stress
Paw Paw Creek	WV-M-49	Ionic Stress, Organic Enrichment, Sedimentation
Sugar Run	WV-M-49-W	Organic Enrichment, Sedimentation, Ionic Stress, Metal Hydroxides
Harvey Run	WV-M-49-X	Ionic Stress
Buffalo Creek	WV-M-54	Ionic Stress, Organic Enrichment, Sedimentation
Whetstone Run	WV-M-54-AA	Ionic Stress, Organic Enrichment, Sedimentation
Moody Run	WV-M-54-E	Inconclusive
Pyles Fork	WV-M-54-X	Ionic Stress, Sedimentation, Organic Enrichment
Flat Run	WV-M-54-X-3	Ionic Stress, Organic Enrichment, Sedimentation, Metal Hydroxides
Llewellyn Run	WV-M-54-X-3-A	Ionic Stress, Sedimentation, Metal Hydroxides
UNT/Monongahela River RM 128.55	WV-M-57	Sedimentation, Ionic Stress
West Run	WV-M-7	pH Toxicity, Aluminum Toxicity, Iron Toxicity, Ionic Stress, Metal Hydroxides
Robinson Run	WV-M-8	Ionic Stress, Sedimentation, Metal Hydroxides
Crafts Run	WV-M-8-A	pH Toxicity, Aluminum Toxicity, Iron Toxicity, Ionic Stress, Metal Hydroxides
UNT/Robinson Run RM 1.09	WV-M-8-B	pH Toxicity, Aluminum Toxicity, Iron Toxicity, Ionic Stress, Metal Hydroxides
UNT/Robinson Run RM 4.09	WV-M-8-F	Ionic Stress

Note:
RM is River Mile
UNT is unnamed tributary.
Inconclusive indicates that insufficient data were available to link likely pollutant stressors to biological assessment.

5.0 METALS SOURCE ASSESSMENT

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

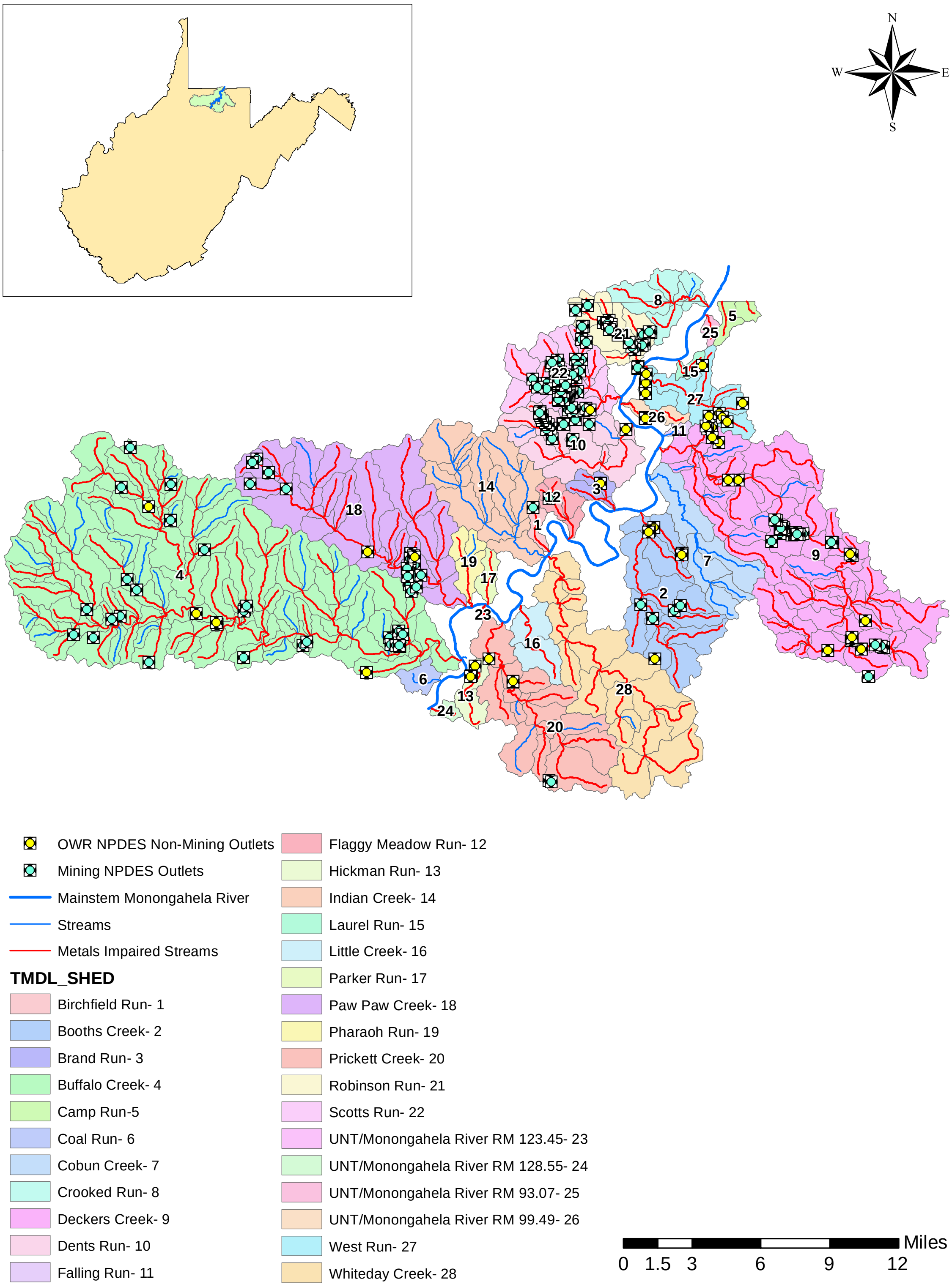
A point source, according to 40 CFR 122.3, is any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, and vessel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

Nonpoint sources of pollutants are diffuse, non-permitted sources. 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 mine 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. Metals point sources in the Monongahela 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 34 mining-related NPDES permits, with 177 associated outlets in the metals impaired watersheds of the Monongahela 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 are six such bond forfeiture sites located in the metals impaired TMDL watersheds.

In past TMDLs, bond forfeiture sites were classified as nonpoint sources. A recent 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, TMDL project classifies bond forfeiture sites as point sources and provides WLAs.

5.1.3 Non-mining Point Sources

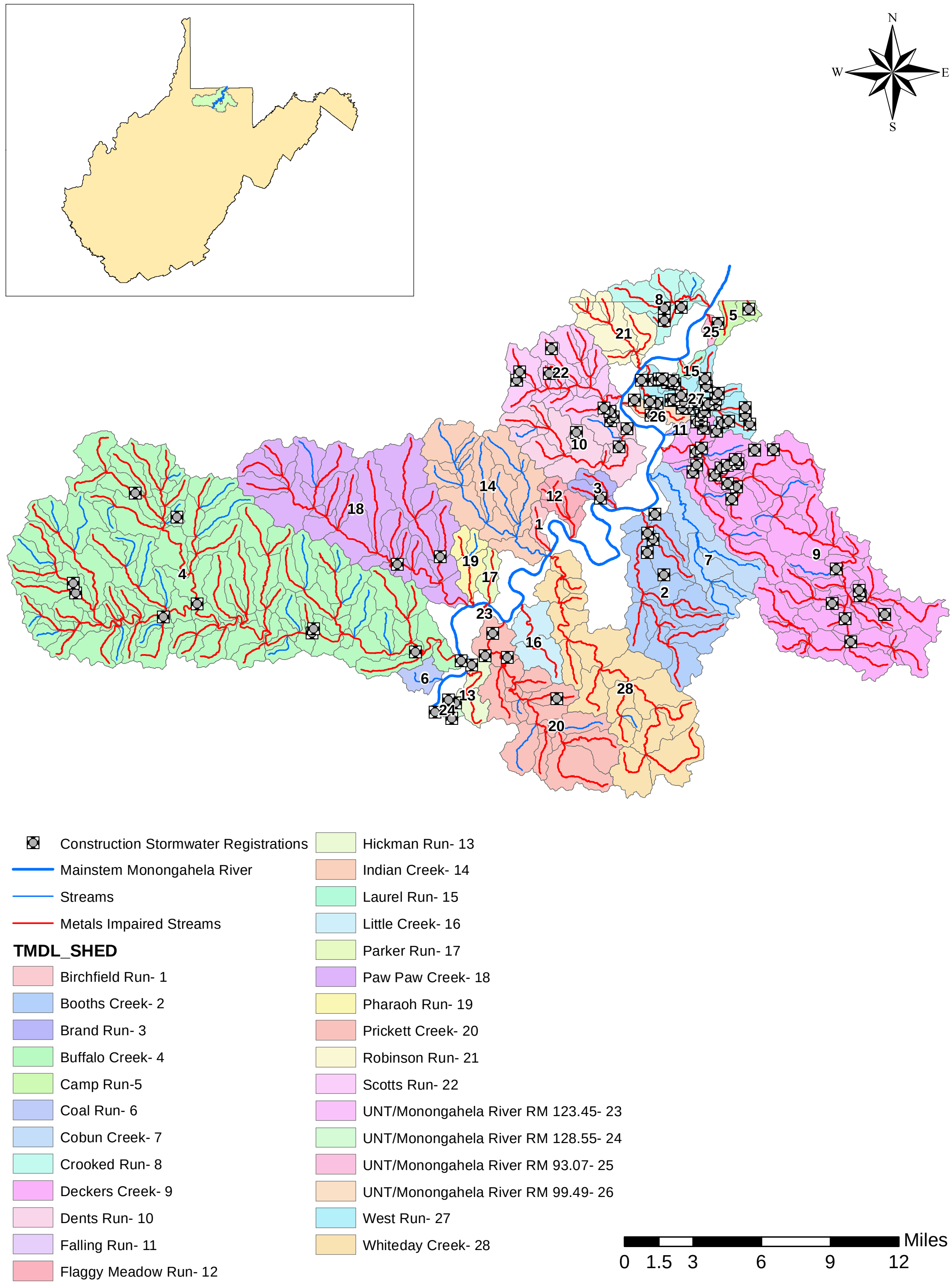
WVDEP DWWM controls water quality impacts from non-mining activities with point source discharges through the issuance of NPDES permits. WVDEP's OWRNPDES GIS coverage was used to determine the locations of these sources, and detailed permit information was obtained from WVDEP's ERIS database. Sources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

There are 58 modeled non-mining NPDES permits in the watersheds of metals impaired streams, which are displayed in **Figure 5-1**. Fifty-five of the non-mining permits regulate stormwater associated with industrial activity or WVDOH facilities and implement stormwater benchmark values of 100 mg/L TSS and/or 1.0 mg/L total iron. Of the remaining permits, one is an individual stormwater permit, one is a groundwater remediation permit, and one is a water treatment permit. 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, 109 active construction sites with a total disturbed acreage of 1579 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 permit as described in **Section 10.0**.



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

Figure 5-2. Construction stormwater permits in the Monongahela 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), Fairmont State University (WVR030045), Town of Star City (WVR030023), City of Westover (WVR030022), Morgantown Utility Board (WVR030030), Federal Correctional Institution – Morgantown (WVR030012), and West Virginia University (WVR030042), and the West Virginia Division of Highways (WVDOH) (WVR030004).

The Fairmont State University MS4 area is within, but separate from the City of Fairmont MS4 area. Likewise, West Virginia University's MS4 area is comprised of parcels that are located inside and outside Morgantown's MS4 permit boundary. WVDOH MS4 area occurs inside and on the periphery of the municipal MS4 entities listed above.

MS4 source representation was based upon precipitation and runoff from landuses determined from the modified NLCD 2006 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 MS4 systems. WVDEP consulted with local governments and obtained information to determine drainage areas to the respective systems and best represent MS4 pollutant loadings. The location and extent of the MS4 jurisdictions are shown in **Figure 5-3**.

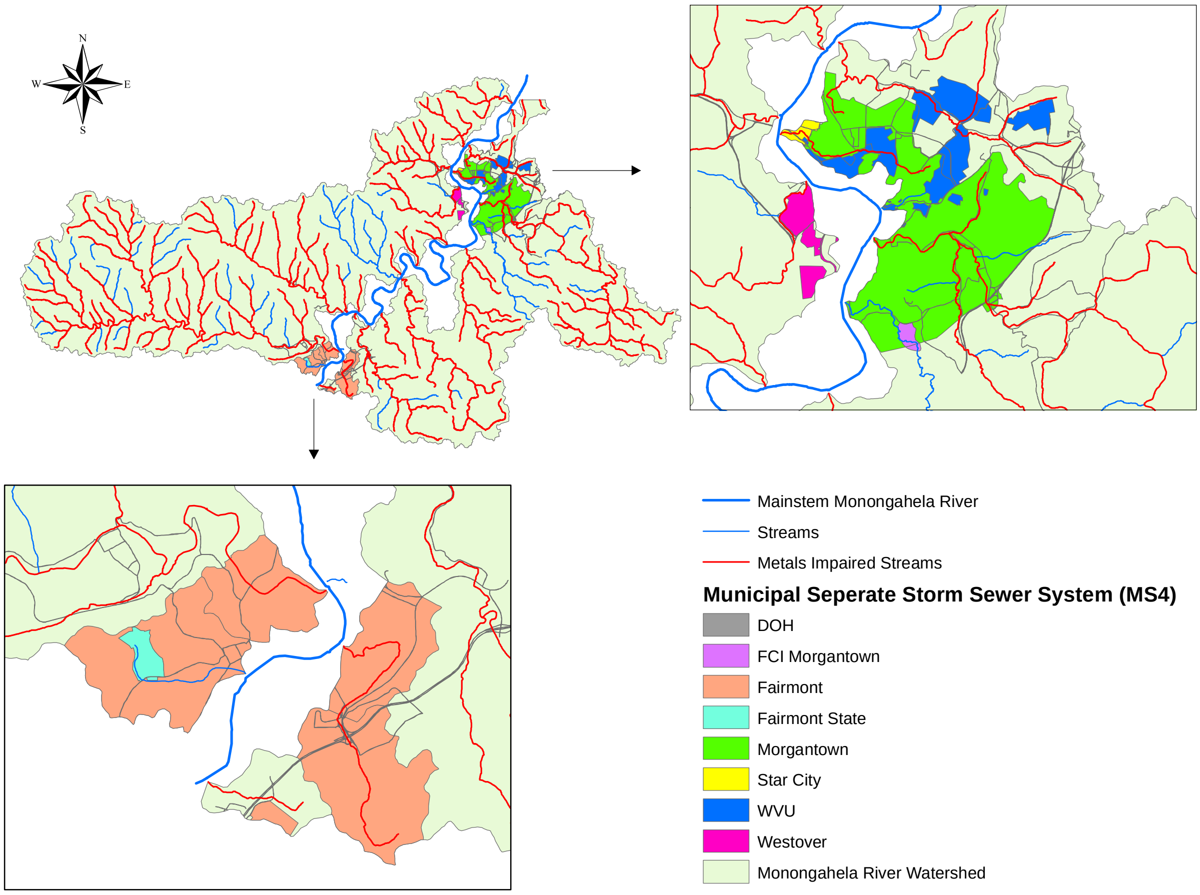


Figure 5-3. MS4 jurisdictions in the Monongahela River Watershed

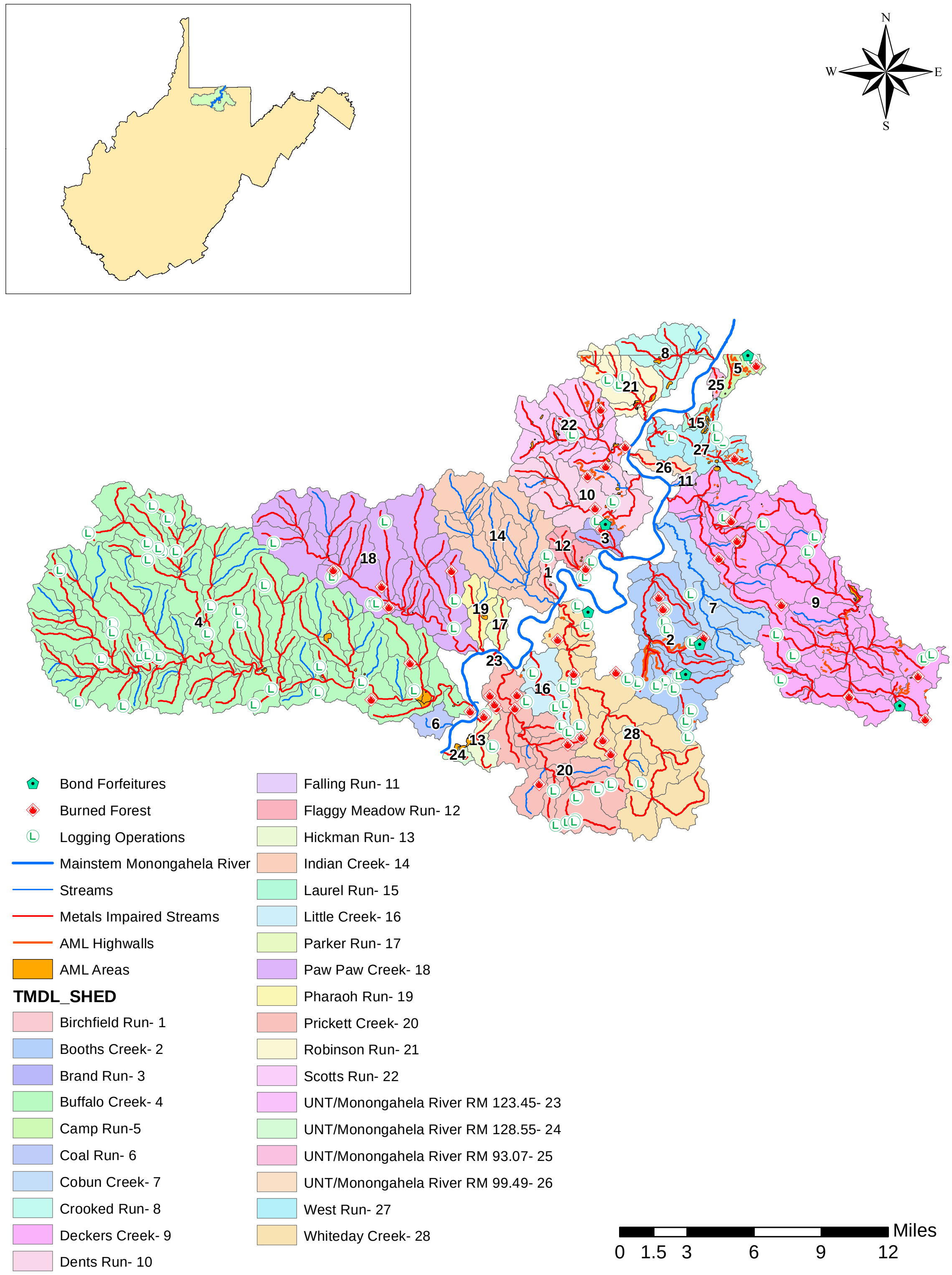
5.2 Metals Nonpoint Sources

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 Monongahela 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 29.3 miles (233 acres) of AML highwall and 168 AML seeps, were incorporated into the TMDL model (**Figure 5-4**).



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

Figure 5-4. Metals non-point sources in the Monongahela 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

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 harvested area (5541.2 acres) and the subset of land disturbed by roads and landings (481.8 acres), as well as 75.5 acres of burned forest, in the metals impaired TMDL watersheds.

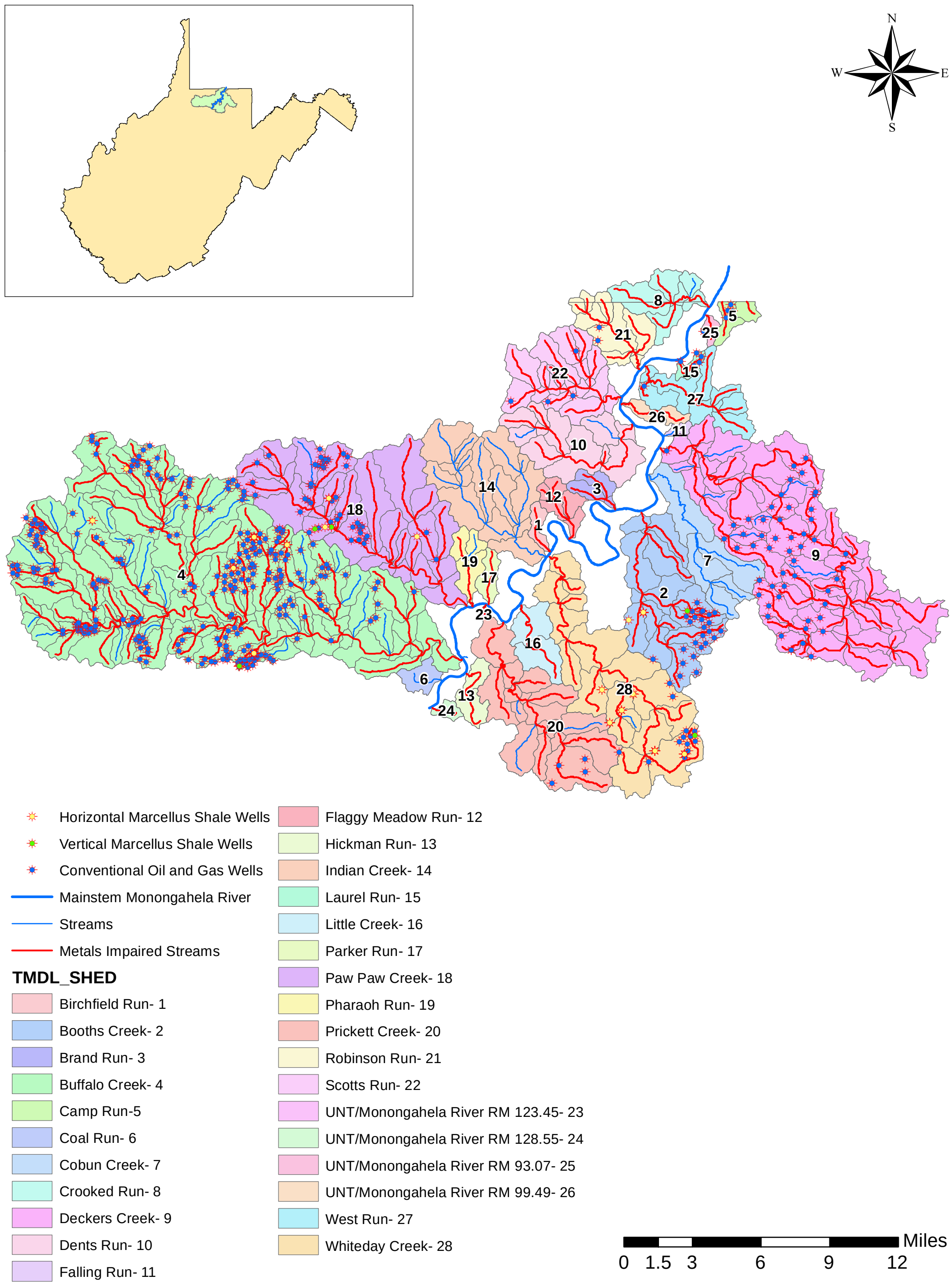
West Virginia recognizes the water quality issues posed by sediment from logging sites. In 1992, the West Virginia Legislature passed the Logging Sediment Control Act. The act requires the use of BMPs to reduce sediment loads to nearby waterbodies. Without properly installed BMPs, logging and associated access roads can increase sediment loading to streams. According to the Division of Forestry, illicit logging operations represent approximately 2.5 percent of the total harvested forest area (registered logging sites) throughout West Virginia. These illicit operations do not have properly installed BMPs and can contribute sediment to streams. This rate of illicit activity has been represented in the model.

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 40,000 active and 25,000 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.

Recent drilling of new 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. In addition to conventional wells, vertical and horizontal Marcellus drilling sites were identified and represented in the model.

Oil and gas data incorporated into the TMDL model were obtained from the WVDEP OOG GIS coverage. There are 419 conventional active oil and gas wells (comprising 578.22 acres), 5 vertical Marcellus wells (11.06 acres), and 56 horizontal Marcellus wells (448.71 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: permits in close proximity appear to overlap in the figure)

Figure 5-5. Oil and Gas Well locations in the Monongahela 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 2009 TIGER/Line shapefiles from the US Census Bureau and the WV Roads GIS coverage prepared by WVU. Unpaved roads that were not included in either GIS coverage were digitized from topographic maps.

Agriculture

Agricultural activities can contribute sediment loads to nearby streams. Agricultural landuses account for approximately 6 percent of the modeled land area in metals impaired TMDL watersheds. Agricultural runoff can contribute excess sediment loads when farming practices allow soils to be washed into the stream. 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 special bank erosion pin study that 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, except in MS4 areas where the loads are categorized with the wasteload allocations. See also **Section 10.7.1**, subtitle, Municipal Separate Storm Sewer System (MS4).

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 2006 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 2006 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 Selenium Source Assessment

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

Arnett Run is identified as impaired and has been listed in the WV 2012 303(d) list pursuant to the aquatic life criteria for selenium, based on pre-TMDL data collected by WVDEP from July 2009 – June 2010. Extensive surface mining operations exist in the Arnett Run watershed, and active and reclaimed mining are the dominant landuses. Given the selenium content of coals being mined in this region, and the prevalence of mining activity in proximity to observed exceedances of the selenium water quality criterion, the disturbances associated with the existing mining operations are assumed to contribute to the selenium impairment. In addition, a coal burning power station is located in the Arnett Run watershed. It has been documented that selenium accumulates in the flyash resulting from the combustion of coal (WVGES, 2002). While industrial permit outlets from the power station do not drain directly to Arnett Run, fly ash disposal and reuse in reclamation have occurred in the watershed and may also contribute to the selenium impairment. Reclamation and disposal areas are within the mining permit boundaries and drainage from these areas are permitted through permitted mining outlets.

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

Significant mining activity is present in the watershed. Pre-TMDL monitoring near the mouth of Arnett Run documented selenium concentrations exceeding the 5.0 µg/l chronic aquatic life criterion, as well as the 20 µg/L acute aquatic life criteria. Two exceedances occurred in nine samples with concentrations measuring 5.5 µg/L and 26.7 µg/L. There were no non-detects. The minimum detection was 0.6 µg/L and the average was 5.2 µg/L.

Figures 5-6 thru 5-7 display the extent of mining in the Arnett Run watershed. Technical Report Appendix F identifies permitted outlets in the watershed.

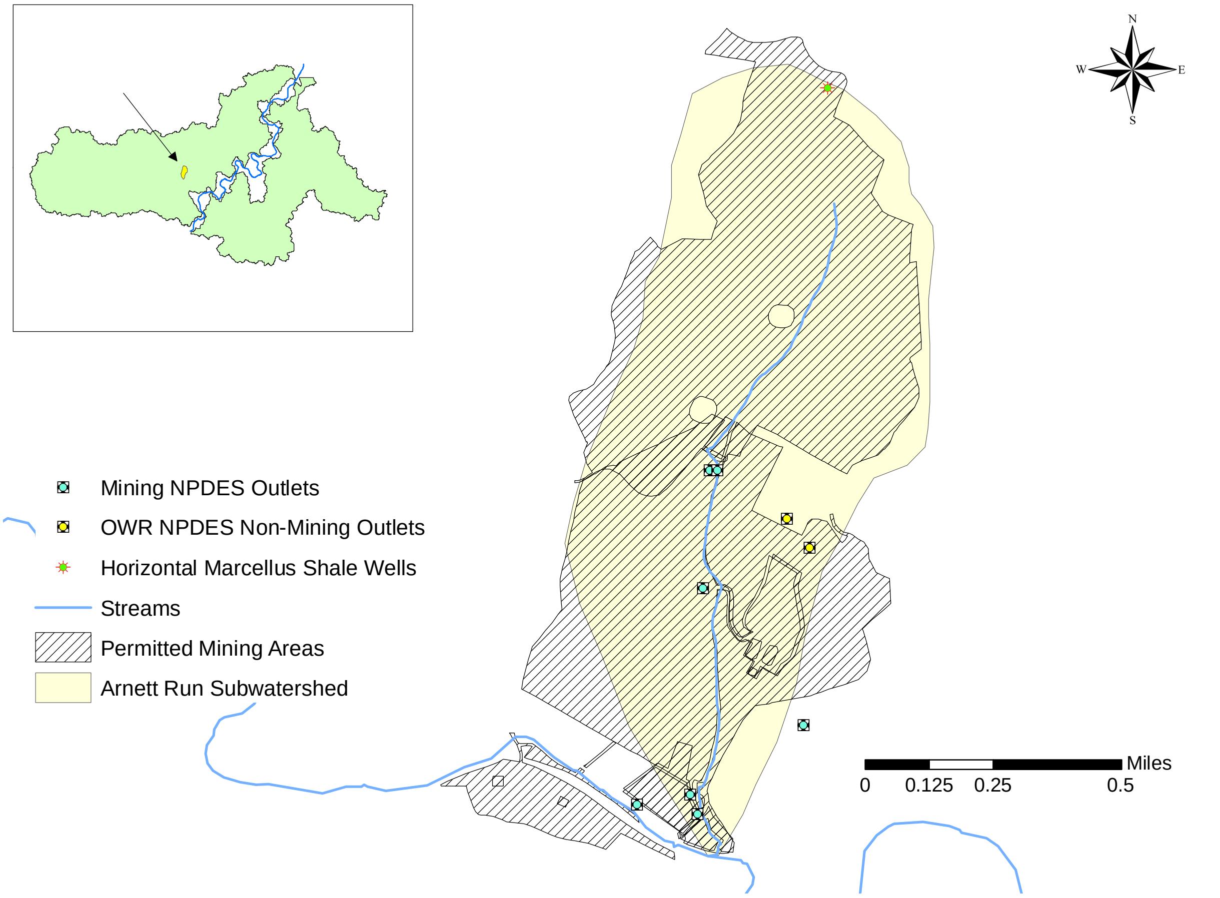


Figure 5-6. Arnett Run selenium impaired stream

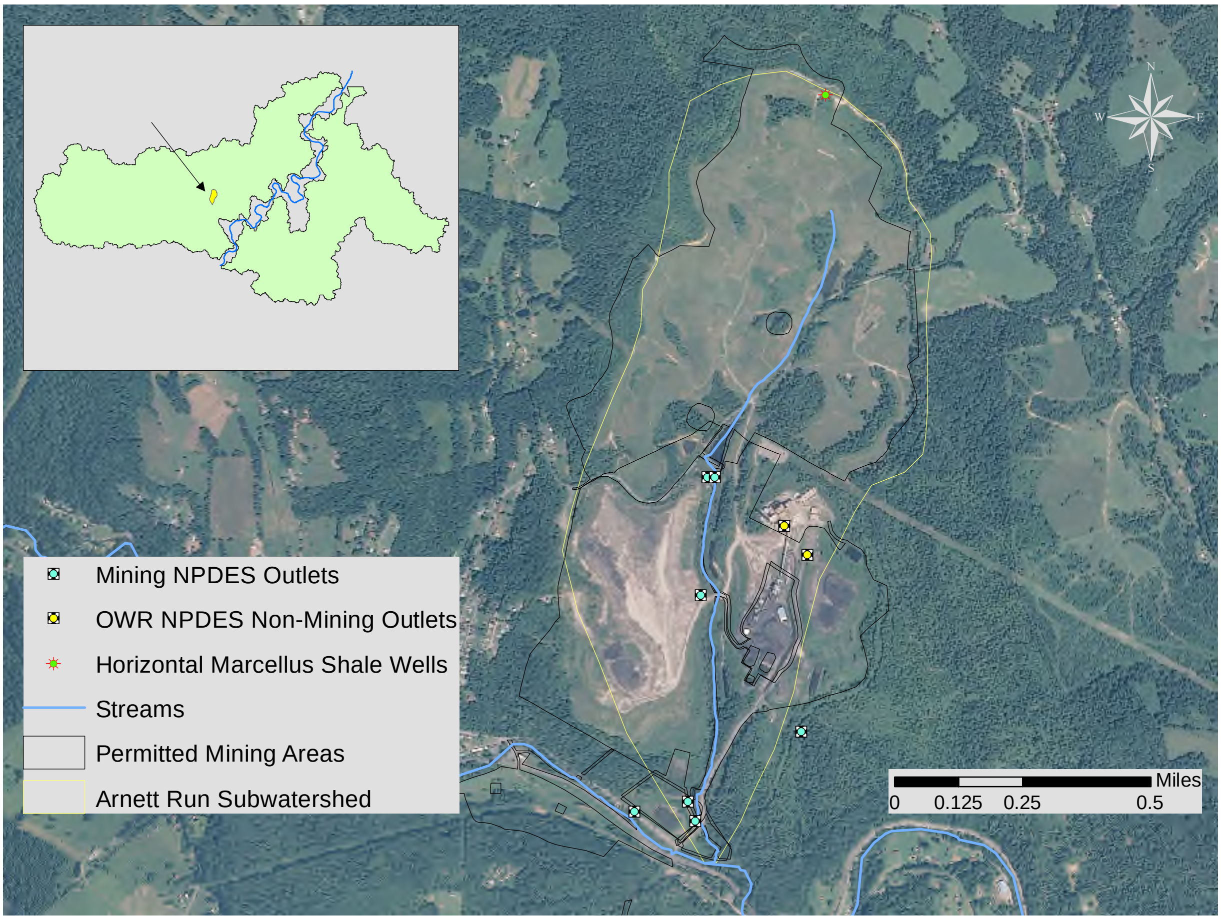


Figure 5-7. Arnett Run aerial photo

6.0 pH SOURCE ASSESSMENT

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

Discharges from historical mining activities can cause low pH impairments, iron and/or aluminum impairments. Because of the complex chemical interactions that occur between dissolved metals and acidity, the TMDL approach focused on reducing metals concentrations to meet metals water quality criteria while accounting for watershed dynamics associated with buffering capacity. Where appropriate, the approach prescribes the necessary reductions associated with the metals TMDL condition and presents the net alkalinity additions necessary to achieve the pH water quality criteria.

While acid precipitation and the low buffering capacity of certain watersheds can contribute to lower observed pH, it is not the causative source for impaired waters. The presence of limestone deposits within the subwatersheds mitigates adverse impacts from of acidic precipitation Atmospheric wet deposition data were obtained from the USEPA Office of Air Quality Planning and Standards at Research Triangle Park, North Carolina. The data are a result of air quality modeling in support of the CAIR For the technical information on these data, please see the Technical Support Document for the Final Clean Air Intestate Rule – Air Quality Modeling (USEPA, 2005c). National Atmospheric Deposition Program (NADP) monitoring data collected at the USDA Forest Service Northeastern Research Station, Tucker County, WV was also used to characterize the extent of atmospheric deposition in the watershed.

7.0 CHLORIDE SOURCE ASSESSMENT

Permitted, high-volume, pumped discharges associated with mining activities are the prevalent sources in six of the eight chloride impaired streams in the watershed. WVDEP's Division of Mining and Reclamation (DMR) provided a spatial coverage of the mining-related NPDES permit outlets and additional information regarding the subset of those outlets for which chloride has been determined to be a pollutant of concern. The discharge characteristics, related permit limits and discharge data for these NPDES outlets were acquired from West Virginia's ERIS database system. Using this information, six such sources were represented as constant flow discharges in the model and assigned individual wasteload allocations. The high-volume pumped discharge outlets discharging to chloride-impaired streams are shown in **Figure 7-1**.

Chloride water quality criteria exceedances have been associated with MS4 and non-mining stormwater point sources and nonpoint source urban/residential impervious land runoff in UNT/Mon River RM 99.49 (Popenoe Run, WV-M-11) and UNT/West Run RM 0.91 (WV-M-7-A). A landuse analysis determined that these two impaired streams had the highest percentages of watershed impervious surface represented in the model, with an estimated 53 percent and 46 percent, respectively. These streams drain small, highly urbanized watersheds located within portions of the Morgantown, WVU, and/or Star City areas. Water quality criteria exceedances were detected only during winter months and the impairments are attributed to runoff of salts used for deicing impervious surfaces. Wasteload allocations prescribing chloride reductions were assigned to MS4 and non-mining point sources and load allocations with reductions were assigned to urban/residential impervious nonpoint sources in those watersheds.

All nonpoint source runoff contains low level chloride concentrations and chloride loadings from groundwater are an additional background source. The influence of abandoned mine land sources upon chloride water quality was evaluated and such sources, inclusive of continuous flow seeps, were found to contribute negligible chloride loadings. Multiple land use types with varying chloride characteristics were represented as "background" sources throughout the watersheds of chloride impaired streams and were not reduced.

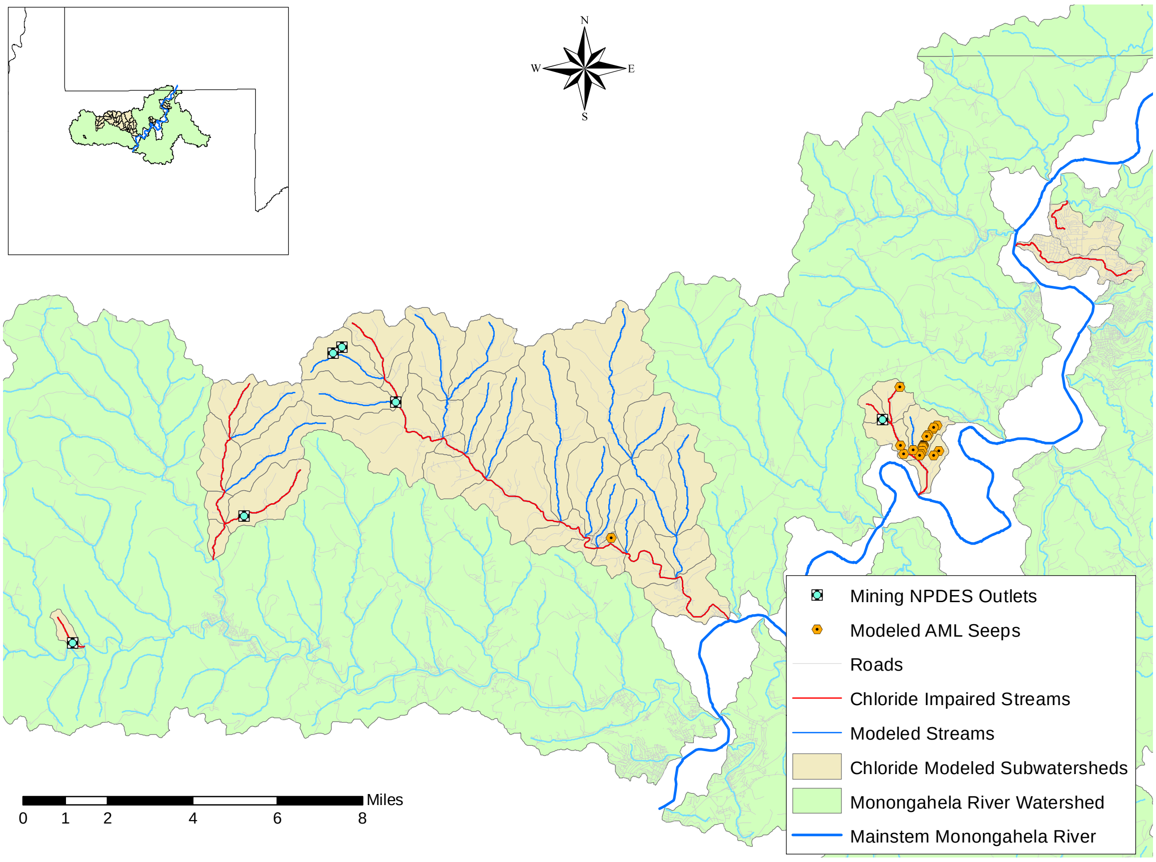


Figure 7-1. Chloride point sources in the Monongahela River Watershed

8.0 FECAL COLIFORM SOURCE ASSESSMENT

8.1 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 Monongahela River Watershed.

8.1.1 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 facilities with extensive wastewater collection systems, whereas private facilities are usually used in smaller applications such as subdivisions and shopping centers.

In the subject watersheds of this report, 3 individually permitted POTW discharges treated effluent at 3 outlets. Four mining bathhouse facilities discharge to TMDL streams in the Monongahela River TMDL watersheds. There are also 3 stormwater industrial permitted outlets with fecal coliform limits.

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.

8.1.2 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 55 CSO outlets associated with POTWs operated by the Town of Barrackville (12), Town of Farmington (1), City of Fairmont (10), Greater Paw Paw Sanitary District (8), the Morgantown Utility Board (23), and the City of Westover (1). No significant SSO discharges were represented in the model.

8.1.3 Municipal Separate Storm Sewer Systems (MS4)

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

MS4 entities and their areas of responsibility are described in **Section 5.1.4** and displayed in **Figure 5-3**. MS4 source representation is based upon precipitation and runoff from landuses determined from the modified NLCD 2006 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.

8.1.4 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, 33 facilities are registered under the “package plant” general permit and 358 are registered under the HAU general permit.

8.2 Fecal Coliform Nonpoint Sources

8.2.1 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 8,800 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 28 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 8-1** shows the failing septic flows represented in the model by subwatershed.

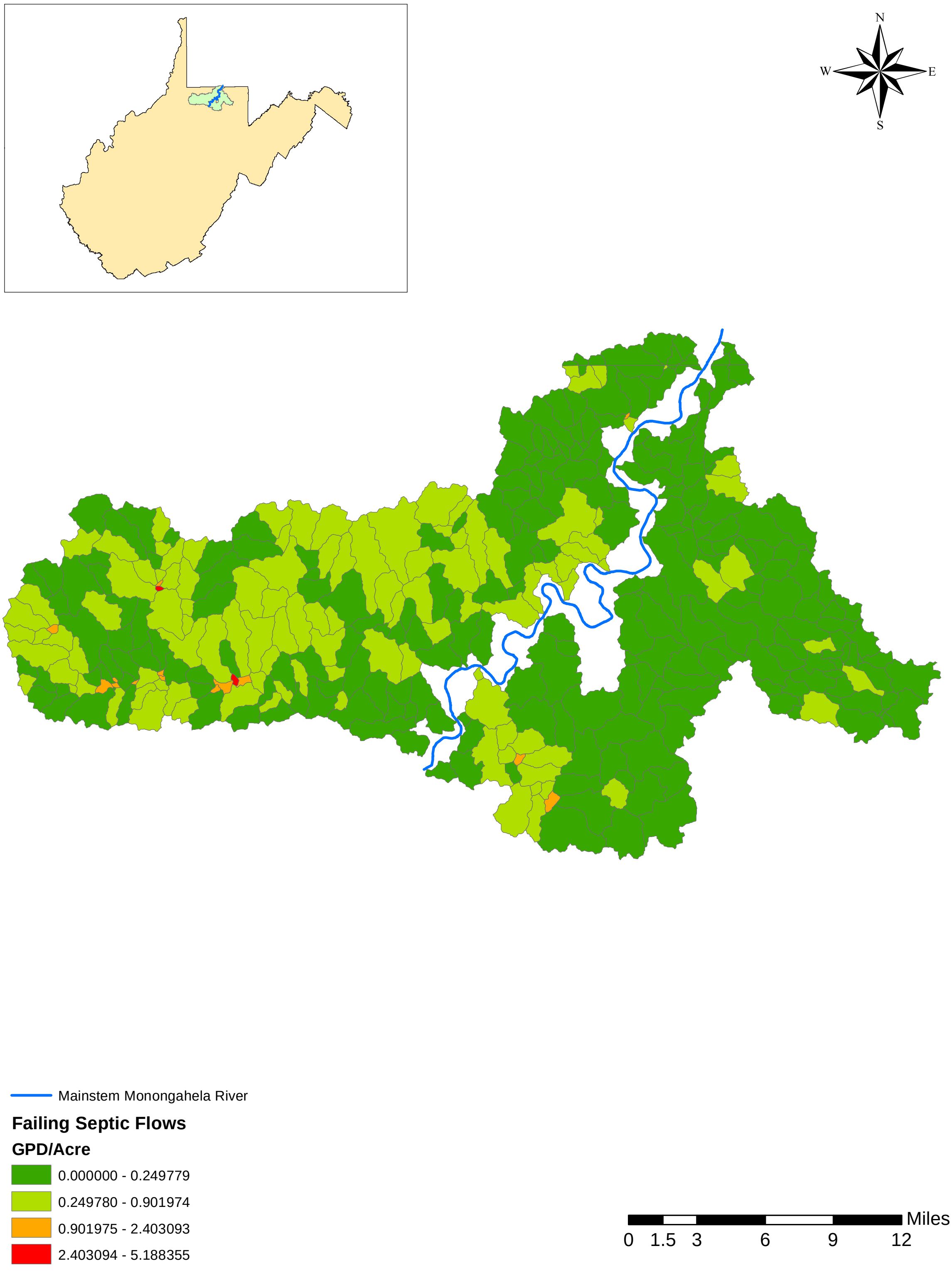


Figure 8-1. Failing septic flows in the Monongahela River Watershed

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.

8.2.2 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 2006 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.

8.2.3 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.

8.2.4 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.

9.0 DISSOLVED OXYGEN SOURCE ASSESSMENT

As noted in **Table 3-3**, a segment of Deckers Creek (WV-M-14) and Mod Run (WV-M-54-T) 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.

In addition to organic enrichment, altered hydrology contributes to reduced dissolved oxygen. The Deckers Creek dissolved oxygen impairment is limited to a 2 mile segment upstream of UNT/Deckers Creek RM 18.48 to pond outlet at RM 20.5. WVDEP's source tracking effort found that the stream in this segment is low gradient in a predominantly agricultural area. No point sources were identified upstream of the water monitoring station (MU-00076-18.7).

Dissolved oxygen impairment at Mod Run is most likely caused by failing septic systems. A large unsewered community is located at the mouth of the stream near the monitoring station. Pre-TMDL monitoring also documented extreme nonattainment with fecal coliform water quality criteria at this location and source tracking activities clearly identify the causative source of both impairments. Dissolved oxygen concentrations below 5 mg/L detected in monitoring data coincided with excessive amount of fecal coliform with maximum counts of 60,000/100 mL.

The actions typically used to reduce instream fecal coliform levels such as restrict stream access, adding streambank buffer zones, developing nutrient management plans and eliminating failing septic systems will reduce fecal coliform levels and increase dissolved oxygen levels. As such, the fecal coliform TMDL presented for Deckers Creek and Mod Run are an appropriate surrogate for the necessary dissolved oxygen TMDL.

Fecal coliform TMDLs are presented for Deckers Creek and Mod Run. Successful implementation of the 96.9 % fecal coliform reduction prescribed for agriculture in the Deckers Creek watershed (model subwatershed 2158) would necessitate installation of BMPs to cease releases of animal wastes to the stream, which, in turn, would result in attainment of the dissolved oxygen criterion. Likewise, implementation of 96.9% reductions in Mod Run watershed (model subwatershed 3639) for agriculture, in combination with 100% reduction of failing septic (model subwatershed 3637 and 3639) would result in attainment of the dissolved oxygen criterion in Mod Run. As such, the Deckers Creek and Mod Run fecal coliform TMDLs are an appropriate surrogate for the dissolved oxygen impairment. **Figure 9-1** shows the possible fecal coliform sources contributing to the dissolved oxygen impairments.

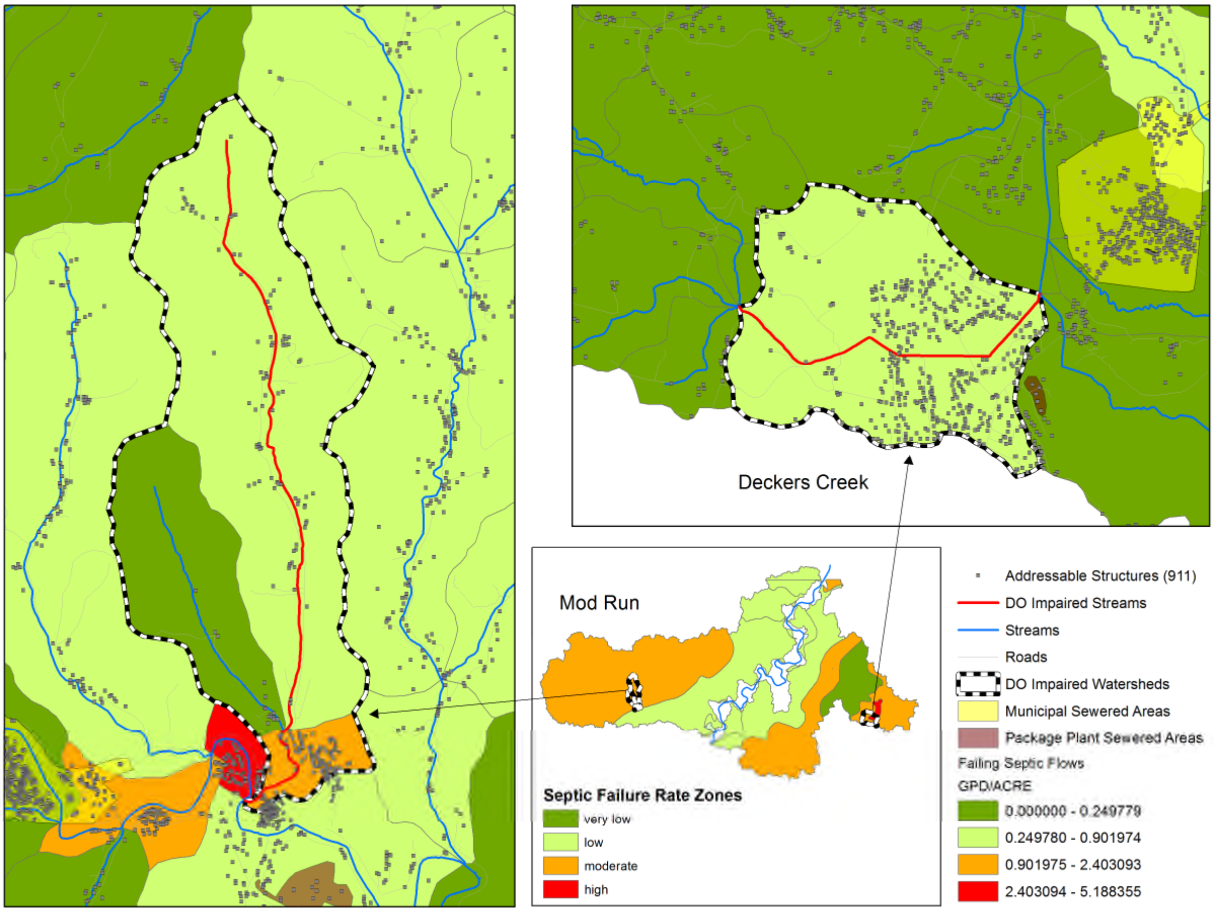


Figure 9-1. Location of dissolved oxygen impaired streams and contributing sources.

10.0 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 Monongahela River watershed.

10.1 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 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 metals and bacteria concentrations
- Metals and bacteria transport mechanisms are highly variable and often weather-dependent
- Selenium concentrations are largely dependent on mining activity and discharges during low-flow stream conditions have the largest impact
- Chloride concentrations are largely dependent on mining discharge practices (i.e. pumping) and discharges during low-flow stream conditions have the largest impact

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, selenium, dissolved oxygen, chloride, pH, manganese, and fecal coliform bacteria in West Virginia are presented in **Section 2.0**, **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 Monongahela 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 AML 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 Mining Data Analysis System (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, manganese, chloride, and fecal coliform bacteria were modeled using the MDAS.

10.2 Model Setup

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

10.2.1 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.

The 28 TMDL watersheds were broken into 370 separate subwatershed units, based on the groupings of impaired streams shown in **Figure 10-1**. 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.

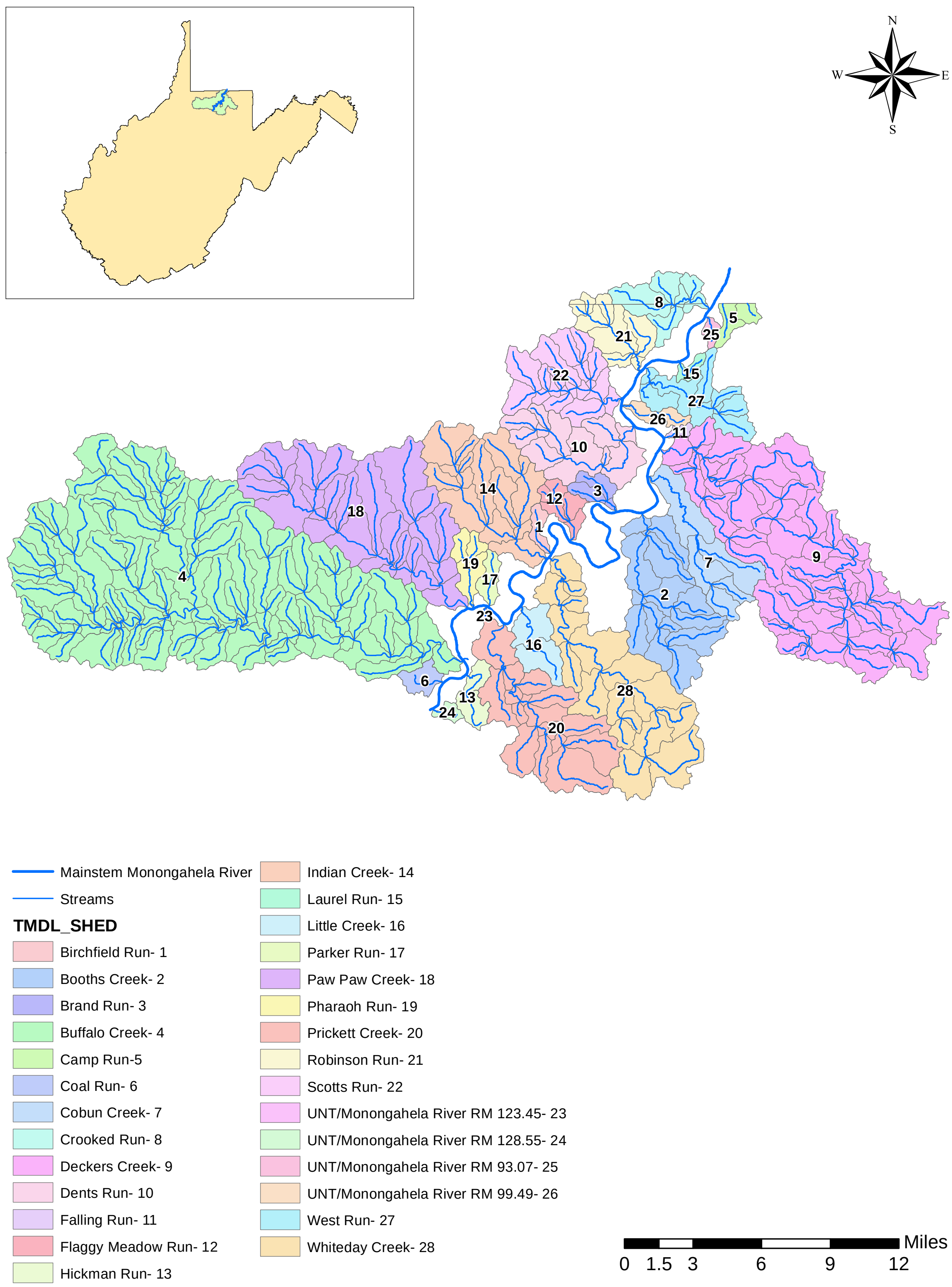


Figure 10-1. 28 TMDL watersheds and subwatershed delineation.

10.2.2 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 2006 landuse categories to create modeled landuse groupings. Several additional landuse categories were created to account for landuses either not included in the NLCD 2006 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. In addition, non-sediment related iron land-based sources were modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget. Other sources, such as AML seeps identified by WVDEP's source tracking efforts, and water treatment plants were modeled as direct, continuous-flow sources in the model. A regression analysis was performed to identify a relationship between stream flow and AML seep flow in subwatersheds where sufficient data were available. In addition, a separate regression analysis was performed to look for correlation between observed iron concentrations and AML seep flow. In certain subwatersheds where regression analysis predicted a strong correlation between seep flow and stream flow, AML seeps were represented in the model as a day-variable time series, with daily seep flow values mathematically derived from stream flow model output. Likewise, in certain subwatersheds where regression analysis predicted a strong correlation between iron concentration and seep flow, AML seeps were represented in the model as a day-variable time series, with daily iron concentration mathematically derived from stream flow model output.

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 10-2**). 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.

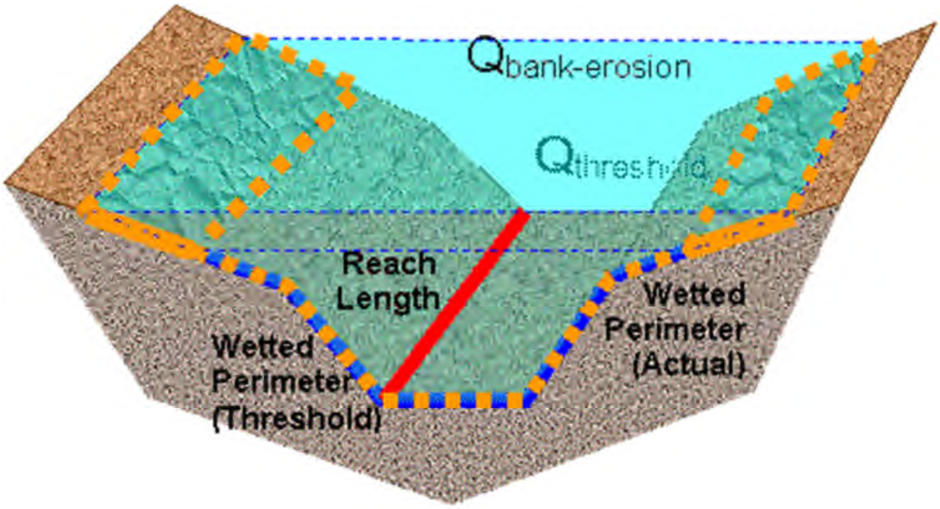


Figure 10-2. Conceptual diagram of stream channel components used in the bank erosion model

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. In order to understand the bank stability for the Monongahela River Watershed, the WVDEP conducted a bank erosion pin study. Observed data from the erosion pin study were processed to calculate the annual sediment loading from streambank erosion in the studied streams segments. Both quantitative and qualitative assessments indicated that vegetative coverage 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 bank vegetative cover was scored and each level was associated with a kber value.

The bank erosion component of the watershed model was then run using various kber values and the modeled loads were compared with the calculated loads from the pin study. Using the pin study streams as reference, the kber values were assigned to subwatersheds through a process that compared stream size, slope, and riparian condition as assessed through aerial photography.

The Technical Report provides more detailed discussions on the technical approaches used for sediment modeling, including the pin study.

10.2.3 Aluminum Manganese, and pH Configuration

To derive the dissolved aluminum and pH TMDLs, it was necessary to include additional MDAS modules capable of representing instream chemical reactions of several water quality components. MDAS 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, if selected by the user. The manganese component was configured in the model to simulate loadings from different non-point/point sources within a watershed. The model also simulates reactive transport of manganese within each modeled reach simulating chemical kinetics (precipitation/dissolution) and speciation. The model selection process, modeling methodologies, and technical approaches are discussed further in the Technical Report.

AML seeps were modeled as direct, continuous-flow sources in the model. AML and other land-based sources 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 directly represented in the direct loadings and land-based loadings in the model.

With the atmospheric deposition module, MDAS is able to model acidity loading from wet deposition. Wet deposition was represented similarly for land uses and included contributions for each of the major ionic species, including aluminum, iron, inorganic carbon, and pH. Concentrations for wet deposition were modeled using data obtained from the USEPA Office of Air Quality Planning and Standards at Research Triangle Park, North Carolina. The data are a result of air quality modeling in support of the CAIR.

Because of the complex chemical interactions that occur between dissolved metals and acidity, the TMDL approach focused on reducing metals concentrations, using the MDAS model previously described, to meet metals water quality criteria and then verifying that the resultant pH associated with the metals TMDL condition would be in compliance with pH criteria.

10.2.4 Chloride Configuration

Modeled landuse categories contributing chloride via surface runoff and groundwater recharge primarily include urban/residential areas and roads. These land-based sources were modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget. Initial loading rates were refined through calibration based upon pre-TMDL monitoring of streams that do not receive high chloride point source discharges. The point source discharges associated with mining activities were modeled as direct, continuous-flow sources in the model based upon available information obtained from the permitting database.

10.2.5 Fecal Coliform Configuration

Modeled landuse categories contributing bacteria via precipitation and runoff include pasture, cropland, urban/residential pervious lands, urban/residential impervious lands, grassland, forest, barren land, and wetlands. Other sources, such as failing septic systems, 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 8.2.1** describes the process of assigning flow and fecal coliform concentrations to failing septic systems.

10.3 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. USGS gauging station 03061500 Buffalo Creek at Barrackville, WV and USGS gauging station 03062500 Deckers Creek at Morgantown, WV both had adequate data records for hydrology calibration for the Monongahela River Watershed.

Hydrology calibration was based on observed data from that station and the landuses present in the watersheds from January 1, 2003 to October 31, 2006. 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, 2000 to September 30, 2010. 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 Monongahela River Watershed. A detailed description of the hydrology calibration and a summary of the results and validation are presented in the Technical Report.

10.4 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 10-3**.

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.

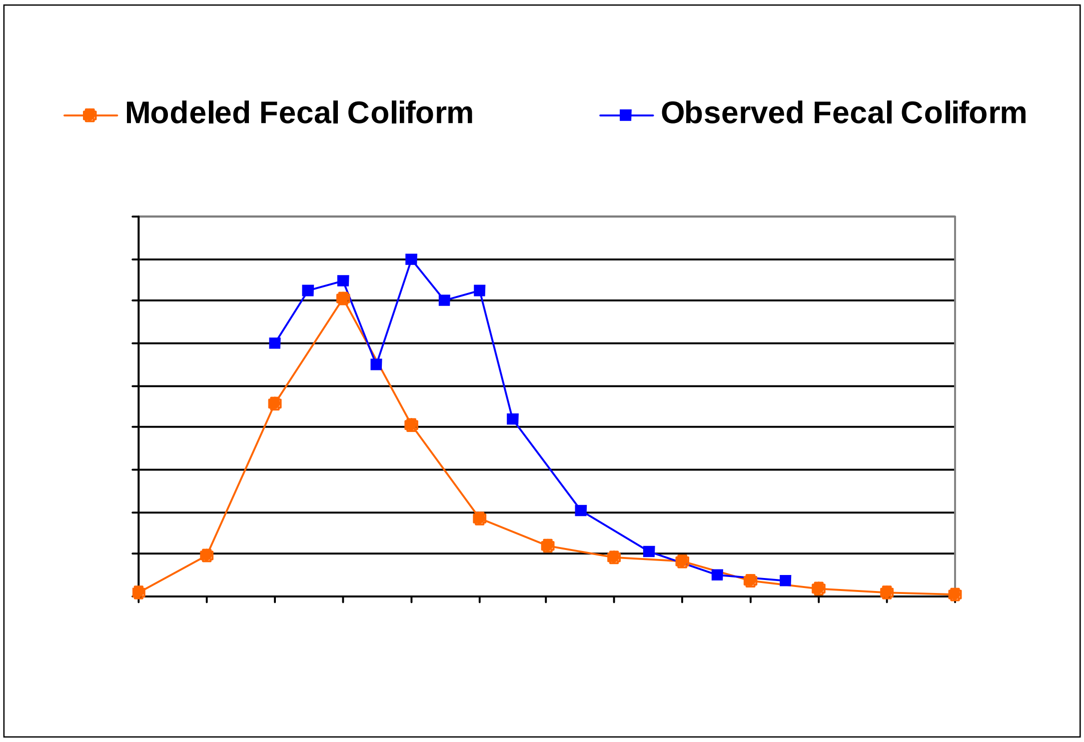


Figure 10-3. Shrewsbury Hollow fecal coliform observed data

10.5 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 a non-impacted watershed that shares similar landuse, ecoregion, and geomorphologic characteristics with the impacted watershed. The normalized loading associated with the reference stream is assumed to represent the conditions needed to resolve sedimentation stress in impacted streams. Given these parameters and a WVSCI score greater than 68.0 Little Paw Paw Creek (WV-M-49-D) was selected as the reference watershed. The location of the reference watershed is shown in **Figure 4-2**.

All of the sediment impacted streams exhibited impairments pursuant to total iron water quality criteria. 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. For affected streams, **Table 10-1** contrasts the sediment reductions necessary to attain iron criteria with those needed to resolve sedimentation stress under the reference watershed approach. Please refer to the Technical Report for details regarding the reference watershed approach.

Table 10-1. Sediment loadings using different modeling approaches

Stream Name	Stream Code	Allocated Sediment Load Iron TMDL (tons/yr)	Allocated Sediment Load Reference Approach (tons/yr)
Aaron Creek	WV-M-14-B	79.96	230.45
Bartholomew Fork	WV-M-54-AK	90.62	266.33
Buffalo Creek	M-54	1512.17	4008.82
Campbell Run	WV-M-54-X-9	55.39	149.41
Deckers Creek	WV-M-14	787.44	2026.96
Dents Run	WV-M-12	177.83	459.11
Dents Run	WV-M-54-Z	81.91	233.75
Flaggy Meadow Run	WV-M-54-W	26.42	78.62
Flat Run	WV-M-54-X-3	95.01	263.51
Hickman Run	WV-M-55	27.11	86.88
Joes Run	WV-M-54-AC	8.53	27.53
Little Creek	WV-M-42	52.39	164.39
Llewellyn Run	WV-M-54-X-3-A	17.02	60.14
Mahan Run	WV-M-54-U	26.57	85.23
Mod Run	WV-M-54-T	36.44	107.81
Owen Davy Fork	WV-M-54-AI	67.04	181.98
Paw Paw Creek	WV-M-49	481.03	1357.19
Prickett Creek	WV-M-44	270.67	782.12
Pyles Fork	WV-M-54-X	354.36	959.04
Robinson Run	WV-M-8	60.61	237.34
Scratchers Run	WV-M-44-H	23.18	76.03
Sugar Run	WV-M-49-W	16.12	52.38
UNT/Bethel Run RM 0.80	WV-M-54-I-1-A	14.71	41.67
UNT/Crooked Run RM 2.27	WV-M-2-B	14.01	42.64

Stream Name	Stream Code	Allocated Sediment Load Iron TMDL (tons/yr)	Allocated Sediment Load Reference Approach (tons/yr)
UNT/Deckers Creek RM 5.70	WV-M-14-E	20.02	60.16
UNT/Finchs Run RM 1.15	WV-M-54-D-2	8.51	32.46
UNT/Monongahela River RM 128.55	WV-M-57	7.35	23.44
Whetstone Run	WV-M-54-AA	28.85	90.31

10.6 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

10.6.1 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 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 included in selenium TMDLs because little modeling uncertainly exists. Non-attainment is directly related to point sources regulated by WV/NPDES permits and water quality will be met at all locations if point sources achieve prescribed WLAs.

The allocation process prescribes criterion end of pipe WLAs for continuous discharges and instream treatment structures and thereby provides an implicit MOS for criterion attainment at all model assessment locations. Similarly, an explicit MOS was not applied for total iron and chloride TMDLs in certain subwatersheds where mining point sources create an effluent dominated scenario and/or the regulated mining activity encompasses a large percentage of the watershed area. Within these scenarios, WLAs are established at the value of the criteria and little uncertainty is associated with the source/water quality linkage. The TMDL endpoints for the various criteria are displayed in **Table 10-2**.

Table 10-2. 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)
Total Iron	Aquatic Life, troutwaters	1.0 mg/L (4-day average)	0.95 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)
Dissolved Aluminum	Aquatic Life, troutwaters	0.087 mg/L (4-day average)	0.0827 mg/L (4-day average)
Chloride	Aquatic Life	230 mg/L (4-day average)	218.5 mg/L (4-day average)
Total Manganese	Public Water Supply	1.0 mg/L (within 5 upstream miles of a public water intake)	0.95 mg/L
Selenium	Aquatic Life	0.005 mg/L (4-day average)	0.005 mg/L (4-day average)
pH	Aquatic Life	6.00 Standard Units (Minimum)	6.02 Standard Units (Minimum)
Fecal Coliform	Water Contact Recreation and Public Water Supply	200 counts / 100 mL (Monthly Geometric Mean)	190 counts / 100 mL (Monthly Geometric Mean)
Fecal Coliform	Water Contact Recreation and Public Water Supply	400 counts / 100 mL (Daily, 10% exceedance)	380 counts / 100 mL (Daily, 10% exceedance)

With the exception of selenium, 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.

Because the selenium impairments have been attributed to point source discharges and low flow critical conditions, the TMDLs are presented as an equation for the maximum daily load that is variable with receiving stream flow.

10.6.2 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, 2004 through December 31, 2009). 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 10-4** presents the annual rainfall totals for the years 1999 through 2010 at the Morgantown Hart Field (WBAN 13736) weather station in West Virginia. The years 2004 to 2009 are highlighted to indicate the range of precipitation conditions used for TMDL development in the Monongahela River Watershed.

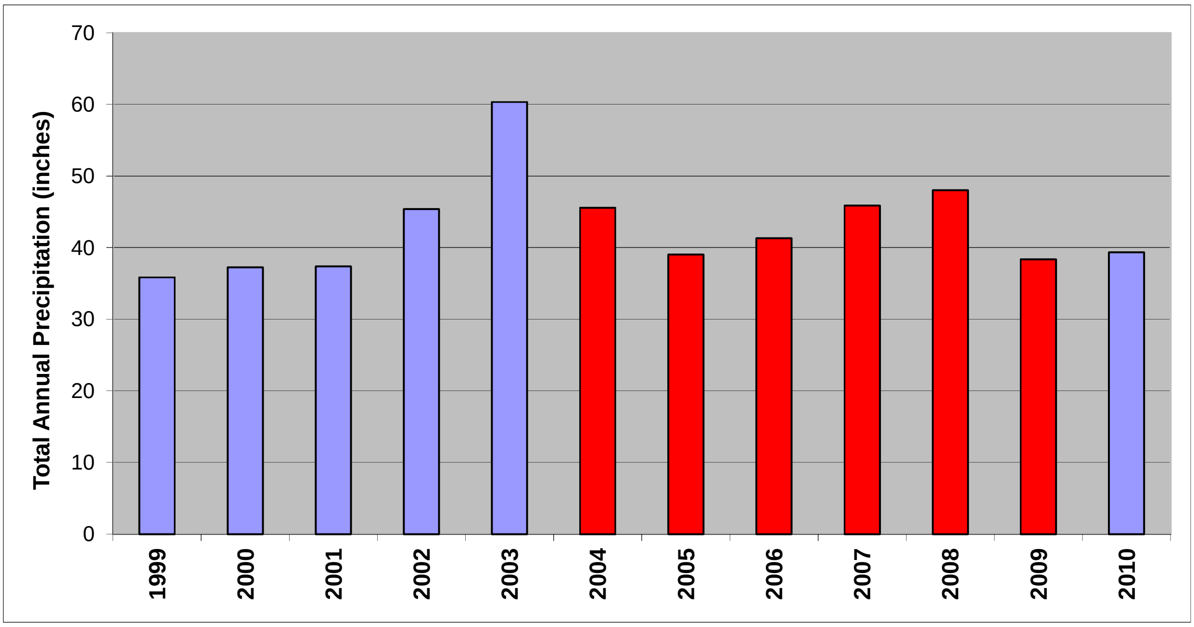


Figure 10-4. Annual precipitation totals for the Morgantown Hart Field (WBAN 13736) weather station

The metals and chloride concentrations associated with common effluent limitations in mining NPDES permits are presented in **Table 10-3**. 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 or water quality based concentrations in **Table 10-3**, as applicable to each permit. The concentrations displayed in **Table 10-3** 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, some existing permits contain interim effluent limits that are water quality based and reflect achieving water quality criteria end-of-pipe (WLA = 0.75 mg/l), However, 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 equal to the concentration used in calibration (1.45 mg/l). Similarly for chloride, existing discharges are not necessarily compliant with existing water quality based effluent limitations and baseline concentrations were equal to discharge-specific calibration concentrations.

Table 10-3. Concentrations used in representing baseline conditions for active mining

Pollutant	Technology-based Permits	Water Quality-based Permits
Aluminum, total	NA	1.45 mg/L
Iron, total	3.2 mg/L	1.5 mg/L
Chloride	NA	230 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, a range of 0.5 to 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.

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. 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 10-5 shows an example of model output for a baseline condition and a successful TMDL scenario.

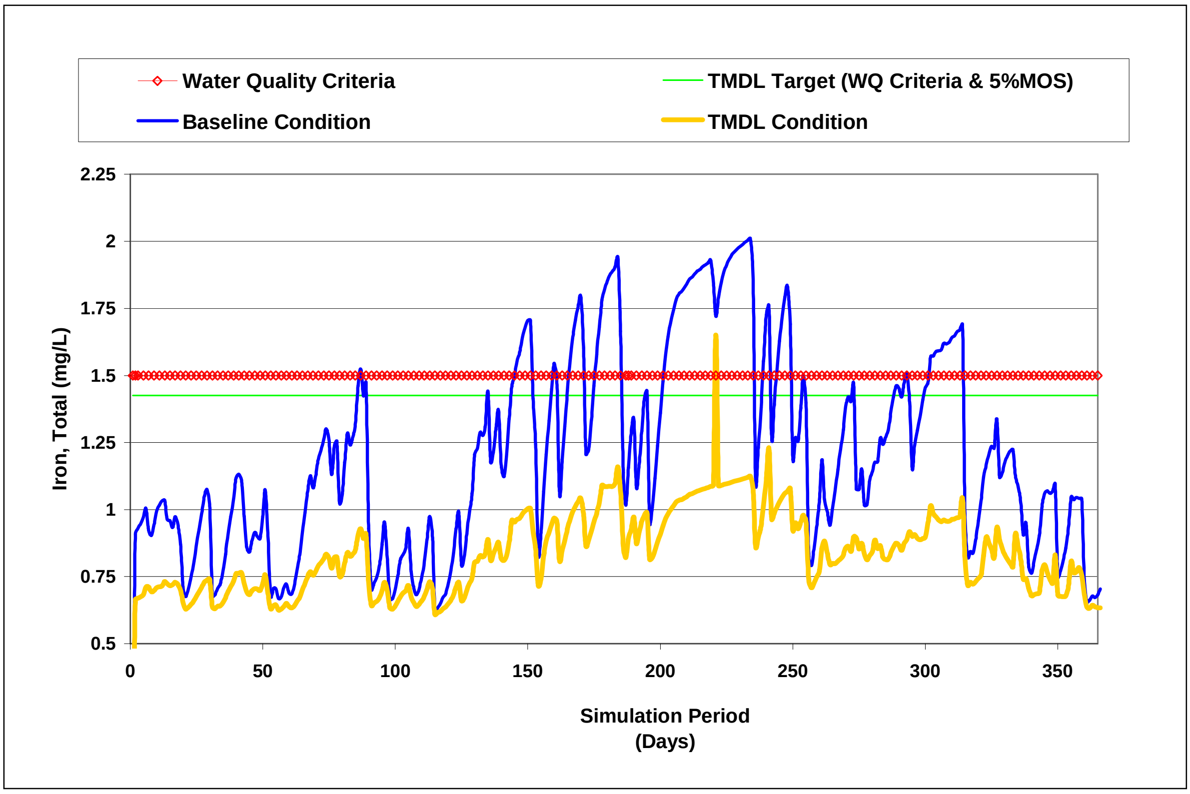


Figure 10-5. Example of baseline and TMDL conditions for total iron

10.6.3 Revised Troutwater Iron Criterion and TMDL Approach

In the 2011 Water Quality Standards triennial review process, WVDEP proposed revision of the iron troutwater criterion to 1.0 mg/L, 4-day average, once per three years average exceedance frequency. The revision was based upon scientific studies and was approved by the West Virginia Legislature. USEPA approved the revision on January 13, 2013 and the new criterion is now effective for Clean Water Act purposes. The iron TMDLs presented for impaired troutwaters are based upon the revised criterion with an explicit 5% MOS.

10.7 TMDLs and Source Allocations

10.7.1 Total Iron TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the iron impaired streams of the Monongahela 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, as determined by the bank erosion pin study.

2. The following land disturbing sources were equitably reduced to the iron loading associated with 100 mg/L TSS.
   - Abandoned mine lands
   - Barren
   - Cropland
   - Pasture
   - Urban/MS4 Pervious
   - Oil and gas
   - Harvested Forest and Skid Roads
   - Burned Forest
   - Unpaved Roads
3. AML seeps were reduced to water quality criterion end of pipe (1.5 mg/L iron).
4. Traditional mining permits were reduced to water quality criterion end of pipe (1.5 mg/L iron) in watershed when the model indicated non-attainment.

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. Initially, 2.5 percent of the subwatershed area was allocated for CSGP activity in each subwatershed.

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, further reductions to CSGP activity area allowances or iron loading from land disturbing sources were made on a subwatershed basis depending on land cover, concentration of sediment associated iron, and dominant disturbances. The CSGP activity area allowances for subwatersheds contributing to non-attaining downstream subwatersheds were incrementally reduced from 2.5 percent to 0.5 percent area allowances. The iron loads from the dominant source were incrementally reduced below the associated 100 mg/l TSS threshold, but not less than 70 mg/l TSS.

After executing the reductions to iron loads from dominant sources, the model continued to indicate non-attainment at the pour points of a limited number of subwatersheds. In those subwatersheds, further reductions were made to the CSGP activity area allowance to zero percent.

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
Baseline iron conditions for bond forfeiture sites were established at the technology based effluent limits of 40 CFR 434 and reduced as necessary to attain the TMDL endpoints. Based upon West Virginia Highlands Conservancy, Inc, et al v. WVDEP, WLAs were established for bond forfeiture sites.

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 Monongahela there are eight 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
- Fairmont State University WVR030045
- Town of Star City WVR030023
- City of Westover WVR030022
- Morgantown Utility Board WVR030030
- Federal Correctional Institution – Morgantown WVR030012
- West Virginia University WVR030042
- 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 10.6.2**. An allocation of 0.0 to 2.5 percent of 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 12**.

Load Allocations (LAs)

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

- AML: loading from abandoned mine lands, including loads from disturbed land, 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)

10.7.2 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 Monongahela River Watershed. Substantive sources (e.g., seeps) of total iron were reduced as described in Section 10.7.1 because existing instream dissolved iron concentrations can significantly reduce pH during precipitation processes. Reduced pH could result in re-dissolution of aluminum minerals (e.g. amorphous aluminum oxides) and could affect instream dissolved aluminum concentrations. During the iron reduction process, the model retained information regarding the phases of total iron, metal acidity, and added alkalinity, that was then linked to dissolved aluminum and pH simulations. If model results predicted non-attainment of the pH and dissolved aluminum criteria, additional reductions were potentially made to total iron, simultaneously with alkalinity additions and total aluminum reductions to source water discharges. Iron reductions for the aluminum/pH model were developed from the baseline scenario for the iron TMDL model, and were the same as the final allocations of the iron TMDL. The following methodology was used to predict necessary alkalinity additions and total aluminum reductions in the model simulation:

- Multiple regressions derived from the observed metal data collected above pH 6.5 in pre-TMDL monitoring were used to estimate realistic dissolved aluminum concentrations associated with the improved source water pH and reduced total aluminum conditions.
- Once the improved pH and the reduced total aluminum concentrations (particulate and dissolved) were determined, the required alkalinity necessary to achieve the improved water quality conditions were quantified and added to the source water discharges. These additions were made throughout the modeling period to simulate instream water quality conditions based on the improved source water loads.
- If the model predicted non-attainment, further total aluminum reduction and/or alkalinity additions were made to source water discharges on a subwatershed basis to the extent necessary to attain dissolved aluminum and pH water quality criteria instream.

All sources were represented and provided allocations in terms of the total aluminum loadings that are necessary to attain the dissolved aluminum water quality criteria. The reductions of total aluminum loading from land-based sources, coupled with the mitigation of acid loading by alkalinity addition, 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. A WLA is provided for five bond forfeiture site with unreclaimed land disturbance and unresolved water quality impacts. The WLAs for active mining operations and bond forfeiture sites 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.

Baseline loadings from non-mining point sources, including facilities registered under the Multi-sector Stormwater, 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 disturbed land, highwalls, deep mine discharges and seeps
- Other nonpoint sources: loading associated with sediment contributions from barren land, harvested forest, oil and gas well operations, agriculture, undisturbed forest and grasslands, and residential/urban/road landuses were represented but not reduced

Baseline and TMDL load allocations (LAs) include the natural background sources of alkalinity from carbonate geologic formations. The additional acidity reduction (alkalinity addition) required to meet pH water quality criterion are presented in the TMDL load allocations for the pH impaired streams.

10.7.3 Total Manganese TMDL

As described previously, the top-down methodology was followed to allocate loads to sources and develop the manganese TMDL. In the watershed of manganese impaired Brand Run, only sources within the AML nonpoint source category contribute significant loadings. Reductions of those sources allowed the manganese water quality endpoint to be met. Loadings from other sources were represented but not reduced in the allocation process. Where present, WLAs were developed for bond forfeiture sites and LAs were developed for all other sources.

10.7.4 Fecal Coliform Bacteria TMDLs

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

- The effluents from all NPDES permitted sewage treatment plants were set at the permit limit (200 counts/100 mL monthly geometric mean)
- Because West Virginia Bureau for Public Health regulations prohibit the discharge of raw sewage into surface waters, all illicit discharges of human waste (from failing septic systems and straight pipes) were reduced by 100 percent in the model
- All CSO discharges were assigned WLAs at the value of the fecal coliform water quality criterion (200 counts/100ml).
- 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 55 CSO outlets associated with POTWs operated by the municipalities or sanitary districts listed below (**Table 10-4**). 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 10-4. Combined sewer overflows in the Monongahela River Watershed

City	Modeled Sub-watershed	Receiving Stream	Receiving Stream Code	Permit ID	Outlet
Farmington	3624	Buffalo Creek	WV-M-54	WV0021865	C003
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C002
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C002A
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C003
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C003A
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C004
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C004A
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C005
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C005A
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C006
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C007
Morgantown	2102	Hartman Run	WV-M-14-A	WV0023124	C009
Morgantown	2102	Hartman Run	WV-M-14-A	WV0023124	C009A
Morgantown	2103	Deckers Creek	WV-M-14	WV0023124	C010
Morgantown	2111	Deckers Creek	WV-M-14	WV0023124	C011
Morgantown	2112	Knocking Run	WV-M-14-C	WV0023124	C012
Morgantown	2113	Deckers Creek	WV-M-14	WV0023124	C013
Morgantown	2113	Deckers Creek	WV-M-14	WV0023124	C014
Morgantown	2113	Deckers Creek	WV-M-14	WV0023124	C015
Morgantown	1801	UNT/Monongahela River RM 99.49 (Popenoe Run)	WV-M-11	WV0023124	C029
Morgantown	1502	UNT/West Run RM 0.91	WV-M-7-A	WV0023124	C034
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C035
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C037
Morgantown	2101	Deckers Creek	WV-M-14	WV0023124	C038
Fairmont	3901	Coal Run	WV-M-56	WV0023353	C016
Fairmont	3901	Coal Run	WV-M-56	WV0023353	C017
Fairmont	3601	Buffalo Creek	WV-M-54	WV0023353	C023
Fairmont	3601	Buffalo Creek	WV-M-54	WV0023353	C024
Fairmont	3801	Hickman Run	WV-M-55	WV0023353	C031

City	Modeled Sub-watershed	Receiving Stream	Receiving Stream Code	Permit ID	Outlet
Fairmont	3801	Hickman Run	WV-M-55	WV0023353	C032
Fairmont	3901	Coal Run	WV-M-56	WV0023353	C034
Fairmont	3801	Hickman Run	WV-M-55	WV0023353	C038
Fairmont	3601	Buffalo Creek	WV-M-54	WV0023353	C041
Fairmont	3901	Coal Run	WV-M-56	WV0023353	C042
Westover	1901	Dents Run	WV-M-12	WV0024449	C006
Barrackville	3604	Buffalo Creek	WV-M-54	WV0081434	C001
Barrackville	3604	Buffalo Creek	WV-M-54	WV0081434	C003
Barrackville	3608	Buffalo Creek	WV-M-54	WV0081434	C004
Barrackville	3608	Buffalo Creek	WV-M-54	WV0081434	C005
Barrackville	3608	Buffalo Creek	WV-M-54	WV0081434	C006
Barrackville	3608	Buffalo Creek	WV-M-54	WV0081434	C007
Barrackville	3608	Buffalo Creek	WV-M-54	WV0081434	C008
Barrackville	3608	Buffalo Creek	WV-M-54	WV0081434	C009
Barrackville	3604	Buffalo Creek	WV-M-54	WV0081434	C010
Barrackville	3608	Buffalo Creek	WV-M-54	WV0081434	C011
Barrackville	3604	Buffalo Creek	WV-M-54	WV0081434	C012
Barrackville	3604	Buffalo Creek	WV-M-54	WV0081434	C013
Greater Paw Paw	3420	Bennefield Prong	WV-M-49-R	WV0084310	C003
Greater Paw Paw	3420	Bennefield Prong	WV-M-49-R	WV0084310	C004
Greater Paw Paw	3420	Bennefield Prong	WV-M-49-R	WV0084310	C005
Greater Paw Paw	3419	Paw Paw Creek	WV-M-49	WV0084310	C006
Greater Paw Paw	3419	Paw Paw Creek	WV-M-49	WV0084310	C007
Greater Paw Paw	3401	Paw Paw Creek	WV-M-49	WV0084310	C008
Greater Paw Paw	3409	Paw Paw Creek	WV-M-49	WV0084310	C011
Greater Paw Paw	3419	Paw Paw Creek	WV-M-49	WV0084310	C012

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 47CSR2-5.2.c., 47CSR2-5.2.g., and 47CSR2-5.2.h.3. More directly, 47CSR2-5.2.c prohibits mixing zones for all human health criteria in streams with seven (7) day, ten (10) year return frequency flow of 5 cfs or less. All of the receiving streams for existing CSO discharges in this project have 7Q10 flows less than 5 cfs.

Since 47CSR2-5.2.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. 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. The analysis demonstrated nonattainment at multiple modeled locations when CSO were modestly increased above 200 counts/100ml.

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, Fairmont State University, Town of Star City, City of Westover, Morgantown Utility Board, Federal Correctional Institution – Morgantown, and West Virginia University, 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)

10.7.5 Chloride TMDLs

The top-down methodology was followed to develop the chloride TMDLs and allocate loads to sources. Source allocations were developed for all modeled subwatersheds contributing to the chloride impaired streams in the watershed.

Wasteload Allocations (WLAs)

Individual chloride WLAs were developed for the high-volume, pumped discharge, mining NPDES outlets. The pumped discharges dominate receiving stream flow and necessitate WLAs that are based upon the achievement of the chronic aquatic life protection criterion in the discharge.

Within the watersheds of UNT/Mon River RM 99.49 (Popenoe Run, WV-M-11) and UNT/West Run RM 0.91 (WV-M-7-A), grouped WLAs were developed for MS4 sources and facilities registered under the Multi-Sector Stormwater General Permit. The WLAs prescribe chloride reductions for impervious areas.

The WLAs for MS4 sources do not include the influences of the small drainage areas of existing facilities registered under the Multi-sector Stormwater General Permit. The chloride loading of areas associated with the multi-sector permit was represented in the same manner as the MS4 land uses but were differentiated under the presumption that they do not drain to the MS4s and are not subject to MS4 control.

No other point sources of chloride were identified within the watersheds of chloride impaired streams. Certain land uses generally associated with point sources (ex. registered area under the Construction Stormwater General Permit, precipitation-induced mining outlets) were not classified as chloride point sources because they do not contribute chloride appreciably greater than background. Their modeled loadings are contained within the aggregated load allocation for background sources discussed in the following section.

Load Allocations (LAs)

Chloride loadings are represented for multiple nonpoint and background sources and source categories.

Exclusive of runoff from urban/residential impervious surfaces, precipitation- induced nonpoint sources are not characterized as chloride sources because they do not contribute chloride significantly greater than expected background. Continuous flow AML seeps were also found to contribute negligible chloride loadings. The modeled chloride loadings for all “background” sources are contained within the aggregated LA for Background and Other Nonpoint Sources”.

Road and impervious surface de-icing activities contribute non-negligible chloride loads to receiving waters and LAs are presented for the non-MS4 urban residential impervious land use. Chloride reduction is not associated with the urban residential impervious LAs except in UNT/West Run RM 0.91 where reductions are consistent with those prescribed for MS4 areas in that watershed. Elsewhere, point source reduction will result in criteria attainment with nonpoint source loading at baseline conditions.

10.7.6 Selenium TMDLs

The TMDL approach simply calculates the assimilative capacity for selenium available at the mouth of Arnett Run at 7Q10 flow, and prescribes WLAs for contributing point sources that are based upon the achievement of the chronic aquatic life protection criterion in the discharge.

The upper half of the Arnett Run watershed has been mined and an instream pond remains. The pond discharge was previously regulated under closed WV/NPDES Permit No.WV1017489 (outlet 001). The pond transmits drainage from the entire upstream watershed area. Monitoring conducted during source tracking activities measured a 0.0046 mg/l selenium concentration at this location. As such, there is little assimilative capacity available for downstream discharges.

Selenium concentrations higher than the criterion were measured in the active permitted downstream discharges (WV0004537) that received WLAs. The achievement of WLAs for those discharges will result in criterion attainment at critical low flow conditions and also during higher flow regimes.

10.7.7 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 metals, chloride and fecal coliform 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.

10.7.8 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, failing on-site sewage systems and AML seeps (both 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.

In six of the eight chloride-impaired waters, pumped point source discharges associated with mining activity were determined to be the causative source of impairments.Because of the minimal dilution available at 7Q10, this low-flow condition was determined critical. In the other two streams, precipitation induced conditions during winter were determined critical.

10.7.9 TMDL Presentation

The TMDLs for all impairments are shown in **Section 11** of this report. The TMDLs for iron chloride, manganese, 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. The TMDLs for selenium are presented as a flow based formula. 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, chloride, manganese, 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 selenium WLAs for active mining operations in the watershed are presented as concentrations that 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 fecal coliform bacteria WLAs for sewage treatment plant effluents and CSOs for 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, Cl) 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. The "MS4 WLA Summary" tab of the chloride spreadsheet prescribes grouped allocations for all contributing MS4 entities in each subwatershed. 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.

11.0 TMDL RESULTS

Table 11-1. Dissolved aluminum TMDLs

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	WLA (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Camp Run	WV-M-1	Camp Run	Aluminum	6.34	0.460	0.36	7.16
Camp Run	WV-M-1-A	UNT/Camp Run RM 0.79	Aluminum	1.35	0.000	0.07	1.43
Crooked Run	WV-M-2	Crooked Run	Aluminum	3.28	0.050	0.18	3.50
UNT/Monongahela River RM 93.07	WV-M-3	UNT/Monongahela River RM 93.07	Aluminum	0.93	0.004	0.05	0.99
West Run	WV-M-7	West Run	Aluminum	7.78	2.615	0.55	10.94
West Run	WV-M-7-D	UNT/West Run RM 3.79	Aluminum	1.44	0.282	0.09	1.81
Robinson Run	WV-M-8-A	Crafts Run	Aluminum	2.61	13.783	0.86	17.26
Robinson Run	WV-M-8-B	UNT/Robinson Run RM 1.09	Aluminum	0.70	0.000	0.04	0.73
Dents Run	WV-M-12-C	UNT/Dents Run RM 3.60	Aluminum	2.70	0.000	0.14	2.84
Deckers Creek	WV-M-14-P	Glady Run	Aluminum	0.51	0.002	0.03	0.54
Deckers Creek	WV-M-14-R	Slabcamp Run	Aluminum	1.10	0.000	0.06	1.16
Deckers Creek	WV-M-14-S	Dillan Creek	Aluminum	6.59	0.030	0.35	6.96
Deckers Creek	WV-M-14-T	Laurel Run/Deckers Creek	Aluminum	22.84	0.003	1.20	24.04
Deckers Creek	WV-M-14-V	Kanes Creek	Aluminum	4.71	0.333	0.27	5.31
Deckers Creek	WV-M-14-V-0.9	UNT/Kanes Creek RM 2.36	Aluminum	0.21	0.000	0.01	0.22
Deckers Creek	WV-M-14-V-1	UNT/Kanes Creek RM 2.49	Aluminum	0.79	0.031	0.04	0.87
Booths Creek	WV-M-17	Booths Creek	Aluminum	15.59	10.512	1.37	27.48
Booths Creek	WV-M-17-G	Owl Creek	Aluminum	3.94	2.488	0.34	6.77
Booths Creek	WV-M-17-H	Mays Run	Aluminum	1.57	3.130	0.25	4.95
Booths Creek	WV-M-17-I	UNT/Booths Creek RM 6.27	Aluminum	0.34	0.000	0.02	0.35
Brand Run	WV-M-20	Brand Run	Aluminum	8.44	0.075	0.45	8.97
Birchfield Run	WV-M-31	Birchfield Run	Aluminum	0.99	0.198	0.06	1.25
Parker Run	WV-M-45	Parker Run	Aluminum	0.94	0.000	0.05	0.98

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	WLA (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
UNT/Monongahela River RM 123.45	WV-M-46	UNT/Monongahela River RM 123.45	Aluminum	1.00	0.006	0.05	1.06

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

Table 11-2. Manganese TMDLs

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Brand Run	WV-M-20	Brand Run	Manganese	6.38	1.45	0.41	8.25

Table 11-3. Iron TMDLs

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Camp Run	WV-M-1	Camp Run	Iron	13.33	0.67	0.74	14.74
Camp Run	WV-M-1-A	UNT/Camp Run RM 0.79	Iron	4.35	0.46	0.25	5.06
Crooked Run	WV-M-2	Crooked Run	Iron	30.85	2.79	1.77	35.40
Crooked Run	WV-M-2-B	UNT/Crooked Run RM 2.27	Iron	3.10	0.43	0.19	3.71
UNT/Monongahela River RM 93.07	WV-M-3	UNT/Monongahela River RM 93.07	Iron	2.58	0.30	0.15	3.04
Laurel Run	WV-M-5	Laurel Run	Iron	2.00	0.60	0.14	2.74
West Run	WV-M-7	West Run	Iron	55.84	28.08	4.42	88.34
West Run	WV-M-7-A	UNT/West Run RM 0.91	Iron	0.96	9.40	0.55	10.91
West Run	WV-M-7-D	UNT/West Run RM 3.79	Iron	4.94	2.93	0.41	8.29
West Run	WV-M-7-F	UNT/West Run RM 4.84	Iron	3.23	1.01	0.22	4.46
West Run	WV-M-7-G	UNT/West Run RM 5.19	Iron	5.11	1.31	0.34	6.76
Robinson Run	WV-M-8	Robinson Run	Iron	43.79	49.96	4.93	98.68

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Robinson Run	WV-M-8-A	Crafts Run	Iron	6.53	14.40	1.10	22.04
Robinson Run	WV-M-8-B	UNT/Robinson Run RM 1.09	Iron	2.64	0.15	0.15	2.94
Robinson Run	WV-M-8-E	UNT/Robinson Run RM 2.91	Iron	2.86	1.01	0.20	4.08
Robinson Run	WV-M-8-F	UNT/Robinson Run RM 4.09	Iron	0.39	16.60	0.89	17.88
Scotts Run	WV-M-10	Scotts Run	Iron	87.85	38.42	6.65	132.91
Scotts Run	WV-M-10-A	UNT/Scotts Run RM 1.36	Iron	3.10	6.66	0.51	10.27
Scotts Run	WV-M-10-C	Wades Run	Iron	15.54	7.28	1.20	24.02
Scotts Run	WV-M-10-C-1	UNT/Wades Run RM 0.49	Iron	5.56	0.19	0.30	6.06
Scotts Run	WV-M-10-C-2	UNT/Wades Run RM 1.34	Iron	3.44	1.17	0.24	4.85
Scotts Run	WV-M-10-D	Guston Run	Iron	7.81	3.41	0.59	11.82
Scotts Run	WV-M-10-E	UNT/Scotts Run RM 3.23	Iron	0.52	6.69	0.38	7.58
Scotts Run	WV-M-10-F	UNT/Scotts Run RM 3.58	Iron	0.35	2.87	0.17	3.40
Scotts Run	WV-M-10-G	UNT/Scotts Run RM 4.17	Iron	0.52	5.05	0.29	5.86
Scotts Run	WV-M-10-H	UNT/Scotts Run RM 4.79	Iron	6.08	0.50	0.35	6.94
Dents Run	WV-M-12	Dents Run	Iron	47.79	23.13	3.73	74.65
Dents Run	WV-M-12-C	UNT/Dents Run RM 3.60	Iron	1.73	0.09	0.10	1.91
Dents Run	WV-M-12-H	UNT/Dents Run RM 5.82	Iron	4.44	0.48	0.26	5.18
Dents Run	WV-M-12-K	UNT/Dents Run RM 7.26	Iron	1.11	2.40	0.18	3.69
Deckers Creek	WV-M-14	Deckers Creek	Iron	428.48	70.88	26.28	525.64
Deckers Creek	WV-M-14-A	Hartman Run	Iron	3.27	7.29	0.56	11.11
Deckers Creek	WV-M-14-B	Aaron Creek	Iron	20.90	9.48	1.60	31.97
Deckers Creek	WV-M-14-D	UNT/Deckers Creek RM 3.63	Iron	5.41	0.24	0.30	5.94
Deckers Creek	WV-M-14-E	UNT/Deckers Creek RM 5.70	Iron	5.33	0.27	0.29	5.89
Deckers Creek	WV-M-14-G	Tibbs Run	Iron	15.29	0.72	0.84	16.86
Deckers Creek	WV-M-14-N	Dry Run	Iron	8.85	0.00	0.47	9.32
Deckers Creek	WV-M-14-O	Falls Run	Iron	3.80	0.69	0.24	4.72
Deckers Creek	WV-M-14-P	Glady Run	Iron	5.00	0.01	0.26	5.28

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Deckers Creek	WV-M-14-R	Slabcamp Run	Iron	5.70	0.00	0.30	6.00
Deckers Creek	WV-M-14-S	Dillan Creek	Iron	58.37	0.09	3.08	61.54
Deckers Creek	WV-M-14-S-1	UNT/Dillan Creek RM 0.30	Iron	4.08	0.09	0.22	4.38
Deckers Creek	WV-M-14-S-2	UNT/Dillan Creek RM 1.02	Iron	4.12	0.00	0.22	4.33
Deckers Creek	WV-M-14-S-3	Swamp Run	Iron	7.94	0.00	0.42	8.35
Deckers Creek	WV-M-14-T	Laurel Run	Iron	62.19	0.00	3.27	65.46
Deckers Creek	WV-M-14-T-1	UNT/Laurel Run RM 1.62	Iron	5.98	0.00	0.31	6.29
Deckers Creek	WV-M-14-U	UNT/Deckers Creek RM 17.28	Iron	8.59	0.00	0.45	9.05
Deckers Creek	WV-M-14-V	Kanes Creek	Iron	34.80	2.36	1.96	39.11
Deckers Creek	WV-M-14-V-0.9	UNT/Kanes Creek RM 2.36	Iron	2.15	0.00	0.11	2.27
Deckers Creek	WV-M-14-V-1	UNT/Kanes Creek RM 2.49	Iron	3.23	0.03	0.17	3.43
Deckers Creek	WV-M-14-W	UNT/Deckers Creek RM 18.48	Iron	10.94	0.92	0.62	12.48
Deckers Creek	WV-M-14-Y	UNT/Deckers Creek RM 20.48	Iron	1.83	0.00	0.10	1.93
Deckers Creek	WV-M-14-Z	UNT/Deckers Creek RM 20.63	Iron	5.87	0.00	0.31	6.18
Deckers Creek	WV-M-14-AB	UNT/Deckers Creek RM 21.95	Iron	2.97	0.00	0.16	3.13
Booths Creek	WV-M-17	Booths Creek	Iron	98.12	40.04	7.27	145.43
Booths Creek	WV-M-17-B	Jolliet Run	Iron	7.54	1.93	0.50	9.97
Booths Creek	WV-M-17-C	Bloody Run	Iron	9.59	2.11	0.62	12.31
Booths Creek	WV-M-17-G	Owl Creek	Iron	17.44	15.88	1.75	35.08
Booths Creek	WV-M-17-G-2	UNT/Owl Creek RM 1.66	Iron	3.85	11.29	0.80	15.94
Booths Creek	WV-M-17-H	Mays Run	Iron	8.48	2.01	0.55	11.05
Booths Creek	WV-M-17-I	UNT/Booths Creek RM 6.27	Iron	1.07	0.28	0.07	1.42
Booths Creek	WV-M-17-L	UNT/Booths Creek RM 7.43	Iron	6.34	3.00	0.49	9.83
Brand Run	WV-M-20	Brand Run	Iron	16.33	2.87	1.01	20.21

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Brand Run	WV-M-20-A	UNT/Brand Run RM 0.72	Iron	8.19	1.72	0.52	10.43
Flaggy Meadow Run	WV-M-30	Flaggy Meadow Run	Iron	21.18	110.70	6.94	138.82
Flaggy Meadow Run	WV-M-30-B	UNT/Flaggy Meadow Run RM 1.07	Iron	9.66	1.01	0.56	11.22
Flaggy Meadow Run	WV-M-30-D	UNT/Flaggy Meadow Run RM 2.15	Iron	0.28	108.39	5.72	114.39
Birchfield Run	WV-M-31	Birchfield Run	Iron	6.02	1.51	0.40	7.92
Whiteday Creek	WV-M-32	Whiteday Creek	Iron	168.00	11.83	9.46	189.29
Whiteday Creek	WV-M-32-C	UNT/Whiteday Creek RM 1.68	Iron	2.41	0.55	0.16	3.12
Whiteday Creek	WV-M-32-E	UNT/Whiteday Creek RM 3.49	Iron	2.44	0.54	0.16	3.14
Whiteday Creek	WV-M-32-H	Laurel Run	Iron	5.30	0.35	0.30	5.95
Whiteday Creek	WV-M-32-M	Lick Run	Iron	8.92	0.56	0.50	9.98
Whiteday Creek	WV-M-32-P	Laurel Run	Iron	17.16	0.89	0.95	19.00
Whiteday Creek	WV-M-32-U	Maple Run	Iron	8.78	0.44	0.49	9.71
Whiteday Creek	WV-M-32-W	Cherry Run	Iron	15.99	0.82	0.88	17.70
Little Creek	WV-M-42	Little Creek	Iron	14.14	3.19	0.91	18.25
Prickett Creek	WV-M-44	Prickett Creek	Iron	76.35	17.01	4.91	98.28
Prickett Creek	WV-M-44-H	Scratchers Run	Iron	5.97	1.48	0.39	7.83
Prickett Creek	WV-M-44-I	Reuben Run	Iron	2.93	0.81	0.20	3.94
Prickett Creek	WV-M-44-K	Piney Run	Iron	3.80	1.03	0.25	5.08
Prickett Creek	WV-M-44-N	Long Run	Iron	2.63	0.80	0.18	3.60
Prickett Creek	WV-M-44-P	Mudlick Run	Iron	6.22	1.94	0.43	8.58
Parker Run	WV-M-45	Parker Run	Iron	3.83	0.80	0.24	4.87
UNT/Monongahela River RM 123.45	WV-M-46	UNT/Monongahela River RM 123.45	Iron	1.01	0.10	0.06	1.16
Pharaoh Run	WV-M-47	Pharaoh Run	Iron	7.79	1.55	0.49	9.83
Paw Paw Creek	WV-M-49	Paw Paw Creek	Iron	144.76	79.97	11.83	236.55

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Paw Paw Creek	WV-M-49-D	Little Paw Paw Creek	Iron	37.64	7.16	2.36	47.15
Paw Paw Creek	WV-M-49-D-2	Ministers Run	Iron	4.69	1.12	0.31	6.13
Paw Paw Creek	WV-M-49-D-4	Chunk Run	Iron	3.72	0.84	0.24	4.80
Paw Paw Creek	WV-M-49-G	Arnett Run	Iron	1.46	3.57	0.26	5.29
Paw Paw Creek	WV-M-49-H	Tarney Run	Iron	1.73	0.45	0.11	2.29
Paw Paw Creek	WV-M-49-I	Panther Lick Run	Iron	7.01	1.80	0.46	9.27
Paw Paw Creek	WV-M-49-K	Robinson Run	Iron	14.20	4.45	0.98	19.64
Paw Paw Creek	WV-M-49-O	Laurel Run	Iron	4.09	0.96	0.27	5.31
Paw Paw Creek	WV-M-49-Q	Rush Run	Iron	3.49	0.66	0.22	4.37
Paw Paw Creek	WV-M-49-R	Bennefield Prong	Iron	11.11	2.44	0.71	14.26
Paw Paw Creek	WV-M-49-W	Sugar Run	Iron	4.31	0.96	0.28	5.55
Paw Paw Creek	WV-M-49-X	Harvey Run	Iron	2.62	27.52	1.59	31.73
Buffalo Creek	WV-M-54	Buffalo Creek	Iron	455.17	168.48	32.82	656.47
Buffalo Creek	WV-M-54-C	Ices Run	Iron	4.51	1.43	0.31	6.25
Buffalo Creek	WV-M-54-D	Finchs Run	Iron	10.56	8.33	0.99	19.88
Buffalo Creek	WV-M-54-D-2	UNT/Finchs Run RM 1.15	Iron	1.90	3.21	0.27	5.37
Buffalo Creek	WV-M-54-I	Dunkard Mill Run	Iron	35.98	6.44	2.23	44.65
Buffalo Creek	WV-M-54-I-1	Bethel Run	Iron	14.99	2.85	0.94	18.78
Buffalo Creek	WV-M-54-J	Little Laurel Run	Iron	1.60	0.30	0.10	2.00
Buffalo Creek	WV-M-54-O	East Run	Iron	2.20	2.67	0.26	5.13
Buffalo Creek	WV-M-54-R	Plum Run	Iron	25.01	4.33	1.54	30.89
Buffalo Creek	WV-M-54-R-1	Carberry Run	Iron	1.92	0.40	0.12	2.44
Buffalo Creek	WV-M-54-R-4	UNT/Plum Run RM 3.81	Iron	3.66	0.61	0.22	4.50
Buffalo Creek	WV-M-54-T	Mod Run	Iron	15.42	5.46	1.10	21.97
Buffalo Creek	WV-M-54-T-1	Little Mod Run	Iron	2.88	1.04	0.21	4.12
Buffalo Creek	WV-M-54-U	Mahan Run	Iron	9.65	3.13	0.67	13.45
Buffalo Creek	WV-M-54-V	Salt Lick Run	Iron	3.94	1.22	0.27	5.43

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Buffalo Creek	WV-M-54-W	Flaggy Meadow Run	Iron	6.41	1.53	0.42	8.36
Buffalo Creek	WV-M-54-W-2	Fleming Fork	Iron	1.89	0.61	0.13	2.63
Buffalo Creek	WV-M-54-X	Pyles Fork	Iron	126.29	38.88	8.69	173.86
Buffalo Creek	WV-M-54-X-3	Flat Run	Iron	27.53	16.90	2.34	46.77
Buffalo Creek	WV-M-54-X-3-A	Llewellyn Run	Iron	3.95	12.04	0.84	16.84
Buffalo Creek	WV-M-54-X-7	State Road Fork	Iron	10.17	3.13	0.70	13.99
Buffalo Creek	WV-M-54-X-9	Campbell Run	Iron	25.03	5.25	1.59	31.88
Buffalo Creek	WV-M-54-X-9-A	Messer Run	Iron	2.79	0.95	0.20	3.94
Buffalo Creek	WV-M-54-X-9-B	Left Fork/Campbell Run	Iron	7.25	1.90	0.48	9.63
Buffalo Creek	WV-M-54-X-10	Big Run	Iron	5.83	2.25	0.43	8.50
Buffalo Creek	WV-M-54-X-14	Beechlick Run	Iron	4.83	1.60	0.34	6.77
Buffalo Creek	WV-M-54-Z	Dents Run	Iron	18.47	7.90	1.39	27.75
Buffalo Creek	WV-M-54-AA	Whetstone Run	Iron	5.91	21.04	1.42	28.37
Buffalo Creek	WV-M-54-AC	Joes Run	Iron	1.53	0.51	0.11	2.15
Buffalo Creek	WV-M-54-AD	Price Run	Iron	3.06	0.21	0.17	3.45
Buffalo Creek	WV-M-54-AE	Long Drain	Iron	2.15	0.82	0.16	3.12
Buffalo Creek	WV-M-54-AH	Huey Run	Iron	8.44	3.23	0.61	12.28
Buffalo Creek	WV-M-54-AI	Owen Davy Fork	Iron	19.86	5.79	1.35	27.00
Buffalo Creek	WV-M-54-AI-3	Laurel Run	Iron	2.58	0.82	0.18	3.57
Buffalo Creek	WV-M-54-AI-4	Camp Run	Iron	2.59	2.31	0.26	5.15
Buffalo Creek	WV-M-54-AK	Bartholomew Fork	Iron	18.63	4.71	1.23	24.57
Buffalo Creek	WV-M-54-AM	Warrior Fork	Iron	12.93	3.08	0.84	16.85
Buffalo Creek	WV-M-54-AM-2	Evans Run	Iron	2.42	0.63	0.16	3.21
Hickman Run	WV-M-55	Hickman Run	Iron	0.62	10.53	0.59	11.74
UNT/Monongahela River RM 128.55	WV-M-57	UNT/Monongahela River RM 128.55	Iron	2.09	0.67	0.14	2.90
Crooked Run	WV-M-2-C	UNT/Crooked Run RM 2.42	Iron	4.79	0.58	0.28	5.65

UNT = unnamed tributary; RM = river mile.

Table 11-4. Selenium TMDLs

TMDL Watershed	Stream Code	Stream Name	Parameter	TMDL (lbs/day)
Paw Paw Creek	WV-M-49-G	Arnett Run	Selenium	Flow in Receiving Stream (MGD) x 0.005 mg/L Selenium x 8.34

Table 11-5. Chloride TMDLs

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
West Run	WV-M-7-A	UNT/West Run RM 0.91	Chloride	123.08	1460.13	83.33	1666.53
UNT/Monongahela River RM 99.49	WV-M-11	UNT/Monongahela River RM 99.49	Chloride	0.00	1931.36	101.65	2033.01
Flaggy Meadow Run	WV-M-30	Flaggy Meadow Run	Chloride	1068.73	16041.83	Implicit	17110.56
Flaggy Meadow Run	WV-M-30-D	UNT/Flaggy Meadow Run RM 2.15	Chloride	544.61	16041.83	Implicit	16586.44
Paw Paw Creek	WV-M-49	Paw Paw Creek	Chloride	7951.95	5109.10	Implicit	13061.05
Buffalo Creek	WV-M-54-X-3	Flat Run	Chloride	1081.73	1382.92	Implicit	2464.65
Buffalo Creek	WV-M-54-X-3-A	Llewellyn Run	Chloride	418.85	1382.92	Implicit	1801.77
Buffalo Creek	WV-M-54-AF	UNT/Buffalo Creek RM 23.53	Chloride	408.02	2489.25	Implicit	2897.27

UNT = unnamed tributary; RM = river mile.

Table 11-6. pH TMDLs

Major 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)
Camp Run	WV-M-1	Camp Run	-6.19	N/A	-0.33	-6.52
Camp Run	WV-M-1-A	UNT/Camp Run RM 0.79	-20.88	N/A	-1.10	-21.98
Crooked Run	WV-M-2	Crooked Run	-12392.71	N/A	-652.25	-13044.95
UNT/Monongahela River RM 93.07	WV-M-3	UNT/Monongahela River RM 93.07	-76.66	N/A	-4.03	-80.69
West Run	WV-M-7	West Run	-269.85	N/A	-14.20	-284.05
West Run	WV-M-7-D	UNT/West Run RM 3.79	-6.56	N/A	-0.35	-6.91
Robinson Run	WV-M-8-A	Crafts Run	-603.99	N/A	-31.79	-635.78
Robinson Run	WV-M-8-B	UNT/Robinson Run RM 1.09	-158.35	N/A	-8.33	-166.69
Dents Run	WV-M-12-C	UNT/Dents Run RM 3.60	-178.32	N/A	-9.39	-187.70
Deckers Creek	WV-M-14-P	Glady Run	-2.33	N/A	-0.12	-2.45
Deckers Creek	WV-M-14-R	Slabcamp Run	-3.47	N/A	-0.18	-3.65
Deckers Creek	WV-M-14-S	Dillan Creek	-906.36	N/A	-47.70	-954.06
Deckers Creek	WV-M-14-T	Laurel Run/Deckers Creek	-3524.49	N/A	-185.50	-3709.99
Deckers Creek	WV-M-14-V	Kanes Creek	-41.41	N/A	-2.18	-43.59
Deckers Creek	WV-M-14-V-0.9	UNT/Kanes Creek RM 2.36	-4.17	N/A	-0.22	-4.39
Deckers Creek	WV-M-14-V-1	UNT/Kanes Creek RM 2.49	-4.96	N/A	-0.26	-5.22
Booths Creek	WV-M-17	Booths Creek	-810.97	N/A	-42.68	-853.65
Booths Creek	WV-M-17-G	Owl Creek	-227.22	N/A	-11.96	-239.18
Booths Creek	WV-M-17-H	Mays Run	-38.99	N/A	-2.05	-41.04
Booths Creek	WV-M-17-I	UNT/Booths Creek RM 6.27	-64.54	N/A	-3.40	-67.93
Brand Run	WV-M-20	Brand Run	-179.30	N/A	-9.44	-188.73
Birchfield Run	WV-M-31	Birchfield Run	-864.19	N/A	-45.48	-909.68
Parker Run	WV-M-45	Parker Run	-164.63	N/A	-8.66	-173.29

Major 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)
UNT/Monongahela River RM 123.45	WV-M-46	UNT/Monongahela River RM 123.45	-10.70	N/A	-0.56	-11.26

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

Table 11-7. Fecal coliform bacteria TMDLs

Major Watershed	Stream Code	Stream Name	Load Allocations (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Crooked Run	WV-M-2	Crooked Run	3.36E+10	4.55E+06	1.77E+09	3.54E+10
Crooked Run	WV-M-2-B	UNT/Crooked Run RM 2.27	5.56E+09	0.00E+00	2.93E+08	5.85E+09
West Run	WV-M-7	West Run	3.18E+10	2.37E+10	2.92E+09	5.85E+10
West Run	WV-M-7-A	UNT/West Run RM 0.91	1.73E+09	9.45E+09	5.88E+08	1.18E+10
West Run	WV-M-7-D	UNT/West Run RM 3.79	4.90E+09	2.73E+09	4.02E+08	8.04E+09
Robinson Run	WV-M-8	Robinson Run	3.94E+10	8.11E+07	2.08E+09	4.16E+10
Scotts Run	WV-M-10	Scotts Run	8.31E+10	6.04E+07	4.38E+09	8.75E+10
Scotts Run	WV-M-10-C	Wades Run	1.88E+10	2.43E+07	9.92E+08	1.98E+10
Scotts Run	WV-M-10-D	Guston Run	1.28E+10	8.36E+06	6.76E+08	1.35E+10
Scotts Run	WV-M-10-H	UNT/Scotts Run RM 4.79	8.00E+09	1.29E+07	4.22E+08	8.43E+09
UNT/Monongahela River RM 99.49	WV-M-11	UNT/Monongahela River RM 99.49	0.00E+00	1.78E+10	9.39E+08	1.88E+10
Dents Run	WV-M-12	Dents Run (M-12)	7.56E+10	1.48E+10	4.76E+09	9.52E+10
Dents Run	WV-M-12-A	Flaggy Meadow Run (M-12-A)	9.47E+09	1.84E+08	5.08E+08	1.02E+10
Falling Run	WV-M-13	Falling Run	0.00E+00	5.85E+09	3.08E+08	6.16E+09
Deckers Creek	WV-M-14	Deckers Creek	3.62E+11	3.34E+10	2.08E+10	4.16E+11
Deckers Creek	WV-M-14-A	Hartman Run	0.00E+00	6.40E+09	3.37E+08	6.74E+09
Deckers Creek	WV-M-14-B	Aaron Creek	3.56E+10	6.19E+09	2.20E+09	4.40E+10
Deckers Creek	WV-M-14-C	Knocking Run	4.42E+09	5.93E+09	5.45E+08	1.09E+10
Deckers Creek	WV-M-14-E	UNT/Deckers Creek RM 5.70	1.14E+10	1.38E+07	5.99E+08	1.20E+10

Major Watershed	Stream Code	Stream Name	Load Allocations (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Deckers Creek	WV-M-14-G	Tibbs Run	3.23E+10	1.58E+08	1.71E+09	3.42E+10
Deckers Creek	WV-M-14-S	Dillan Creek	4.44E+10	0.00E+00	2.34E+09	4.67E+10
Cobun Creek	WV-M-15	Cobun Creek	6.33E+10	1.18E+10	3.95E+09	7.91E+10
Booths Creek	WV-M-17-L	UNT/Booths Creek RM 7.43	1.53E+10	3.12E+08	8.23E+08	1.65E+10
Flaggy Meadow Run	WV-M-30	Flaggy Meadow Run (M-30)	2.00E+10	3.03E+07	1.05E+09	2.10E+10
Whiteday Creek	WV-M-32-C	UNT/Whiteday Creek RM 1.68	2.72E+09	4.55E+06	1.44E+08	2.87E+09
Whiteday Creek	WV-M-32-P	Laurel Run/Whiteday Creek	2.00E+10	4.55E+06	1.05E+09	2.11E+10
Indian Creek	WV-M-33	Indian Creek	1.12E+11	7.65E+07	5.89E+09	1.18E+11
Indian Creek	WV-M-33-E	Little Indian Creek	3.99E+10	4.70E+07	2.10E+09	4.20E+10
Indian Creek	WV-M-33-P	UNT/Indian Creek RM 7.23	2.91E+09	0.00E+00	1.53E+08	3.06E+09
Prickett Creek	WV-M-44	Prickett Creek	1.29E+11	8.31E+08	6.85E+09	1.37E+11
Prickett Creek	WV-M-44-H	Scratchers Run	1.24E+10	2.81E+07	6.55E+08	1.31E+10
Prickett Creek	WV-M-44-M	Grassy Run	1.27E+10	3.71E+07	6.71E+08	1.34E+10
Parker Run	WV-M-45	Parker Run	8.32E+09	0.00E+00	4.38E+08	8.76E+09
Pharaoh Run	WV-M-47	Pharaoh Run	1.86E+10	2.62E+07	9.82E+08	1.96E+10
Paw Paw Creek	WV-M-49	Paw Paw Creek	2.04E+11	1.27E+08	1.08E+10	2.15E+11
Paw Paw Creek	WV-M-49-D	Little Paw Paw Creek	5.24E+10	2.95E+07	2.76E+09	5.52E+10
Paw Paw Creek	WV-M-49-R	Bennefield Prong	2.71E+10	2.80E+07	1.43E+09	2.85E+10
Paw Paw Creek	WV-M-49-W	Sugar Run	8.77E+09	0.00E+00	4.61E+08	9.23E+09
Buffalo Creek	WV-M-54	Buffalo Creek	6.32E+11	9.37E+09	3.38E+10	6.75E+11
Buffalo Creek	WV-M-54-D	Finchs Run	2.09E+10	6.15E+07	1.11E+09	2.21E+10
Buffalo Creek	WV-M-54-D-2	UNT/Finchs Run RM 1.15	4.72E+09	1.74E+07	2.49E+08	4.98E+09
Buffalo Creek	WV-M-54-E	Moody Run	6.23E+09	4.11E+04	3.28E+08	6.56E+09
Buffalo Creek	WV-M-54-I	Dunkard Mill Run	5.46E+10	1.74E+07	2.87E+09	5.75E+10
Buffalo Creek	WV-M-54-I-1	Bethel Run	2.49E+10	4.55E+06	1.31E+09	2.62E+10
Buffalo Creek	WV-M-54-I-1-A	UNT/Bethel Run RM 0.80	6.83E+09	0.00E+00	3.60E+08	7.19E+09
Buffalo Creek	WV-M-54-J	Little Laurel Run	5.23E+09	4.55E+06	2.76E+08	5.51E+09
Buffalo Creek	WV-M-54-R	Plum Run	3.51E+10	1.36E+07	1.85E+09	3.70E+10
Buffalo Creek	WV-M-54-T	Mod Run	1.63E+10	8.33E+06	8.60E+08	1.72E+10

Major Watershed	Stream Code	Stream Name	Load Allocations (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Buffalo Creek	WV-M-54-U	Mahan Run	1.46E+10	1.59E+07	7.71E+08	1.54E+10
Buffalo Creek	WV-M-54-W	Flaggy Meadow Run (M-54-W)	1.52E+10	0.00E+00	7.97E+08	1.59E+10
Buffalo Creek	WV-M-54-W-2	Fleming Fork	5.07E+09	0.00E+00	2.67E+08	5.34E+09
Buffalo Creek	WV-M-54-X	Pyles Fork	1.55E+11	1.51E+08	8.16E+09	1.63E+11
Buffalo Creek	WV-M-54-X-3	Flat Run	4.56E+10	1.59E+07	2.40E+09	4.80E+10
Buffalo Creek	WV-M-54-X-7	State Road Fork	2.00E+10	1.21E+07	1.05E+09	2.11E+10
Buffalo Creek	WV-M-54-X-9	Campbell Run	2.44E+10	0.00E+00	1.28E+09	2.57E+10
Buffalo Creek	WV-M-54-Z	Dents Run (M-54-Z)	3.59E+10	5.22E+08	1.92E+09	3.84E+10
Buffalo Creek	WV-M-54-AA	Whetstone Run	1.37E+10	0.00E+00	7.22E+08	1.44E+10
Buffalo Creek	WV-M-54-AC	Joes Run	5.74E+09	0.00E+00	3.02E+08	6.04E+09
Buffalo Creek	WV-M-54-AI	Owen Davy Fork	2.88E+10	3.79E+06	1.52E+09	3.04E+10
Buffalo Creek	WV-M-54-AK	Bartholomew Fork	3.98E+10	3.79E+06	2.09E+09	4.19E+10
Buffalo Creek	WV-M-54-AM	Warrior Fork	2.53E+10	8.33E+06	1.33E+09	2.67E+10
Buffalo Creek	WV-M-54-AM-2	Evans Run	5.53E+09	3.79E+06	2.91E+08	5.82E+09
Hickman Run	WV-M-55	Hickman Run	0.00E+00	2.25E+10	1.18E+09	2.37E+10
Coal Run	WV-M-56	Coal Run	0.00E+00	1.97E+10	1.04E+09	2.08E+10
UNT/Monongahela River RM 128.55	WV-M-57	UNT/Monongahela River RM 128.55	4.59E+09	7.28E+08	2.80E+08	5.60E+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.

12.0 FUTURE GROWTH

12.1 Iron, Aluminum, Manganese, 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 effluent limitations. A new facility could be permitted in the aluminum impaired watersheds 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.
- 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, pH or manganese 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.

12.2 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.

12.3 Chloride and Selenium

Specific future growth allocations are not prescribed. The absence of specific future growth allocations does not prohibit new discharges in the watersheds of streams for which chloride and selenium TMDLs have been developed. A new discharge may be permitted anywhere in the watershed, provided that effluent limitations are based on the achievement of water quality standards at end-of-pipe.

13.0 PUBLIC PARTICIPATION

13.1 Public Meetings

An informational public meeting was held on June 30, 2009 at the National Research Center for Coal and Energy on the West Virginia University campus in Morgantown. The June 30, 2009 meeting occurred prior to pre-TMDL stream monitoring and pollutant source tracking and included a general TMDL overview and a presentation of planned monitoring and data gathering activities. A public meeting was held on August 20, 2013 at Fairmont State University in Fairmont, WV to present and facilitate comments on the draft TMDLs.

13.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised in various local newspapers beginning on August 2, 2013. Interested parties were invited to submit comments during the public comment period, which began on August 2, 2013 and ended on September 16, 2013. The electronic documents were also posted on the WVDEP's internet site at www.dep.wv.gov/tmdl.

13.3 Response Summary

The West Virginia Department of Environmental Protection received written comments on the draft TMDLs from Appalachian Mountain Advocates, Arch Coal, Inc., City of Bridgeport, CONSOL Energy, Inc., City of Fairmont Sanitary Sewer Board, Greer Industries, Inc., MEPCO, Morgantown Utility Board, John M. and Petra B. Wood, WV Coal Association, WV Municipal Water Quality Association. Comments have been compiled and responded to in this response summary. Comments and comment summaries are in boldface and italic. Agency responses appear in plain text.

Multiple commenters expressed displeasure with the report discussion of biological impairment and stressor identification, contending that agency positions are in direct contravention of House Concurrent Resolution 111 and Senate Bill 562, ignore the will of elected officials, indicate a serious misunderstands of legislative intent, and are an attempt to administratively bypass required rulemaking. They further stated that past biological impairments determined via application of the West Virginia Stream Condition Index (WVSCI) are no longer relevant or appropriate for discussion in the TMDL.

DEP positions and actions are completely consistent with Senate Bill 562 and the report discussions accurately chronicle recent happenings on this topic. The discussion is relevant because the project was initiated prior to Senate Bill 562 and DEP stated in prior public forums that biological impairment TMDLs would be developed in this project.

DEP interprets Senate Bill 562 to require the agency to develop a new methodology for assessing the narrative criterion at 47 CSR 2 §3.2.i for legislative approval. Accordingly, DEP did not propose new biological impairment listings in the draft 2012 Section 303(d) list presented to EPA and has not developed biological impairment TMDLs in this project.

The above notwithstanding, the TMDL development contract for this project and the majority of funded stressor identification work was executed prior to passage of SB 562. Through EPA action, all of the streams for which biological stressor identification was performed are now contained on the West Virginia 2012 Section 303(d) list. As stated in the draft report, the stressor identification results are presented for consideration in future 303(d) decision making. This work may allow future removal of the biological impairment listings for the waters identified in **Table 4-1** because implementation of the TMDLs developed pursuant to numeric water quality criteria have been determined to address all significant stressors associated with the biological impacts to the benthic macroinvertebrates upon which existing listings were based.

Section 4.0 of the draft report and Section 2.0 of the technical report has been updated in the final reports to clarify agency positions and chronicle additional EPA over-list actions that occurred after public notice of the draft TMDLs.

Multiple commenters stated that DEP should not include selenium impairments on the 303(d) list based upon "obsolete" selenium criteria.

While comments regarding selenium 303(d) listing decisions are beyond the scope of the Draft TMDL, the existing selenium criteria were properly promulgated, approved by EPA and effective for Clean Water Act permitting, listing and TMDL processes.

The process used to develop stressor identification water quality thresholds was questioned by multiple commenters.

The stressor identification thresholds presented in Table 2-1 of the Technical Report and on the Threshold Table tab in Appendix B are not stand alone determinants of biological stressors but serve to summarize the water quality data and highlight potential stressors on which to focus further investigation and discussion during the comprehensive SI process. The SI process is a strength-of-evidence evaluation of habitat metrics, stressor-specific sensitivities of collected benthic organisms, water quality observations, and all available information regarding land use and potential sources in the watershed. In many situations, multiple stressors impact biota and must be addressed.

Section 2.4.1, including Table 2-1 of the Technical Report details the process for identifying the threshold values and explains each parameter. The table presented in the Appendix B contained some obsolete information and has been revised. Table 2-1 of the Technical Report explains that manganese and iron toxicity to benthic macroinvertebrates are not well established. Instantaneous water column manganese concentrations were not used in the SI decision making process and thresholds have been removed in Appendix B. Similarly, “iron toxicity” was not identified as a significant stressor based on water quality observations, except where water quality data exhibited consistent and gross exceedances of the state water quality criterion for aquatic life protection. Fecal coliform thresholds are not based on direct aquatic life impacts but are used as indicators of nutrient and organic loadings that can stress biota.

One commenter contended that the stressor identification process incorrectly identified ionic stress for 15 streams listed in Table 4-2 and stated that manganese or limited habitat were more significant stressors in some of the streams.

The purpose of including the results of the stressor identification work was to potentially allow delisting of impairments in future 303(d) lists. Because existing 303(d) “biological impairment” listings were based on benthic macroinvertebrate impacts, future delisting is possible if all potential stressors associated with macroinvertebrate impacts are addressed by the TMDLs presented for numeric water quality criteria. That scenario applies to the streams listed in **Table 4-1**. **Table 4-2** identifies streams for which the stressor identification work could not conclude that all potential stressors are addressed by the TMDLs for numeric criteria. In response to the comment, DEP reevaluated the stressor identification work for the questioned streams and reaffirmed that ionic stress to benthic macroinvertebrates is present. As this TMDL project does not address those impacts, it alone will not support future removal of the 303(d) biological impairment listings for those streams. The listings will remain on the 303(d) list pending application of the new methodology that is under development and/or until biological impairment TMDLs are developed.

One commenter interpreted information presented in the Technical Report as all conductivity, sulfates and chloride water column concentrations must exceed certain thresholds before DEP identifies ionic stress as a stressor. The commenter stated that the water quality of only one stream exceeded the chloride threshold yet ionic stress was identified in 32 streams.

The interpretation is incorrect. Stressor identification is a strength-of-evidence analysis of water quality, habitat, source and biological information. With respect to water quality, ionic stress can be evidenced by elevated concentrations of various dissolved constituents and the stressor identification process includes evaluations of individual and combined ionic influences. Threshold values were derived for sulfate and chloride parameters only because too few data were available for other ions when the analysis was completed. Table 2-1 has been modified to indicate that ionic strength may be evidenced through a combination of conductivity and sulfate **or** chloride.

Citing example calibration plots shown in Appendix J, multiple commenters questioned predictive capability of the model and validity of the TMDL recommendations. Commenters asked for evidence of the model calibration using measured in-stream data.

Appendix J inappropriately contained evaluation tools designed for in-house use to review model calibration that did not function properly for outside users. Confusion resulted because a watershed that was displayed in one version of the tool was from a previous TMDL project, inadvertently left in the folder in the draft version. The plot appearing in the previous version was not representative of the Monongahela River Watershed TMDL. The relevant version, containing a stream from the Monongahela River Watershed displayed only one calibration plot for fecal coliform, leading to additional confusion.

The goal of the modeling calibration was to determine a set of parameters to best describe the hydrologic and water quality processes in the Monongahela River Watershed. Extreme care and diligence were taken to thoroughly examine and analyze the myriad of available data that included many types and formats originating from various sources (including data collected and submitted by industry). Even so, the hydrology and water quality calibration process first objective is not to match every sampled point, but to adequately replicate processes occurring in the watershed and streams. The purpose of comparing modeled results with data is to assess that the model is simulating low flow, mean flow, and storm peaks within observed ranges.

Composite analysis of the available in-stream data (pre-TMDL monitoring data, in-stream Discharge Monitoring Report data, WVDEP DMR trend station data, etc.) from all monitoring stations was performed to establish low-flow, high-flow and seasonal trends. Background values were established by using a composite of samples from watersheds that were minimally disturbed, according to the landuse coverage. In addition, the sediment-metals relationship was determined, and applied to those watersheds where metals-sediment correlation was observed. For the abandoned mine lands, the concentrations were based on the source tracking monitoring. Values for permitted mines used for calibration were based on DMR data, although it is important to note that those were changed to represent permitted conditions during the allocation process, referred to as baseline conditions.

Although error statistics are often used in evaluating model calibration, their use, particularly for water quality calibration, is not recommended for this modeling effort due to the following reasons: (1) Most of the available data for calibration were instantaneous grab samples, not continuous sampling. Instantaneous grab sample data only permits comparison during a snapshot in time, and this snapshot is representative of only a single condition. Although multiple water quality data are available at many locations, they are not necessarily representative of all conditions (which are, in fact, simulated by the model because it is continuous). (2) Making a "point-by-point" comparison (i.e. a comparison of a water quality observation for a given date and time versus the modeled value for the same date and time) will likely result in poor statistical results, because the precise timing of all physical, chemical, and biological phenomenon are likely not perfect in a model. (3) There were data gaps associated with configuring the modeling framework, so it is unrealistic to assume that the model will be able to precisely predict each and every condition. For example, weather gages are a source of model error. The lack of weather gages on every subwatershed increases model error in terms of amount and timing of water flowing through the system. The sparse weather gage network particularly increases model error during storm events (timing and volume of water). Representing point sources and AML seeps as continuous flow discharges is another example. These are simplifications, since they have the potential to have variable flow and water quality (with little or no supporting data).

Looking at a time series plot of modeled versus observed data provides more insight into the nature of the system and is more useful in water quality calibration, in particular, than a statistical comparison. Trends in the observed data and cause-effect relationships between various parameters can be replicated with a model, although precise values at each and every point in time may not be. As long as the trends, relationships, and magnitudes are well-represented, and thus the underlying physics and kinetics are also being represented, a model is successful and can be used for simulating management alternatives. It is important to note that only EPA approved public domain models were applied during this effort. .

Model calibration is accomplished by examining multiple subwatershed with corresponding monitoring data, for each water quality parameter group (i.e., fecal coliform, iron, TSS, aluminum, pH, manganese, and chloride) for a variety of landuse/pollutant-specific parameter combinations. Graphical results for each location evaluated were too numerous to display in the Technical Report. Representative examples have been added in Appendix J of the Technical Report. These examples provide an overview of calibration in streams of various size and dominant pollutant sources.

One commenter inaccurately determined that the graph on page 56 demonstrates that the model is not accurately predicting trends in the fecal coliform values.

Figure 10-3 shown on page 56, provides data collected during a study to establish background fecal coliform contributions in a forested watershed with no disturbances. The study results were used to parameterize the model by assigning a background fecal coliform concentration. As discussed in the previous comment response, the modeling trend reasonably observances across the storm event. Figure 10-3 has been revised to show the scales and units for each axis.

Multiple commenters objected to the determination of impairment through the evaluation of modeling output and subsequent TMDL development. Some contended that TMDLs developed for stream/impairments not contained on the 2012 303(d) list or for which actual monitoring data did not exceed the State's listing methodology are procedurally invalid. Others asked "Which streams had modeling-only impairments and for which pollutants?", "Which streams had TMDLs proposed for pollutants not identified on 2012 303(d) list?" and "Which streams have TMDLs proposed for which actual monitoring data do not exceed the State's listing methodology?"

Section 3.3 of the TMDL report explains difficulties with comparing instantaneous stream measurements with criteria exposure duration and exceedance frequency components and DEP's long-established approach to consider impairment based upon model output for the baseline condition. The use of modeling to identify impairment is clearly authorized by 40 CFR 130.7 and there is no prohibition against TMDL development for waters not contained on 303(d) lists.

All of the impairments indicated with an "M" in **Table 3-3** are predicted to be impaired in the base condition despite lacking observed data indicating exceedance of thresholds contained in the State's 303(d) listing methodology. TMDLs were presented for "modeled impairments" only for total iron. The majority of modeled iron impairments are tributaries of streams for which iron sampling exceeded the 303(d) listing methodology, which would result in the need to prescribe load and wasteload allocations in upstream contributing watersheds.

Multiple commenters suggested that data available from NPDES monitoring requirements were not considered and should have been compared with modeling results and presented.

DEP specifically requests NPDES-based stream monitoring data and this information is examined during the TMDL development process to identify sources contributions, support model set up and model calibration. In response to the comment, additional analyses were performed to specifically investigate if there were instances where available monitoring data contradicts the modeled impairment determination. In some instances the NPDES data directly supported modeled impairment determinations, as the data indicated exceedances of the listing methodology. Otherwise, the NPDES data do not directly contradict model output. DEP recognizes the difficulty capturing critical conditions that are known to routinely occur due to precipitation events. The industry data contains infrequent instances of elevated TSS, thus they do not often capture the iron criteria exceedances associated with sediment sources. It is also important to note that baseline condition model scenario includes all permitted discharges at existing permit limits.

One commenter stated iron reductions to traditional mining sources are not necessary because of the lack of model calibration and its inability to accurately predict exceedances. The commenter also contended that the only sources subject to routine monitoring and enforcement of allocations are traditional mining sources and that the only realized reductions will come at a cost only to mining operations.

As stated previously, the model is appropriately calibrated and accurately predicts criteria exceedances. The commenter' discharges are located in the Deckers Creek watershed. Multiple water quality monitoring stations in Deckers Creek demonstrated exceedances of the iron criterion. DEP reviewed the allocations for the commenter's discharges and reaffirmed that the prescribed wasteload allocations coupled with prescribed reductions for all other sources in the watershed, are necessary to attain iron criteria in the receiving streams and affected downstream waters. Additionally, DEP reconsidered the draft iron allocation methodology that universally reduced mining discharges to criteria-end-of-pipe. Reevaluation determined that the allocations resulting from the draft methodology were necessary in the majority of scenarios, but that relaxation was possible in limited instances. The allocation methodology discussion of Section 10.7.1 of the report, as well as references in the Technical Report, were revised and the TMDLs and allocation spreadsheets were updated.

TMDLs define the pollutant reductions necessary from all sources that will result in water quality standard attainment but do not extend regulatory authority. The lack of regulatory mechanisms for TMDL implementation by some sources does not provide grounds to alter necessary allocations for regulated sources.

Multiple commenters stated that TMDLs incorrectly assigned iron wasteload allocations to NPDES outlets for post-mining areas. One commenter provided copies of permit modifications granting "post-mining limits for manganese" as evidence of errors.

"Post- mining outlets" are classified as effluent type H in the Division of Mining and Reclamation permit database. The TMDLs are not in error in this regard as wasteload allocations are not assigned to effluent type H outlets. "Post-mining limits" are generally granted after demonstration of compliance with effluent limitations at the influent to treatment structures. In such situations, prior technology-based effluent limitations for iron, manganese and TSS are replaced with effluent limitations only for pH and settleable solids. In TMDL development projects, DEP does not represent or assign iron wasteload allocations to effluent type H outlets because reclamation has progressed beyond the need for NPDES iron effluent limitations and accordingly, the need for TMDL wasteload allocations. Although the specific permits/outlets described in the comments were modified to "grant post-mining limits for manganese" (technology-based manganese limits were removed from the permit), the modifications are not relevant to iron TMDL development. As indicated in the comments, technology based iron effluent limitations remain applicable to the subject permits/outlets and the TMDL must provide iron wasteload allocations to allow any discharge of iron. Wasteload allocations based upon the existing effluent limitations can be granted only to the extent that such level of control results in the attainment of iron water quality criteria.

Multiple commenters disagreed with the elimination of alternative precipitation technology based effluent limits for active mining operations and suggested that reductions or changes to existing effluent limits only be implemented after pre-law AMD discharges and other nonpoint pollution sources have been corrected.

The elimination of alternative precipitation technology based effluent limitations is a long established provision of West Virginia total iron TMDLs because the alternative "limits" in effect remove the applicability of iron limits and thereby preclude assurance of compliance with iron water quality criteria where influenced by precipitation induced sources. The draft TMDLs include wasteload allocations for point sources and load allocations for nonpoint sources that will result in attainment of water quality criteria. All sources and source categories must achieve allocations and approvable TMDLs cannot include allocations that will not attain criteria.

One commenter requested clarification of information and data used to establish iron/TSS relationships. Another contended that Technical Report Section 3.2.7 and Figure 3.6 do not justify the TSS and iron relationships used in the modeling.

Section 3.2.7 has been revised to better clarify the process used in the linear regression analysis. Figure 3.6 of the Technical Report displays the TSS and iron data for one stream in the Monongahela River watershed as an example. Overall the iron and TSS relationship was based on monitored data for 105 stations throughout the watershed. As described earlier, sampling of the critical condition (precipitation induced events) is limited in pre-TMDL monitoring; but where accomplished is most indicative of the iron associated with elevated TSS.

One commenter provided a detailed description of past and current mining, remining and ash disposal activities in the Arnett Run watershed. The commenter noted that the selenium discussion in the report implies that coal mining of the Middle Pennsylvanian results in selenium water quality exceedances whereas only Upper Pennsylvanian coal seams have been mined in the watershed. The commenter stated that the selenium impairment is more likely the result of flyash disposal operations rather than the coal mining operations.

The supplemental information is appreciated and has been incorporated. The discussion in the draft document did not accurately describe local mined coal seams, the presence of the coal fired power plant in the watershed, fly ash disposal or the use of fly ash in past mining reclamation. Revisions have been made to Section 5.3 to clarify the potential sources of selenium. The draft allocations have not been changed because elevated selenium in the active NPDES permitted outlets must be reduced to meet applicable water quality criteria.

One commenter indicated that some of the represented mining related chloride sources have been removed and/or have discharge limits less than their allocation and should no longer be considered as contributing to the impairment of their respective streams.

DEP recognizes that some of the previous significant chloride point sources have been recently redirected to a new treatment facility. To the extent that permitted discharges remain, the existing limitations mentioned in the comment appear consistent with the wasteload allocations of the TMDLs. Implementation of chloride wasteload allocations are expected via conversion to NPDES effluent limitations per the protocols of the Technical Support Document for Water Quality-Based Toxics Control (TSD). Chloride effluent limitations of 218 mg/l average monthly and 378 maximum daily result from the application of TSD protocols to a 230 mg/l, chronic aquatic life protection wasteload allocation under 2/month monitoring frequencies. As such, the existing effluent limitations appear to properly implement the TMDLs and compliance with them will not cause or contribute to water quality standard violations with respect to chloride.

One commenter contended that model representation of dissolved aluminum is flawed in that it ignores the presence of aluminum in regional soils and the significant contribution of total aluminum to streams from eroded soils. The commenter also questioned the relationship of dissolved aluminum TMDLs to site-specific translator studies and pending hardness-based dissolved aluminum water quality criteria revisions.

Section 3.4 and 3.5 of the Technical Report details the model representation of aluminum that accurately reflects the total aluminum loadings from eroded soils. It also captures the aluminum and acidity loadings from all sources and represents the translation of total to dissolved aluminum, including upland and streambank sediments.

Approved TMDLs would override previous translator studies in that they provide total aluminum allocations to existing sources that are protective of criteria in the immediate receiving stream and downstream waters after resolution of the usually more problematic legacy mining acidity impacts. Note that baseline total aluminum conditions for active mining discharges were universally established at the 95^{th} percentile of the maximum concentration reported on Discharge Monitoring Reports throughout the Monongahela River Watershed, even though some discharges have more stringent existing limits (see Section 10.6.2). In the draft TMDLs baseline conditions were not reduced in allocations for most of the permitted mining discharges. Two permits were mistakenly given allocations equal to water quality criteria and existing permit limits. This contradicted the methodology described in Section 10.6.2. Reevaluation determined that water quality criteria could be attained at baseline conditions for those discharges. As such, no aluminum reductions are associated with the final aluminum allocations for any mining discharge.

Dissolved aluminum TMDLs are based on currently effective criteria. If EPA approves pending revisions, then their status can be re-examined. It is important to note that the pending aluminum revision would not be applicable when pH is less than 6.5 standard units. All of the streams for which aluminum TMDLs have been developed are also pH impaired (pH is less than 6.0 standard units).

Multiple commenters stated that the scope of the TMDL project is too complex for meaningful evaluation and that information presented does not allow real evaluation of the modeling structure and input. Multiple commenters requested additional opportunity for public review and comment.

DEP recognizes the size and complexity of its watershed TMDL projects and has always attempted to present technical information as clearly as possible. In this instance, many aspects of information presented in the Technical Report were incorrectly interpreted. Additionally, the draft Technical Report contained some incorrect and outdated information and its Appendices were not presented as clearly as they could have been. It also inappropriately included evaluation tools designed for in-house use in model calibration that did not function properly for outside users. This resulted in additional confusion.

DEP responded to comments, questions and requested clarifications in this summary and has made substantive technical and non-technical revisions to draft documents in response to the comments received. An additional public notice of draft TMDLs was not conducted.

One commenter stated that there are simply far too many stream segments and impairments to meaningfully evaluate as presented. The commenter suggested that each stream segment should have a short description of the pollutants of concern and the data for the pollutants, provide a hot link to the data, explain how the data exceed the applicable water quality standards, and explain the approach to developing the TMDL.

The size and complexity of projects is a recognized disadvantage to the many positive aspects of watershed TMDLs. DEP strives to continuously improve clarity. Although the “hot-linking” suggestion cannot be accomplished, the requested information is contained in the report and can be reasonably obtained. **Table 3-3** identifies the impairments for which TMDLs are being developed and Technical Report Appendix K provides all available water quality data. The Appendix K spreadsheet is easily filterable to view stream specific monitoring locations and results. Description of the “approach to developing the TMDL” is not able to be accomplished in a short summary. Section 10 of the report provides discussions of multiple modeling aspects and pollutant-specific allocation approaches that were used to develop the TMDLs.

Multiple commenters questioned why a fecal coliform TMDL was developed for West Run when monitoring showed only limited criteria exceedances. Commenters incorrectly assumed that fecal coliform impairment was determined from evaluation of modeling output.

Impairment assessments are made at the station scale and fecal coliform monitoring performed in West Run at mile point 1.5 demonstrated exceedance of the State's 303(d) listing methodology. Fecal coliform monitoring of UNT/West Run RM 0.91 and UNT/West Run RM 3.97 near their mouths also exceeded the listing methodology. Fecal coliform impairments for all three streams are included on the West Virginia 2012 Section 303(d) list.

Multiple commenters incorrectly stated that a fecal coliform TMDL was developed for Whiteday Creek and incorrectly assumed that fecal coliform impairment in Whiteday Creek was determined from evaluation of modeling output.

DEP did not determine that Whiteday Creek was impaired pursuant to fecal coliform criteria and a fecal coliform TMDL was not developed. Fecal coliform TMDLs were developed for two tributaries of Whiteday Creek, UNT/Whiteday Creek RM 1.68 (WV-M-32-C) and Laurel Run (WV-M-32-P). Fecal coliform monitoring of those streams indicated impairment pursuant to the

State's 303(d) listing methodology. Allocations are presented for the four subwatersheds that make up the drainage area of the impaired tributaries.

One commenter contended that the fecal coliform data used to identify impairments and draft TMDLs are invalid because hundreds of fecal coliform analytical results are qualified as "estimated".

In analysis of fecal coliform using the membrane filter technique, the analyst is directed to set up dilutions expected to yield 20-60 colonies per membrane. Prediction of dilutions that will capture the range is difficult for sample sources such as streams where bacteria density may be highly variable. Standard Method 9222D, EPA document EPA- 600/8-78-017, and DEP guidance all recognize the potential to not achieve for the desired range of colony growth and prescribe calculation and reporting procedures for such situations. The “estimated” notation results from those procedures. The analytical results are valid as they are calculated in accordance with the methodology established by EPA.

One commenter questioned if ionic toxicity is a pollutant suitable for TMDL development.

DEP has not developed draft TMDLs for biological impairment or "ionic toxicity".

On commenter asked "How was the hardness adjustment factor addressed for hardness-dependent metals criteria?"

The TMDLs associated with this project are not based on metals criteria that are hardness-dependent.

Multiple commenters requested explanation of how precipitation was addressed in the determination of TMDL critical conditions and baseline modeling scenarios , comparison of the six-year design precipitation period (January 2004 - December 2009) to the long term average precipitation, and asked if instream data were censored to ensure that they did not reflect extreme flow events.

The baseline modeling condition applies the referenced period of precipitation to existing precipitation-induced nonpoint sources and precipitation induced point sources discharging at permit limits. The model compares predicted results to criteria with consideration of averaging period and exceedance frequency components. As displayed in Figure 10-4, the design precipitation period includes modestly wet, modestly dry and near average conditions as compared to long term average annual precipitation. The observed instream data collected during pre-TMDL monitoring was not censored when evaluating impairment as the criteria are applicable in high flow events. However, the predicted influences of multi-day storm events and/or exceptionally large storms present in the design hydrology were considered in the evaluation of the acceptability of model outputs for TMDL scenarios.

Multiple commenters provided similar comments relative to Combined Sewer Overflows. General support was expressed for the implementation provisions discussed in Section 14.1. The prohibition of mixings zones pursuant to 47 CSR 2 §5.2.c was disputed in relationship to CSOs. The commenters argued that the provision is not applicable because discharges are expected to occur when stream flows are above 5 cfs. One commenter stated that the recent

"Iowa Cities" decision makes clear that the Federal Clean Water Act does not prohibit mixing zones for bacteria.

The supporting comments are noted. DEP's interpretation of 47 CSR 2 §5.2.c remains as documented in the TMDL report. The provision barring mixing zones for human health criteria in streams with 7Q10 flow less than 5 cfs is not dependent upon the flow conditions at discrete points in time. The "Iowa Cities" decision does not alter currently effective West Virginia Water Quality Standards.

Multiple commenters supported the Section 14.1 MS4 wasteload allocation implementation discussion and stated that MS4 and CSO discharges will need long-term implementation schedules to implement controls to meet TMDL wasteload allocations. The commenters requested revision of Section 15.1 text as follows: "WVDEP's DWWM and DMR have the responsibility to ensure that NPDES permits contain effluent limitations as prescribed by the TMDL WLAs, appropriate long-term implementation schedules, and to assess and compel compliance. Permits will contain self-monitoring and reporting requirements that are periodically reviewed by WVDEP."

DEP recognizes that varying compliance schedule time periods may be necessary to implement wasteload allocations and that certain stormwater discharges may need more time than traditional point sources. But there is not an absolute and universal need for "long-term" schedules for all wasteload allocations. The Section 15.1 text has been modified to recognize the use of compliance schedules to implement wasteload allocations and that the amount of time needed for particular discharges will be a case-by-case determination in the NPDES permitting process.

Multiple commenters questioned lower required reductions for DOH MS4 areas in contrast to those prescribed for community MS4 entities.

MS4 allocations are provided relative to fecal coliform, total iron and chloride impairments and allocation approaches vary by pollutant. For fecal coliform bacteria, the DOH drainage area is represented as a background loading and reductions were not prescribed consistent with the background land uses within the communities. For chloride, impervious land use areas were targeted and equal reductions were prescribed for DOH and the communities. For iron, pervious land use areas and stream bank erosion were targeted, while impervious areas were not targeted. . Streambank erosion reductions were prescribed for both DOH and the communities

One commenter questioned the correctness of the MS4 WLA Fecal Detailed spreadsheet table, stating that it does not include baseline fecal coliform loadings for most sources.

The spreadsheet table is correct. It displays baseline and allocated loadings for the lands of each MS4 entity for each model subwatershed. Many line items in the spreadsheet have zero loads for various MS4 entities because those entities do not have contributing MS4 area in the subwatershed. For example, MS4 baseline and allocated loads are presented for Fairmont State University only on the table line for model subwatershed 3901 because the MS4 area of FSU exists only in that subwatershed. For subwatershed 3901, baseline loads are also displayed for Fairmont and DOH, but not for Morgantown, WVU, Star City, Westover or FCI.

One commenter stated that DEP should have posted the Technical Report online before the start of the comment period.

The Technical Report and appendices were available and multiple stakeholders obtained the information and based their comments on it. Because of size, the most practical means of transmission is via CD distributed directly from DEP. DEP will consider providing the Technical Report and appendices online along with the public report release in future project for the convenience of reviewers.

Multiple commenters expressed concern with the general allocation principle that most problematic sources should be reduced first and proposed that practical implementation, cost effectiveness likelihood of success, public support and other factors should be considered in determining allocations. The commenters also state that the principle pre-supposes impacts and negates the need for modeling.

The general principle has been retained. The primary role of a TMDL is to identify the source reductions needed to attain standards and in many instances alternatives to reducing the most problematic sources are few or none. Allocations that target less significant sources and avoid sources contributed a greater amount of pollutant would often not attain criteria and would not result in an approvable TMDL.

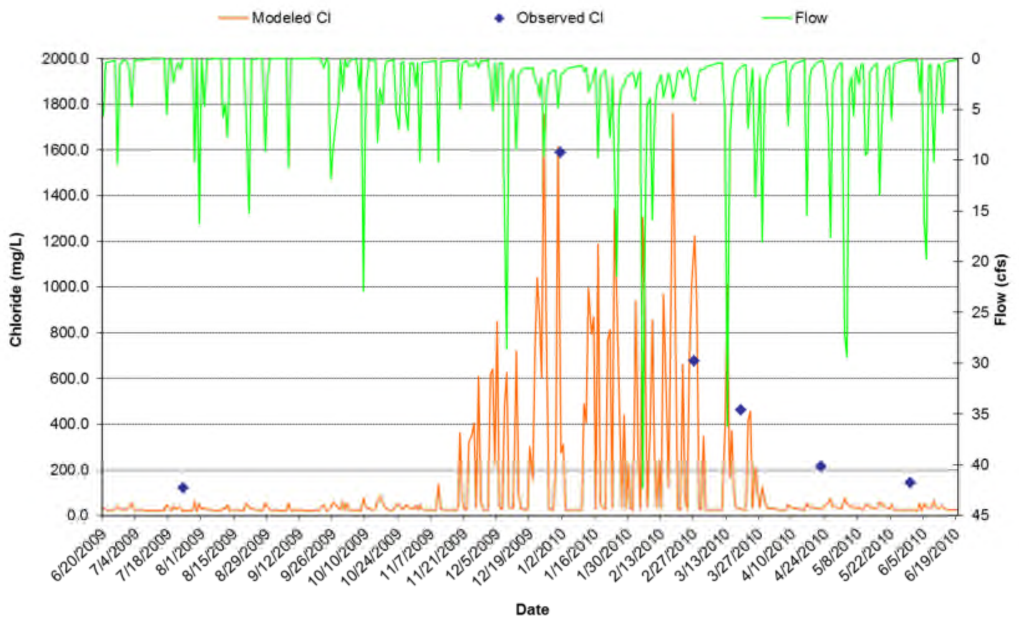
The principle does not negate the need for modeling. DEP performs extensive water quality monitoring and source characterization that allows model calibration and then uses the calibrated model to judge the effect of allocations relative to criteria attainment.

One commenter stated that runoff of chlorides from roads is the most impacting source, similar chloride loadings were assigned to DOH and Morgantown MS4 areas, roads dominate DOH areas but account for only 5% of Morgantown MS4 area, and that the model should account for the differences and assign allocations accordingly. The commenter requested additional information on the methodology used to calculate chloride baseline loads for MS4s.

Two streams - UNT/Mon River RM 99.49 (Popenoe Run, WV-M-11) and UNT/West Run RM 0.91 (WV-M-7-A) had non-low flow chloride water quality criteria exceedances documented in the pre-TMDL monitoring effort. High instream chloride levels were observed in the winter months. Salt application for road, sidewalk and parking lot de-icing was presumed to be the winter chloride source in these small streams draining highly urbanized watersheds. No point sources or other discharges with significant chloride levels are known to exist in these watersheds.

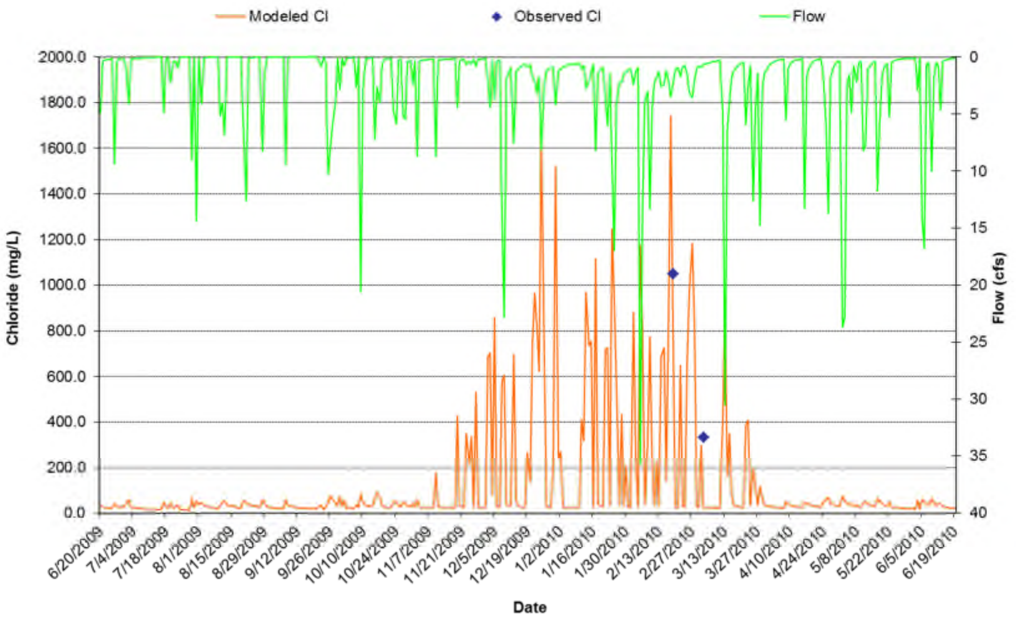
In the chloride modeling effort presented in the draft TMDL report, impervious surfaces were considered sources and targeted for chloride reduction. All other modeled landuses were represented as background. The baseline chloride loading from all impervious surfaces in the modeled subwatersheds were equally represented and the models were calibrated to observed measurements as depicted in the following graph(s).

Simulated & Observed Chloride (SubID: 1801 UNT/Mon River RM 99.49 (Popenoe Run))



Note: One sample for instream chloride concentration of 20,700 mg/l is not shown on this figure due to the scale. The model calibration and simulation did not achieve this concentration level.

Simulated & Observed Chloride (SubID: 1502 UNT/West Run RM 0.91)



Elevated chlorides are expected in the runoff from roads, sidewalks, and parking lots but not in the runoff from roofs. As such, DEP agrees that the chloride concentration in the runoff from DOH impervious area, which is predominately road surface, should be higher than that of community impervious area, which is a mix of roads, sidewalks, parking lots and roofs. The relative impact of chloride loading to streams is also dependent upon the amounts of DOH and community impervious surface area draining to the streams. In that regard, the impervious associated with community MS4 entities is many times greater than that of DOH. DEP lacks information to properly differentiate the unit area loadings of the individual MS4 entities. As such, we have modified the draft TMDLs by replacing the individual facility wasteload allocations with a grouped wasteload allocation for all MS4 entities (see revised Sections 10.7.5, 10.7.9, and chloride allocation spreadsheet) and have modified the text of Section 14.1 of the report to identify implementation expectations in the permitting process.

DEP recently deployed continuous conductivity meters at multiple locations in the subject streams. The metering is planned to be maintained on a long-term basis. At the time of servicing (approximately monthly), DEP will collect discreet samples for chloride and other parameters. The data generated will allow development of a relationship between chloride and conductivity that, in turn, will allow continuous conductivity measurement to further refine the magnitude and duration of chloride impairments. It will also allow assessment of the effects of any corrected actions implemented.

One commenter requested graphs of baseline and TMDL conditions for Simpson Creek.

Simpson Creek of the West Fork River is not addressed in this TMDL project.

Multiple commenters requested clarification of the discussion of biological diagnostic tools in Section 2.1.5 of the Technical Report and explanation of the purpose of the analyses and their use in the TMDL process.

The weighted averaging regression models and the dirty reference models were developed during WVDEP's first TMDL development project in 2004. These biological stressor diagnostic tools were explored to determine if collected organisms (either individually or by community) could assist in identifying the relative impact of individual stressors in a multi-stressor environment. In the weighted averaging regression models, tolerance values (optima and breadth) associated with individual stressors were established for over 150 genera of commonly collected benthic macroinvertebrates in the West Virginia biological samples that were available at that time. It was theorized that the presence or absence of certain organisms, in light of their expected presence or absence with respect to individual stressors would provide additional information to inform the stressor identification process. The dirty reference models were constructed under a philosophy that distinct community structures would result from exposure to individual stressors and that the similarity of the collected assemblage to those associated with individual stressors could also inform the stressor identification process. The tool identifies the relative similarity of the collected biological assemblage to one of four single stressors and the clean reference. "Dirty reference groups" are the biological assemblages from waters affected by single stressors and the "clean reference group" is the compilation of assemblages from sites with low levels of stress.

Neither tool was intended to be used independently. When consulted, the information that they provide is considered in conjunction with water quality, habitat, source and other information in the strength-of-evidence analysis of biological stressors. As explained earlier, no biological impairment TMDLs have been developed in this project and the stressor identification results are presented only for consideration in future 303(d) decision making.

One commenter pointed out that the Technical Report in one instance indicated failing septic systems were modeled as point sources and later showed them as nonpoint sources. The commenter requested clarification of how those sources were modeled.

The commenter pointed out confusing terminology used in the Technical Report regarding model representation of failing septic systems and straight pipes. Those sources were represented as “continuous flow sources” per the protocols discussed Section 3.3.4, subtitle: *Failing Septic Systems and Straight Pipes* of the Technical Report. Their loads are classified as nonpoint sources and included in the load allocation component of TMDLs. The confusion resulted from the Technical Report use of the term “point source” in place of the more appropriate term “continuous flow source”. Corrections have been made to the report.

One commented asked why TMDLs for bacteria were presented in average number of colonies per day instead of the maximum number of colonies per day.

The expression of TMDLs in average terms more accurately captures the flow variable aspects of stream water quality and its linkage to precipitation induced sources. Because water quality criteria are expressed by concentration, the allowable loadings at discreet points in time are dependent upon stream flow, and an individual “maximum load” would be either over-protective for the majority of stream flows or under-protective during critical low flow periods. All West Virginia fecal coliform TMDLs developed and approved to date have been expressed as average loads. The approach used captures modeled daily maximum loads that are summed to give annual loadings over the six-year design period. The annual loads are averaged and converted to daily loads. The average values appropriately reflect the range of expected stream flow and weather conditions.

Multiple commenters questioned the practicality of MS4 entities reducing sediment and iron loading associated with streambank erosion when they generally don’t control banks.

Bank erosion is most strongly influenced by bank stability and upland imperviousness. Within MS4 areas, the bank erosion loading is included in the wasteload allocation because upland imperviousness is a significant factor in the erosion of sediment and iron from the banks and into the water column. Runoff reduction BMPs are expected to be implemented under the MS4 permit. In Section 10.7.1, the discussion under the subtitle *Municipal Separate Storm Sewer System (MS4)* of the TMDL report recognizes that the existing degraded stability of streambanks may continue to accelerate erosion after maximization of uplands controls and minimization of stormwater volume and intensity and that an unspecified nonpoint source loading is contained within the wasteload allocations. The TMDL does not mandate bank stabilization projects, but MS4 entities could choose to include them in Stormwater Pollutant Prevention Plans and/ or pursue cooperative projects with watershed stakeholder groups and WVDEP’s Nonpoint Source Program.

Multiple commenters objected to wasteload allocations for Construction Stormwater General Permit (CSGP) registrations that limit the amount of concurrent disturbance, particularly where active MS4 agencies exercise permit oversight. The commenters contended that the allocation approach may discourage economic development and that local regulatory control provides additional requirements and increased oversight that eliminates the need to limit concurrent disturbed area. The Morgantown Utility Board specifically requested that construction stormwater area not be limited in areas discharging to CSOs and MS4 stormwater outlets for which it has oversight.

The allocation process for disturbed area registered under the CSGP is consistent with the approach used in multiple previous TMDL projects. The representation of sediment and iron loadings is based upon an assumption that the typical general permit controls result in average effluent quality of 100 mg/l TSS, with the resultant total iron concentration dictated by local TSS/FE relationships. The initial allocation area is based upon anticipated activity and is reduced only when the runoff from that area at its represented iron quality, coupled with the allocated loads from other existing sources are shown to not attain water quality standards. The resultant area “caps” define the area that can be registered concurrently under the permit with no additional consideration.

Section 12.1 of the TMDL report discusses additional considerations for registering areas exceeding allocations including effluent limitations and monitoring requirements, project phasing, disturbances over existing non-background land uses, or additional controls beyond those normally required by the permit. The recently reissued CSGP recognizes potential TMDL caps and allows registrations based upon the contingencies discussed in Section 12.1.

Authority to administer the Construction Stormwater General Permit has not been delegated to any local entities and no MS4 agencies exercise direct oversight of the CSGP. The MS4 permit does not ensure construction activity control to the extent that would allow the requested unlimited disturbance. That notwithstanding, DEP will cooperate with local governments in the administration of the CSGP and will give due consideration of local controls where they support the Section 12.1 contingencies and can be built into the registrations on a case-by-case basis.

One commenter stated that the scope of the TMDL project is poorly explained and lacks any rationale and suggested that the final report include a figure depicting the Monongahela River watershed in West Virginia and outlining the portion addressed in this project. Another commenter stated that the figures in the TMDL report do not readily allow location of impaired waters and sources.

DEP recognizes that fine detail is difficult to communicate in static maps, so a GIS project and shapefiles are provided to facilitate identification of impaired streams and the existing sources pollutant sources that were represented in the model. In response to the comment Section 3.1 and Figure 3-1 have been modified to clarify the scope of the project.

One permittee stated that it is difficult to determine which permittees are impacted by the TMDLs because permittee names and permit numbers are not contained in the report text and only the permit number is provided in the wasteload allocation tables of the allocation spreadsheets.

This format for the allocation spreadsheet components of the TMDL project has been used in all WVDEP TMDL projects to date and has been successfully used in implementation. It is designed to efficiently provide allocation information for the NPDES permitting process. The wasteload allocation tables can be filtered by NPDES permit number to identify wasteload allocations for permitted outlets in specific model subwatersheds.

One commenter stated that the inclusion of percent reduction column in tables for certain source categories and the lack thereof in the wasteload allocation tables is deceptive in that it appears there are no reductions prescribed for point sources.

There is no intended deception in the format of the tables of the allocation spreadsheets. For certain nonpoint and stormwater point source categories, percent reduction information may be useful in implementation. For traditional point sources, the formats of the wasteload allocation tables are designed to clearly communicate the concentration-based wasteload allocations that are operational. The permitted outlets for which pollutant reductions are prescribed can be gleaned from comparing the wasteload allocation column entries to the baseline column entries.

One commenter incorrectly stated that chloride reduction was not assigned to urban impervious surface runoff in the Popenoe Run (WV-M-11) watershed.

All urban land in the Popenoe Run watershed is associated with MS4 systems and the prescribed reductions are displayed in the MS4 WLA Summary and MS4 WLA Details tables of the chloride allocation spreadsheet.

One commenter requested graphs showing modeled baseline conditions for iron, aluminum and TSS at modeled locations in Deckers Creek over the time period modeled.

Baseline condition is a representation of multi-year design precipitation applied to existing nonpoint sources and permits at permit limits. It should not be construed as a representation of existing conditions, but rather permitted conditions. It is more useful to compare the calibration results to observed monitoring to gauge model performance. In that regard the technical report appendix has been revised to include calibration graphs for TSS and iron for 33 subwatersheds within the project area, including five examples for Deckers Creek. Deckers Creek was not modeled for aluminum because it was not determined to be impaired pursuant to existing dissolved aluminum water quality criteria.

One commenter asked: "Were the reduction in iron loadings used for the dissolved aluminum TMDL included in the baseline run for the iron TMDL?

The iron reductions for AML seeps determined necessary in iron TMDLs (i.e the iron AML seep load allocations) were an initial allocation step in the dissolved aluminum TMDLs.

One commenter disagreed with the TMDL report statement "Arnett Run is the only selenium impaired stream in the Monongahela River Watershed", noting that the West Virginia 2012 Section 303(d) list includes two other newly listed selenium impaired waters - UNT/Building Run (WVM-1-C-3-A-1) and Tunnel Hollow (WVM-19-J).

Selenium was comprehensively assessed in the pre-TMDL monitoring conducted in the Monongahela River watershed. That monitoring effort identified impairment only in Arnett Run. As such, only the Arnett Run selenium impairment was included in the scope of work for the TMDL development project. The commenter is correct that the unnamed tributary of Building Run and Tunnel Hollow are selenium impairments newly identified on the 2012 Section 303(d) list. Tunnel Hollow is located in the Monongahela River watershed and the unnamed tributary of Building Run is in the Dunkard River watershed. The Dunkard River watershed is beyond the scope of this project. Both impairments were identified after the Monongahela River watershed TMDL modeling and report development contract was executed and the timing did not allow them to be addressed in this project. The TMDL report text should have stated that the only selenium impaired stream ***addressed in this project*** is Arnett Run. The report has been revised to clarify this issue. The other selenium impairments will remain on the 303(d) list until new information indicates water quality standard attainment or until TMDL development is accomplished.

One commenter asked if the Phase II expansion of the Scotts Run Public Service District sanitary sewer collection system was represented in the fecal coliform modeling of Scotts Run, Guston Run and Wades Run.

The Phase II expansion of Scotts Run Public Service District was not represented in the modeling associated with the draft TMDLs but has been captured in the final fecal coliform TMDLs for affected streams. Calibration was not adversely affected because the expansion was not complete when pre-TMDL monitoring was performed. Since the new collection system now provides service to a portion of existing residences in Scotts Run, Guston Run and Wades Run, the baseline conditions for the affected streams and subwatersheds were remodeled. As displayed in the final fecal coliform allocation spreadsheet, reduced baseline load allocations for septic systems in subwatersheds 1705, 1708 and, 1710 resulted from the elimination of failing systems now served by the collection system expansion. In addition WLAs for five individual permits for home aeration units were also removed.

One commenter stated that the Technical Report discusses in detail input options and assumptions that a TMDL developer has to consider but lacks explanation of assumptions made or options used to derive the TMDLs. The commenter specifically referenced Section 3.5 and indicated that DEP should document specific assumptions and MDAS programming options used.

DEP acknowledges that Section 3.5 provided details of the model capabilities and development that were inappropriate to include in the Technical Report for the TMDL effort. In response to the comment, the section was revised to provide clarification on what specific model elements were employed to develop pH and aluminum TMDLs in the Monongahela River Watershed. Appropriate discussions for the modeling approaches for other parameters were presented in the draft document.

One commenter stated that WVDEP should have included 45 segments of 38 streams as biologically impaired on the 2012 Section 303(d) list and has not given good cause for excluding them.

The Draft Monongahela River Watershed TMDL project does not present TMDLs for biological impairments. 303(d) listing methodologies and decisions are generally beyond the scope of the project. 303(d) listed impairments will be retained until TMDLs are developed or otherwise addressed and delisted.

One commenter stated that WVDEP should acknowledge that sulfate and specific conductance are "pollutants that are strongly correlated indicators of "mining pollution" and "parameters of concern in the Monongahela River Watershed", and should place numerical limits for those pollutants in NPDES permits. The commenter identified three specific WV/NPDES permits for mining operations and stated that those permits routinely discharge concentrations exceeding the likely stressor and definite stressor thresholds displayed in Technical Report of Appendix B.

DEP recognizes that elevated dissolved solids can adversely impact some aquatic life. Because West Virginia has not promulgated numeric water quality criteria for sulfates or for cumulative measures of dissolved pollutants, stream impairment assessments, TMDLs, and permit conditions must address impacts per the biological integrity component of the narrative criterion at 47 CSR 2 §3.2.i. Per SB 562, DEP is developing a new methodology to assess that narrative criterion and will present it for legislative review.

One commenter restated an excerpt from Senate Bill 562 ("Senate Bill 562 mandates the secretary to develop proposed rules that support a balanced aquatic community that is diverse in species composition") and indicated that WVDEP should adopt the genus-level GLIMPSS index because it is taxonomically closer to " species" than the family-level WVSCI index.

Although not germane to the draft TMDLs, the comment is noted.

14.0 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.

14.1 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 12**.

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 Monongahela River Watershed will be reissued beginning in July 2013 and the reissuance of mining permits will begin January 1, 2014.

In regard to chloride TMDLs, the causative sources of impairment in some instances are NPDES permitted facilities that are not achieving currently prescribed effluent limitations. WVDEP will implement TMDL through regulatory actions necessary to compel compliance with NPDES permit limits.

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 and educational institutions 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.

The MS4 WLAs for chloride will present a unique and difficult challenge in that the de-icing of roads, sidewalks and other impervious surfaces are the cause of water quality standard violations. DEP recognizes that MS4 entities will have to reduce chloride loadings to streams while maintaining public safety. Effective control may require research of alternative deicing practices and an extended period of time to accomplish. To assist in BMP effectiveness assessment, DEP is committed to long-term maintenance of continuous conductivity monitoring of the impaired streams and the development of conductivity/chloride relationships.

Additionally, the chloride TMDLs are not intended to prohibit the pursuit of the water quality standard modifications as provided in 46 CSR 6, if such measures are determined to be necessary. The chloride TMDLs may be modified to properly implement future water quality standard revisions (designated use and/or criteria), if enacted and approved by the USEPA.

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.

14.2 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 Northern Nonpoint Source Program Basin Coordinator, Martin Christ (Martin.J.Christ@wv.gov).

The Allegheny Conservation Corps, Buffalo Creek Dream Makers, Downstream Alliance, Friends of Deckers Creek, Monongahela Revival Project, West Run Watershed Association, and

White Day Creek Association, Inc. are active watershed associations in the Monongahela River Watershed. For additional information concerning the associations, contact the above mentioned Basin Coordinator.

14.3 Public Sewer Projects

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

14.4 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.

15.0 MONITORING PLAN

The following monitoring activities are recommended:

15.1 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.

15.2 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.

15.3 TMDL Effectiveness Monitoring

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

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