


Final USEPA Approved Report

Total Maximum Daily Loads for Selected Streams in the Cheat River Watershed, West Virginia

January 2011

Prepared for

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

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ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

7Q10	7-day, 10-year low-flow
AMD	acid mine drainage
AML	abandoned mine land
AML&R	[WVDEP] Office of Abandoned Mine Lands & Reclamation
BMP	best management practice
BOD	biochemical oxygen demand
CFR	Code of Federal Regulations
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
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
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. The term "watershed" is also used more generally to refer to the land area that contributes precipitation runoff that eventually drains to the Cheat River.

TMDL Watershed

This term is used to describe the total land area draining to an impaired stream for which a total maximum daily load (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.

Subwatershed

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

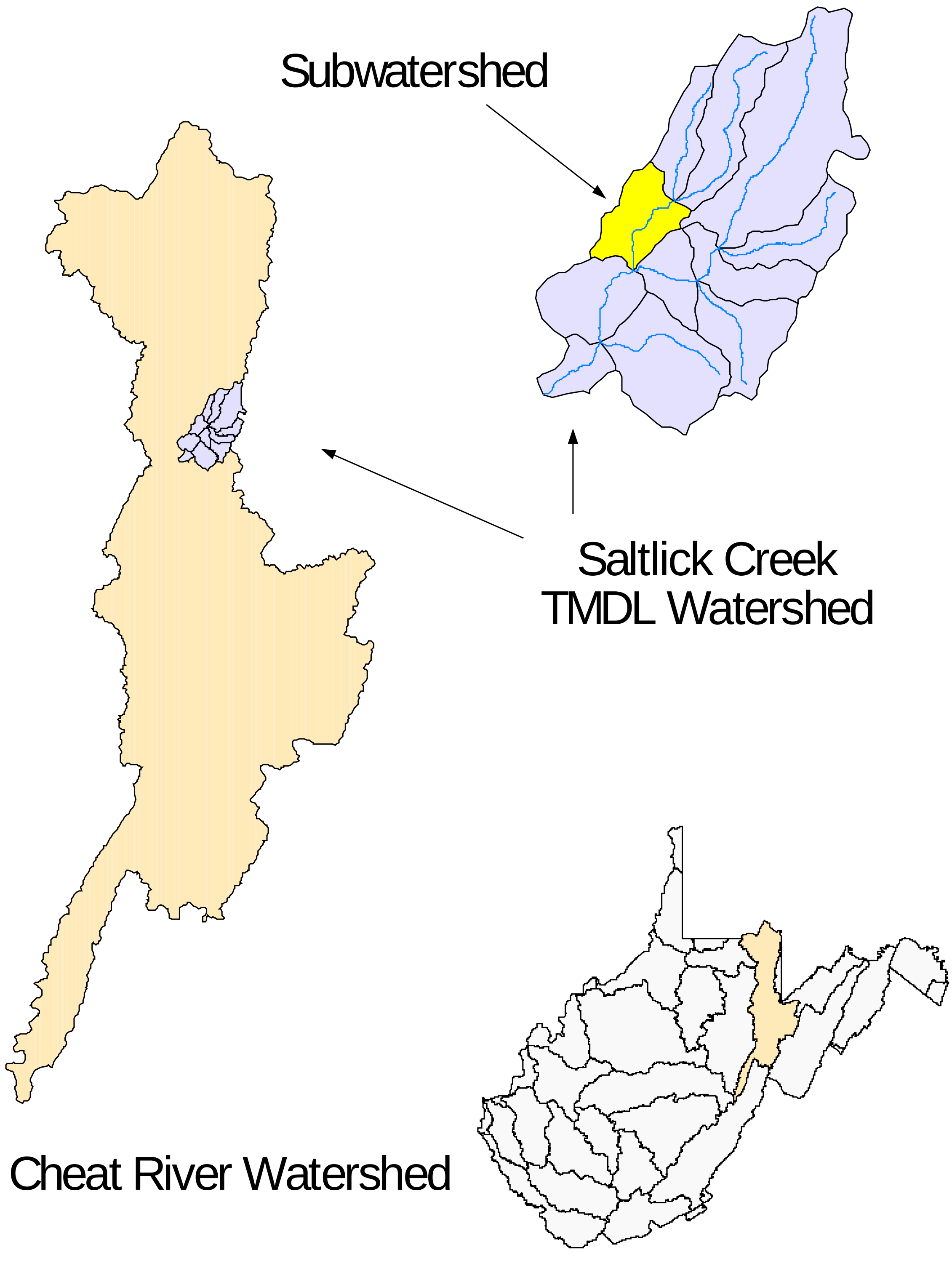

Figure I-1 Examples of a watershed, TMDL watershed, and subwatersheds

EXECUTIVE SUMMARY

This project is a collaborative effort between EPA Region 3 and the West Virginia Department of Environmental Protection and additional support was provided by the Friends of Cheat (FOC) watershed association. This report includes Total Maximum Daily Loads (TMDLs) for 99 impaired streams in the Cheat River watershed located in the north central portion of West Virginia.

A TMDL establishes the maximum allowable pollutant loading for a waterbody to remain in compliance with applicable 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 majority of the subject impaired streams are included on West Virginia's Draft 2010 Section 303(d) List. Documented impairments are related to numeric water quality criteria for total iron, total manganese, dissolved aluminum, pH, and fecal coliform bacteria. Certain waters are also biologically impaired based on the narrative water quality criterion of 47 CSR 2–3.2.i, which prohibits the presence of wastes in state waters that cause or contribute to significant adverse impacts on the chemical, physical, hydrologic, and biological components of aquatic ecosystems.

Impaired waters were organized into 22 TMDL watersheds. For hydrologic modeling purposes, impaired and unimpaired streams in these 22 TMDL watersheds were further divided into 566 smaller subwatershed units for modeling. 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 the linkage between pollutant sources and instream responses for fecal coliform bacteria, iron, manganese, 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.

Portions of the Big Sandy Creek TMDL watershed and direct drains of the Cheat River are located in Pennsylvania. The TMDLs do not prescribe specific load and wasteload allocations for contributing drainage areas in Pennsylvania. Instead, they assign a gross load expressed as a load allocation by model subwatershed, thereby allowing Pennsylvania the flexibility to determine appropriate and necessary point and nonpoint source reductions. Although a large portion of the Cheat River watershed is addressed by this report, TMDLs have not been developed in the Shavers Fork and Dry Fork watersheds, nor in the Blackwater River watershed upstream of Beaver Creek. The areas are represented as boundary conditions for the Cheat River and Blackwater River mainstem TMDLs.

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. There are no CSOs, SSOs, or MS4s contributing to Cheat River streams for which fecal coliform TMDLs were developed.

Within this effort, the iron TMDLs presented for troutwaters do not assure complete attainment of the chronic aquatic life protection iron criterion. Criterion attainment would require pollutant reductions from existing sources that are beyond practical levels, coupled with significant reductions of undisturbed upland and streambank background loadings, and no provisions for future growth. The relatively high iron content of the soils in the Cheat River watershed is the primary influencing factor. An adaptive implementation approach is proposed (Section **9.7.2**) under which the source allocations necessary to universally achieve an interim iron water quality target (1.0 mg/L, 4-day average, once per three years average exceedance frequency) are implemented concurrently with WVDEP's efforts to pursue criterion revisions.

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, 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.

The pH and dissolved aluminum impairments in the Cheat River watershed are related and are attributable to two separate nonpoint source categories. In certain watersheds with low buffering capacity, acidic precipitation decreases pH below the pH criterion. Decreased pH may in turn increase the portion of aluminum in solution and result in exceedances of the dissolved aluminum criterion. Dissolved aluminum and pH impairments have also been attributed to acidity and aluminum loading from abandoned mine land (AML) sources. The acidic pH impairments coincide with overlapping metals impairments and the TMDLs for pH impairments were developed using an approach where instream metal (iron and aluminum) concentrations were reduced for attainment of iron and aluminum water quality criteria coupled with direct pollutant reductions to offset acid load from atmospheric deposition. The total manganese impairments in the Cheat River Watershed are solely attributed to discharges associated with legacy mining activities in the watershed.

Biological integrity/impairment is based on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index (WVSCI). The first step in TMDL development for biologically impaired waters is stressor identification (SI). Section 4 discusses the SI process. SI was followed by stream-specific determinations of the pollutants for which TMDLs must be developed. Metals and pH toxicity, organic enrichment, and sedimentation were identified as causative stressors for the biologically impaired streams addressed in this effort.

Where biological impairments in the watershed were attributed to toxicity from low pH and elevated dissolved metals, it was determined that the implementation of those pollutant-specific TMDLs would address the biological impairment.

Organic enrichment was identified as a significant biological stressor in many waters. All such waters also demonstrated violations of the numeric criteria for fecal coliform bacteria. It was determined that implementation of fecal coliform TMDLs would removed untreated sewage and significantly reduce animal wastes, thereby reducing the organic and nutrient loading causing the biological impairment.

Where sedimentation was identified as a significant stressor, sediment TMDLs were initially developed within the MDAS using a reference watershed approach. The MDAS was configured to examine upland sediment loading and streambank erosion and depositional processes. Load reductions for sediment-impaired waters were projected based upon the sediment loading present in an unimpaired reference watershed. For all of those waters, a strong, positive correlation between iron and total suspended solids (TSS) was identified and iron TMDLs are presented. It was universally determined that the sediment reductions necessary for the attainment of iron water quality criteria exceed those necessary to address biological stress from sedimentation. As such, the iron TMDLs serve as surrogates for the biological impairments caused by sedimentation.

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 the identified 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. Precipitation induced source reductions were not specified beyond natural (background) levels and allocations for continuous flow sources were no more stringent than numeric water quality criteria.

Applicable TMDLs are displayed in Section 10 of this report. Accompanying spreadsheets provide TMDLs and allocations of loads to categories of point and nonpoint sources that achieve the total TMDL. Also provided with is draft report is an interactive ArcGIS geographic information system (GIS) project that allows for the exploration of spatial relationships among the source assessment data. A dynamic web based “TMDL Viewer” tool is currently being developed and is anticipated to available at the completion of this project. A Technical Report is also available that describes the detailed technical approaches used in the process and displays data upon which the TMDLs are based.

In 2001, EPA, with support from WVDEP, developed the metals and pH TMDLs for the Cheat River Watershed (EPA, 2001). Due to technical issues, EPA cautioned against immediate implementation of wasteload allocations and stated their plans for modification of the TMDLs. Additionally, West Virginia water quality standards were subsequently revised. This project includes detailed implementable TMDLs for the Cheat River watershed that are consistent with effective water quality criteria. All streams/impairments for which TMDLs were developed in 2001 have been re-evaluated. Upon approval, the TMDLs presented herein shall supersede those developed previously. This re-evaluation determined impairments for which TMDLs developed in 2001 are no longer effective. All total aluminum TMDLs developed in 2001 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, and 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.

1.0 REPORT FORMAT

This report describes the overall total maximum daily load (TMDL) development process for the Cheat River watershed, identifies impaired streams, and outlines the source assessment for all pollutants for which TMDLs are presented. It also describes the modeling and allocation processes and lists measures that will be taken to ensure that the TMDLs are met. The applicable TMDLs are displayed in Section 10 of this report. The draft report is supported by a compact disc containing an interactive ArcGIS project that provides further details on the data and allows the user to explore the spatial relationships among the source assessment data. A dynamic web based “TMDL Viewer” tool is currently being developed and is anticipated to available at the completion of this project. With this tool, users can magnify streams and other features of interest. Also included on the CD are spreadsheets (in Microsoft Excel format) that provide detailed source allocations associated with successful TMDL scenarios. A Technical Report is also included that describes the detailed technical approaches used in the process and displays 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.

This project is a collaborative effort between EPA and WVDEP that consisted of a very substantial effort from both parties that has been ongoing since 2006. Additional source tracking support was provided by the Friends of Cheat (FOC) watershed association whereby pollutant source tracking efforts were coordinated in order to avoid duplication of work and to take advantage of FOC personnel’s extensive knowledge of the central Cheat tributaries and acid mine drainage (AMD) source locations.

In 2001, EPA, with support from WVDEP, developed the metals and pH TMDLs for the Cheat River Watershed (EPA, 2001). EPA was faced with the challenge of using an untested and proprietary model developed by a third party to develop TMDL allocations for 55 acid mine drainage impacted streams in the Cheat River watershed. As a result of inadequacies and uncertainty associated with the setup of the proprietary model, EPA was forced to use broad-based assumptions that ultimately resulted in a TMDL that was difficult to implement and was inconsistent with WVDEP TMDL program policies and objectives. In addition, significant aluminum and manganese water quality criterion revisions have been enacted since EPA approval of the 2001 TMDL project rendering the existing TMDLs obsolete. The goal for this project is to produce detailed “implementable” TMDLs for the Cheat River watershed that are technically defensible and consistent with effective water quality criteria.

All streams/impairments for which TMDLs were developed in 2001 have been re-evaluated. Upon approval, the TMDLs presented herein shall supersede those developed previously. All total aluminum TMDLs developed in 2001 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 no longer applies. In limited instances, this re-evaluation determined that the impairments for which TMDLs were developed in 2001 no longer exist. Snyder Run (WV-MC-124-K-15-E) and Hawkins Run (WV-MC-124-K-23-C) are not impaired for iron and UNT/Heather Run RM 1.5(WV-MC-52-A) is not impaired for iron, manganese, and pH. The Cheat River mainstem is not impaired for pH. A summary of previous 303(d) listings and EPA 2001 TMDLs which are no longer effective is provided in Technical Report Appendix K.

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 pollutant loading a waterbody can receive while maintaining 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, 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 in 2009 TMDLs should be pursued in Hydrologic Group A, which includes the Cheat River watershed (due to funding complications this project was delayed by approximately 9 months). 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. WVDEP then presents its allocation strategies in a second public meeting, after which final TMDL reports are developed. The draft TMDL is advertised for public review and comment, and a third informational meeting is held during the public comment period. Public comments are addressed, and the draft TMDL is submitted to USEPA for approval.

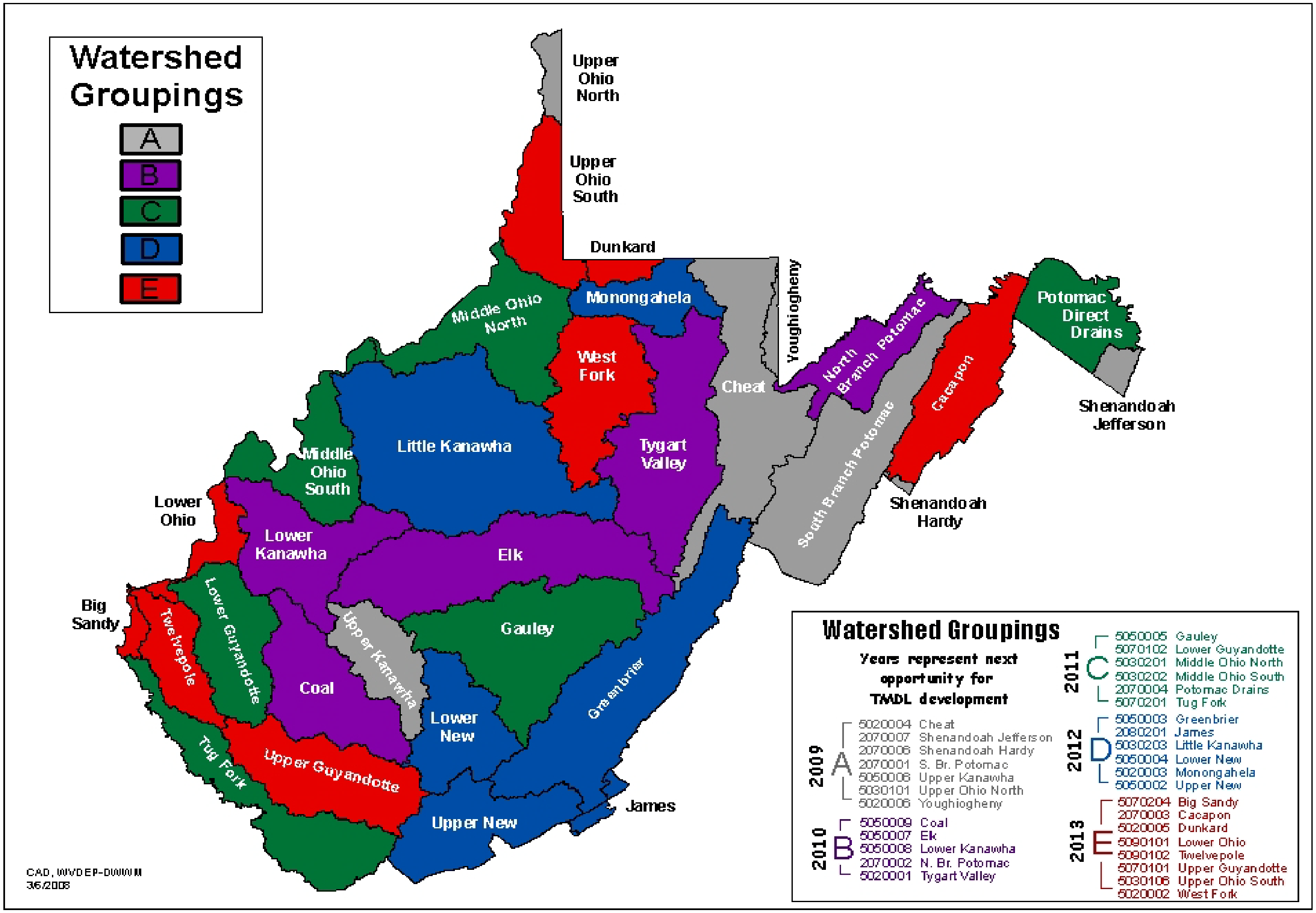

Figure 2-1. Hydrologic groupings of West Virginia's watersheds

2.2 Water Quality Standards

The determination of impaired waters involves comparing instream conditions with 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://www.wvsos.com/csr/verify.asp?TitleSeries=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. Most of the waterbodies in the Cheat River watershed are designated as warmwater fisheries, but there are 17 impaired streams designated as troutwaters. For the impaired waters of this report, West Virginia iron and aluminum aquatic life protection numeric water quality criteria vary with respect to warmwater fisheries and troutwaters.

In various streams in the Cheat River watershed, the warmwater fishery and troutwater aquatic life use impairments have been determined pursuant to exceedances of iron, dissolved aluminum, and/or pH numeric water quality criteria. Water contact recreation and public water supply use impairments have also been determined pursuant to exceedances of numeric water quality criteria for fecal coliform bacteria, total iron, total manganese and pH.

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 applicable in Heather Run, Lick Run, UNT/Lick Run RM 1.04, Joes Run, Pringle Run and that these streams are impaired pursuant to the criterion.

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 is the basis for "biological impairment" determinations. Biological impairment signifies a stressed aquatic community, and is discussed in detail in Section **4.0**.

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 both numeric and narrative 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 EPA 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	--	0.5	1.5
Manganese, total (mg/L)	--	--	--	--	1.0[c]
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

As shown in **Figure 3-1**, the Cheat River watershed in West Virginia lies mostly within Preston, Monongalia, Tucker, and Randolph Counties in West Virginia, with a portion in Fayette County in Pennsylvania. In West Virginia and Pennsylvania, its drainage area encompasses approximately 1,422 square miles. The average elevation in the watershed is 2,270 feet. The highest point is 4,845 feet on Back Allegheny Mountain in the Shavers Fork headwaters. The minimum elevation is 870 feet, which is the normal pool elevation of Cheat Lake. The total population living in the subject watersheds of this report is estimated to be 40,000 people.

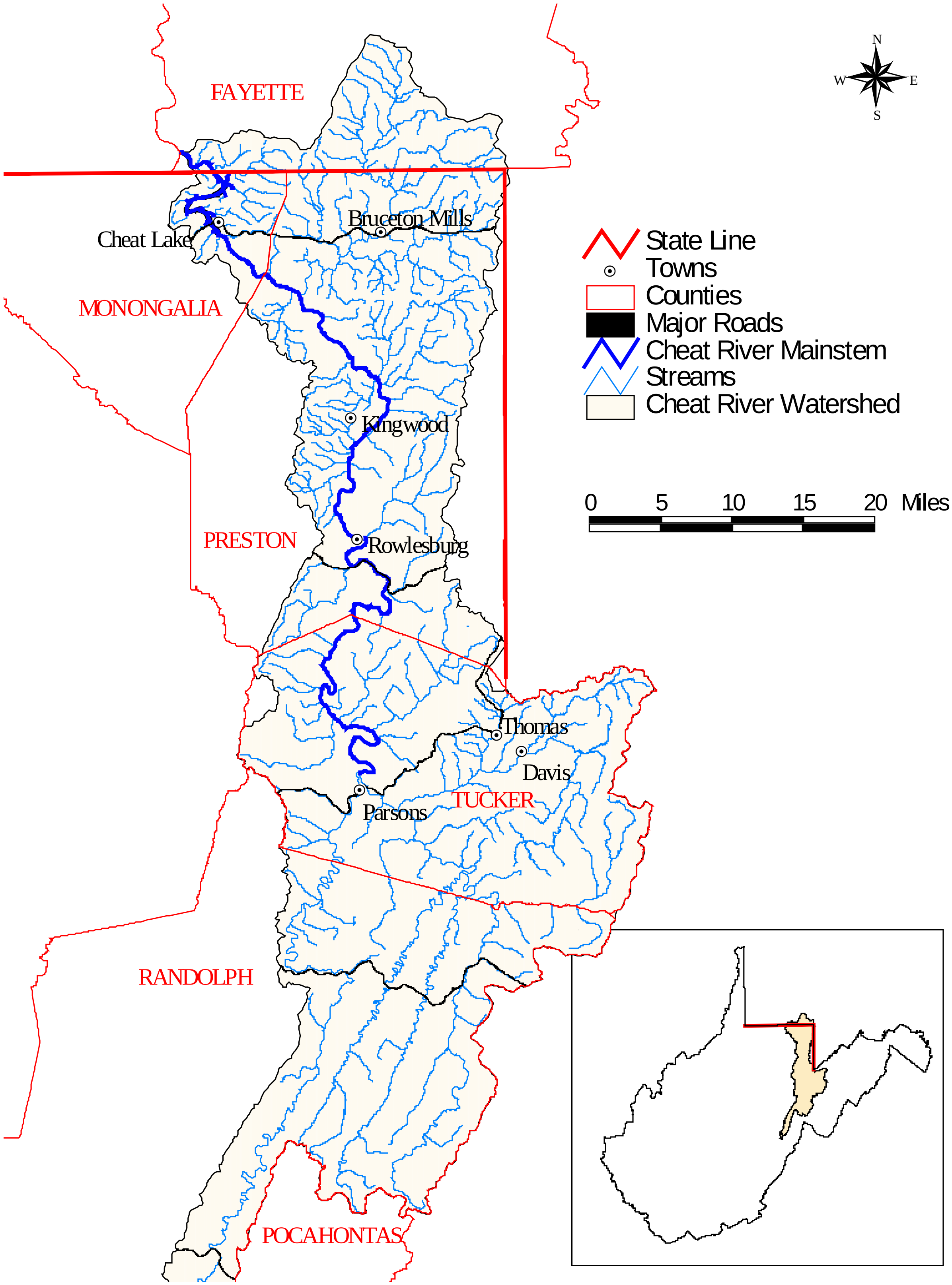

Figure 3-1 Location of the Cheat River watershed in West Virginia

Table 3-1 displays the landuse distribution for the 566 modeled subwatersheds in the Cheat River watershed. The dominant landuse is forest, which constitutes 84.9 percent of the total landuse area. Other important modeled landuse types are grassland (4.8 percent), urban/residential (4.9 percent), and cropland (1.6 percent). Individually, all other land cover types compose one percent or less of the total watershed area.

Landuse and land cover estimates were originally obtained from vegetation data gathered from the National Land Cover Dataset (NLCD) 2001. 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 Modified landuse for the Cheat River TMDL watersheds

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
Water	8188.6	12.8	0.9%
Wetland	7671.3	12.0	0.8%
Barren	6362.0	9.9	0.7%
Forest	772277.9	1206.7	84.9%
Grassland	43540.2	68.0	4.8%
Cropland	14557.4	22.7	1.6%
Pasture	4917.3	7.7	0.5%
Urban/Residential	44235.1	69.1	4.9%
Mining	5454.5	8.5	0.6%
AML	2809.9	4.4	0.3%
Total Area	910014.1	1421.9	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 I. The Friends of Cheat (FOC) watershed association provided assistance to WVDEP in the mining pollutant source tracking efforts.

The geographic information is provided in the ArcGIS project included on the CD version of this report.

Table 3-2 Datasets used in TMDL development

Type of Information		Data Sources
Watershed physiographic data	Stream network	West Virginia Division of Natural Resources (WVDNR)
	Landuse	National Land Cover Dataset 2001 (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, Friends of Cheat (FOC)
	National Pollutant Discharge Elimination System (NPDES) data	WVDEP DMR, WVDEP DWWM
	Discharge Monitoring Report data	WVDEP DMR, Mining Companies

Type of Information		Data Sources
	Abandoned mine land data	WVDEP DMR, WVDEP DWWM, Friends of Cheat
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 Cheat River watershed from July 2006 through June 2007. 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 (modeled impairment).

TMDLs were developed for impaired waters in 22 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. Modeled impairments are called out separately, in the bottom section of the table.

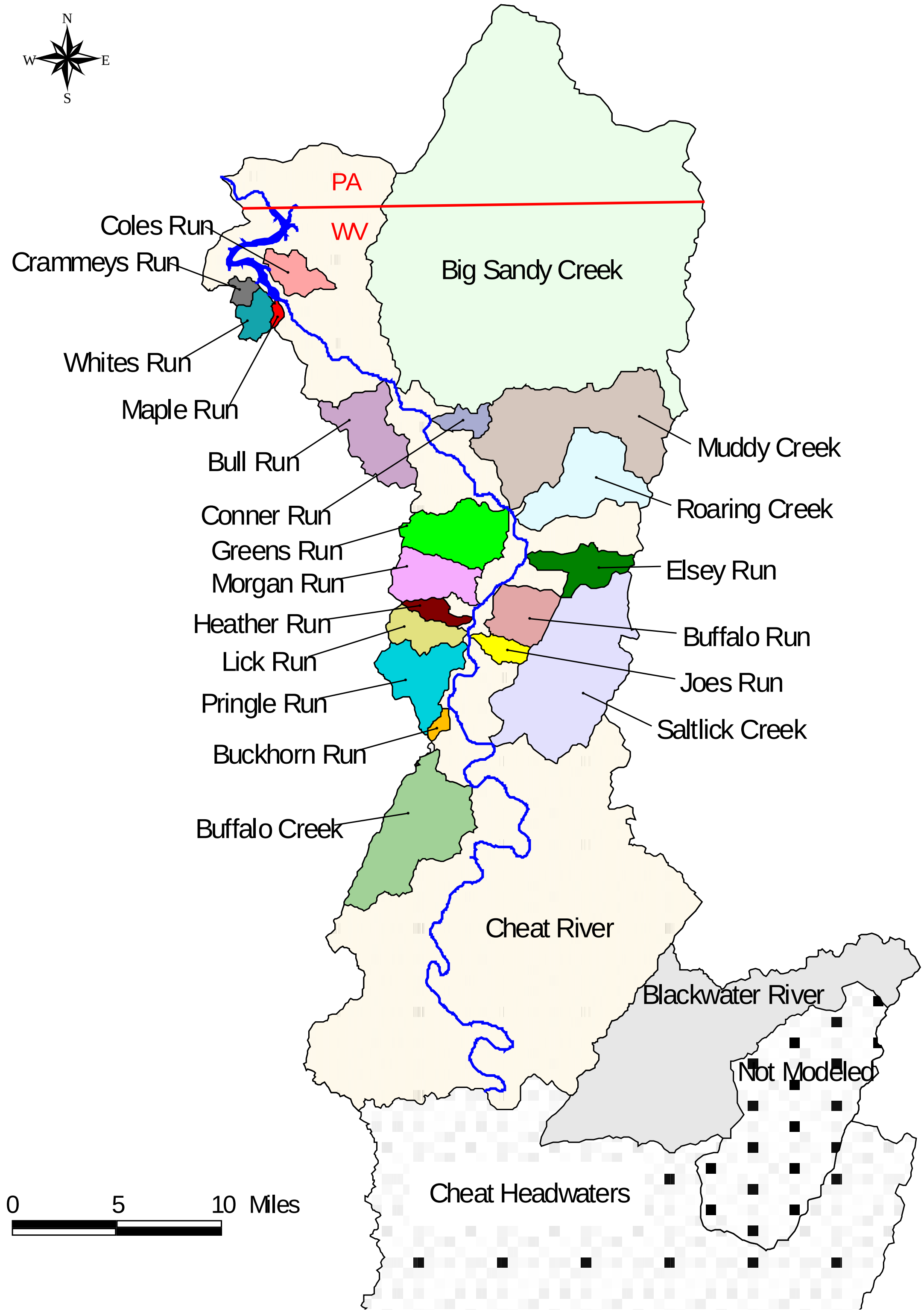

Figure 3-2 22 Cheat River TMDL watersheds

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

Stream Name	NHD Code	Trout	pH	Fe	Al	Mn	FC	Bio
Cheat River	WV-MC			x				
UNT/Cheat River RM 7.70	WV-MC-10		x	x	x			
UNT/Cheat River RM 8.39	WV-MC-11		x	x	x			
Blackwater River	WV-MC-124-K	Yes		x	x			
Tub Run	WV-MC-124-K-11		x		x			
Finley Run	WV-MC-124-K-14		x	x	x			
North Fork/Blackwater River	WV-MC-124-K-15		x	x	x			
Long Run	WV-MC-124-K-15-C		x	x	x			x
Middle Run	WV-MC-124-K-15-D		x					
Snyder Run	WV-MC-124-K-15-E		x					
Sand Run	WV-MC-124-K-15-H	Yes		x	x		x	x
Beaver Creek	WV-MC-124-K-23		x					
Hawkins Run	WV-MC-124-K-23-C		x		x			
UNT/Beaver Creek RM 8.81	WV-MC-124-K-23-H		x					
UNT/Beaver Creek RM 11.36	WV-MC-124-K-23-J	Yes	x	x	x			
UNT/Beaver Creek RM 11.91	WV-MC-124-K-23-K		x					
Big Run	WV-MC-124-K-8		x					
Coles Run	WV-MC-13						x	x
Kelly Run	WV-MC-13-A			x			x	x
Birch Hollow	WV-MC-13-D						x	
Crammeys Run	WV-MC-14						x	
Whites Run	WV-MC-15						x	x
Maple Run	WV-MC-16		x		x			
UNT/Cheat River RM 1.85	WV-MC-2		x	x	x			
Bull Run	WV-MC-25		x	x	x			x
UNT/Bull Run RM 1.64	WV-MC-25-A		x		x			
Middle Run	WV-MC-25-B		x	x	x			
Mountain Run	WV-MC-25-C		x		x			
Lick Run	WV-MC-25-C-1		x	x	x			
UNT/Bull Run RM 3.73	WV-MC-25-D		x	x	x			
Right Fork Bull Run	WV-MC-25-E		x		x			x
Left Fork Bull Run	WV-MC-25-F		x					
Big Sandy Creek	WV-MC-27		x	x			x	x
UNT/Big Sandy Creek RM 2.91	WV-MC-27-B		x	x	x			
Sovern Run	WV-MC-27-F		x		x		x	x
Parker Run	WV-MC-27-H			x			x	
Little Laurel Run	WV-MC-27-I-4	Yes	x		x			

Stream Name	NHD Code	Trout	pH	Fe	Al	Mn	FC	Bio
Little Sandy Creek	WV-MC-27-J	Yes		x			x	
Elk Run	WV-MC-27-J-10		x					
Piney Run	WV-MC-27-J-11	Yes	x	x			x	
Cherry Run	WV-MC-27-J-12	Yes		x	x		x	
UNT/Cherry Run RM 1.96	WV-MC-27-J-12-D		x	x				
Mill Run	WV-MC-27-J-13	Yes		x	x			
Webster Run	WV-MC-27-J-2						x	
UNT/Webster Run RM 1.25	WV-MC-27-J-2-B		x		x			x
UNT/Little Sandy Creek RM 2.80	WV-MC-27-J-3						x	
UNT/Little Sandy Creek RM 5.04	WV-MC-27-J-5						x	
Beaver Creek	WV-MC-27-J-6	Yes	x	x	x			
Glade Run	WV-MC-27-J-6-B						x	
UNT/Beaver Creek RM 1.25	WV-MC-27-J-6-C		x					
UNT/Beaver Creek RM 1.68	WV-MC-27-J-6-D		x		x			
Barnes Run	WV-MC-27-J-7						x	
Hog Run	WV-MC-27-J-9	Yes		x				
Hazel Run	WV-MC-27-K	Yes	x	x	x		x	x
Glade Run	WV-MC-27-M			x			x	
UNT/Big Sandy Creek RM 10.23	WV-MC-27-N						x	
Glade Run	WV-MC-27-T			x			x	
Conner Run	WV-MC-30		x	x	x			
Greens Run	WV-MC-38		x	x	x			x
South Fork/Greens Run	WV-MC-38-C		x	x	x			x
UNT/South Fork RM 0.63/Greens Run	WV-MC-38-C-1		x	x	x			x
Muddy Creek	WV-MC-39	Yes	x	x	x		x	x
Sypolt Run	WV-MC-39-B		x	x				
Crab Orchard Run	WV-MC-39-D			x				
Martin Creek	WV-MC-39-E		x	x	x			x
Fickey Run	WV-MC-39-E-1		x	x	x		x	x
Glade Run	WV-MC-39-E-2		x	x	x			x
UNT/Glade Run RM 1.06	WV-MC-39-E-2-A		x	x	x			
UNT/Glade Run RM 1.36	WV-MC-39-E-2-B		x	x	x			
UNT/Muddy Creek RM 9.80	WV-MC-39-I			x			x	
UNT/UNT RM 0.12/Muddy Creek RM 9.80	WV-MC-39-I-1		x		x			
Jump Rock Run	WV-MC-39-J	Yes	x	x	x			
Sugarcamp Run	WV-MC-39-L	Yes	x		x			
Roaring Creek	WV-MC-40	Yes			x			
UNT/Roaring Creek RM 0.34	WV-MC-40-A						x	

Stream Name	NHD Code	Trout	pH	Fe	Al	Mn	FC	Bio
Lick Run	WV-MC-40-C		x					
Little Lick Run	WV-MC-40-C-1						x	
UNT/Ragtavern Run RM 0.81	WV-MC-44-A-1						x	
Buffalo Run	WV-MC-47		x		x			
UNT/Cheat River RM 4.07	WV-MC-5		x	x	x			
Morgan Run	WV-MC-50		x	x	x			x
UNT/Morgan Run RM 1.03	WV-MC-50-A			x			x	x
UNT/UNT RM 0.34/Morgan Run RM 1.03	WV-MC-50-A-1						x	
Church Creek	WV-MC-50-B		x	x	x			x
UNT/Church Creek RM 1.26	WV-MC-50-B-1		x	x	x			
UNT/UNT RM 0.12/Church Creek RM 1.26	WV-MC-50-B-1-A		x	x	x			
Heather Run	WV-MC-52		x	x	x	x		x
UNT/Heather Run RM 1.47	WV-MC-52-A						x	
Lick Run	WV-MC-54		x	x	x	x		x
UNT/Lick Run RM 1.04	WV-MC-54-A		x	x	x	x		
Joes Run	WV-MC-55		x		x	x		x
Pringle Run	WV-MC-56		x	x	x	x		x
UNT/Pringle Run RM 3.17	WV-MC-56-C		x	x	x			
UNT/Pringle Run RM 3.33	WV-MC-56-D		x	x	x			
UNT/Pringle Run RM 3.60	WV-MC-56-E		x	x	x			
Buckhorn Run	WV-MC-61		x					
Spruce Run	WV-MC-67-D	Yes		x				
Bucklick Run	WV-MC-67-J	Yes					x	
Birchroot Run	WV-MC-68-I						x	
Modeled Impairments								
Stream Name	**NHD Code**	**Trout**	**pH**	**Fe**	**Al**	**Mn**	**FC**	**Bio**
Blackwater River	WV-MC-124-K	Yes	x					
Tub Run	WV-MC-124-K-11			x				
Middle Run	WV-MC-124-K-15-D			x	x			
Beaver Creek	WV-MC-124-K-23			x	x			
Coles Run	WV-MC-13			x				
Crammeys Run	WV-MC-14			x				
Whites Run	WV-MC-15			x				
UNT/Bull Run RM 1.64	WV-MC-25-A			x				
Mountain Run	WV-MC-25-C			x				
Right Fork Bull Run	WV-MC-25-E			x				
Left Fork Bull Run	WV-MC-25-F			x	x			
Sovern Run	WV-MC-27-F			x				
Parker Run	WV-MC-27-H		x					

Stream Name	NHD Code	Trout	pH	Fe	Al	Mn	FC	Bio
Little Laurel Run	WV-MC-27-I-4	Yes		x				
Little Sandy Creek	WV-MC-27-J	Yes	x		x			
Piney Run	WV-MC-27-J-11	Yes			x			
Cherry Run	WV-MC-27-J-12	Yes	x					
Mill Run	WV-MC-27-J-13	Yes	x					
Webster Run	WV-MC-27-J-2		x	x				
UNT/Webster Run RM 1.25	WV-MC-27-J-2-B			x				
Glade Run	WV-MC-27-J-6-B		x	x	x			
UNT/Beaver Creek RM 1.68	WV-MC-27-J-6-D			x				
Barnes Run	WV-MC-27-J-7		x					
Hog Run	WV-MC-27-J-9	Yes	x		x			
UNT/Muddy Creek RM 9.80	WV-MC-39-I		x					
Sugarcamp Run	WV-MC-39-L	Yes		x				
Roaring Creek	WV-MC-40	Yes	x	x				
Lick Run	WV-MC-40-C				x			
Little Lick Run	WV-MC-40-C-1		x		x			
Buffalo Run	WV-MC-47			x				
UNT/Morgan Run RM 1.03	WV-MC-50-A		x		x			
UNT/UNT RM 0.34/Morgan Run RM 1.03	WV-MC-50-A-1			x				
Joes Run	WV-MC-55			x				
Bucklick Run	WV-MC-67-J	Yes		x				

Note:
RM = River Mile
MP = Mile Point
UNT = unnamed tributary.
FC indicates fecal coliform bacteria impairment
BIO indicates a biological impairment

4.0 BIOLOGICAL IMPAIRMENT AND STRESSOR IDENTIFICATION

Initially, TMDL development in biologically impaired waters requires identification of the pollutants that cause the stress to the biological community. Sources of those pollutants are mine drainage, untreated sewage, and sediment. Section 2 of the Technical Report discusses biological impairment and the stressor identification (SI) process in detail.

4.1 Introduction

Assessment of the biological integrity of a stream is based on a survey of the stream's benthic macroinvertebrate community. Benthic macroinvertebrate communities are rated using a multimetric index developed for use in wadeable streams of West Virginia. The West Virginia Stream Condition Index (Gerritsen, Burton, & Barbour, 2000) (WVSCI) is composed of six metrics that were selected to maximize discrimination between streams with known impairments and reference streams. In general, streams with WVSCI scores of fewer than 60.6 points, on a normalized 0–100 scale, are considered biologically impaired.

Biological assessments are useful in detecting impairment, but they may not clearly identify the causes of impairment, which must be determined before TMDL development can proceed. USEPA developed *Stressor Identification: Technical Guidance Document* (Cormier, Sutter, & Norton, 2000) to assist water resource managers in identifying stressors and stressor combinations that cause biological impairment. Elements of the SI process were used to evaluate and identify the significant stressors to the impaired benthic communities. In addition, custom analyses of biological data were performed to supplement the framework recommended by the guidance document.

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. TMDLs were established for the responsible pollutants at the conclusion of the SI process. As a result, the TMDL process established a link between the impairment and benthic community stressors.

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 2001 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 comprehensive list of candidate causes, or stressors. The candidate causes responsible for biological impairments are listed below:

1. Metals contamination (including metals contributed through soil erosion) causes toxicity
    - Dissolved Aluminum
    - Total Iron
2. Acidity (low pH) causes toxicity
3. Basic (high pH >9) causes toxicity
4. High sulfates, high chlorides, and increased ionic strength causes toxicity
5. Increased total suspended solids (TSS)/erosion, altered hydrology (etc.), and algal growth causes sedimentation and other habitat alterations
6. Increased metals flocculation (aluminum, iron and manganese) and deposition causes habitat alterations (e.g., embeddedness)
7. Organic enrichment (e.g. sewage discharges, agricultural runoff) causes 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.

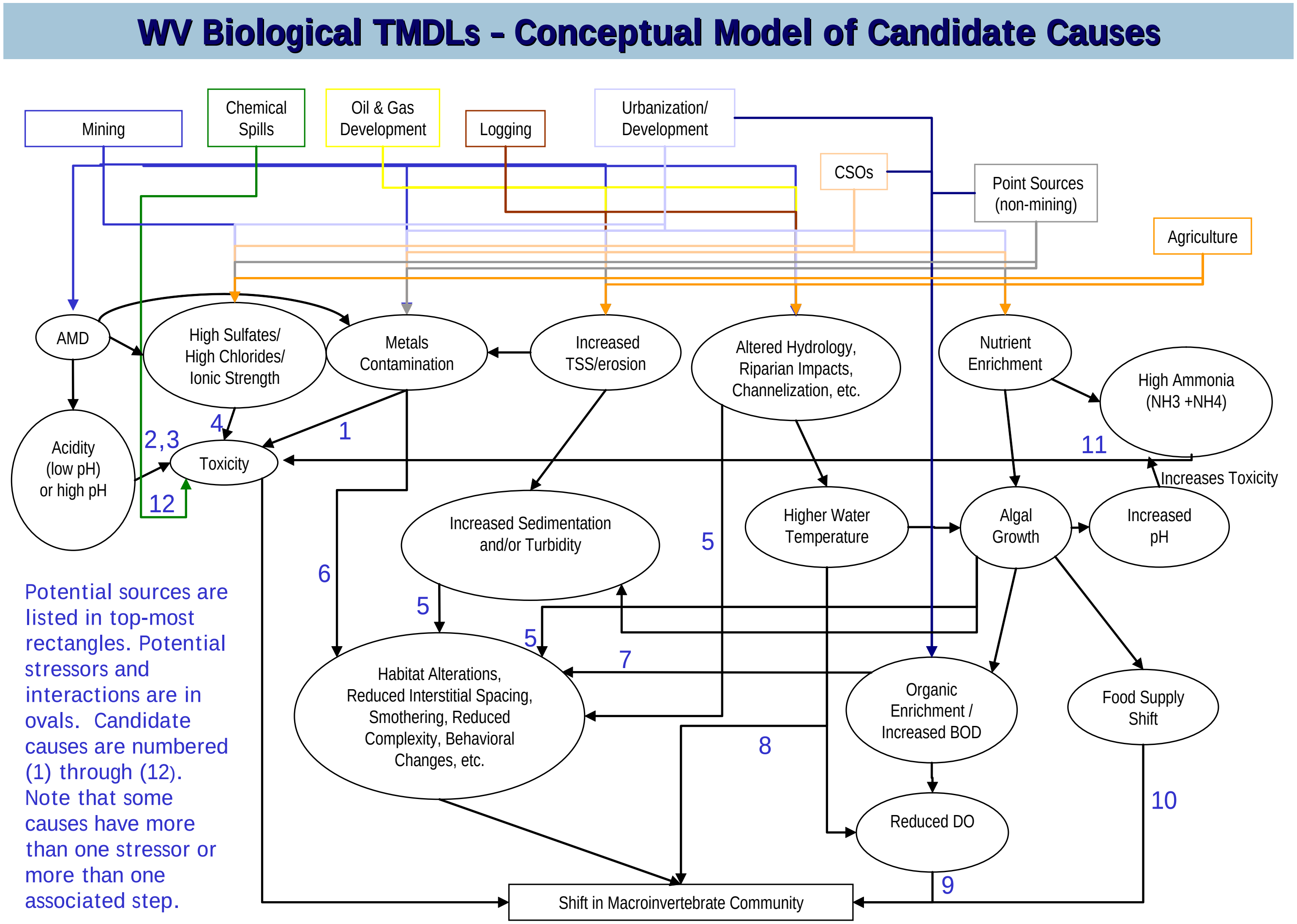

Figure 4-1 Conceptual model of candidate causes and potential biological effects

4.4 Stressor Identification Results

The SI process determined the significant causes of biological impairment in the Cheat River watershed. Biological impairment was linked to a single stressor in some cases and multiple stressors in others. The stressors identified during this process are:

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

After stressors were identified, WVDEP determined the pollutants for which TMDLs were required to address the impairment.

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

Where the SI process identified organic enrichment as the cause of biological impairment, 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 resolve the biological impairment in these streams. Therefore, fecal coliform TMDLs will serve as a surrogate where organic enrichment was identified as a stressor.

WVDEP initially pursued the development of TMDLs directly for sediment to address the sedimentation biological stressor. The intended approach involved selection of a reference stream with an unimpaired biological condition, prediction of the sediment loading present in the reference stream, and use of the area-normalized sediment loading of the reference stream as the TMDL endpoint for sediment impaired waters.

Bucklick Run (WV-MC-67-J) was selected as the achievable reference stream as it shares similar landuse, ecoregion and geomorphologic characteristics with the sediment impaired streams. The location of Bucklick Run is shown in **Figure 4-2**.

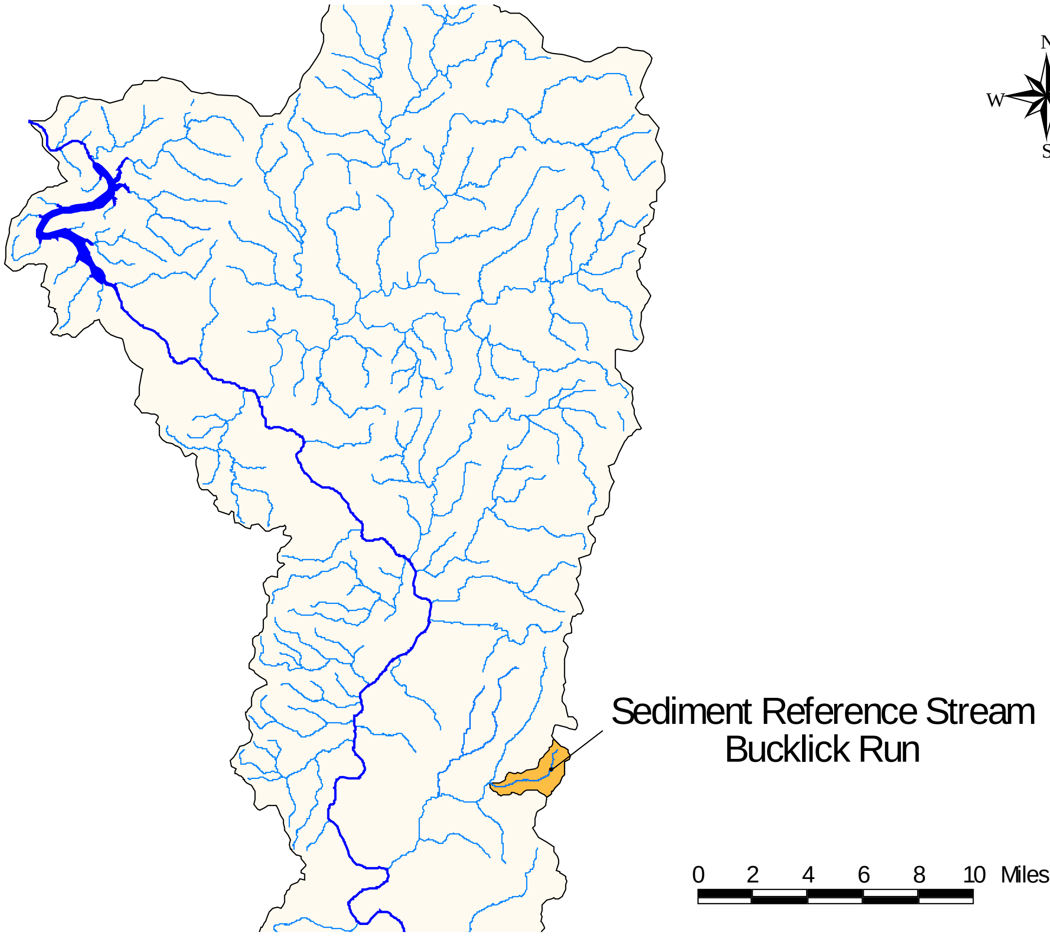

Figure 4-2. Location of the sediment reference stream, Bucklick Run (WV-MC-67-J)

All of the biologically impaired waters for which sedimentation was identified 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. 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. As such, the iron TMDLs are acceptable surrogates for biological impairments from sedimentation.

Table 4-1 provides a list of biologically impaired streams and how they are addressed in the Cheat River TMDL effort.

Table 4-1 Significant stressors of biologically impaired streams in the Cheat River watershed

TMDL Watershed	Stream Name	NHD Code	Biological Stressors	TMDL to be Developed
Coles Run	Coles Run	WV-MC-13	Sedimentation	Total Iron
Coles Run	Kelly Run	WV-MC-13-A	Sedimentation Iron Hydroxide (substrate limiting)	Total Iron
Whites Run	Whites Run	WV-MC-15	Sedimentation Organic Enrichment	Total Iron Fecal Coliform
Bull Run	Bull Run	WV-MC-25	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Bull Run	Right Fork Bull Run	WV-MC-25-E	pH Toxicity Aluminum Toxicity	pH Dissolved Aluminum
Big Sandy	Big Sandy Creek	WV-MC-27	Sedimentation	Total Iron
Big Sandy	Sovern Run	WV-MC-27-F	Aluminum Toxicity pH Toxicity	Dissolved Aluminum pH
Big Sandy	UNT/Webster Run RM 1.25	WV-MC-27-J-2-B	Aluminum Toxicity pH Toxicity Sedimentation	Dissolved Aluminum pH Total Iron
Big Sandy	Hazel Run	WV-MC-27-K	Sedimentation	Total Iron
Greens Run	Greens Run	WV-MC-38	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Greens Run	South Fork/Greens Run	WV-MC-38-C	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH

TMDL Watershed	Stream Name	NHD Code	Biological Stressors	TMDL to be Developed
Greens Run	UNT/South Fork RM 0.63/Greens Run	WV-MC-38-C-1	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Muddy Creek	Muddy Creek	WV-MC-39	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Muddy Creek	Martin Creek	WV-MC-39-E	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Muddy Creek	Fickey Run	WV-MC-39-E-1	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Muddy Creek	Glade Run	WV-MC-39-E-2	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Morgan Run	Morgan Run	WV-MC-50	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Morgan Run	UNT/Morgan Run RM 1.03	WV-MC-50-A	Organic Enrichment Iron Hydroxide (substrate limiting)	Fecal Coliform Total Iron
Morgan Run	Church Creek	WV-MC-50-B	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Heather Run	Heather Run	WV-MC-52	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Lick Run	Lick Run	WV-MC-54	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH

TMDL Watershed	Stream Name	NHD Code	Biological Stressors	TMDL to be Developed
Joes Run	Joes Run	WV-MC-55	Aluminum Toxicity pH Toxicity	Dissolved Aluminum pH
Pringle Run	Pringle Run	WV-MC-56	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Blackwater River	Long Run	WV-MC-124-K-15-C	Metals Toxicity pH Toxicity	Total Iron Dissolved Aluminum pH
Blackwater River	Sand Run	WV-MC-124-K-15-H	Sedimentation	Total Iron

5.0 METALS SOURCE ASSESSMENT

This section identifies and examines the potential sources of iron, aluminum, and manganese impairments in the Cheat 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 the 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 bond forfeiture sites and abandoned mine lands (AML). The assignment of LAs to AML and bond forfeiture sites does not reflect any determination by WVDEP or USEPA as to whether there are, in fact, unpermitted point source discharges within these landuses. 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.

The Friends of Cheat (FOC) watershed association provided assistance to WVDEP in the mining pollutant source tracking efforts. The FOC data collection was focused on Sovern Run of Big Sandy Creek, Greens Run, Muddy Creek, Morgan Run, Heather Run, Lick Run, and Pringle Run – all located in the greater Kingwood area. Most of the data was collected during the pre-TMDL monitoring period (July 2006 to June 2007), though the entire FOC source data set used in the TMDL model extended from July 2005 through November 2009. FOC used similar source tracking methods as WVDEP to locate individual AMD sources. Once located, the sources were sampled; and flow measurements and GPS coordinates were taken for each source. Larger sources were sampled on multiple occasions.

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 project on the CD version of this TMDL report.

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**.

5.1.1 Mining Point Sources

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) 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 Environmental Resources Information System (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 25 mining-related NPDES permits with 65 associated outlets in the metals impaired watersheds of the Cheat River watershed. Six of these permits (26 outlets) are for quarries. 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 G of the Technical Report. **Figure 5-1** illustrates the extent of the mining NPDES outlets in the watershed.

5.1.2 Non-mining Point Sources

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

There are 21 modeled non-mining NPDES permits in the watersheds of metals impaired streams, which are displayed in **Figure 5-1.**

The non-mining permits that regulate stormwater associated with industrial activity implement stormwater benchmark values of 100 mg/L TSS and/or 1.0 mg/L total iron. 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 G of the Technical Report.

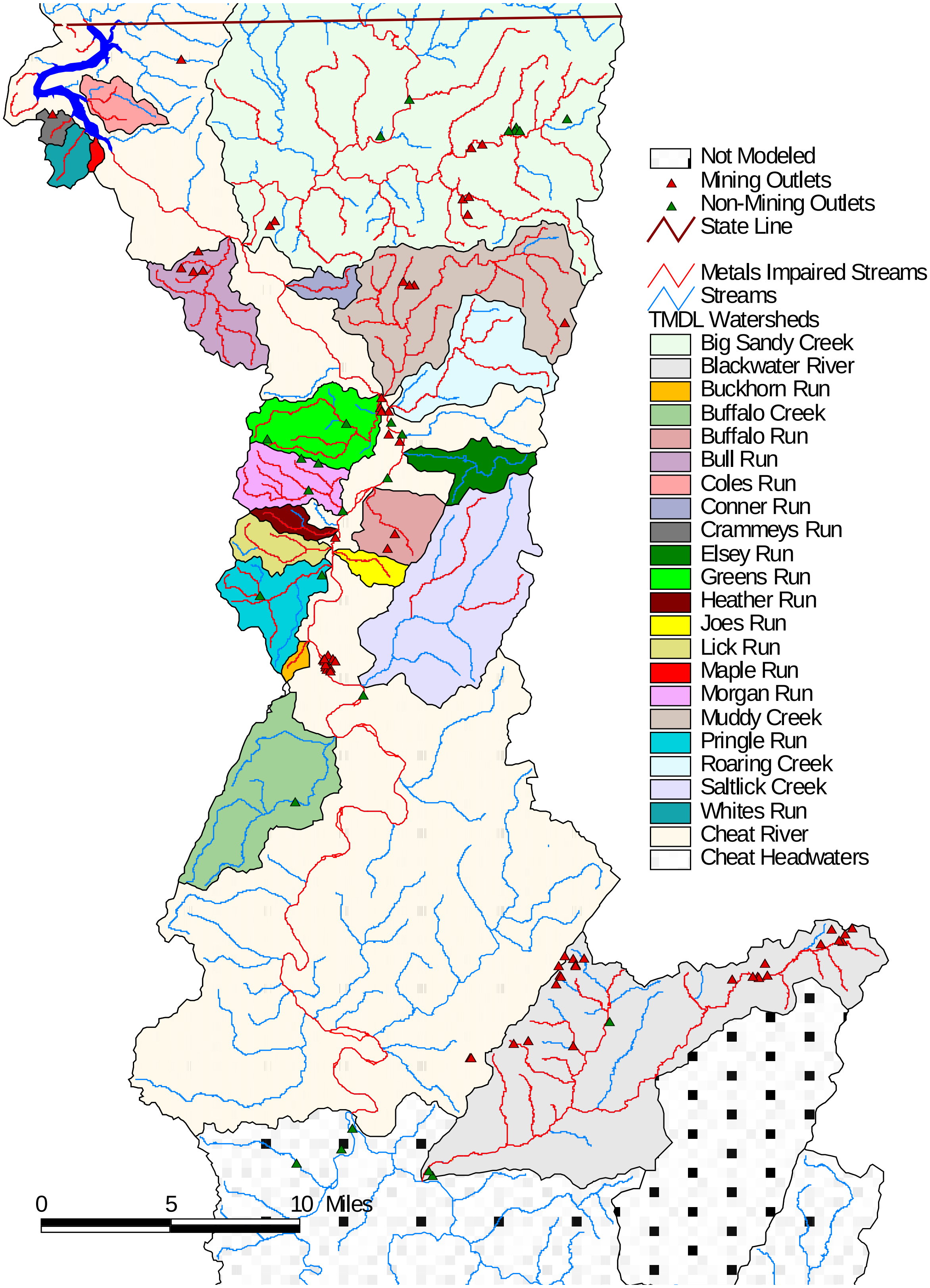

Figure 5-1. Metals point sources in the Cheat River watershed

5.1.3 Construction Stormwater Permits

The discharges from construction activities that disturb more than one acre of land are legally defined as point sources and the sediment introduced from such discharges can contribute iron 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.

There are 43 active construction sites with a total disturbed acreage of 468 acres registered under the Construction Stormwater General Permit in the watersheds of metals impaired waters (**Figure 5-2**).

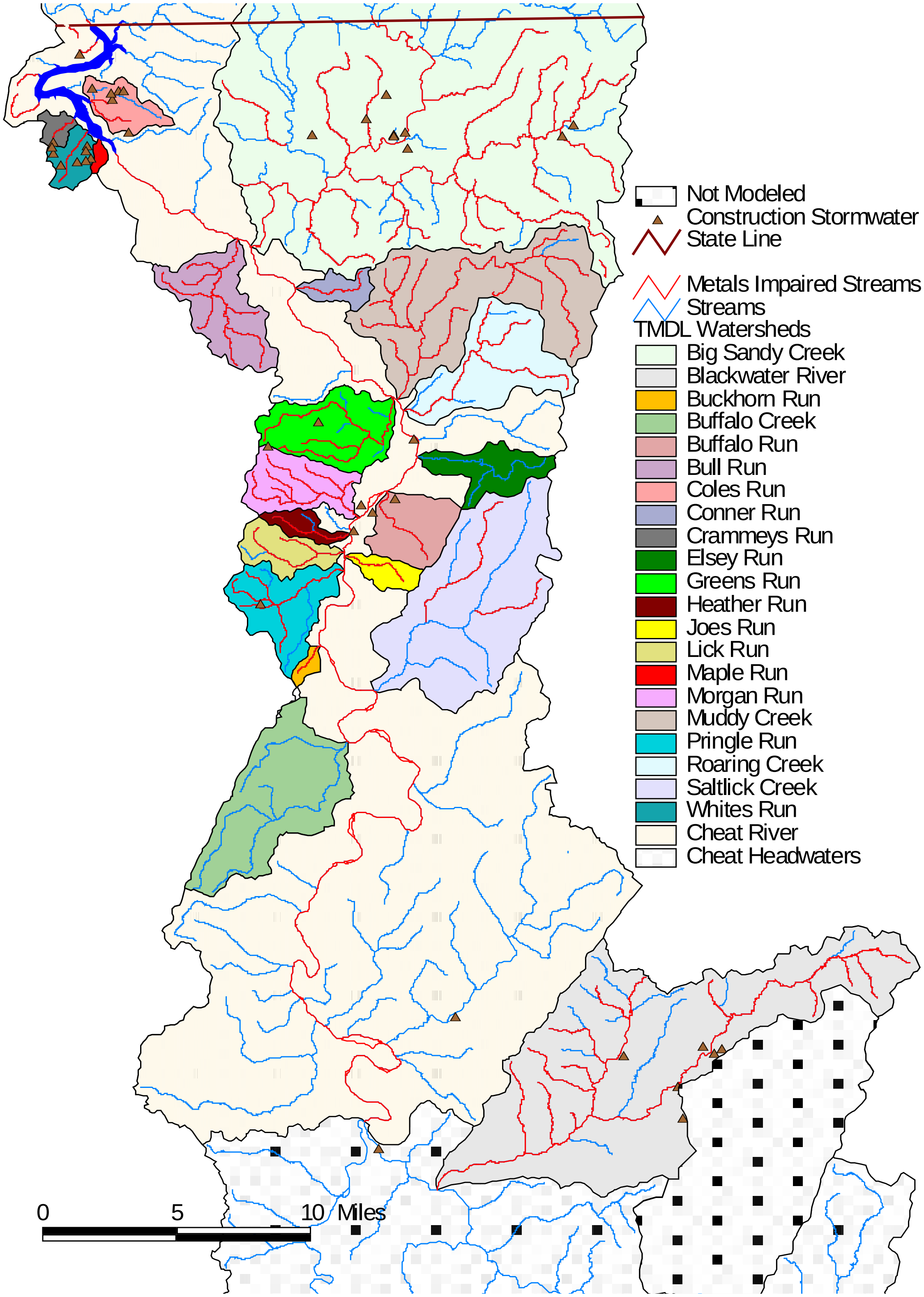

Figure 5-2. Construction stormwater permits in the Cheat River watershed

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

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 Cheat 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 1,977 acres of AML area, 342 AML seeps, and 70 miles (833 acres) of highwall were incorporated into the TMDL model (**Figure 5-3**).

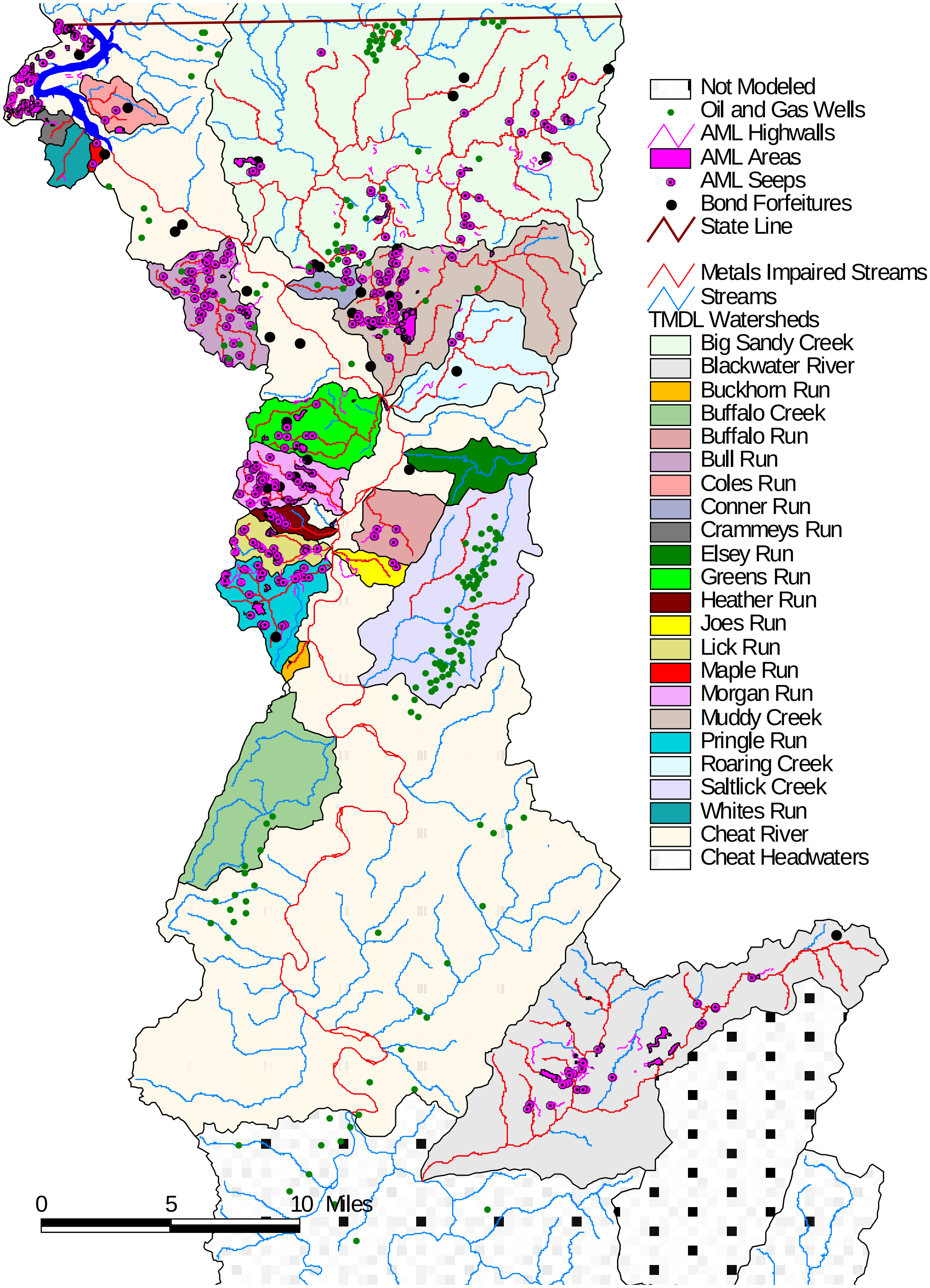

Figure 5-3. Metals nonpoint sources in the Cheat River watershed

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. 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 (22,645 acres) and the subset of land disturbed by roads and landings (1,505acres) for 343 registered logging sties, as well as 216 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.

Oil and gas data incorporated into the TMDL model were obtained from the WVDEP OOG GIS coverage. There are 224 active (328 acres) oil and gas wells 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 5-3**).

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 2000 TIGER/Line shapefiles from the U.S. Census Bureau and the WV Roads GIS coverage prepared by West Virginia University (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 less than 3 percent of the modeled land area in metals impaired TMDL watersheds. Source tracking information shows minimal upland loading impact from these sources. Sedimentation/iron impacts from agricultural landuses are indirectly reflected in the streambank erosion allocations.

Streambank Erosion

Streambank erosion has been determined to be a significant sediment source. The sediment loading from bank erosion is considered a nonpoint source and LAs are assigned. The streambank erosion modeling process is discussed in Section **9.2.2**.

Other Land-Disturbance Activities

Stormwater runoff from residential and urban landuses is a significant source of sediment in parts of the watershed. The modified NLCD2001 landuse data were used to determine the extent of residential and urban areas and source representation was based upon precipitation and runoff.

The NLCD 2001 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 SMCRA Bond Forfeiture Sites

Facilities that were subject to SMCRA during active operations are required to post a performance bond to ensure the completion of reclamation requirements. 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. There are 35 unreclaimed 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 wasteload allocations. The court decision is currently under appeal and contingencies relative to the outcome are discussed in Section **9.7.1**.

6.0 PH SOURCES

The pH impairments in the Cheat River watershed have been attributed to two source categories. In areas where historical, unregulated mining occurred, discharges from AML continue to introduce drainage of low pH and high dissolved metals. In contrast, the low pH impairments of waters in relatively pristine areas are the result of acid precipitation and the low buffering capacity of the watershed. 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 acidic atmospheric deposition and low watershed buffering capacity.

6.1 Acid Deposition

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

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

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

Atmospheric 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. The data include concentrations of sulfate and nitrogen oxides in wet and dry deposition. For the technical information on these data, please see the Technical Support Document for the Final Clean Air Intestate Rule – Air Quality Modeling (USEPA, 2005e). 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.

6.2 pH – Natural Influences

Decreased pH levels in streams can be aided by natural conditions such as wetlands, more specifically, bogs; and the lack of stream buffering capacity. Bogs receive most of their water from precipitation, which is naturally acidic, and pH may be decreased from the natural decomposition of organic materials (MDE 2003). The other natural condition that may result in lowered pH levels is the lack of buffering capacity in soils and certain geologic formations. Acidic soils (e.g., Atkins, Brinkerton, Delkalb, Ernest, Gilpin, and Latham) and the Pottsville Sandstone formation (very low buffering capacity) are known to significantly influence the pH conditions.

6.3 Alkalinity Sources

A small area of the Cheat River Watershed is underlain by carbonate bedrocks such as limestone and dolomite. Dissolution of carbonate rocks neutralizes the excessive acidity from atmospheric precipitation and provides natural loading of alkalinity to the streams. As a result, near neutral pH levels are commonly observed in the streams from geologic formations of carbonate rocks.

To restore water quality and protect fisheries in streams affected by acid deposition, selected acidic streams in the Cheat River Watershed are treated with instream applications of fine-grained limestone or limestone slurry addition using water-powered limestone grinding stations (Clayton et al., 1998). The location of liming stations and present and target amounts of limestone treatment in the Cheat River Watershed were provided by the West Virginia Division of Natural Resources.

7.0 FECAL COLIFORM SOURCE ASSESSMENT

7.1 Fecal Coliform Point Sources

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

7.1.1 Individual NPDES Permits

WVDEP issues individual NPDES permits to both publicly owned and privately owned wastewater treatment facilities. Publicly owned treatment works (POTWs) are relatively large 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, one individually permitted POTW discharges treated effluent at two outlets. There is also one drinking water treatment facility with a permit to discharge fecal coliform at very low concentrations. One additional privately owned sewage treatment plant operating under an individual NPDES permit discharges treated effluent at one outlet.

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

7.1.2 Overflows

CSOs are outfalls from POTW sewer systems that carry 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. There are no CSOs or SSOs contributing to Cheat River streams for which fecal coliform TMDLs were developed.

7.1.3 Municipal Separate Storm Sewer Systems (MS4)

Runoff from residential and urbanized areas during storm events can be a significant fecal coliform source. USEPA’s stormwater permitting regulations require public entities to obtain NPDES permit coverage for stormwater discharges from Municipal Separate Storm Sewer Systems (MS4s) in specified urbanized areas. As such, MS4 stormwater discharges are considered point sources and are prescribed wasteload allocations. There are no MS4 areas contributing to Cheat River streams for which fecal coliform TMDLs were developed.

7.1.4 General Sewage Permits

General sewage permits are designed to cover like discharges from numerous individual owners and facilities throughout the state. General Permit WV0103110 regulates small, privately owned sewage treatment plants (“package plants”) that have a design flow of less than 50,000 gallons per day (gpd). In the areas draining to streams for which fecal coliform TMDLs have been developed, 10 facilities are registered under the “package plant” general permit

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, there are 26 “HAU” general permit registrations.

7.2 Fecal Coliform Nonpoint Sources

7.2.1 On-site Treatment Systems

Failing septic systems and straight pipes are significant nonpoint sources of fecal coliform bacteria. Information collected during source tracking efforts by WVDEP yielded an estimate of 3,600 homes that are not served by centralized sewage collection and treatment systems. 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 7-1** shows the failing septic flows represented in the model by subwatershed.

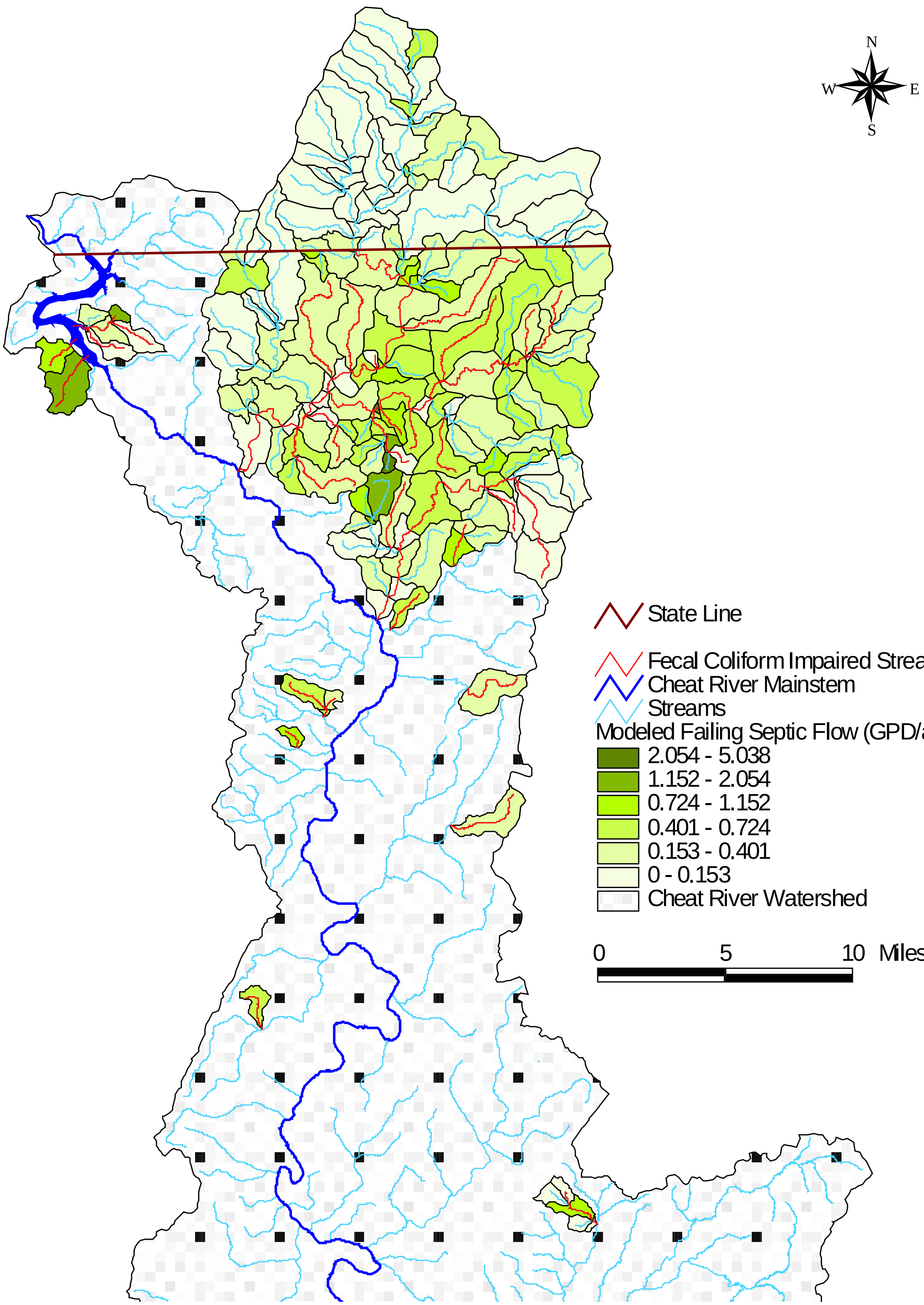

Figure 7-1. Failing septic flows in the Cheat River watershed

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.

7.2.2 Urban/Residential Runoff

Stormwater runoff from residential and urbanized areas 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 2001 landuse data were used to determine the extent of residential and urban areas, and source representation was based upon precipitation and runoff.

7.2.3 Agriculture

Agricultural activities can contribute fecal coliform bacteria to receiving streams through surface runoff and 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.

Agricultural activity is ubiquitous in the watersheds of fecal coliform bacteria impaired streams. Source tracking efforts identified pastures and feedlots near impaired segments that have localized impacts on instream bacteria levels. Source representation was based upon precipitation and runoff, and source tracking information regarding number of livestock, proximity and access to stream, and overall runoff potential were used to develop accumulation rates.

7.2.4 Natural Background (Wildlife)

A certain “natural background” contribution of fecal coliform bacteria can be attributed to deposition by wildlife in forested areas. Accumulation rates for fecal coliform bacteria in forested areas were developed using reference numbers from past TMDLs, incorporating wildlife estimates obtained from West Virginia’s Division of Natural Resources (DNR). 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 stormwater sampling results, and model simulations, wildlife is not considered to be a significant nonpoint source of fecal coliform bacteria in the watershed.

8.0 SEDIMENT SOURCE ASSESSMENT

Excess sediment has been identified as a significant stressor in relation to the biological impairments of a number of streams in the Cheat River watershed. These waters are also impaired pursuant to the numerical water quality criteria for iron. In all of the subject waters, it was determined that the sediment reductions necessary to ensure attainment of the iron water quality criteria exceed those that would be needed to address biological impairment through a reasonably achievable sediment reference approach. Therefore, the iron TMDLs are an appropriate surrogate in place of sediment TMDLs. Sediment sources considered in the TMDL model are described in detail in Section **5.2.2**.

9.0 MODELING PROCESS

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

9.1 Model Selection

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

- Scale of analysis
- Point and nonpoint sources
- Metals and fecal coliform bacteria impairments are temporally variable and occur at low, average, and high flow conditions
- Dissolved aluminum 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

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, manganese, pH, and fecal coliform bacteria in West Virginia are presented in **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 Cheat 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 modeled watershed 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, total manganese, and fecal coliform bacteria were modeled using the MDAS.

9.2 Model Setup

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

9.2.1 General MDAS Configuration

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

The TMDL watersheds were broken into separate subwatershed units, based on the groupings of impaired streams shown in **Figure 9-1**. 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.

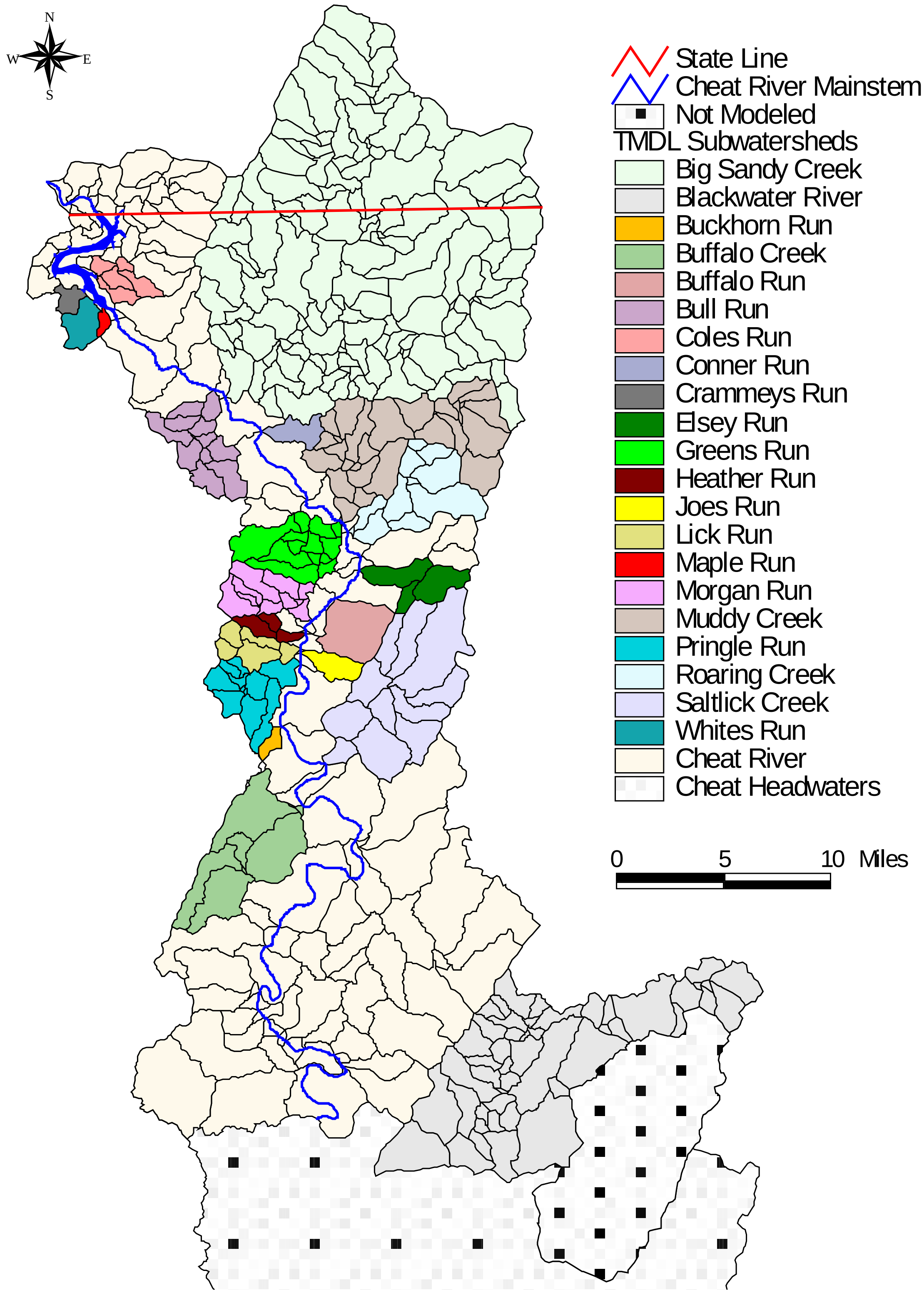

Figure 9-1 Cheat River TMDL watersheds and subwatershed delineation

9.2.2 Iron and Sediment Configuration

The modeled landuse categories contributing metals via precipitation and runoff include forest, pasture, cropland, wetlands, barren, residential/urban impervious, and residential/urban pervious. These sources were represented explicitly by consolidating existing NLCD 2001 landuse categories to create modeled landuse groupings. Several additional landuse categories were created to account for landuses either not included in the NLCD 2001 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 and aluminum 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 mining pumped discharges were modeled as direct, continuous-flow sources in the model.

Sediment-producing landuses and bank erosion are sources of iron and aluminum because these metals are associated with sediment. Statistical analyses using pre-TMDL monitoring data collected in the TMDL watersheds were performed to establish the correlation between sediment and metals concentrations and to evaluate the spatial variability of this correlation. The results were then applied to the sediment from sediment-producing landuses and bank erosion to calculate the iron and aluminum loads delivered to the streams. Generation of sediment depends on the intensity of surface runoff. It also varies by landuse and the characteristics of the land. Sediment delivery paths modeled were surface runoff erosion, and streambank erosion. Surface sediment sources were modeled using average sediment runoff concentrations by landuse. These concentrations were applied to the corresponding surface runoff flows. Bank erosion was modeled as a rate per unit area of submerged erodible area. Bank erosion will only happen after a critical flow is reached, and as the flow increases, so does the bank erosion yield. The amount of sediment produced during bank erosion episodes is also dependent on the stability of the banks, as defined by the Bank Stability Index (S-value).

The relevant parameters in the bank-erosion algorithms are the threshold flow at which bank erosion starts to occur, and a coefficient for scour of the bank matrix soil for the reach. The threshold flow at which bank erosion starts to occur was estimated as the flow that occurs at bank-full depth. The coefficient for scour of the bank matrix soil was a direct function of the reach's S-value.

The MDAS bank erosion model takes into account stream flow and bank stability. The bank erosion rate per unit area was defined as a function of: bank flow volume above a specified threshold and the bank erodible area. Each stream segment had a flow threshold above which streambank erosion occurred. The bank scouring process is a power function dependent on high-flow events, defined as exceeding the flow threshold. The coefficient of scour for the bank soil was related to the Bank Stability Index. Streambank erosion was modeled as a unique sediment source independent of other upland-associated erosion sources.

The wetted perimeter and reach length represent ground area covered by water (**Figure 9-2**). 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. The Technical Report provides more detailed discussions on the technical approaches used for sediment modeling.

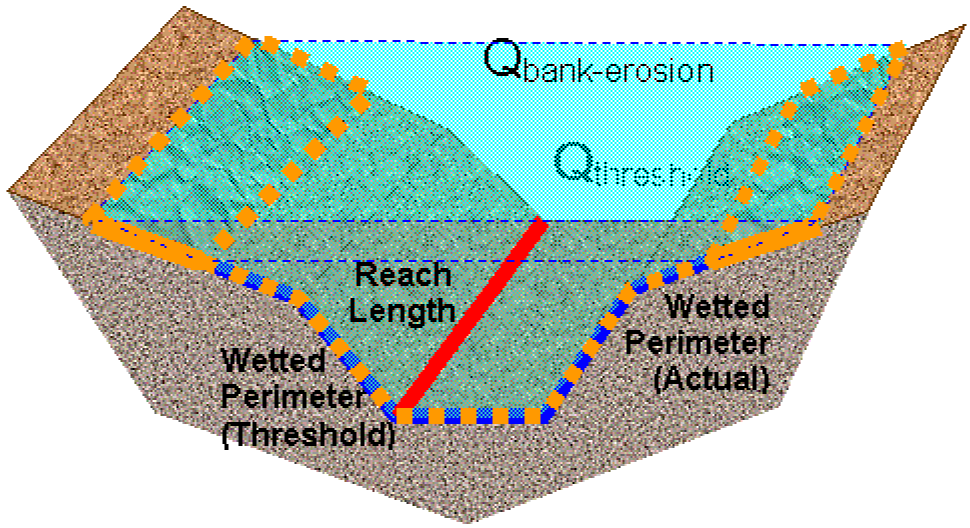

Figure 9-2 Conceptual diagram of stream channel components used in the bank erosion model

9.2.3 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. The MDAS includes a dynamic chemical species fate and transport module that simulates soil subsurface and instream water quality, taking into account chemical species interaction and transformation. The total chemical concentration and flow time series generated by the MDAS are used as inputs for the modules' pollutant transformation and transport routines. The modules simulate soil subsurface and instream chemical reactions, assuming instant mixing and equally distributed concentrations 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 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.

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.

9.2.4 Fecal Coliform Configuration

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

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

9.3 Hydrology Calibration

Hydrology and water quality calibration were performed in sequence because water quality modeling is dependent on an accurate hydrology simulation. Typically, hydrology calibration involves a comparison of model results with instream flow observations from U.S. Geological Survey (USGS) flow gauging stations throughout the watershed. There are 4 USGS flow gauging stations in the Cheat River watershed with adequate data records for hydrology calibration:

- USGS 03065000 Dry Fork at Hendricks, WV
- USGS 03066000 Blackwater River at Davis, WV
- USGS 03069500 Cheat River near Parsons, WV
- USGS 03070500 Big Sandy Creek at Rockville, WV

Hydrology calibration was based on observed data from each 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 from January 1, 1998 to December 31, 2007. 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 Cheat River watershed. A detailed description of the hydrology calibration and a summary of the results and validation are presented in the Technical Report.

9.4 Water Quality Calibration

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

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

WVDEP also conducted storm monitoring on Shrewsbury Hollow in Kanawha State Forest, Kanawha County, West Virginia. The data gathered during this sampling episode was used in the calibration of fecal coliform and to enhance the representation of background conditions from undisturbed areas. The results of the storm sampling fecal coliform calibration are shown in **Figure 9-3**.

The water quality parameters that were adjusted to obtain a calibrated model for sediment were the sediment concentrations by landuse, and the magnitude of the coefficient of scour for bank-erosion. Calibration parameters that were relevant for the land-based sediment calibration were the sediment concentrations (in mg/L) for runoff, interflow, and groundwater. These concentrations were defined for each modeled landuse. 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. Streambank erosion as a unique sediment source was calibrated by adjusting the coefficient of scour. The parameter was estimated for each modeled reach based on the bank stability index (S-value).

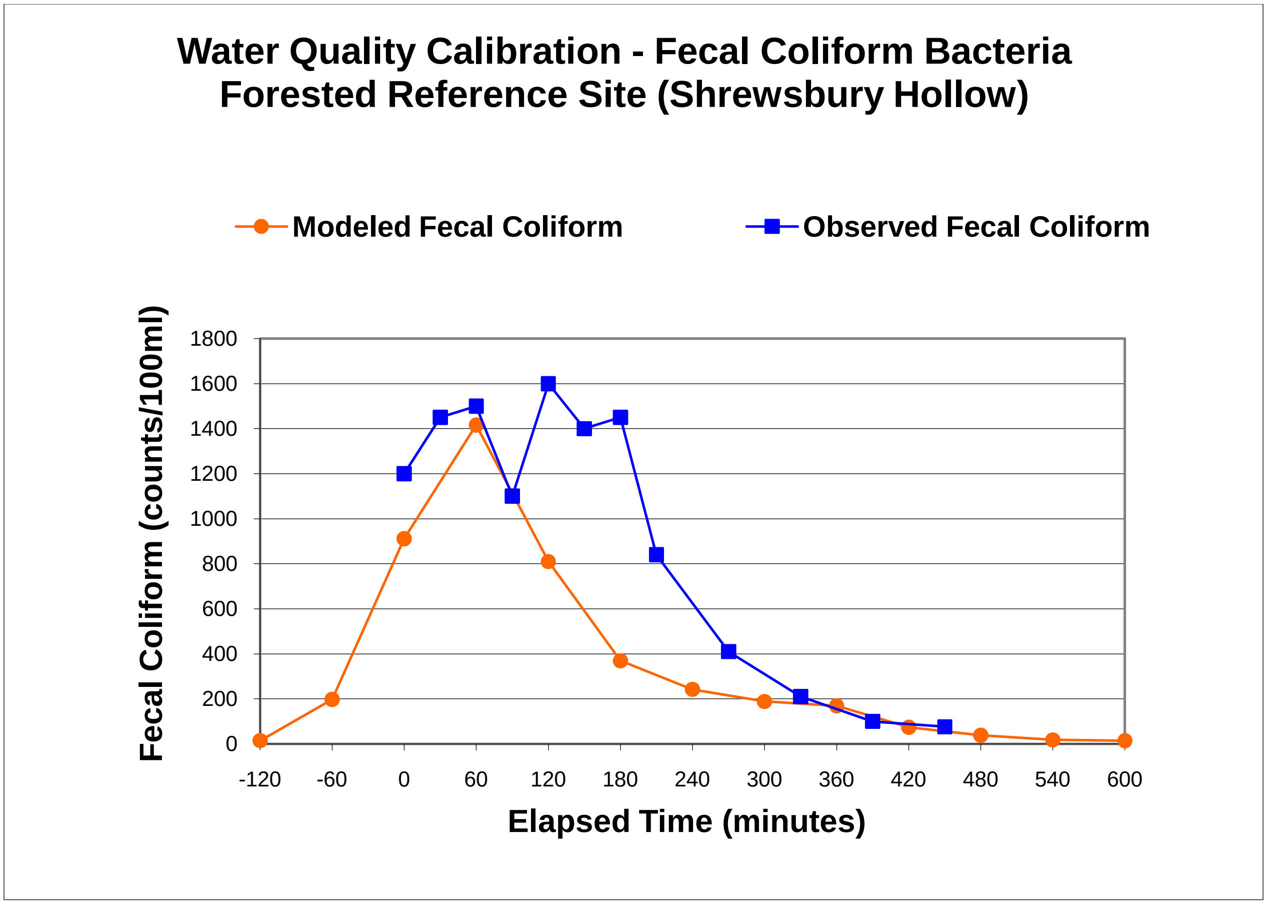

Figure 9-3 Shrewsbury Hollow fecal coliform observed data

9.5 Modeling Technique for Biological Impairments with Sedimentation Stressors

The SI process discussed in Section 4 indicated a need to reduce the contribution of excess sediment to some of the biologically impaired streams. Initially, a “reference watershed” TMDL development approach was pursued. The approach was based on selecting a non-impaired watershed that shares similar landuse, ecoregion, and geomorphologic characteristics with the impaired watershed. Stream conditions in the reference watershed are assumed to be representative of the conditions needed for the impaired streams to attain their designated uses, and the normalized loading associated with the reference stream is used as the TMDL endpoint for the impaired streams. Given these parameters and a non-impaired WVSCI score, Bucklick Run (WV-MC-67-J) was selected as the reference watershed. The location of the reference watershed is shown in **Figure 4-2**.

All of the sediment-impaired 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 impairments associated with sediment. As such, the iron TMDLs presented for the subject waters are appropriate surrogates for necessary sediment TMDLs. For affected streams, **Table 9-1** contrasts the sediment reductions necessary to attain iron criteria with those needed to resolve biological impairment under the reference watershed approach. Please refer to the Technical Report for details regarding the reference watershed approach.

Table 9-1 Sediment loadings using different modeling approaches

Stream Name	Stream Code	Allocated Sediment Load Iron TMDL (tons/yr)	Allocated Sediment Load Reference Approach (tons/yr)
Whites Run	WV-MC-15	92	104
Sand Run	WV-MC-124-K-15-H	88	89
Hazel Run	WV-MC-27-K	163	221
Big Sandy Creek	WV-MC-27	5,365	7,477
UNT/Webster Run RM 1.25	WV-MC-27-J-2-B	42	56
Kelly Run	WV-MC-13-A	27	37
Coles Run	WV-MC-13	129	151

9.6 Allocation Strategy

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

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

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

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

9.6.1 TMDL Endpoints

TMDL endpoints represent the water quality targets used to quantify TMDLs and their individual components. In general, West Virginia’s numeric water quality criteria for the subject pollutants and an explicit five percent MOS were used to identify endpoints for TMDL development.

The five percent explicit MOS was used to counter uncertainty in the modeling process and for those cases where monitoring might not have captured the full range of instream conditions. Long-term water quality monitoring data were used for model calibration. Although these data represented actual conditions, they were not of a continuous time series and might not have captured the full range of instream conditions that occurred during the simulation period. The TMDL endpoints incorporating the explicit MOS are displayed in **Table 9-2**. An explicit MOS was not applied only in limited scenarios involving dominant continuous flow sources and low flow critical conditions. Uncertainty of allocations necessary to achieve water quality standards is minimal in these scenarios and allocations are established at water quality criteria.

Table 9-2 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	0.5 mg/L (4-day average)	0.475 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)
Total Manganese	Public Water Supply	1.0 mg/L	0.95 mg/L
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)

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

9.6.2 Baseline Conditions and Source Loading Alternatives

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

Baseline Conditions for MDAS

The MDAS model was run for baseline conditions using hourly precipitation data for a representative six year simulation period (January 1, 1998 through December 31, 2003). The precipitation experienced over this period was applied to the landuses and pollutant sources as they existed at the time of TMDL development. Predicted instream concentrations were compared directly with the TMDL endpoints. This comparison allowed for the evaluation of the magnitude and frequency of exceedances under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods. **Figure 9-4** presents the annual rainfall totals for the years 1992 through 2008 at the Lake Lynn (WV5002) weather station in West Virginia. The years 1998 to 2003 are highlighted to indicate the range of precipitation conditions used for TMDL development in the Cheat River watershed.

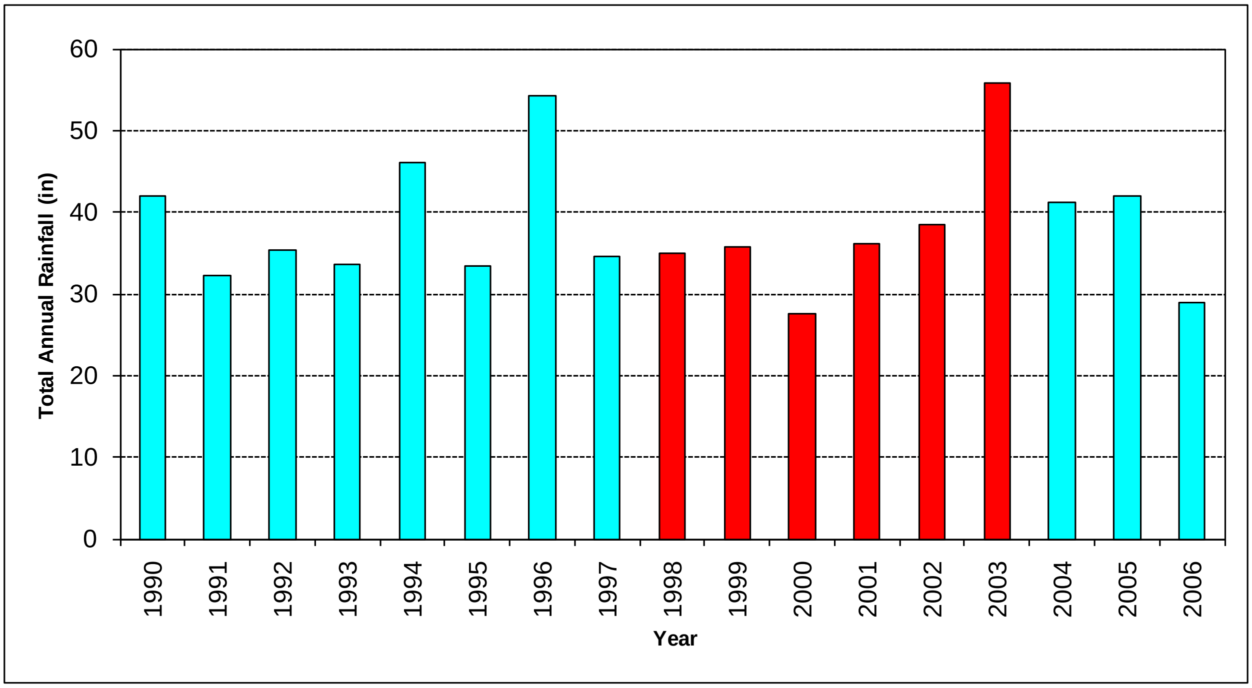

Figure 9-4 Annual precipitation totals for the Lake Lynn (WV5002) weather station in West Virginia

Mining discharges that are influenced by precipitation were represented during baseline conditions using precipitation, drainage area, and applicable effluent limitations. For non-precipitation-induced mining discharges, available flow and/or pump capacity information was used in conjunction with applicable effluent limitations. The metals concentrations associated with common effluent limitations are presented in **Table 9-3**. The concentrations are displayed in **Table 9-3** accurately represent existing wasteload allocations for the majority of mining discharges. In the limited instances where existing effluent limitations vary from the displayed values, the outlets were represented at the next higher condition. For example, existing iron effluent limits between 1.5 and 3.2 mg/L were represented at 3.2 mg/L.

Table 9-3 Concentrations used to represent permitted conditions for active mining

Pollutant	Technology-based Permits	Water Quality-based Permits
Aluminum, total	1.47 mg/L (95th percentile DMR values)	0.75 mg/L
Iron, total	3.2 mg/L	1.5 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.

1.5%percent of the total subwatershed area was generally allotted for concurrent construction activity under the Construction Stormwater General Permit. 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.

Source Loading Alternatives

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

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

Figure 9-5 shows an example of model output for a baseline condition and a successful TMDL scenario.

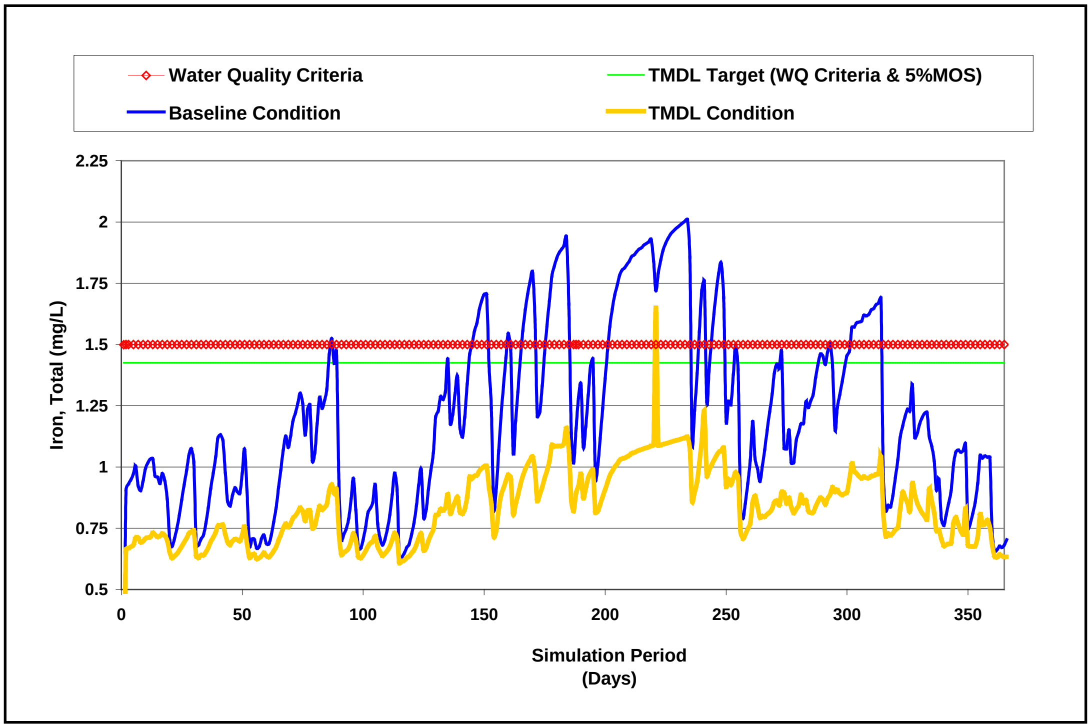

Figure 9-5 Example of baseline and TMDL conditions for total iron

9.7 TMDLs and Source Allocations

9.7.1 Total Iron TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the iron impaired streams of the Cheat River watershed. A top-down methodology was followed to allocate loads to sources. Headwaters were analyzed first because their loading affects downstream water quality. Loading contributions were reduced from applicable sources in impaired headwaters until criteria were attained at the subwatershed outlet. The loading contributions of unimpaired headwaters and the reduced loadings for impaired headwaters were then routed through downstream waterbodies. Using this method ensured that contributions from all sources were weighted equitably and 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. Allocations to continuous flow sources were no more stringent than water quality criteria. The most stringent streambank erosion reductions were based upon the loading characteristics of the reference stream. The following methodology was used when allocating to iron sources.

- In watersheds influenced by AML, iron loadings were reduced until water quality criterion was attained or until practical limits were reached.

- If further reduction was necessary, sediment-contributing nonpoint sources including streambank erosion were evaluated and loads were reduced to practical limits.

- If further reduction was necessary, mining point sources (including bond forfeiture sites) were reduced until water quality criteria were met.

Wasteload Allocations (WLAs)

WLAs were developed for all point sources permitted to discharge iron under a NPDES permit. Because of the established relationship between iron and TSS, iron WLAs are also provided for facilities with stormwater discharges that are regulated under NPDES permits that contain TSS and/or iron effluent limitations or benchmarks values, and facilities registered under the General NPDES permit for construction stormwater.

<u>Active Mining Operations</u>

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, total manganese 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. The decision to assign WLAs to those sources does not reflect a determination by WVDEP as to whether they are, in fact, point source discharges. The decision has been appealed and an alternative conclusion may result, thereby requiring minor TMDL revision to reclassify bond forfeiture sites as load allocations. Regardless of the WLA/LA reclassification, WVDEP will pursue necessary pollutant reductions.

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.

Discharges Regulated by the Water Treatment Plant General Permit

Registrations under this general permit implement iron and TSS effluent limitations. Facilities that are compliant with such limitations are not considered to be significant sources of sediment or iron. Facilities that are present in the watersheds of iron-impaired streams are assigned WLAs that allow for continued discharge under existing permit conditions.

Construction Stormwater

Specific WLAs for existing and future activity under the Construction Stormwater General Permit are provided at the subwatershed scale and are described in Section 11.1. An allocation of 1.5 percent of subwatershed area was provided with loadings 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. As such, specific WLAs for existing registrations under the General Permit are not presented. Instead, grouped allocations are provided by subwatershed with intended implementation to be accomplished by maintenance of disturbed permitted area less than the allocated area.

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, and residential/urban/road landuses and streambank erosion

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

9.7.2 Non-attainment of Troutwater Iron Criterion and Phased TMDL Approach

Troutwater iron TMDLs are presented for the streams listed in **Table 9-4**. Implementation of the described allocation methodology does not assure complete attainment of the chronic aquatic life protection, troutwater iron criterion. The unattainable iron criterion is a four-day average concentration equal to 0.5 mg/L total iron that is not to be exceeded more than once every three years. The relatively high iron content of the soils in the watershed is the primary influencing factor. Initial allocation scenarios for the subject waters included the following provisions:

- All point sources and continuous flow nonpoint sources were set at the value of the troutwater criterion
- All streambank stability ratings were set to the best measured condition in the watershed
- All land disturbing nonpoint sources were reduced to the forest background loading
- No allowance for new activity under the Construction Stormwater General Permit was provided

Table 9-4 Streams for which troutwater iron TMDLs are presented

Stream Name	NHD Code
Blackwater River	WV-MC-124-K
Sand Run	WV-MC-124-K-15-H
UNT/Beaver Creek RM 11.36	WV-MC-124-K-23-J
Little Sandy Creek	WV-MC-27-J
Piney Run	WV-MC-27-J-11
Cherry Run	WV-MC-27-J-12
Mill Run	WV-MC-27-J-13
Beaver Creek	WV-MC-27-J-6
Hog Run	WV-MC-27-J-9
Hazel Run	WV-MC-27-K
Muddy Creek	WV-MC-39
Jump Rock Run	WV-MC-39-J
Spruce Run	WV-MC-67-D
Little Laurel Run	WV-MC-27-I-4

Stream Name	NHD Code
Sugarcamp Run	WV-MC-39-L
Roaring Creek	WV-MC-40
Bucklick Run	WV-MC-67-J

Even under those stringent and unachievable allocation scenarios, modeling output did not ensure criterion attainment over the design period of precipitation. Non-attainment was predicted in response to extreme precipitation events or a series of significant storms that elevate instream TSS and iron concentrations. The magnitudes of the predicted exceedances under the initial allocation scenarios were not extreme, but exceedances were predicted more often than the one per three year frequency prescribed by the criterion. Criterion attainment would require pollutant reductions from existing sources that are well beyond practical levels, coupled with significant reductions of undisturbed upland and streambank background loadings, and no construction stormwater allowances.

To address this situation, phased implementation of the TMDLs is proposed, under which the source allocations necessary to universally achieve an interim iron water quality target (1.0 mg/L, 4-day average, once per three years average exceedance frequency) are implemented concurrently with WVDEP's efforts to pursue criterion revisions. As a result of the Water Quality Standards 2011 triennial review, WVDEP proposed revision of the iron troutwater criterion to 1.0 mg/L, 4-day average, once per three years average exceedance frequency. If the proposed revision is approved, the TMDLs proposed herein will be applicable and further TMDL modifications will not be necessary.

For the subject troutwaters, the iron TMDLs and allocations are presented under the following methodology:

- All land disturbance activities are reduced to loadings slightly greater than the background forest loading
- The iron loading associated with sediment from streambank erosion is reduced to levels commensurate with those observed in the reference stream
- All point source and continuous flow nonpoint source allocations are set at concentrations necessary to ensure attainment of the proposed criterion during low flow conditions and are no more stringent than 1.0 mg/L
- Allowance for new construction activity is provided such that 1.5 % of the area of each subwatershed is reserved for site registrations under the Construction Stormwater General Permit

This allocation methodology results in universal attainment of the iron water quality target (1.0 mg/L, 4-day average, once per three years average exceedance frequency) at the pour points of all subwatersheds within the impaired troutwaters.

9.7.3 Dissolved Aluminum and pH TMDLs

The water quality criteria for pH allow no values below 6.0 or above 9.0. With respect to AMD, pH is not a good indicator of the acidity in a waterbody and can be a misleading characteristic. Water with near-neutral pH (~ 7) but containing elevated concentrations of dissolved ferrous (Fe2+) ions can become acidic after oxidation and precipitation of the iron (PADEP (Pennsylvania Department of Environmental Protection), 2000). Therefore, a more practical approach to meeting the water quality criteria for pH is to use the concentration of metal ions as a surrogate for pH. It was assumed that reducing instream metals (iron and aluminum) concentrations to meet water quality criteria (or TMDL endpoints) would result in meeting the water quality standard for pH. This assumption was verified by executing the MDAS under TMDL conditions (where prescribed metals reductions are achieved) and comparing simulated results at all subwatershed outlets with the pH criteria. Additional details regarding the pH modeling approach are provided in the Technical Report.

Source allocations were developed for all modeled subwatersheds contributing to the dissolved aluminum and/or pH impaired streams of the Cheat River watershed. Sources of total iron were reduced prior to total aluminum reduction because existing instream iron concentrations can significantly reduce pH and consequently increase dissolved aluminum concentrations. The dissolved aluminum and pH TMDL endpoints were not attained after source reductions to iron, therefore the total aluminum loading was reduced in combination with acidity reduction (via alkalinity addition) until the water quality criteria for both pH and dissolved aluminum were attained. Figure 9-6 displays the methodology used to allocate aluminum loadings and/or offset excess acidity.

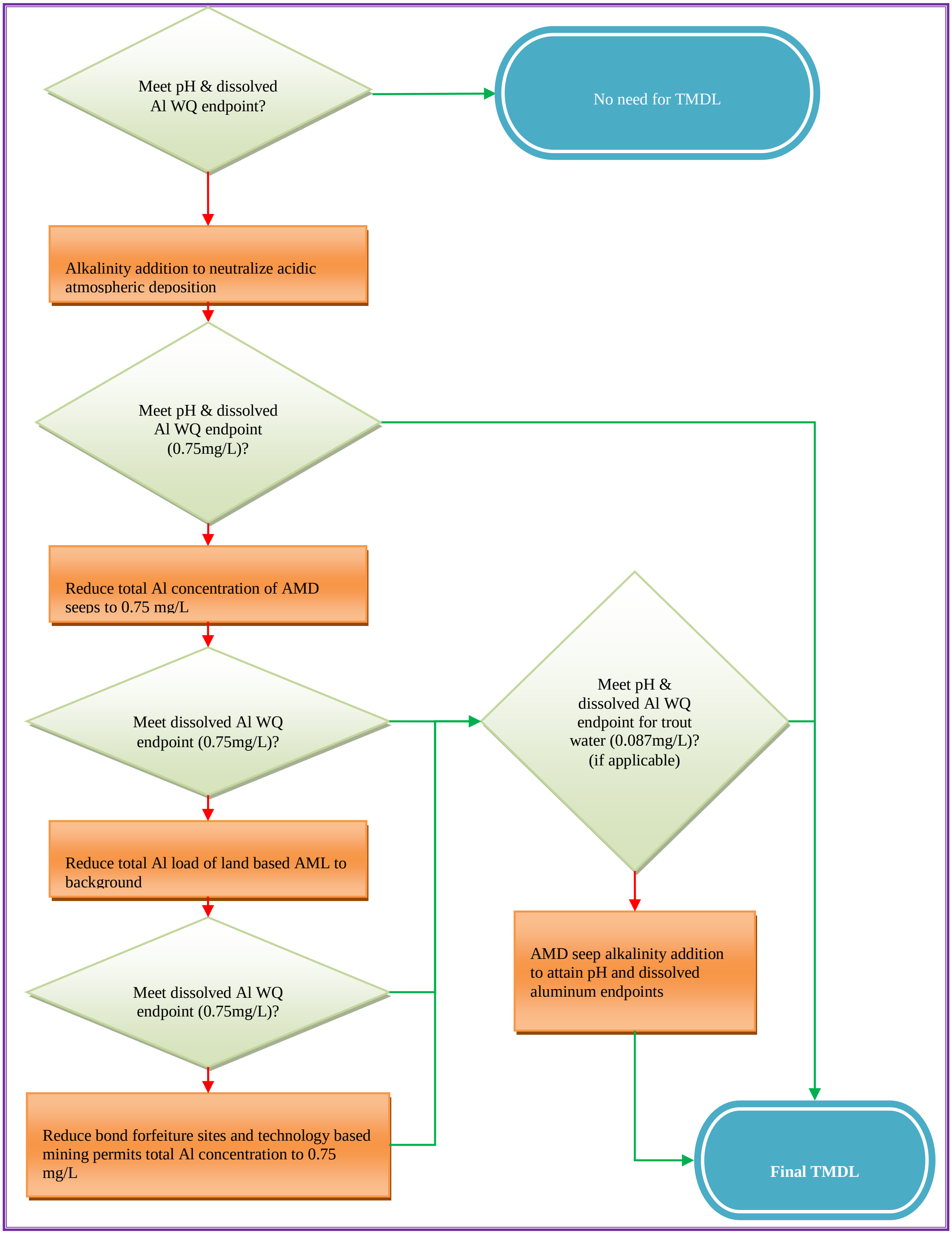

Figure 9-6 Aluminum and pH allocation methodology

Waste load Allocations (WLAs)

As described in Section 9.7.1, aluminum WLAs were developed for all active mining operations and bond forfeiture sites located in the watersheds of aluminum impaired streams. 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.

Load Allocations (LAs)

LAs of total aluminum are made for contributing nonpoint source categories as follows:

- Abandoned mine land sources: loading from disturbed land, highwalls, deep mine discharges and seeps
- Background and other nonpoint sources: loading from undisturbed forest and grasslands, barren land, harvested forest, oil and gas well operations, and residential/urban/road and agricultural landuses (loadings associated with these source categories were represented but not reduced)

The baseline and TMDL model scenarios incorporate the alkalinity additions associated with multiple fine-grained limestone applications in the watershed by the West Virginia Division of Natural Resources and that provided by the Blackwater River drum liming station. The modeling also incorporates natural background sources of alkalinity from carbonate geologic formations. Where further alkalinity addition is prescribed to meet pH and aluminum water quality criteria, load allocations for AML and atmospheric deposition are included in the pH TMDLs.

9.7.4 Total Manganese TMDL

As described previously, the top-down methodology was followed to allocate loads to sources and develop the manganese TMDLs. In the watersheds of manganese impaired streams, 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, wasteload allocations were developed for bond forfeiture sites and load allocations were developed for all other sources.

9.7.5 Fecal Coliform Bacteria TMDLs

TMDLs and source allocations were developed for impaired steams and their tributaries on a subwatershed basis throughout the watershed. As described in Section **9.7.1** a top-down methodology was followed to develop these TMDLs and allocate loads to sources.

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) (loadings associated with this category were represented but not reduced)

- Because West Virginia Bureau for Public Health regulations prohibit the discharge of raw sewage into surface waters, all illicit discharges of human waste (from failing septic systems and straight pipes) were reduced by 100 percent in the model

- If further reduction was necessary, nonpoint source loadings from agricultural lands and residential areas were subsequently reduced until instream water quality criteria were met

Wasteload Allocations (WLAs)

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

Sewage Treatment Plant Effluents

The fecal coliform effluent limitations for NPDES permitted sewage treatment plants are more stringent than water quality criteria; therefore, all effluent discharges from sewage treatment facilities were given wasteload allocations equal to existing monthly fecal coliform effluent limitations of 200 counts/100 mL.

Combined Sewer Overflows (CSO) and Municipal Separate Storm Sewer Systems (MS4)

No CSOs or MS4s are present in the watersheds addressed in this TMDL.

Load Allocations (LAs)

Fecal coliform LAs are assigned to the following source categories:

- Pasture/Cropland

- On-site Sewage Systems — loading from all illicit discharges of human waste (including failing septic systems and straight pipes)

- Residential — loading associated with urban/residential runoff from non-MS4 areas

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

9.7.6 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, pH, sediment, 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.

9.7.7 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 & 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.

9.7.8 TMDL Presentation

The TMDLs for all impairments are shown in Section **10.0** of this report. The TMDLs for iron, aluminum, and manganese 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 TMDLs for pH are presented as average daily acidity or alkalinity loads, in the units of pounds $CaCO_3$ per day. The MDAS simulated pH results under baseline and TMDL conditions are displayed in the allocation spreadsheets included on the CD version of this report. The biological TMDLs are handled using surrogate approaches where metal or fecal loads are presented. The TMDLs for fecal coliform bacteria are presented in average number of colonies per day. All TMDLs were developed to meet TMDL endpoints under a range of conditions observed over the modeling period. TMDLs and their components are also presented in the allocation spreadsheets associated with this report. The filterable spreadsheets also display detailed source allocations and include multiple display formats that allow for the comparison of pollutant loadings among categories and facilitate implementation.

The iron, aluminum, and manganese WLAs for active mining operations and bond forfeiture sites 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. Iron WLAs for nonmining activities are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are operable and are equivalent to existing effluent limitations/benchmark values. For stormwater point sources, the concentration allocations are to be directly implemented as stormwater benchmark values and for other sources, they 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 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.

10.0 TMDL RESULTS

Table 10-1. Dissolved Aluminum TMDLs

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Cheat	WV-MC-2	UNT/Cheat River RM 1.85	Aluminum	1.67	0.25	0.10	2.02
Cheat	WV-MC-5	UNT/Cheat River RM 4.07	Aluminum	1.57	N/A	0.08	1.66
Cheat	WV-MC-10	UNT/Cheat River RM 7.70	Aluminum	6.08	N/A	0.32	6.40
Cheat	WV-MC-11	UNT/Cheat River RM 8.39	Aluminum	9.31	N/A	0.49	9.81
Maple Run	WV-MC-16	Maple Run	Aluminum	1.00	N/A	0.05	1.05
Bull Run	WV-MC-25	Bull Run	Aluminum	19.61	2.06	1.14	22.81
Bull Run	WV-MC-25-A	UNT/Bull Run RM 1.64	Aluminum	1.29	1.22	0.13	2.64
Bull Run	WV-MC-25-B	Middle Run	Aluminum	2.38	0.84	0.17	3.39
Bull Run	WV-MC-25-C	Mountain Run	Aluminum	3.39	N/A	0.18	3.57
Bull Run	WV-MC-25-C-1	Lick Run	Aluminum	1.76	N/A	0.09	1.85
Bull Run	WV-MC-25-D	UNT/Bull Run RM 3.73	Aluminum	2.50	N/A	0.13	2.63

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Bull Run	WV-MC-25-E	Right Fork Bull Run	Aluminum	3.41	N/A	0.18	3.59
Bull Run	WV-MC-25-F	Left Fork Bull Run	Aluminum	1.60	N/A	0.08	1.69
Big Sandy	WV-MC-27-B	UNT/Big Sandy Creek RM 2.91	Aluminum	3.80	0.99	0.25	5.04
Big Sandy	WV-MC-27-F	Sovern Run	Aluminum	6.32	1.17	0.39	7.89
Big Sandy	WV-MC-27-I-4	Little Laurel Run	Aluminum	3.71	N/A	0.20	3.91
Big Sandy	WV-MC-27-J	Little Sandy Creek	Aluminum	39.12	6.30	2.39	47.81
Big Sandy	WV-MC-27-J-11	Piney Run	Aluminum	1.04	N/A	0.05	1.09
Big Sandy	WV-MC-27-J-12	Cherry Run	Aluminum	4.79	0.25	0.26	5.30
Big Sandy	WV-MC-27-J-13	Mill Run	Aluminum	3.08	1.16	0.22	4.46
Big Sandy	WV-MC-27-J-2-B	UNT/Webster Run RM 1.25	Aluminum	1.51	N/A	0.08	1.59
Big Sandy	WV-MC-27-J-6	Beaver Creek	Aluminum	10.23	3.50	0.72	14.45
Big Sandy	WV-MC-27-J-6-B	Glade Run	Aluminum	1.60	N/A	0.08	1.68
Big Sandy	WV-MC-27-J-6-D	UNT/Beaver Creek RM 1.68	Aluminum	1.13	2.08	0.17	3.38
Big Sandy	WV-MC-27-J-9	Hog Run	Aluminum	2.63	N/A	0.14	2.77

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Big Sandy	WV-MC-27-K	Hazel Run	Aluminum	4.11	N/A	0.22	4.33
Conner Run	WV-MC-30	Conner Run	Aluminum	2.14	1.09	0.17	3.40
Greens Run	WV-MC-38	Greens Run	Aluminum	19.84	1.38	1.12	22.34
Greens Run	WV-MC-38-C	South Fork/Greens Run	Aluminum	14.06	N/A	0.74	14.80
Greens Run	WV-MC-38-C-1	UNT/South Fork RM 0.63/Greens Run	Aluminum	7.58	N/A	0.40	7.98
Muddy Creek	WV-MC-39	Muddy Creek	Aluminum	50.15	10.55	3.19	63.89
Muddy Creek	WV-MC-39-E	Martin Creek	Aluminum	19.77	9.49	1.54	30.80
Muddy Creek	WV-MC-39-E-1	Fickey Run	Aluminum	6.91	3.38	0.54	10.83
Muddy Creek	WV-MC-39-E-2	Glade Run	Aluminum	8.90	2.03	0.58	11.51
Muddy Creek	WV-MC-39-E-2-A	UNT/Glade Run RM 1.06	Aluminum	0.25	1.83	0.11	2.19
Muddy Creek	WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	Aluminum	2.15	N/A	0.11	2.26
Muddy Creek	WV-MC-39-I-1	UNT/UNT RM 0.12/Muddy Creek RM 9.80	Aluminum	0.53	N/A	0.03	0.55

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Muddy Creek	WV-MC-39-J	Jump Rock Run	Aluminum	0.62	N/A	0.03	0.65
Muddy Creek	WV-MC-39-L	Sugarcamp Run	Aluminum	0.92	N/A	0.05	0.97
Roaring Creek	WV-MC-40	Roaring Creek	Aluminum	10.59	1.41	0.63	12.63
Roaring Creek	WV-MC-40-C	Lick Run	Aluminum	3.60	N/A	0.19	3.79
Roaring Creek	WV-MC-40-C-1	Little Lick Run	Aluminum	1.99	N/A	0.10	2.10
Buffalo Run	WV-MC-47	Buffalo Run	Aluminum	5.99	1.26	0.38	7.63
Morgan Run	WV-MC-50	Morgan Run	Aluminum	14.98	3.31	0.96	19.25
Morgan Run	WV-MC-50-A	UNT/Morgan Run RM 1.03	Aluminum	2.92	1.38	0.23	4.53
Morgan Run	WV-MC-50-B	Church Creek	Aluminum	7.57	1.06	0.45	9.09
Morgan Run	WV-MC-50-B-1	UNT/Church Creek RM 1.26	Aluminum	3.75	0.45	0.22	4.41
Morgan Run	WV-MC-50-B-1-A	UNT/UNT RM 0.12/Church Creek RM 1.26	Aluminum	0.58	0.45	0.05	1.08
Heather Run	WV-MC-52	Heather Run	Aluminum	8.09	0.22	0.44	8.74
Lick Run	WV-MC-54	Lick Run	Aluminum	16.44	N/A	0.87	17.31

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Lick Run	WV-MC-54-A	UNT/Lick Run RM 1.04	Aluminum	1.11	N/A	0.06	1.17
Joes Run	WV-MC-55	Joes Run	Aluminum	1.91	N/A	0.10	2.01
Pringle Run	WV-MC-56	Pringle Run	Aluminum	15.78	0.12	0.84	16.74
Pringle Run	WV-MC-56-C	UNT/Pringle Run RM 3.17	Aluminum	2.08	0.12	0.12	2.32
Pringle Run	WV-MC-56-D	UNT/Pringle Run RM 3.33	Aluminum	1.56	N/A	0.08	1.64
Pringle Run	WV-MC-56-E	UNT/Pringle Run RM 3.60	Aluminum	2.24	N/A	0.12	2.35
Blackwater River	WV-MC-124-K	Blackwater River	Aluminum	126.30	26.87	8.06	161.23
Blackwater River	WV-MC-124-K-11	Tub Run	Aluminum	1.94	N/A	0.10	2.04
Blackwater River	WV-MC-124-K-14	Finley Run	Aluminum	0.39	N/A	0.02	0.41
Blackwater River	WV-MC-124-K-15	North Fork/Blackwater River	Aluminum	31.40	9.67	2.16	43.23
Blackwater River	WV-MC-124-K-15-C	Long Run	Aluminum	5.57	2.18	0.41	8.16
Blackwater River	WV-MC-124-K-15-D	Middle Run	Aluminum	3.41	N/A	0.18	3.59
Blackwater River	WV-MC-124-K-15-H	Sand Run	Aluminum	1.95	0.94	0.15	3.04
Blackwater River	WV-MC-124-K-23	Beaver Creek	Aluminum	21.77	17.20	2.05	41.02

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Blackwater River	WV-MC-124-K-23-C	Hawkins Run	Aluminum	1.96	N/A	0.10	2.07
Blackwater River	WV-MC-124-K-23-J	UNT/Beaver Creek RM 11.36	Aluminum	0.44	N/A	0.02	0.47

Table 10-2. 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)
Cheat	WV-MC	Cheat River	Iron	11021.71	1053.93	635.56	12711.20
Cheat	WV-MC-2	UNT/Cheat River RM 1.85	Iron	8.63	1.23	0.52	10.38
Cheat	WV-MC-5	UNT/Cheat River RM 4.07	Iron	4.38	0.19	0.24	4.81
Cheat	WV-MC-10	UNT/Cheat River RM 7.70	Iron	13.93	0.36	0.75	15.03
Cheat	WV-MC-11	UNT/Cheat River RM 8.39	Iron	20.82	0.66	1.13	22.61
Coles Run	WV-MC-13	Coles Run	Iron	27.04	3.55	1.61	32.20
Coles Run	WV-MC-13-A	Kelly Run	Iron	5.79	0.85	0.35	6.99
Crammeys Run	WV-MC-14	Crammeys Run	Iron	8.24	1.08	0.49	9.82
Whites Run	WV-MC-15	Whites Run	Iron	16.74	2.36	1.01	20.11
Bull Run	WV-MC-25	Bull Run	Iron	96.47	11.02	5.66	113.15
Bull Run	WV-MC-25-A	UNT/Bull Run RM 1.64	Iron	8.56	2.60	0.59	11.74
Bull Run	WV-MC-25-B	Middle Run	Iron	11.11	2.16	0.70	13.96
Bull Run	WV-MC-25-C	Mountain Run	Iron	22.37	1.68	1.27	25.32
Bull Run	WV-MC-25-C-1	Lick Run	Iron	8.27	0.55	0.46	9.28
Bull Run	WV-MC-25-D	UNT/Bull Run RM 3.73	Iron	7.41	0.48	0.41	8.30
Bull Run	WV-MC-25-E	Right Fork Bull Run	Iron	10.71	0.67	0.60	11.98
Bull Run	WV-MC-25-F	Left Fork Bull Run	Iron	7.32	0.86	0.43	8.61
Big Sandy	WV-MC-27	Big Sandy Creek	Iron	1888.62	187.89	109.29	2185.79
Big Sandy	WV-MC-27-B	UNT/Big Sandy Creek RM 2.91	Iron	9.99	1.90	0.63	12.52

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Big Sandy	WV-MC-27-F	Sovern Run	Iron	35.23	7.03	2.22	44.49
Big Sandy	WV-MC-27-H	Parker Run	Iron	14.40	1.78	0.85	17.02
Big Sandy	WV-MC-27-I-4	Little Laurel Run	Iron	35.37	4.68	2.11	42.16
Big Sandy	WV-MC-27-J	Little Sandy Creek	Iron	371.48	56.66	22.53	450.67
Big Sandy	WV-MC-27-J-11	Piney Run	Iron	10.96	1.34	0.65	12.95
Big Sandy	WV-MC-27-J-12	Cherry Run	Iron	40.47	5.46	2.42	48.36
Big Sandy	WV-MC-27-J-12-D	UNT/Cherry Run RM 1.96	Iron	11.25	1.74	0.68	13.68
Big Sandy	WV-MC-27-J-13	Mill Run	Iron	29.86	5.36	1.85	37.08
Big Sandy	WV-MC-27-J-2	Webster Run	Iron	31.88	4.02	1.89	37.79
Big Sandy	WV-MC-27-J-2-B	UNT/Webster Run RM 1.25	Iron	13.30	1.64	0.79	15.72
Big Sandy	WV-MC-27-J-6	Beaver Creek	Iron	80.00	15.73	5.04	100.77
Big Sandy	WV-MC-27-J-6-B	Glade Run	Iron	9.06	1.07	0.53	10.66
Big Sandy	WV-MC-27-J-6-D	UNT/Beaver Creek RM 1.68	Iron	11.77	4.93	0.88	17.58
Big Sandy	WV-MC-27-J-9	Hog Run	Iron	42.05	5.81	2.52	50.39
Big Sandy	WV-MC-27-K	Hazel Run	Iron	38.53	5.04	2.29	45.87
Big Sandy	WV-MC-27-M	Glade Run	Iron	35.56	3.23	2.04	40.83
Big Sandy	WV-MC-27-T	Glade Run	Iron	50.11	8.84	3.10	62.05
Conner Run	WV-MC-30	Conner Run	Iron	10.06	3.81	0.73	14.59
Greens Run	WV-MC-38	Greens Run	Iron	133.02	15.58	7.82	156.42
Greens Run	WV-MC-38-C	South Fork/Greens Run	Iron	51.38	5.11	2.97	59.46
Greens Run	WV-MC-38-C-1	UNT/South Fork RM 0.63/Greens Run	Iron	21.72	2.06	1.25	25.03
Muddy Creek	WV-MC-39	Muddy Creek	Iron	237.97	49.13	15.11	302.20
Muddy Creek	WV-MC-39-B	Sypolt Run	Iron	13.18	1.77	0.79	15.74
Muddy Creek	WV-MC-39-D	Crab Orchard Run	Iron	31.44	4.11	1.87	37.41
Muddy Creek	WV-MC-39-E	Martin Creek	Iron	41.40	22.73	3.38	67.51
Muddy Creek	WV-MC-39-E-1	Fickey Run	Iron	12.70	6.72	1.02	20.44
Muddy Creek	WV-MC-39-E-2	Glade Run	Iron	20.59	5.98	1.40	27.97
Muddy Creek	WV-MC-39-E-2-A	UNT/Glade Run RM 1.06	Iron	1.21	4.36	0.29	5.86

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Muddy Creek	WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	Iron	4.21	0.31	0.24	4.75
Muddy Creek	WV-MC-39-I	UNT/Muddy Creek RM 9.80	Iron	18.65	2.29	1.10	22.04
Muddy Creek	WV-MC-39-J	Jump Rock Run	Iron	6.67	0.85	0.40	7.92
Muddy Creek	WV-MC-39-L	Sugarcamp Run	Iron	9.44	1.33	0.57	11.34
Roaring Creek	WV-MC-40	Roaring Creek	Iron	95.06	13.91	5.74	114.71
Buffalo Run	WV-MC-47	Buffalo Run	Iron	71.42	12.06	4.39	87.87
Morgan Run	WV-MC-50	Morgan Run	Iron	80.66	17.85	5.18	103.69
Morgan Run	WV-MC-50-A	UNT/Morgan Run RM 1.03	Iron	16.18	4.23	1.07	21.49
Morgan Run	WV-MC-50-A-1	UNT/UNT RM 0.34/Morgan Run RM 1.03	Iron	2.65	0.34	0.16	3.14
Morgan Run	WV-MC-50-B	Church Creek	Iron	28.19	5.33	1.76	35.29
Morgan Run	WV-MC-50-B-1	UNT/Church Creek RM 1.26	Iron	9.91	1.75	0.61	12.27
Morgan Run	WV-MC-50-B-1-A	UNT/UNT RM 0.12/Church Creek RM 1.26	Iron	1.77	1.21	0.16	3.13
Heather Run	WV-MC-52	Heather Run	Iron	29.85	2.80	1.72	34.37
Lick Run	WV-MC-54	Lick Run	Iron	73.84	6.70	4.24	84.78
Lick Run	WV-MC-54-A	UNT/Lick Run RM 1.04	Iron	8.79	1.21	0.53	10.52
Joes Run	WV-MC-55	Joes Run	Iron	20.81	1.99	1.20	24.00
Pringle Run	WV-MC-56	Pringle Run	Iron	95.44	12.84	5.70	113.97
Pringle Run	WV-MC-56-C	UNT/Pringle Run RM 3.17	Iron	17.24	2.38	1.03	20.65
Pringle Run	WV-MC-56-D	UNT/Pringle Run RM 3.33	Iron	9.38	1.60	0.58	11.56
Pringle Run	WV-MC-56-E	UNT/Pringle Run RM 3.60	Iron	14.28	1.56	0.83	16.67
Saltlick Creek	WV-MC-67-D	Spruce Run	Iron	11.52	1.50	0.69	13.71
Saltlick Creek	WV-MC-67-J	Bucklick Run	Iron	17.82	1.12	1.00	19.93
Blackwater River	WV-MC-124-K	Blackwater River	Iron	1216.61	149.72	71.91	1438.24
Blackwater River	WV-MC-124-K-11	Tub Run	Iron	24.63	3.19	1.46	29.28
Blackwater River	WV-MC-124-K-14	Finley Run	Iron	4.60	0.58	0.27	5.45
Blackwater River	WV-MC-124-K-15	North Fork/Blackwater River	Iron	167.20	33.98	10.59	211.77
Blackwater River	WV-MC-124-K-15-C	Long Run	Iron	22.51	7.78	1.59	31.89
Blackwater River	WV-MC-124-K-15-D	Middle Run	Iron	11.16	0.93	0.64	12.73

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Blackwater River	WV-MC-124-K-15-H	Sand Run	Iron	17.69	4.59	1.17	23.45
Blackwater River	WV-MC-124-K-23	Beaver Creek	Iron	111.72	49.09	8.46	169.27
Blackwater River	WV-MC-124-K-23-J	UNT/Beaver Creek RM 11.36	Iron	5.26	0.67	0.31	6.24

Table 10-3. 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)
Heather Run	WV-MC-52	Heather Run	Manganese	10.88	0.34	0.59	11.82
Lick Run	WV-MC-54	Lick Run	Manganese	32.73	N/A	1.72	34.45
Lick Run	WV-MC-54-A	UNT/Lick Run RM 1.04	Manganese	6.59	N/A	0.35	6.94
Joes Run	WV-MC-55	Joes Run	Manganese	3.85	N/A	0.20	4.06
Pringle Run	WV-MC-56	Pringle Run	Manganese	44.42	0.19	2.35	46.96

Table 10-4. pH TMDLs

Major Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Cheat	WV-MC-2	UNT/Cheat River RM 1.85	-15.32	N/A	-0.81	-16.12
Cheat	WV-MC-5	UNT/Cheat River RM 4.07	-12.17	N/A	-0.64	-12.81
Cheat	WV-MC-10	UNT/Cheat River RM 7.70	-22.99	N/A	-1.21	-24.20
Cheat	WV-MC-11	UNT/Cheat River RM 8.39	-42.45	N/A	-2.23	-44.69
Maple Run	WV-MC-16	Maple Run	-16.57	N/A	-0.87	-17.44
Bull Run	WV-MC-25	Bull Run	-342.94	N/A	-18.05	-360.99
Bull Run	WV-MC-25-D	UNT/Bull Run RM 3.73	-30.14	N/A	-1.59	-31.73
Bull Run	WV-MC-25-F	Left Fork Bull Run	-56.76	N/A	-2.99	-59.75
Bull Run	WV-MC-25-E	Right Fork Bull Run	-65.95	N/A	-3.47	-69.42
Bull Run	WV-MC-25-C	Mountain Run	-78.84	N/A	-4.15	-82.99
Bull Run	WV-MC-25-C-1	Lick Run	-39.98	N/A	-2.10	-42.09
Bull Run	WV-MC-25-B	Middle Run	-22.21	N/A	-1.17	-23.38
Bull Run	WV-MC-25-A	UNT/Bull Run RM 1.64	-20.89	N/A	-1.10	-21.99
Big Sandy	WV-MC-27	Big Sandy Creek	-6,219.23	N/A	-327.33	-6,546.56
Big Sandy	WV-MC-27-B	UNT/Big Sandy Creek RM 2.91	-45.15	N/A	-2.38	-47.52
Big Sandy	WV-MC-27-F	Sovern Run	-151.80	N/A	-7.99	-159.79
Big Sandy	WV-MC-27-H	Parker Run	-61.27	N/A	-3.22	-64.49
Big Sandy	WV-MC-27-I-4	Little Laurel Run	-507.52	N/A	-26.71	-534.23
Big Sandy	WV-MC-27-J	Little Sandy Creek	-1,570.98	N/A	-82.68	-1,653.66
Big Sandy	WV-MC-27-J-7	Barnes Run	-127.20	N/A	-6.69	-133.90
Big Sandy	WV-MC-27-J-9	Hog Run	-111.77	N/A	-5.88	-117.65
Big Sandy	WV-MC-27-J-11	Piney Run	-46.14	N/A	-2.43	-48.57
Big Sandy	WV-MC-27-J-12	Cherry Run	-168.50	N/A	-8.87	-177.36
Big Sandy	WV-MC-27-J-12-D	UNT/Cherry Run RM 1.96	-48.72	N/A	-2.56	-51.28
Big Sandy	WV-MC-27-J-13	Mill Run	-132.11	N/A	-6.95	-139.07
Big Sandy	WV-MC-27-J-10	Elk Run	-123.48	N/A	-6.50	-129.98
Big Sandy	WV-MC-27-J-6	Beaver Creek	-455.02	N/A	-23.95	-478.97

Major Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Big Sandy	WV-MC-27-J-6-C	UNT/Beaver Creek RM 1.25	-13.34	N/A	-0.70	-14.04
Big Sandy	WV-MC-27-J-6-D	UNT/Beaver Creek RM 1.68	-19.21	N/A	-1.01	-20.22
Big Sandy	WV-MC-27-J-6-B	Glade Run	-68.97	N/A	-3.63	-72.60
Big Sandy	WV-MC-27-J-2	Webster Run	-117.61	N/A	-6.19	-123.80
Big Sandy	WV-MC-27-J-2-B	UNT/Webster Run RM 1.25	-43.85	N/A	-2.31	-46.16
Big Sandy	WV-MC-27-K	Hazel Run	-173.67	N/A	-9.14	-182.81
Conner Run	WV-MC-30	Conner Run	-66.11	N/A	-3.48	-69.59
Greens Run	WV-MC-38	Greens Run	-305.73	N/A	-16.09	-321.82
Greens Run	WV-MC-38-C	South Fork/Greens Run	-96.60	N/A	-5.08	-101.68
Greens Run	WV-MC-38-C-1	UNT/South Fork RM 0.63/Greens Run	-35.43	N/A	-1.86	-37.29
Muddy Creek	WV-MC-39	Muddy Creek	-1,898.43	N/A	-99.92	-1,998.35
Muddy Creek	WV-MC-39-B	Sypolt Run	-36.81	N/A	-1.94	-38.75
Muddy Creek	WV-MC-39-E	Martin Creek	-205.34	N/A	-10.81	-216.15
Muddy Creek	WV-MC-39-E-2	Glade Run	-93.45	N/A	-4.92	-98.37
Muddy Creek	WV-MC-39-E-2-A	UNT/Glade Run RM 1.06	-4.15	N/A	-0.22	-4.37
Muddy Creek	WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	-18.79	N/A	-0.99	-19.78
Muddy Creek	WV-MC-39-E-1	Fickey Run	-80.32	N/A	-4.23	-84.55
Muddy Creek	WV-MC-39-I	UNT/Muddy Creek RM 9.80	-78.85	N/A	-4.15	-83.00
Muddy Creek	WV-MC-39-I-1	UNT/UNT RM 0.12/Muddy Creek RM 9.80	-29.21	N/A	-1.54	-30.75
Muddy Creek	WV-MC-39-J	Jump Rock Run	-29.26	N/A	-1.54	-30.80
Muddy Creek	WV-MC-39-L	Sugarcamp Run	-46.19	N/A	-2.43	-48.62
Roaring Creek	WV-MC-40	Roaring Creek	-424.30	N/A	-22.33	-446.63
Roaring Creek	WV-MC-40-C	Lick Run	-150.59	N/A	-7.93	-158.52
Roaring Creek	WV-MC-40-C-1	Little Lick Run	-68.07	N/A	-3.58	-71.65
Buffalo Run	WV-MC-47	Buffalo Run	-204.34	N/A	-10.75	-215.10
Morgan Run	WV-MC-50	Morgan Run	-207.26	N/A	-10.91	-218.17
Morgan Run	WV-MC-50-B	Church Creek	-91.35	N/A	-4.81	-96.15

Major Watershed	Stream Code	Stream Name	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Morgan Run	WV-MC-50-B-1	UNT/Church Creek RM 1.26	-21.83	N/A	-1.15	-22.98
Morgan Run	WV-MC-50-B-1-A	UNT/UNT RM 0.12/Church Creek RM 1.26	-5.10	N/A	-0.27	-5.37
Morgan Run	WV-MC-50-A	UNT/Morgan Run RM 1.03	-38.40	N/A	-2.02	-40.42
Heather Run	WV-MC-52	Heather Run	-56.53	N/A	-2.98	-59.50
Lick Run	WV-MC-54	Lick Run	-139.58	N/A	-7.35	-146.93
Lick Run	WV-MC-54-A	UNT/Lick Run RM 1.04	-24.52	N/A	-1.29	-25.81
Joes Run	WV-MC-55	Joes Run	-72.39	N/A	-3.81	-76.20
Pringle Run	WV-MC-56	Pringle Run	-873.75	N/A	-45.99	-919.74
Pringle Run	WV-MC-56-C	UNT/Pringle Run RM 3.17	-45.98	N/A	-2.42	-48.40
Pringle Run	WV-MC-56-D	UNT/Pringle Run RM 3.33	-32.24	N/A	-1.70	-33.94
Pringle Run	WV-MC-56-E	UNT/Pringle Run RM 3.60	-62.64	N/A	-3.30	-65.93
Buckhorn Run	WV-MC-61	Buckhorn Run	-25.83	N/A	-1.36	-27.19
Blackwater River	WV-MC-124-K	Blackwater River	-6,510.03	N/A	-342.63	-6,852.66
Blackwater River	WV-MC-124-K-8	Big Run	-161.16	N/A	-8.48	-169.65
Blackwater River	WV-MC-124-K-11	Tub Run	-69.04	N/A	-3.63	-72.68
Blackwater River	WV-MC-124-K-14	Finley Run	-12.36	N/A	-0.65	-13.01
Blackwater River	WV-MC-124-K-15	North Fork/Blackwater River	-821.87	N/A	-43.26	-865.13
Blackwater River	WV-MC-124-K-15-C	Long Run	-77.59	N/A	-4.08	-81.68
Blackwater River	WV-MC-124-K-15-D	Middle Run	-37.60	N/A	-1.98	-39.58
Blackwater River	WV-MC-124-K-15-E	Snyder Run	-145.26	N/A	-7.65	-152.90
Blackwater River	WV-MC-124-K-15-E	UNT/Beaver Creek RM 8.81	-61.59	N/A	-3.24	-64.83
Blackwater River	WV-MC-124-K-23	Beaver Creek	-626.80	N/A	-32.99	-659.79
Blackwater River	WV-MC-124-K-23-C	Hawkins Run	-60.34	N/A	-3.18	-63.51
Blackwater River	WV-MC-124-K-23-K	UNT/Beaver Creek RM 11.91	-71.80	N/A	-3.78	-75.58
Blackwater River	WV-MC-124-K-23-J	UNT/Beaver Creek RM 11.36	-24.08	N/A	-1.27	-25.35

Table 10-5. Fecal coliform bacteria TMDLs

TMDL Watershed	Stream Code	Stream Name	LA (counts/day)	WLA (counts/day)	MOS (counts/day)	TMDL (counts/day)
Coles Run	WV-MC-13	Coles Run	4.07E+10	2.55E+07	2.14E+09	4.28E+10
Coles Run	WV-MC-13-A	Kelly Run	1.01E+10	N/A	5.30E+08	1.06E+10
Coles Run	WV-MC-13-D	Birch Hollow	8.89E+09	2.45E+06	4.68E+08	9.36E+09
Crammeys Run	WV-MC-14	Crammeys Run	1.94E+10	5.90E+08	1.05E+09	2.10E+10
Whites Run	WV-MC-15	Whites Run	3.21E+10	3.28E+07	1.69E+09	3.38E+10
Big Sandy	WV-MC-27	Big Sandy Creek	1.64E+12	4.95E+09	8.65E+10	1.73E+12
Big Sandy	WV-MC-27-F	Sovern Run	4.82E+10	N/A	2.54E+09	5.07E+10
Big Sandy	WV-MC-27-H	Parker Run	1.67E+10	N/A	8.79E+08	1.76E+10
Big Sandy	WV-MC-27-J	Little Sandy Creek	4.26E+11	4.41E+09	2.26E+10	4.53E+11
Big Sandy	WV-MC-27-J-2	Webster Run	3.25E+10	N/A	1.71E+09	3.42E+10
Big Sandy	WV-MC-27-J-3	UNT/Little Sandy Creek RM 2.80	8.27E+09	N/A	4.35E+08	8.71E+09
Big Sandy	WV-MC-27-J-5	UNT/Little Sandy Creek RM 5.04	1.48E+10	N/A	7.81E+08	1.56E+10
Big Sandy	WV-MC-27-J-6-B	Glade Run (27-J-6-B)	2.12E+10	N/A	1.12E+09	2.23E+10
Big Sandy	WV-MC-27-J-7	Barnes Run	3.02E+10	1.36E+08	1.60E+09	3.20E+10
Big Sandy	WV-MC-27-J-11	Piney Run	1.16E+10	8.33E+07	6.15E+08	1.23E+10
Big Sandy	WV-MC-27-J-12	Cherry Run	4.62E+10	3.79E+09	2.63E+09	5.26E+10
Big Sandy	WV-MC-27-K	Hazel Run	5.90E+10	N/A	3.11E+09	6.22E+10
Big Sandy	WV-MC-27-M	Glade Run (27-M)	3.20E+10	N/A	1.68E+09	3.37E+10
Big Sandy	WV-MC-27-N	UNT/Big Sandy Creek RM 10.23	3.03E+09	N/A	1.60E+08	3.19E+09
Big Sandy	WV-MC-27-T	Glade Run (27-T)	4.07E+10	N/A	2.14E+09	4.29E+10
Muddy Creek	WV-MC-39	Muddy Creek	2.81E+11	2.94E+06	1.48E+10	2.96E+11
Muddy Creek	WV-MC-39-E-1	Fickey Run	1.47E+10	N/A	7.76E+08	1.55E+10
Muddy Creek	WV-MC-39-I	UNT/Muddy Creek RM 9.80	2.03E+10	N/A	1.07E+09	2.14E+10
Roaring Creek	WV-MC-40-A	UNT/Roaring Creek RM 0.34	1.06E+10	N/A	5.59E+08	1.12E+10
Roaring Creek	WV-MC-40-C-1	Little Lick Run	1.74E+10	N/A	9.14E+08	1.83E+10
Elsey Run	WV-MC-44-A-1	UNT/Ragtavern Run RM 0.82	3.12E+10	N/A	1.64E+09	3.28E+10

TMDL Watershed	Stream Code	Stream Name	LA (counts/day)	WLA (counts/day)	MOS (counts/day)	TMDL (counts/day)
Morgan Run	WV-MC-50-A	UNT/Morgan Run RM 1.03	2.40E+10	1.34E+08	1.27E+09	2.54E+10
Morgan Run	WV-MC-50-A-1	UNT/UNT RM 0.34/Morgan Run RM 1.03	9.50E+09	5.11E+07	5.03E+08	1.01E+10
Heather Run	WV-MC-52-A	UNT/Heather Run RM 1.47	4.40E+09	N/A	2.32E+08	4.64E+09
Saltlick Creek	WV-MC-67-J	Bucklick Run	2.43E+10	N/A	1.28E+09	2.55E+10
Buffalo Creek	WV-MC-68-I	Birchroot Run	1.41E+10	N/A	7.42E+08	1.48E+10
Blackwater River	WV-MC-124-K-15-H	Sand Run	2.29E+10	N/A	1.21E+09	2.41E+10

NA = not applicable; UNT = unnamed tributary.

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

Table 10-6. Biological TMDLs

Stream Name	NHD Code	Biological Stressors	Parameter	Load Allocation	Wasteload Allocation	Margin of Safety	TMDL	Units
Coles Run	WV-MC-13	Sedimentation	Iron	27.04	3.55	1.61	32.20	lbs/day
Kelly Run	WV-MC-13-A	Iron Hydroxide (substrate limiting) /Sedimentation	Iron	5.79	0.85	0.35	6.99	lbs/day
Whites Run	WV-MC-15	Organic Enrichment	Fecal Coliform	3.21E+10	3.28E+07	1.69E+09	3.38E+10	counts/day
		Sedimentation	Iron	16.74	2.36	1.01	20.11	lbs/day
Bull Run	WV-MC-25	Metals Toxicity	Aluminum	19.6	2.1	1.1	22.8	lbs/day
		Metals Toxicity	Iron	96.5	11.0	5.7	113.1	lbs/day
		pH Toxicity	pH	-342.9	N/A	-18.0	-361.0	Net Acidity (lbs/day)
Right Fork Bull Run	WV-MC-25-E	Aluminum Toxicity	Aluminum	3.4	N/A	0.2	3.6	lbs/day
		pH Toxicity	pH	-65.9	N/A	-3.5	-69.4	Net Acidity (lbs/day)
Big Sandy Creek	WV-MC-27	Sedimentation	Iron	1888.62	187.89	109.29	2185.79	lbs/day
Sovern Run	WV-MC-27-F	Aluminum Toxicity	Aluminum	6.3	1.2	0.4	7.9	lbs/day
		pH Toxicity	pH	-151.8	N/A	-8.0	-159.8	Net Acidity (lbs/day)
UNT/Webster Run RM 1.25	WV-MC-27-J-2-B	Aluminum Toxicity	Aluminum	1.5	N/A	0.1	1.6	lbs/day
		Sedimentation	Iron	13.30	1.64	0.79	15.72	lbs/day
		pH Toxicity	pH	-43.9	N/A	-2.3	-46.2	Net Acidity (lbs/day)
Hazel Run	WV-MC-27-K	Sedimentation	Iron	38.5	5.0	2.3	45.9	lbs/day
Greens Run	WV-MC-38	Metals Toxicity	Aluminum	19.8	1.4	1.1	22.3	lbs/day
		Metals Toxicity	Iron	133.02	15.58	7.82	156.42	lbs/day
		pH Toxicity	pH	-305.7	N/A	-16.1	-321.8	Net Acidity (lbs/day)
South Fork/Greens Run	WV-MC-38-C	Metals Toxicity	Aluminum	14.1	N/A	0.7	14.8	lbs/day
		Metals Toxicity	Iron	51.38	5.11	2.97	59.46	lbs/day
		pH Toxicity	pH	-96.6	N/A	-5.1	-101.7	Net Acidity

Stream Name	NHD Code	Biological Stressors	Parameter	Load Allocation	Wasteload Allocation	Margin of Safety	TMDL	Units
								(lbs/day)
UNT/South Fork RM 0.63/Greens Run	WV-MC-38-C-1	Metals Toxicity	Aluminum	7.6	N/A	0.4	8.0	lbs/day
		Metals Toxicity	Iron	21.72	2.06	1.25	25.03	lbs/day
		pH Toxicity	pH	-35.4	N/A	-1.9	-37.3	Net Acidity (lbs/day)
Muddy Creek	WV-MC-39	Metals Toxicity	Aluminum	50.2	10.5	3.2	63.9	lbs/day
		Metals Toxicity	Iron	237.97	49.13	15.11	302.20	lbs/day
		pH Toxicity	pH	-1898.4	N/A	-99.9	-1998.3	Net Acidity (lbs/day)
Martin Creek	WV-MC-39-E	Metals Toxicity	Aluminum	19.8	9.5	1.5	30.8	lbs/day
		Metals Toxicity	Iron	41.40	22.73	3.38	67.51	lbs/day
		pH Toxicity	pH	-205.3	N/A	-10.8	-216.1	Net Acidity (lbs/day)
Fickey Run	WV-MC-39-E-1	Metals Toxicity	Aluminum	6.9	3.4	0.5	10.8	lbs/day
		Metals Toxicity	Iron	12.70	6.72	1.02	20.44	lbs/day
		pH Toxicity	pH	-80.3	N/A	-4.2	-84.5	Net Acidity (lbs/day)
Glade Run	WV-MC-39-E-2	Metals Toxicity	Aluminum	8.9	2.0	0.6	11.5	lbs/day
		Metals Toxicity	Iron	20.59	5.98	1.40	27.97	lbs/day
		pH Toxicity	pH	-93.5	N/A	-4.9	-98.4	Net Acidity (lbs/day)
Morgan Run	WV-MC-50	Metals Toxicity	Aluminum	15.0	3.3	1.0	19.3	lbs/day
		Metals Toxicity	Iron	80.7	17.9	5.2	103.7	lbs/day
		pH Toxicity	pH	-207.3	N/A	-10.9	-218.2	Net Acidity (lbs/day)
UNT/Morgan Run RM 1.03	WV-MC-50-A	Iron Hydroxide (substrate limiting)	Iron	16.2	4.2	1.1	21.5	lbs/day
		Organic Enrichment	Fecal Coliform	2.40E+10	1.34E+08	1.27E+09	2.54E+10	counts/day
Church Creek	WV-MC-50-B	Metals Toxicity	Aluminum	7.6	1.1	0.5	9.1	lbs/day
		Metals Toxicity	Iron	28.2	5.3	1.8	35.3	lbs/day
		pH Toxicity	pH	-91.3	N/A	-4.8	-96.2	Net Acidity (lbs/day)

Stream Name	NHD Code	Biological Stressors	Parameter	Load Allocation	Wasteload Allocation	Margin of Safety	TMDL	Units
Heather Run	WV-MC-52	Metals Toxicity	Aluminum	8.1	0.2	0.4	8.7	lbs/day
		Metals Toxicity	Iron	29.8	2.8	1.7	34.4	lbs/day
		pH Toxicity	pH	-56.5	N/A	-3.0	-59.5	Net Acidity (lbs/day)
Lick Run	WV-MC-54	Metals Toxicity	Aluminum	16.4	N/A	0.9	17.3	lbs/day
		Metals Toxicity	Iron	73.8	6.7	4.2	84.8	lbs/day
		pH Toxicity	pH	-139.6	N/A	-7.3	-146.9	Net Acidity (lbs/day)
Joes Run	WV-MC-55	Aluminum Toxicity	Aluminum	1.9	N/A	0.1	2.0	lbs/day
		pH Toxicity	pH	-72.4	N/A	-3.8	-76.2	Net Acidity (lbs/day)
Pringle Run	WV-MC-56	Metals Toxicity	Aluminum	15.8	0.1	0.8	16.7	lbs/day
		Metals Toxicity	Iron	95.44	12.84	5.70	113.97	lbs/day
		pH Toxicity	pH	-873.8	N/A	-46.0	-919.7	Net Acidity (lbs/day)
Long Run	WV-MC-124-K-15-C	Metals Toxicity	Aluminum	5.6	2.2	0.4	8.2	lbs/day
		Metals Toxicity	Iron	22.51	7.78	1.59	31.89	lbs/day
		pH Toxicity	pH	-77.6	N/A	-4.1	-81.7	Net Acidity (lbs/day)
Sand Run	WV-MC-124-K-15-H	Sedimentation	Iron	17.7	4.6	1.2	23.4	lbs/day

NA = not applicable; UNT = unnamed tributary.

“Scientific notation” is a method of writing or displaying numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10. The scientific notation of 10,492, for example, is 1.0492×10^4. (Scientific Notation)

11.0 FUTURE GROWTH

11.1 Iron, Aluminum and Manganese

With the exception of allowances provided for Construction Stormwater General Permit registrations discussed below, this TMDL does not include specific future growth allocations for iron, aluminum, or manganese. However, the absence of specific future growth allocations does not prohibit the permitting of new or expanded activities in the watersheds of streams for which metals TMDLs have been developed. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits must be "consistent with the assumptions and requirements of any available wasteload allocation 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 or expanded source 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.

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

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

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

- Most traditional, non-mining point source discharges are assigned technology-based TSS effluent limitations that would not cause biological impairment. 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 biologically impaired streams for which sedimentation has been identified as a significant stressor with the implementation of applicable technology-based TSS requirements. If iron, aluminum, or manganese 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 for the pollutants of concern.

- Subwatershed-specific future growth allowances have been provided for site registrations under the Construction Stormwater General Permit. In general, the successful TMDL allocation provides 1.5 percent of modeled subwatershed area to be registered under the general permit at any point in time. Furthermore, the iron allocation spreadsheet provides a cumulative area allowance 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, larger projects may be permitted in phases that adhere to the area allowances or by implementing controls beyond those afforded by the general permit. Larger areas may be permitted if it can be demonstrated that more stringent controls will result in a loading condition commensurate with that afforded by the management practices associated with the General Permit.

11.2 Fecal Coliform Bacteria

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

In many cases, the implementation of the TMDLs will consist of providing public sewer service to unsewered areas. The NPDES permitting procedures for sewage treatment facilities include technology-based fecal coliform effluent limitations that are more stringent than applicable water quality criteria. Therefore, a new sewage treatment facility may be permitted anywhere in the watershed, provided that the permit includes monthly geometric mean and maximum daily fecal coliform limitations of 200 counts/100 mL and 400 counts/100 mL, respectively. Furthermore, WVDEP will not authorize the construction of combined collection systems or permit overflows from newly constructed collection systems.

12.0 PUBLIC PARTICIPATION

12.1 Public Meetings

Informational public meetings were held on May 16, 2006 and May 17, 2006 at Preston County High School in Kingwood, WV and the Tucker County Senior Citizens Building in Parsons, WV. A public meeting was also held at the Tucker County Senior Citizens Building in Parsons, WV on April 28, 2010. Additional public meetings were held on August 3, 2010 and August 4, 2010 at Camp Dawson in Kingwood, WV and at Blackwater Falls State Park, respectively.

The May 2006 meetings occurred prior to pre-TMDL stream monitoring and pollutant source tracking and included a general TMDL overview and a presentation of planned monitoring and data gathering activities. The April 2010 meeting occurred prior to allocation of pollutant loads and included a presentation of planned allocation strategies. Draft TMDLs were presented at the August 2010 meetings to provide information to stakeholders intended to facilitate public comments.

12.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised in various local newspapers between July 21, 2010 and July 28, 2010. Interested parties were invited to submit comments during the public comment period, which began on July 26, 2010 and ended on August 23, 2010. The electronic documents were also posted on the WVDEP's internet site at http://www.wvdep.org/wvtmdl, on July 26, 2010.

12.3 Response Summary

Comments were received from the Tucker County Development Authority (TCDA). The commenter opposed development of TMDLs within the Cheat River watershed, stating that TMDLs limit the ability for industry to locate in affected areas and complicate the TCDA's ability to promote economic sustainability and growth within Tucker County.

Because TMDLs are required to be developed for impaired waters by federal law, the DEP cannot resolve the commenter's opposition. The DEP is committed to using the best available science to accurately identify impaired waters and develop reasonable TMDLs. A significant component of this project involved reevaluation and improvement of existing TMDLs developed by EPA nearly ten years ago.

Within Tucker County, the majority of the TMDLs relate to the iron, aluminum and pH impairments in the Blackwater River watershed that are attributable to Abandoned Mine Lands and/or acid rain. A fecal coliform TMDL is also drafted for Sand Run of North Fork of Blackwater River which is adversely impacted by inadequate onsite sewage systems. The TMDLs identify pollutant reductions needed to restore water quality and focus on causative existing sources. When accomplished, the pollutant reductions prescribed by TMDLs will restore beneficial uses and may positively impact economic development.

Provisions for future growth are described in Section 11, which includes multiple mechanisms for permitting new activities, many of which are commensurate with requirements for discharge into non-impaired streams. For example, the Sand Run fecal coliform TMDL only prescribes pollutant reductions from existing failing onsite sewage systems and does not restrict future disinfected discharges from new sewage treatment facilities. Another example is the area allowance provided for new activity under the Construction Stormwater General Permit. The TMDLs authorize future registrations under the existing permit and the areas provided accommodate the level of activity anticipated by permitting staff.

13.0 REASONABLE ASSURANCE

Reasonable assurance for maintenance and improvement of water quality in the affected watershed rests primarily with two programs. The NPDES permitting program is implemented by WVDEP to control point source discharges. The West Virginia Watershed Network is a cooperative nonpoint source control effort involving many state and federal agencies, whose task is protection and/or restoration of water quality.

13.1 NPDES Permitting

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

Both the permitting and TMDL development processes have been synchronized with the Watershed Management Framework cycle, such that TMDLs are completed just before the permit expiration/reissuance time frames. Permits for existing nonmining facilities in the Cheat River watershed will be reissued beginning in July 1, 2010 and the reissuance of mining permits will begin January 1, 2011.

13.2 Nonpoint Source Program

WVDEP's Nonpoint Source Program works with partner agencies, nonprofits, academia, volunteer watershed associations and other interested stakeholders to implement the nonpoint source components of TMDLs. The combined resources of these partners are used to address all different types of nonpoint source pollution through both public education and on-the-ground projects. The partners coordinate existing programs, local watershed association goals, and limited resources, leading to the development of project teams and Watershed Based Plans to implement TMDLs and document environmental results.

Over the past fifteen years, some of West Virginia's most substantive and beneficial nonpoint source pollution abatement activities have occurred in the Cheat watershed. The nonprofit watershed association Friends of the Cheat was formed in 1994 with a mission to "restore, preserve, and promote the outstanding natural qualities of the Cheat watershed." Friends of the Cheat developed and coordinated *"River of Promise: A Shared Commitment for the Restoration of the Cheat River, West Virginia."* By signing this agreement, over twenty public, private and nonprofit entities demonstrated a commitment to clean up acid mine drainage impacts in the watershed. A Watershed Based Plan was developed and approved for the Lower River thereby facilitating CWA Section 319 grant funding for restoration projects. The combined work of River of Promise stakeholders has improved water quality, as evidenced by the continued maintenance of acceptable pH at the headwaters of Cheat Lake and the improved fishery in the lower river. This TMDL project will be an additional tool to plan future nonpoint source pollution abatement projects and continue the positive water quality trend.

Cheat Lake Environmental and Recreation (CLEAR), Bull Run Community Association, Downstream Alliance, Friends of Blackwater, Horseshoe Run Watershed Association and Shavers Fork Coalition, Inc. are additional registered watershed associations with varying areas of interest within the Cheat River watershed. Additional information regarding watershed associations and planned restoration activities can be obtained from the Northern Nonpoint Source Program Basin Coordinator, Lou Schmidt (louschmidt@frontiernet.net)

13.3 Public Sewer Projects

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

13.4 AML Projects

Within WVDEP, AML&R manages the reclamation of lands and waters affected by mining prior to the passage of 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 AML 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 AMD.

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

14.0 MONITORING PLAN

The following monitoring activities are recommended:

14.1 NPDES Compliance

WVDEP's DWWM and DMR have the responsibility to ensure that NPDES permits contain effluent limitations as prescribed by the TMDL WLAs and to assess and compel compliance. Permits will contain self-monitoring and reporting requirements that are periodically reviewed by WVDEP. WVDEP also inspects treatment facilities and independently monitors NPDES discharges. The combination of these efforts will ensure implementation of the TMDL WLAs.

14.2 Nonpoint Source Project Monitoring

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

14.3 TMDL Effectiveness Monitoring

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

15.0 REFERENCES

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