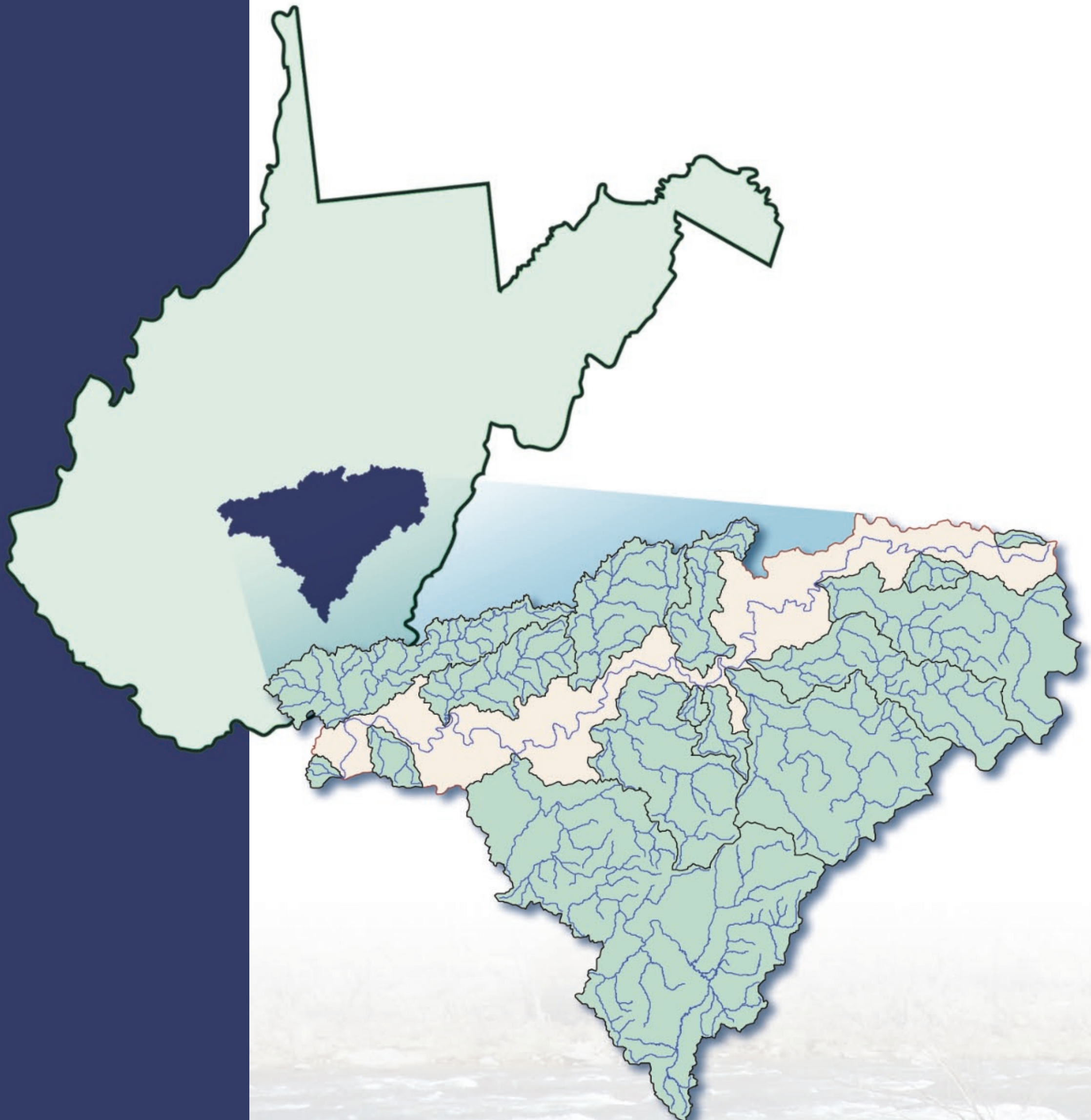

March 27, 2008

FINAL APPROVED REPORT

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

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

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8. Meadow River

ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

7Q10	7-day, 10-year low flow
AD	Acid Deposition Model
AMD	acid mine drainage
AML	abandoned mine land
AML&R	[WVDEP] Office of Abandoned Mine Lands & Reclamation
BMP	best management practice
BOD	biochemical oxygen demand
BPH	[West Virginia] Bureau of Public Health
CAIR	Clean Air Interstate Rule
CFR	Code of Federal Regulations
CSO	combined sewer overflow
CSR	Code of State Rules
DEM	Digital Elevation Model
DESC-R	Dynamic Equilibrium In-stream Chemical Reactions model
DMR	[WVDEP] Division of Mining and Reclamation
DNR	Department of Natural Resources
DO	dissolved oxygen
DWWM	[WVDEP] Division of Water and Waste Management
ERIS	Environmental Resources Information System
GAP	Gap Analysis Land Cover Project
GIS	geographic information system
gpd	gallons per day
GPS	global positioning system
HAU	home aeration unit
LA	load allocation
µg/L	micrograms per liter
MDAS	Mining Data Analysis System
mg/L	milligram per liter
mL	milliliter
MF	membrane filter counts per test
MPN	most probable number
MOS	margin of safety
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NOAA-NCDC	National Oceanic and Atmospheric Administration, National Climatic Data Center
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OOG	Office of Oil and Gas
POTW	publicly owned treatment works

PSD	public service district
SI	stressor identification
SMCRA	Surface Mining Control and Reclamation Act
SRF	State Revolving Fund
SO2	sulfur dioxide
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. Throughout this report, the Gauley watershed refers to the mainstem of the Gauley River and all of the tributary streams that eventually drain to the Gauley River. The term "watershed" is also used to refer to the land area that contributes precipitation runoff that eventually drains to the Gauley River.

TMDL watershed

This term is used to describe the major contributing streams draining directly to the Gauley River mainstem for which TMDLs are being developed. For this report, the Gauley River watershed has been divided into 15 TMDL watersheds: Big Beaver Creek, Big Run, Cherry River, Cranberry River, Hominy Creek, Little Laurel Creek, Meadow River, Muddlety Creek, Panther Creek, Peters Creek, Rich Creek, Scrabble Creek, Turkey Creek, Twentymile Creek, and Williams River (Figure 3-2).

Subwatershed

The subwatershed delineation is the most detailed scale of the delineation that breaks each TMDL watershed into numerous catchments for modeling purposes. The entire Gauley watershed has been subdivided into a total of 520 subwatersheds. The 15 TMDL watersheds have been subdivided into a total of 447 subwatersheds. Only 260 of these subwatersheds (which contain impairments or contribute to impaired waters) were modeled as part of this effort. Pollutant sources, allocations and reductions are presented at the subwatershed scale to facilitate future permitting actions and TMDL implementation.

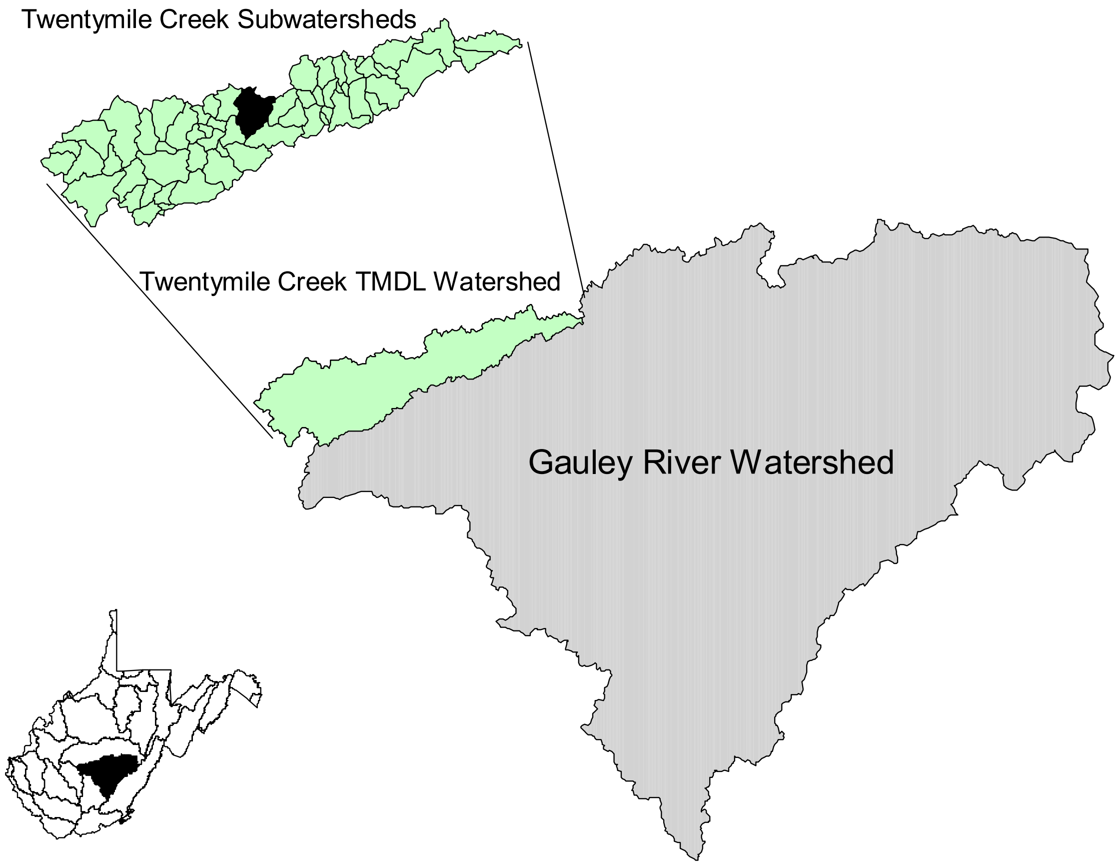


Figure I-1. Examples of a watershed, TMDL watershed, and subwatersheds

EXECUTIVE SUMMARY

The Gauley River watershed is in southern West Virginia and encompasses approximately 1,419 square miles. The majority of the watershed lies within Nicholas, Webster, Pocahontas, and Greenbrier counties. Smaller portions of the watershed lie in Randolph, Clay, Fayette, and Summers counties. Major tributaries include Twentymile Creek, Williams River, Cranberry River, Cherry River, and Meadow River.

This report includes Total Maximum Daily Loads (TMDLs) for various impaired streams in the Gauley River watershed. A TMDL establishes the maximum allowable pollutant loading for a waterbody to comply with water quality standards, distributes the load among pollutant sources, and provides a basis for actions needed to restore water quality.

West Virginia's water quality standards are codified at Title 47 of the *Code of State Rules* (CSR), Series 2, and titled *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*. The standards include designated uses of West Virginia waters and numeric and narrative criteria to protect those uses. The West Virginia Department of Environmental Protection routinely assesses use support by comparing observed water quality data with criteria and reports impaired waters every two years as required by Section 303(d) of the Clean Water Act ("303(d) list"). The act requires that TMDLs be developed for listed impaired waters.

West Virginia's 2006 Section 303(d) list includes 104 impaired streams in the Gauley River watershed. The impairments are related to numeric water quality criteria for fecal coliform bacteria, dissolved aluminum, total iron, total selenium, and pH. 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.

From 1997 through September 2003, the U.S. Environmental Protection Agency (USEPA), Region 3, developed West Virginia TMDLs under the settlement of a 1995 lawsuit, Ohio Valley Environmental Coalition, Inc., West Virginia Highlands et al. v. Browner et al. The lawsuit resulted in a consent decree between the plaintiffs and USEPA. The consent decree established a rigorous schedule for TMDL development and required TMDLs for the impaired waters on West Virginia's 1996 Section 303(d) list. The schedule included TMDL development dates that extend through March 2008. Since October 2003, West Virginia's TMDLs were and will continue to be developed by WVDEP. This report accommodates the timely development of the remaining Gauley River watershed TMDLs as required by the consent decree.

Impaired waters were organized into 15 TMDL watersheds. For hydrologic modeling purposes, impaired and unimpaired streams in these 15 watersheds were further divided into 447 subwatersheds. The subwatershed delineation provided a basis for georeferencing pertinent source information, monitoring data, and presentation of the TMDLs.

Only three active construction sites were registered under the Construction Stormwater General Permit in the watersheds of metals or sediment impaired waters. Although specific wasteload allocations are not prescribed for these sites, the associated disturbed areas conform to the subwatershed based allocations for registrations under the permit, as described in Section 9.1.

The Mining Data Analysis System (MDAS) was used to represent the source-response linkage for total aluminum and iron. The MDAS is a comprehensive data management and modeling system that is capable of representing loads from nonpoint and point sources in the watershed and simulating instream processes. The MDAS was also linked with the Dynamic Equilibrium In-stream Chemical Reactions (DESC-R) model to address aluminum speciation and develop dissolved aluminum TMDLs where necessary in the watershed.

The MDAS was also used to represent the source-response linkage for fecal coliform bacteria. Both point and nonpoint sources contribute to the fecal coliform bacteria impairments in the watershed. The most significant nonpoint sources are those related to the inadequate treatment of sewage. Failing onsite systems and direct discharges of untreated sewage often result in exceedances of the fecal coliform criteria. Precipitation runoff from residential areas is another nonpoint source of fecal coliform bacteria. Agricultural sources of fecal coliform bacteria are present, but less significant. Point sources of fecal coliform bacteria include the effluents of sewage treatment facilities and collection system overflows from publicly owned treatment works (POTWs).

Acidic pH impairments were addressed in two ways. For streams with overlapping pH and metals impairments (where the impairments are primarily caused by historical mining sources), the TMDLs for pH impairments were developed using a surrogate approach where it was assumed that reducing instream metal (iron and aluminum) concentrations allows for attainment of pH water quality criteria. This assumption was then verified by applying the DESC-R model. Stand-alone pH impairments (where the impairment results from acid precipitation and low watershed buffering capacity) were addressed by the Acid Deposition (AD) model that was created within the MDAS. The AD model is composed of six modules: (1) the nitrogen soil transformation module, (2) the nitrogen stream module, (3) the sulfate adsorption/desorption module, (4) the sulfate stream module, (5) the soil chemical reaction module, and (6) the aqueous (stream) chemical reaction module.

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. In the majority of the impaired waters assessed, a strong, positive correlation between iron and total suspended solids (TSS) was identified. In all biologically-impaired waters where sedimentation was identified as a significant stressor, iron TMDLs and pollutant reductions from existing sources were also necessary. WVDEP 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. Point sources of sediment, iron and aluminum include permitted mining activities, permitted non-mining activities and stormwater discharges from construction sites greater than 1 acre. Nonpoint sources include abandoned mine lands

(AML), bond forfeiture sites, roads, oil and gas operations, timbering, agriculture, and urban/residential land disturbance. The permitted discharges from mining activities are the most prevalent point sources throughout the watershed. The presence of individual nonpoint source categories and their relative significance varies by subwatershed.

The iron TMDLs for troutwaters, and the pollutant reductions associated with the prescribed load and wasteload allocations, do not assure complete attainment of the troutwater, chronic aquatic life protection criterion. Non-attainment is predicted when large precipitation events elevate instream TSS concentrations and has been attributed to the relatively high iron content of the soils in those watersheds. The magnitudes of the predicted exceedances under TMDL conditions are not extreme, but exceedances are predicted more often than the once per three years average frequency prescribed by the criterion. In the allocation process, sediment producing non-point sources were reduced to the maximum practical extent and wasteload allocations for point sources were set equal to the chronic water quality criterion.

The selenium TMDL presented for Hughes Fork of Bells Creek is a simple calculation of assimilative capacity at the 7-day, 10-year (7Q10) low flow. Point sources associated with mining activity are the primary sources contributing to the selenium impairment, and the critical condition occurs at low-flow. Nonpoint sources associated with surface disturbances (i.e., barren areas, unpaved roads, harvested forest, and oil and gas well operations) were considered to be negligible sources of selenium because these land disturbances typically do not disturb the subsurface strata that contain selenium. The TMDL prescribes wasteload allocations (WLAs) for all mining point sources in the watershed equal to the value of water quality criteria. “Criteria end-of-pipe” allocations are also protective at higher flow conditions.

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 7 discusses the SI process. The causative stressors to the benthic communities identified in this effort include metals toxicity, pH toxicity, organic enrichment, sedimentation, and ionic toxicity.

SI was followed by stream-specific determinations of the pollutants for which TMDLs must be developed. The biological stressors metals and pH toxicity were identified in waters that also violated water quality criteria for iron, aluminum, or pH. It was determined that implementation of those pollutant-specific TMDLs would address the metals and pH toxicity-related biological impairment. Where organic enrichment was identified as the biological stressor, the waters also demonstrated violations of the numeric criteria for fecal coliform bacteria. It was determined that implementation of fecal coliform TMDLs would remove untreated sewage and significantly reduce animal wastes, thereby reducing the organic and nutrient loading causing the biological impairment. Where sedimentation was identified as the biological stressor, the waters also demonstrated violations of the numeric criteria for iron. WVDEP determined that the iron TMDLs, and the sediment reductions required by them, are an acceptable surrogate for biological stress from sedimentation. Available information regarding the pollutants that cause ionic toxicity and their associated impairment thresholds was insufficient for TMDL development in the given timeframe. TMDL development has been deferred, and the waters have been retained on the 303(d) list.

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

The TMDL watershed appendices focus on the impaired waters and applicable TMDLs (sum of wasteload allocations + sum of load allocations + margin of safety) in the specified subwatersheds. Applicable TMDLs are displayed in each appendix. Accompanying spreadsheets provide TMDLs, WLAs to individual point sources, and example allocations of loads to categories of nonpoint sources that achieve the total TMDL. Also provided is an interactive ArcExplorer geographic information system (GIS) project that allows for the exploration of spatial relationships among the source assessment data.

Considerable resources were used to acquire recent water quality and pollutant source information upon which the TMDLs are based. 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. REPORT FORMAT

This report consists of a main section, appendices, a supporting GIS application, and spreadsheet data tables. The main section describes the overall TMDL development process for the Gauley River watershed, identifies impaired streams, and outlines the source assessment of metals, pH, fecal coliform, and biological stressors. It also describes the modeling process, presents Total Maximum Daily Load (TMDL) allocations, and lists measures that will be taken to ensure that the TMDLs are met. The main section is followed by eight appendices that describe the specific conditions in each of the 15 TMDL watersheds for which TMDLs were developed. The applicable TMDLs are displayed in each appendix. The main section and appendices are supported by a compact disc containing an interactive ArcExplorer GIS project that provides further details on the data and allows the user to explore the spatial relationships among the source assessment data. 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 the data used during the TMDL development process, as well as detailed source allocations associated with successful TMDL scenarios. A Technical Report that describes the detailed technical approaches used throughout the TMDL development process is also included.

2. INTRODUCTION

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

2.1 Total Maximum Daily Loads

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

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

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

From 1997 through September 2003, USEPA Region 3 developed West Virginia TMDLs, under the settlement of a 1995 lawsuit, Ohio Valley Environmental Coalition, Inc., West Virginia Highlands et al. v. Browner et al. The lawsuit resulted in a consent decree between the plaintiffs and USEPA. The consent decree established a rigorous schedule for TMDL development and required TMDLs for the impaired waters on West Virginia's 1996 Section 303(d) list. The schedule included TMDL development dates that extend through March 2008. Since October 2003, West Virginia's TMDLs were and will continue to be developed by WVDEP. WVDEP's TMDL program accommodates the timely development of the remaining TMDLs required by the consent decree.

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 2006 TMDLs should be pursued in Hydrologic Group C, which includes the Gauley River watershed. Figure 2-1 depicts the hydrologic groupings of West Virginia's watersheds; the legend includes the target year for finalization of each TMDL.

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

The TMDL development process begins with pre-TMDL water quality monitoring and source identification and characterization. Informational public meetings are held in the affected watersheds. Data obtained from pre-TMDL efforts are compiled, and the impaired waters are modeled to determine baseline conditions and the gross pollutant reductions needed to achieve water quality standards. 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.

This document provides TMDLs for most of the Gauley River watershed stream/impairment listings from West Virginia's 2006 Section 303(d) list that have a projected TMDL date of 2006. All Gauley River watershed impairments for which USEPA committed to TMDL development by 2008 are addressed in this effort. TMDL development has been deferred for certain biologically impaired waters (Scrabble Creek, Left Fork/Scrabble Creek, Boardtree Branch, Sugarcamp Branch, Stillhouse Branch, and Robinson Fork), where ionic toxicity has been determined to be a significant stressor. The remaining streams on the Section 303(d) list in the Gauley River watershed will be completed by their projected TMDL dates.

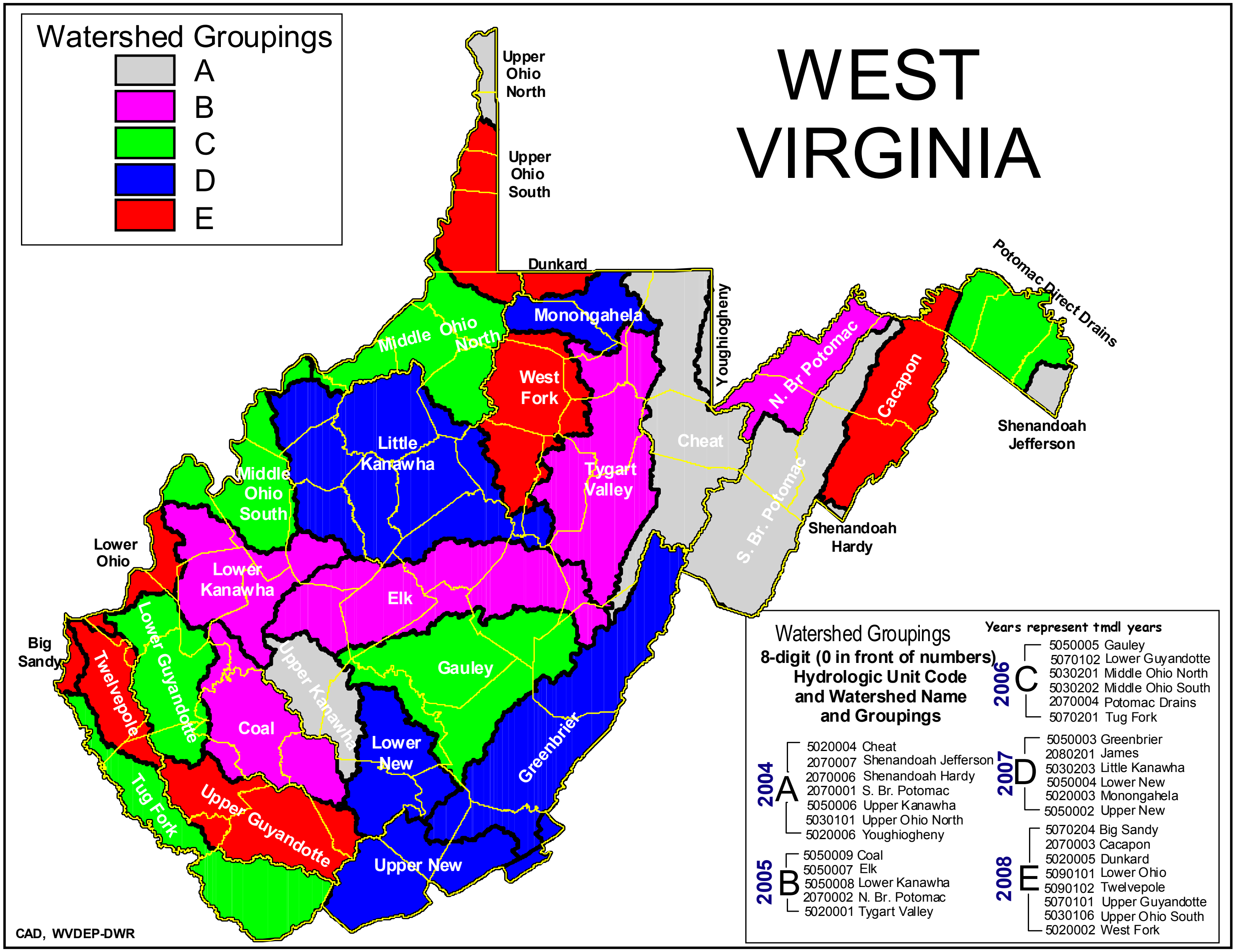


Figure 2-1. Hydrologic groupings of West Virginia's watersheds

2.2 Water Quality Standards

The determination of impaired waters involves comparing instream conditions to applicable water quality standards. West Virginia's water quality standards are codified at Title 47 of the *Code of State Rules* (CSR), Series 2, titled *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*. These standards can be obtained online from the West Virginia Secretary of State internet site (http://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 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 Gauley 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 Gauley River watershed, the aquatic life use has been determined to be violated pursuant to exceedances of iron, dissolved aluminum, selenium, 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. The numeric water quality criteria associated with impairments in the Gauley River watershed are shown in Table 2-1. The stream-specific impairments are displayed in Table 3-3.

Table 2-1. Applicable West Virginia water quality criteria

POLLUTANT	USE DESIGNATION				
	Aquatic Life				Human Health
	Warmwater Fisheries		Troutwaters		Contact Recreation/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
Selenium, total (µg/L)	20	5	20	5	10
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.

Source: 47 CSR, Series 2, *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*.

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 on 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 6.

On June 29, 2005, USEPA approved a revision to the West Virginia Water Quality Standards that altered the zone of applicability of the manganese water quality criterion for the public water supply designated use. The criterion is now applicable only in a five-mile zone upstream of known public or private water supply intakes used for human consumption. The revision necessitated WVDEP's identification of intakes and the reevaluation of prior impairment decisions.

WVDEP secured the Bureau of Public Health's (BPH) database of water supply intakes and determined locations where surface waters are currently used for human consumption. County sanitarians and BPH regional offices were also contacted to seek their guidance relative to any existing intakes that may not be contained in the database. WVDEP regional office field personnel were similarly queried.

Based upon the intake locations derived from the aforementioned sources, five-mile distances were delineated 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. There were no streams where monitoring and/or modeling indicated impairment relative to the current criterion.

On January 9, 2006, USEPA approved a revision to the dissolved aluminum criteria. The warmwater chronic aquatic life protection criterion was changed from 87 micrograms per liter (µg/L) to 750 µg/L, from the date of approval until July 4, 2007. During that period, the 750 µg/L criterion is effective for Clean Water Act purposes in warmwater fisheries. The chronic aquatic life protection dissolved aluminum criterion for troutwaters remains 87 µg/L. Pending revisions to water quality standards propose permanent applicability of the 750 µg/L chronic criterion for warmwater fisheries. The dissolved aluminum TMDLs are based upon the current criteria.

3. WATERSHED DESCRIPTION AND DATA INVENTORY

3.1 Watershed Description

As shown in Figure 3-1, the Gauley River watershed lies mostly within Webster, Pocahontas, Greenbrier, and Nicholas counties in southern West Virginia. Portions of the watershed extend into Randolph, Clay, Fayette, and Summers counties. As a component of the New/Kanawha River drainage, the Gauley River watershed encompasses nearly 1,419 square miles. The Gauley River mainstem runs through the northern portion of the watershed. Major tributaries include Twentymile Creek, Williams River, Cranberry River, Cherry River, and Meadow River. The average elevation in the watershed is 2,483 feet. The highest point is at 4,703 feet on Red Spruce Knob, which is in the western portion of the watershed in Pocahontas County. The minimum elevation is 653 feet at the mouth of the Gauley River at Gauley Bridge, Fayette County.

Landuse and land cover estimates were originally obtained from vegetation data gathered from the West Virginia Gap Analysis Land Cover Project (GAP). The Natural Resource Analysis Center and the West Virginia Cooperative Fish and Wildlife Research Unit of West Virginia University (WVU) produced the GAP coverage. The GAP database for West Virginia was derived from satellite imagery taken during the early 1990s, and it includes detailed vegetative spatial data. Enhancements and updates to the GAP 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 GAP spatial database is provided in the appendices of the Technical Report. The categories for vegetation cover were consolidated to create nine landuse categories, summarized in Table 3-1.

As shown in Table 3-1, the dominant modeled landuse type in the Gauley River watershed is forest, which constitutes 85.7 percent of the total landuse area. Other important modeled landuse types are grassland (7.0 percent), mining (2.4 percent), AML (1.5), urban/residential (1.3 percent), and water (1.0 percent). Individually, all other land cover types compose less than two percent of the total watershed area.

The total population for the entire Gauley River watershed, derived from the 2000 U.S. Census data, is approximately 36,000 people.

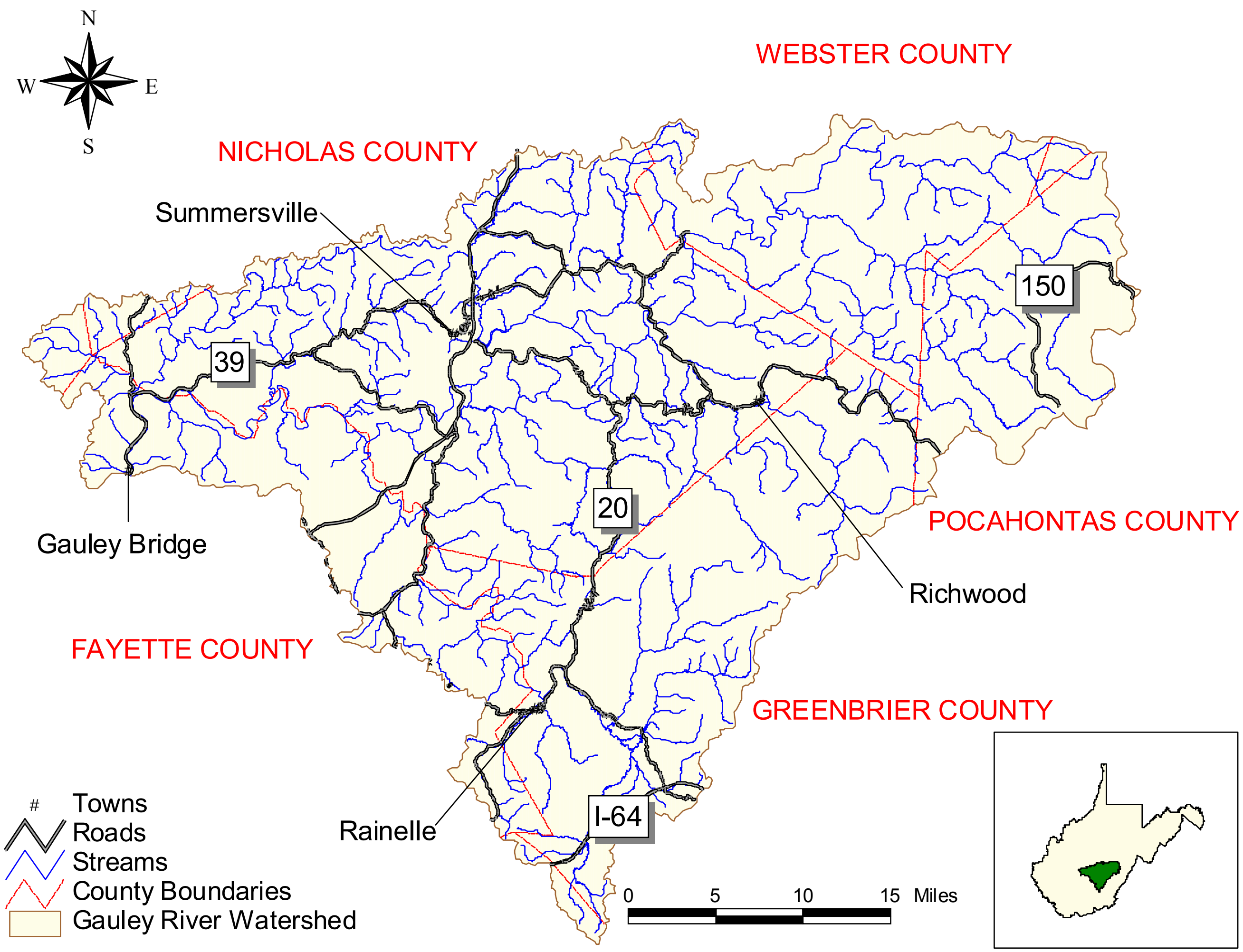


Figure 3-1. Location of the Gauley River watershed

Table 3-1. Modified modeled landuse for the Gauley River watershed

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
Water	9,194.3	14.4	1.0
Wetland	8,446.5	13.2	0.9
Forest	778,085.4	1,215.8	85.7
Grassland	63,275.8	98.9	7.0
Pasture	1,094.0	1.7	0.1
Cropland	948.7	1.5	0.1
Urban/residential	11,580.7	18.1	1.3
Mining	21,919.4	34.2	2.4
AML	13,533.5	21.1	1.5
Total Acres	908,257.4	1,419.2	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 for the Gauley River watershed. These data describe the physical conditions of the watershed, 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. The geographic information is provided in the ArcExplorer GIS 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 (DNR)
	Landuse	WV Gap Analysis Project (GAP)
	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

Type of Information		Data Sources
	Cataloging Unit 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	U.S. Census Bureau, 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	USDA, Forest Service (FS)
	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
	National Pollutant Discharge Elimination System (NPDES) data	WVDEP DMR, WVDEP DWMM
	Discharge Monitoring Report data	WVDEP DMR, Mining Companies
	Abandoned mine land data	WVDEP DMR, WVDEP DWMM
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 from July 2003 through June 2004 in the Gauley River watershed. 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. Despite best efforts, 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.

Additionally, the baseline condition portrayal of the cumulative impact of multiple point sources discharging at existing permit limits sometimes resulted in model prediction of impairment. Where existing pollutant sources were predicted to cause noncompliance with a particular criterion, the subject water was characterized as impaired for that pollutant.

TMDLs were developed for impaired waters in 15 TMDL watersheds (Figure 3-2): Big Beaver Creek, Big Run, Cherry River, Cranberry River, Hominy Creek, Little Laurel Creek, Meadow River, Muddlety Creek, Panther Creek, Peters Creek, Rich Creek, Scrabble Creek, Turkey Creek, Twentymile Creek, and Williams River. 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.

WVDEP attempted to develop the TMDLs necessary to address all impairments in each listed waterbody. Due to insufficient available information regarding causative pollutants and tolerance thresholds, TMDL development was deferred for streams where the biological stressor identification (SI) process identified ionic toxicity as the most significant stressor. All waters and impairments excluded from TMDL development in this effort have been retained on West Virginia’s Section 303(d) list of impaired waters.

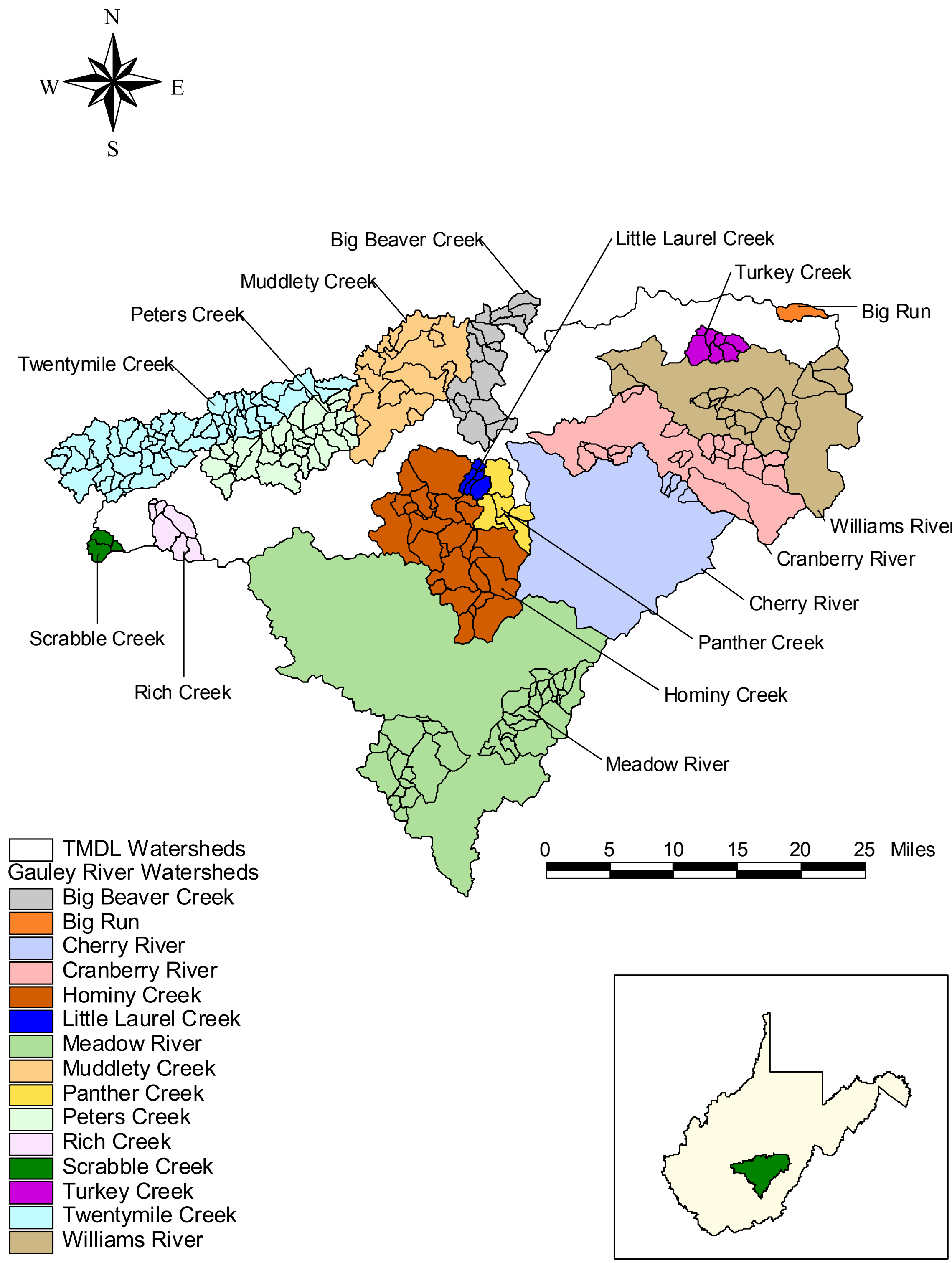


Figure 3-2. Gauley River watersheds (TMDL watersheds are outlined in black)

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

TMDL Watershed	Code	Trout	Stream Name	Fe	Al	pH	Se	FC	BIO
Big Beaver Creek	WVKG-30		Big Beaver Creek					X	
	WVKG-30-D		Wyatt Run					X	
	WVKG-30-E		Little Beaver Creek					X	
	WVKG-30-E-4		UNT/Little Beaver Creek RM 4.0	X				X	
	WVKG-30-H		Left Fork/Big Beaver Creek					X	
	WVKG-30-K		Paddy Run	X					
	WVKG-30-L		Bearpen Fork	X					X
	WVKG-30-P		Upper Laurel Run		X	X			
Big Run	WVKG-70		Big Run			X			
Cherry River	WVKG-34-H-11.5		Carpenter Run			X			
	WVKG-34-H-8		Windy Run			X			
	WVKG-34-H-9		Armstrong Run			X			
Cranberry River	WVKGC-14		Lick Branch			X			
	WVKGC-17.3		Little Rough Run			X			
	WVKGC-18		Cold Run			X			
	WVKGC-19	T	Dogway Fork			X			
	WVKGC-21		Birchlog Run			X			
	WVKGC-22		Tumbling Rock Run			X			
	WVKGC-24	T	North Fork/Cranberry River			X			
	WVKGC-24-C		Left Fork/North Fork/Cranberry River			X			
	WVKGC-4		Barrenshe Run			X			
	WVKGC-9		Aldrich Branch			X			
Hominy Creek	WVKG-24	T	Hominy Creek (upstream of RM 17.3)	X					
	WVKG-24-E-2	T	Brushy Meadow Creek	X				X	
	WVKG-24-E-2-B		UNT/Brushy Meadow Creek RM 1.3					X	
	WVKG-24-I		Colt Branch	X					
Little Laurel Creek	WVKG-31		Little Laurel Creek			X			
	WVKG-31-B		UNT/Little Laurel Creek RM 1.1			X			
	WVKG-31-C		UNT/Little Laurel Creek RM 1.9			X			

Table 3-3. (continued)

TMDL Watershed	Code	Trout	Stream Name	Fe	Al	pH	Se	FC	BIO
Meadow River	WVKG-19-Q		Sewell Creek	X				X	
	WVKG-19-Q-1		Little Sewell Creek	X				X	
	WVKG-19-Q-1-A		Boggs Creek	X					
	WVKG-19-U-2-A		Briery Creek		X	X			
	WVKG-19-V	T	Little Clear Creek	X		X			
	WVKG-19-V-1		Beaver Creek	X					
	WVKG-19-V-2		Stoney Run	X					
	WVKG-19-V-3		Rader Run	X					
	WVKG-19-V-3.8		UNT/Little Clear Creek RM 7.5	X					
	WVKG-19-V-4		Cutlip Branch	X					
	WVKG-19-V-5	T	Laurel Creek	X		X			
	WVKG-19-V-7	T	Kuhn Branch	X					
	WVKG-19-V-7-A		Joe Knob Branch	X					
Muddlety Creek	WVKG-26-B-2		Jones Run					X	X
	WVKG-26-C		Duffy Branch	X					
	WVKG-26-D		Phillips Run	X					
	WVKG-26-H		Enoch Branch	X					
	WVKG-26-I		McMillion Creek	X					
	WVKG-26-K	T	Brushy Fork	X					
	WVKG-26-K-1		Lower Spruce Run	X					
	WVKG-26-K-1-A		Spruce Run	X	X	X			
	WVKG-26-O-2		Falls Run			X			
	WVKG-26-P		Laurel Fork	X					
Panther Creek	WVKG-32	T	Panther Creek	X	X				
	WVKG-32-I		Nettle Run	X					
	WVKG-32-J		Cranes Nest Run	X					
Peters Creek	WVKG-13	T	Peters Creek	X				X	
	WVKG-13-B		Otter Creek	X				X	
	WVKG-13-C		Line Creek					X	
	WVKG-13-C-1		Right Fork/Line Creek	X					
	WVKG-13-C-3		UNT/Line Creek RM 1.3		X	X			
	WVKG-13-E		Laurel Creek					X	
	WVKG-13-F		Jerry Fork	X					
	WVKG-13-G		Jones Branch	X				X	
	WVKG-13-H		Keenan Branch					X	

Table 3-3. (continued)

TMDL Watershed	Code	Trout	Stream Name	Fe	Al	pH	Se	FC	BIO
Peters Creek	WVKG-13-J		Whitewater Branch					X	
	WVKG-13-K		Buck Garden Creek	X				X	
	WVKG-13-K-1		Hutchison Branch	X				X	
	WVKG-13-L		Rockcamp Branch	X					
	WVKG-13-M		McClung Branch	X				X	
	WVKG-13-N		Pine Run	X					
	WVKG-13-O		Bryant Branch	X					
Rich Creek	WVKG-6	T	Rich Creek	X				X	
	WVKG-6-A		Lick Branch					X	
	WVKG-6-B		Bridge Fork	X					
	WVKG-6-D		Kelly Fork					X	
Scrabble Creek	WVKG-1		Scrabble Creek					X	
Turkey Creek	WVKG-60	T	Turkey Creek			X			
	WVKG-60-A	T	Right Fork/Turkey Creek			X			
Twentymile Creek	WVKG-5		Twentymile Creek	X		X		X	X
	WVKG-5-A		Buckles Branch	X					
	WVKG-5-B		Bells Creek	X				X	X
	WVKG-5-B-1		Open Fork	X	X	X		X	X
	WVKG-5-B-1-B		Williams Hollow		X	X			
	WVKG-5-B-1-C		Sangamore Fork	X	X	X			X
	WVKG-5-B-2		Smith Branch					X	
	WVKG-5-B-4		Hughes Fork	X			X		
	WVKG-5-B-5		Rockcamp Fork					X	
	WVKG-5-B-7		Campbell Fork	X				X	X
	WVKG-5-F		Rockcamp Fork		X	X			X
	WVKG-5-F-1		Spring Branch	X	X	X			X
	WVKG-5-G		Lilly Branch	X					
	WVKG-5-K		Hardaway Branch	X					
	WVKG-5-K-2		UNT/Hardaway Branch	X					
	WVKG-5-M		Boardtree Branch	X					
	WVKG-5-N		Sugarcamp Branch	X					
	WVKG-5-O		Stillhouse Branch	X					
	WVKG-5-P		Robinson Fork	X					
	WVKG-5-P.5		UNT/Twentymile Creek	X					
	WVKG-5-P-4		UNT/Robinson Fork RM 1.22 (Wildcat Hollow)	X					
	WVKG-5-R		Rader Fork	X					

Table 3-3. (continued)

TMDL Watershed	Code	Trout	Stream Name	Fe	Al	pH	Se	FC	BIO
Williams River	WVKGW-1	T	Craig Run			**X**			
	WVKGW-10	T	Middle Fork/Williams River			**X**			
	WVKGW-18		Kens Creek			**X**			
	WVKGW-20	T	Tea Creek			**X**			
	WVKGW-21	T	Sugar Creek			**X**			
	WVKGW-21-B		UNT/Sugar Creek RM 2.5			**X**			

Note:
UNT = unnamed tributary.
T indicates troutwater
FC indicates fecal coliform bacteria impairment
BIO indicates a biological impairment

4. METALS SOURCE ASSESSMENT

This section identifies and examines the potential sources of aluminum, iron, selenium, and pH impairments in the Gauley 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 National Pollutant Discharge Elimination System (NPDES) program, established under Clean Water Act Sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources. For purposes of this TMDL, NPDES-permitted discharge points are considered point sources.

Nonpoint sources of pollutants are diffuse, non-permitted sources. They most often result from precipitation-driven runoff. For the purposes of these TMDLs only, WLAs (WLAs) are given to NPDES-permitted discharge points, and LAs (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 the previous section enabled the characterization of pollutant sources. As part of the TMDL development process, WVDEP performed additional field-based source tracking activities to supplement the available source characterization data. WVDEP staff recorded physical descriptions of pollutant sources and the general stream condition in the vicinity of the sources. WVDEP collected global positioning system (GPS) data and water quality samples for laboratory analysis as necessary to characterize the sources and their impacts. Source tracking information was compiled and electronically plotted on maps using GIS software. Detailed information, including the locations of pollutant sources, is provided in the subwatershed appendices, the Technical Report, and the ArcExplorer project on the CD version of this TMDL report.

4.1 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.

4.1.1 Mining Point Sources

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

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

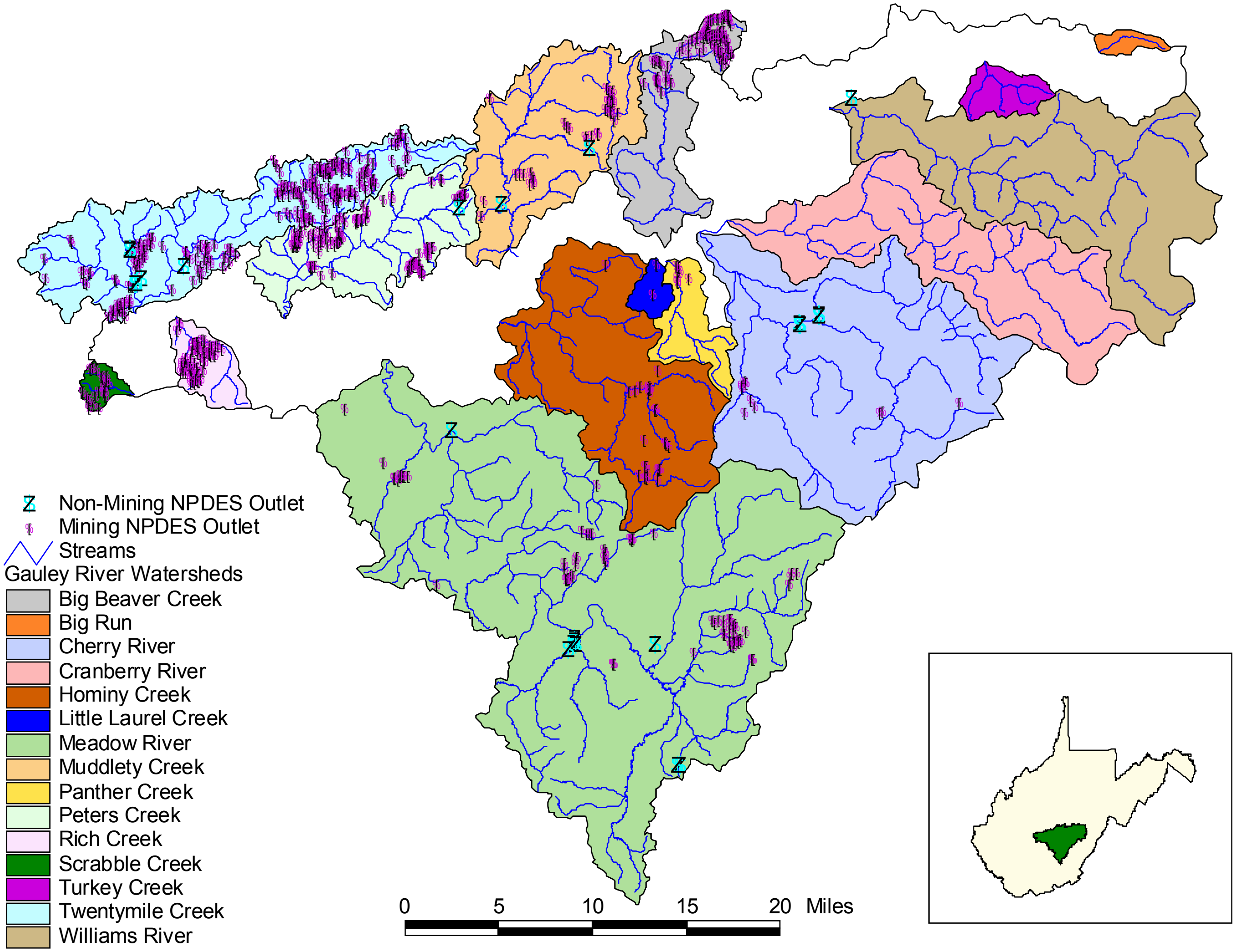
- Restoring the affected land to a condition capable of supporting the uses that it was capable of supporting prior to any mining

- Backfilling and compacting (to ensure stability or to prevent leaching of toxic materials) to restore the approximate original contour of the land, including all highwalls

- Minimizing disturbances to the hydrologic balance and to the quality and quantity of water in surface water and groundwater systems both during and after surface coal mining operations and during reclamation by avoiding acid or other toxic mine drainage

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

In the 15 TMDL watersheds, there are 61 mining-related NPDES permits, with 499 associated outlets. Some permits discharge to one or more adjacent TMDL watersheds through multiple outlets. A complete list of the permits and outlets is provided in Appendix F of the Technical Report. Figure 4-1 illustrates the extent of the mining NPDES outlets in the watershed.



NOTE: Some mapped features in close proximity to each other may plot as one location on the map.

Figure 4-1. Mining NPDES outlets in the 15 TMDL watersheds of the Gauley River watershed

4.1.2 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. Using this information, the non-mining point sources that are directly authorized to discharge iron or aluminum were represented in the model and assigned individual WLAs. Sources may include the process wastewater discharges from water treatment plants and industrial manufacturing operations, and stormwater discharges associated with industrial activity. Based upon the minimal flow and disturbed area associated with existing, non-mining point sources of metals, the assigned WLAs allow for continued discharge at existing permit limits. There are eight NPDES permits for non-mining activities with sixteen associated outlets that discharge in the watersheds of iron-impaired streams. A list of the permits and outlets, including existing effluent limitation information, is provided in Appendix F of the Technical Report.

4.1.3 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.

Only three active construction sites with a total disturbed acreage of 43.98 acres were registered under the Construction Stormwater General Permit in the watersheds of metals or sediment impaired waters. Although specific wasteload allocations are not prescribed for these sites, the associated disturbed areas conform to the subwatershed based allocations for registrations under the permit, as described in Section 9.1.

4.2 Metals Nonpoint Sources

In addition to point sources, nonpoint sources can contribute to water quality impairments related to metals. AML contributes acid mine drainage (AMD), which produces low pH and high metals concentrations in surface and subsurface water. Similarly, facilities that were subject to SMCRA during active operations and subsequently forfeited their bonds and abandoned operations can be a significant source of metals and low-pH. Also, land disturbing activities that introduce excess sediment are considered nonpoint sources of metals.

4.2.1 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 AMLs in the Gauley River watershed from their records. In addition, source tracking efforts by WVDEP DWWM and AML&R identified additional AML sources (discharges, seeps, portals, culverts, refuse piles, diversion ditches, and ponds). Field data, such as GPS locations, water samples, and flow measurement, were collected to represent these sources and characterize their impact on water quality. Based on this work, AMLs represent a significant source of metals in some subwatersheds of the Gauley River watershed and were represented in the Gauley River TMDLs. A total of 1,264 acres of AML area, 53 AML seeps, and 155 miles of highwall were incorporated into the TMDL model.

4.2.2 SMCRA Bond Forfeiture Sites

As stated previously, mining permittees 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. Sites with unreclaimed land disturbance and unresolved water quality impacts were represented, as were sites with ongoing water treatment activities. There are 14 bond forfeiture sites in the metals impaired areas of the Gauley River watershed.

4.2.3 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 Gauley River watershed. This information included the harvested area and the subset of land disturbed by roads and landings for 37 registered logging sties in the 15 TMDL subwatersheds.

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 account for approximately an additional 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 to 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 392 active oil and gas wells in the watersheds addressed in this report. Runoff from unpaved access roads to these wells and the disturbed areas around the wells might contribute sediment to adjacent streams.

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 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; however, there is very little agricultural activity in the Gauley River watershed. Row crop agriculture and pasture each account for approximately 0.1 percent of the watershed, as shown by the modified modeled landuse data (Table 3-1) and source tracking efforts throughout the watershed.

Streambank Erosion

Streambank erosion has been determined to be a significant sediment source throughout the watershed. The sediment loading from bank erosion is considered a nonpoint source and LAs are assigned.

Other Land-Disturbance Activities

Stormwater runoff from residential and urbanized areas is a significant source of sediment in parts of the watershed. The modified GAP 2000 landuse data were used to determine the extent of residential and urban areas.

The GAP 2000 landuse data also classifies certain areas as "barren" land. In the model configuration process, portions of the barren landuse were reclassified to account for known sources (active mining, abandoned mine lands, SMCRA bond forfeiture sites, 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 various landuse categories where they may be present.

4.3 Selenium Sources

Hughes Fork of Bells Creek of Twentymile Creek (KG-5-B-4) is impaired pursuant to West Virginia's water quality criteria for selenium. This impaired waterbody is shown in Figure 4-2.

This stream was listed based on data collected by WVDEP (from July 2003 through June 2004) during the pre-TMDL stream monitoring effort, which is summarized in Table 4-1. Of the nine available observations, two violated the chronic aquatic life criterion for total selenium (5.0 µg/L). No observations violated the acute aquatic life criterion (20.0 µg/L) or the 10 µg/L criterion applicable to the public water supply use.

Table 4-1. Water quality observations for selenium in Hughes Fork

Watershed	Stream Name	DNR Code	Mile Point	Total Observations	Non-Detect Observations	Total Selenium (µg/L)			Water Quality Criteria Violations		
						Ave	Min	Max	5 µg/L	20 µg/L	10 µg/L
Twentymile Creek	Hughes Fork	WVKG-5-B-4	0.0	9	0	5.7	0.01	5.0	2	0	0

Source: WVDEP, DWWM

ND = Non-detect

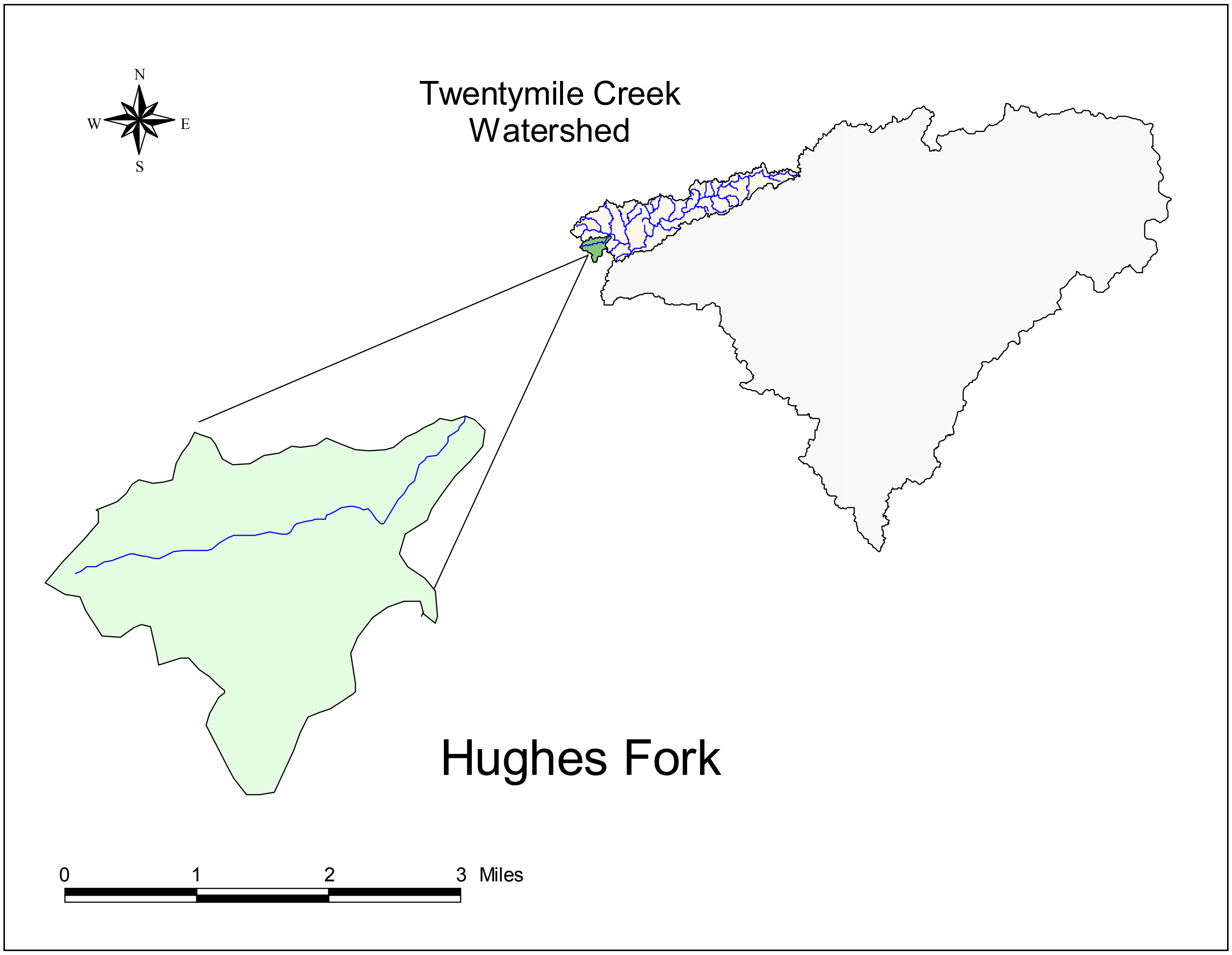


Figure 4-2. Location of the Hughes Fork subwatershed

Selenium is a naturally occurring element that is found in Cretaceous marine sedimentary rocks, coal and other fossil fuel deposits (Dreher, 1992; CCREM 1987; USEPA 1987; Haygarth 1994). When such deposits are mined, mobilization of selenium is typically enhanced from the crushing of ore and waste materials along with the resulting increase in surface area of material exposed to weathering processes. Studies have shown that selenium mobilization appears to be associated with various disturbance activities associated with surface coal mining in Wyoming and western Canada (Dreher and Finkelman 1992; McDonald and Strosher 1998). In West Virginia, coals that contain the highest selenium concentrations are found in a region of south central West Virginia where the Allegheny and upper Kanawha Formations of the Middle Pennsylvanian are mined (WVGES 2002).

Extensive surface mining operations exist in the Hughes Fork watershed, and active mining is the dominant landuse. Given the high selenium content of coals in this region, and the prevalence of mining activity, subsurface disturbances associated with the extensive surface mining operations are the likely cause of the selenium impairment.

4.4 pH Sources

The pH impairments in the Gauley watershed have been attributed to two separate 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 and separate TMDL development methodologies were employed for each source category. Table 4-2 shows the pH impaired streams and the causative sources of the impairment.

Table 4-2. Causative sources of pH impaired streams

TMDL Watershed	Code	Stream Name	Causative Sources
Big Beaver Creek	WVKG-30-P	Upper Laurel Run	Historic Mining
Big Run	WVKG-70	Big Run	Acid deposition
Cherry River	WVKG-34-H-11.5	Carpenter Run	Acid deposition
Cherry River	WVKG-34-H-8	Windy Run	Acid deposition
Cherry River	WVKG-34-H-9	Armstrong Run	Acid deposition
Cranberry River	WVKGC-14	Lick Branch	Acid deposition
Cranberry River	WVKGC-17.3	Little Rough Run	Acid deposition
Cranberry River	WVKGC-18	Cold Run	Acid deposition
Cranberry River	WVKGC-19	Dogway Fork (upstream of RM 6.8)	Acid deposition
Cranberry River	WVKGC-21	Birchlog Run	Acid deposition
Cranberry River	WVKGC-22	Tumbling Rock Run	Acid deposition
Cranberry River	WVKGC-24	North Fork/Cranberry River	Acid deposition
Cranberry River	WVKGC-24-C	Left Fork/North Fork/Cranberry River	Acid deposition
Cranberry River	WVKGC-4	Barrenshe Run (above Little Barrenshe)	Acid deposition
Cranberry River	WVKGC-9	Aldrich Branch	Acid deposition
Little Laurel Creek	WVKG-31	Little Laurel Creek (upstream of RM 1.1)	Acid deposition
Little Laurel Creek	WVKG-31-B	UNT/Little Laurel Creek RM 1.1	Acid deposition
Little Laurel Creek	WVKG-31-C	UNT/Little Laurel Creek RM 1.9	Acid deposition
Meadow River	WVKG-19-U-2-A	Briery Creek	Historic Mining
Meadow River	WVKG-19-V	Little Clear Creek (above Kuhn Branch)	Acid deposition
Meadow River	WVKG-19-V-5	Laurel Creek	Acid deposition
Muddlety Creek	WVKG-26-K-1-A	Spruce Run	Historic Mining
Muddlety Creek	WVKG-26-O-2	Falls Run	Acid deposition
Peters Creek	WVKG-13-C-3	UNT/Line Creek RM 1.3	Historic Mining
Turkey Creek	WVKG-60	Turkey Creek	Acid deposition
Turkey Creek	WVKG-60-A	Right Fork/Turkey Creek	Acid deposition
Twentymile Creek	WVKG-5	Twentymile Creek (above Deal Fork)	Acid deposition
Twentymile Creek	WVKG-5-B-1	Open Fork	Historic Mining
Twentymile Creek	WVKG-5-B-1-B	Williams Hollow	Historic Mining
Twentymile Creek	WVKG-5-B-1-C	Sangamore Fork	Historic Mining
Twentymile Creek	WVKG-5-F	Rockcamp Fork	Historic Mining

TMDL Watershed	Code	Stream Name	Causative Sources
Twentymile Creek	WVKG-5-F-1	Spring Branch	Historic Mining
Williams River	WVKGW-1	Craig Run	Acid deposition
Williams River	WVKGW-10	Middle Fork/Williams River	Acid deposition
Williams River	WVKGW-18	Kens Creek	Acid deposition
Williams River	WVKGW-20	Tea Creek	Acid deposition
Williams River	WVKGW-21	Sugar Creek (upstream of RM 2.5)	Acid deposition
Williams River	WVKGW-21-B	UNT/Sugar Creek RM 2.5	Acid deposition

4.4.1 pH Sources – Historic Mining

Where the discharges from historical mining activities were determined to be the cause of low pH impairments, iron and/or aluminum impairments also existed. 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 and then verifying that the resultant pH associated with the metals TMDL condition would be in compliance with pH criteria. The historical mining sources are described in Section 4.2.

4.4.2 pH Sources - Acid Deposition

Where low pH impairments were associated solely with acid precipitation and low watershed buffering capacity, the TMDL approach captures the watershed dynamics associated with acidic atmospheric deposition and presents the net acidity reductions (and net alkalinity additions) necessary to achieve the pH water quality criteria.

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-forth 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 Babcock State Park, Fayette County, WV and the USDA Forest Service Northeastern Research Station, Tucker County, WV was also used to characterize the extent of atmospheric deposition in the watershed.

4.4.3 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., Mandy, Simoda, Snowdog, and Trussel) and the Pottsville Sandstone formation (very low buffering capacity) are known to significantly influence the pH conditions throughout the eastern Gauley watershed. In certain areas, it has been observed that intrusions of the Mauch Chunk formation provides limited buffering capacity which slightly increases instream pH conditions.

5. FECAL COLIFORM SOURCE ASSESSMENT

5.1 Fecal Coliform Point Sources

The most significant fecal coliform point sources are the permitted discharges from sewage treatment plants. These facilities (including publicly and privately owned treatment works, combined sewer overflows, and home aeration units) are regulated by NPDES permits. Permits require effluent disinfection and compliance with strict fecal coliform limitations (200 counts/100 milliliters (mL) [average monthly] and 400 counts/100 mL [maximum daily]). However, noncompliant discharges and collection system overflows can also contribute significant loadings of fecal coliform bacteria to receiving streams. The following sections discuss the specific types of fecal coliform point sources that were identified in the Gauley River watershed.

5.1.1 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. The effluents of sewage treatment plants are not significant sources of fecal coliform bacteria because they are permitted to discharge only at limits more stringent than water quality criteria.

One POTW (Greenbrier County PSD No. 2, Outlet 001) discharges treated effluent into Sewell Creek. This POTW is also permitted to discharge stormwater from areas adjacent to the wastewater treatment plant site (Outlets 002 and 003). The stormwater discharges are also subject to an existing stormwater benchmark for fecal coliform bacteria that is equal to the fecal coliform monthly geometric mean water quality criterion.

5.1.2 Overflows

Combined sewer 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, but neither CSOs nor SSOs have been identified in the watersheds of the impaired waters that are the subject of this TMDL effort.

5.1.3 Municipal Separate Storm Sewer Systems

USEPA’s stormwater permitting regulations require municipalities to obtain permit coverage for all stormwater discharges from municipal separate storm sewer systems (MS4s). There are no MS4 municipalities located within the drainage of any of the fecal coliform impaired streams of the Gauley watershed at the time of this TMDL document.

5.1.4 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). 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. The effluents from facilities regulated by both general permits are not significant sources of fecal coliform bacteria because they are permitted to discharge only at limits more stringent than the water quality criteria. Within the watersheds of fecal coliform impaired streams, three facilities are registered under the "package plant" general permit and 2 are registered under the "HAU" general permit.

5.2 Fecal Coliform Nonpoint Sources

5.2.1 On-site Treatment Systems

Overall, failing septic systems and straight pipes represent the most significant nonpoint source of fecal coliform bacteria in the Gauley River watershed. According to the West Virginia Bureau for Public Health, the failure rate for septic systems in the watershed is estimated to be 70 percent during the first 10 years after installation. Information collected during source tracking efforts by WVDEP yielded an estimate of 2,064 homes in the fecal coliform impaired watersheds that are not served by centralized sewage collection and treatment systems.

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.

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 point source 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 geology, and defined by rates of septic system failure. Two types of failure were considered, complete failure and seasonal 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. Seasonal failure was defined as 25 gallons per house per day of untreated sewage escaping a septic system as overland flow to receiving waters. Both types of failure were modeled as daily, year-round flows to simplify calculations.

Once failing septic flows had been modeled, the next step was to calculate an average fecal coliform concentration for failing septic systems in the TMDL watershed. Precipitation data from spring of 2003 to summer of 2004 was examined to identify dry periods with no significant precipitation. Pre-TMDL monitoring data was queried to identify fecal coliform observations with concurrent stream flow measurements during the identified summer dry periods. There were 30 observations from 26 pre-TMDL monitoring stations suitable for this analysis. It was assumed that all fecal coliform loading would originate from failing septic systems during dry periods. Monitoring data from streams with known permitted fecal coliform point sources were excluded from the analysis.

Observed stream fecal coliform concentration was multiplied by observed stream flow to calculate stream fecal load. This load was divided by the total failing septic flow draining to the water quality monitoring sample location, which rendered a failing septic fecal coliform concentration. The calculated concentrations for the 30 observations were averaged to yield a failing septic fecal coliform concentration of 1,782,292 counts per 100 mL. This concentration was used as a starting point and further refined during calibration of the model. Additional details of the failing septic analyses are presented in the Technical Report.

5.2.2 Stormwater Runoff

Stormwater runoff represents another nonpoint source of fecal coliform bacteria in residential and urbanized areas. Runoff from residential and urbanized areas during storm events can be a significant source, delivering bacteria from the waste of pets and wildlife to the waterbody. GAP 2000 landuse data were used to determine the number of acres of residential and urbanized areas in the Gauley River watershed. Literature reference values were used to determine fecal accumulation rates for these areas.

5.2.3 Agriculture

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

Based on GAP 2000 landuse data, it was determined that agriculture is not prevalent in the impaired portions of the Gauley River watershed. Although agriculture is not widespread, source tracking efforts identified isolated instances of pastures and feedlots near impaired segments that potentially have significant localized impacts on instream bacteria levels. Livestock counts from the 1997 Census of Agriculture (USDA, 1997) were used to develop accumulation rates for agricultural sources of fecal coliform bacteria.

5.2.4 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 storm water sampling results, and model simulations, wildlife is not considered to be a significant nonpoint source of fecal coliform bacteria in the Gauley River watershed.

6. SEDIMENT SOURCE ASSESSMENT

For certain waters in the Gauley River watershed, excess sediment has been identified as a significant stressor in relation to biological impairment. All such 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, and that the iron TMDLs are therefore an appropriate surrogate. Sediment sources are described in Section 4. The biological SI process is detailed in Section 7, which includes a discussion of the TMDLs that are necessary to address specific stressors.

7. 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 often analogous to those already described: mine drainage, untreated sewage, and sediment. The Technical Report discusses biological impairment and the SI process in detail.

7.1 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 (WVSCI; Gerritsen et al., 2000) 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 less than 60.6 points, on a normalized 0–100 scale, are considered biologically impaired.

Biological assessments are useful in detecting impairment, but they might not clearly identify the causes of impairment, which must be determined before TMDL development can proceed. USEPA developed *Stressor Identification: Technical Guidance Document* (Cormier et al., 2000) to assist water resource managers in identifying stressors and stressor combinations that cause biological 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.

7.2 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, GAP2000 landuse information, Natural Resources Conservation Service (NRCS) STATSGO soils data, NPDES point source data, and literature sources.

7.3 Candidate Causes/Pathways

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

- Metals contamination (including metals contributed through soil erosion) causes toxicity
- Acidity (low pH) causes toxicity
- High sulfates and increased ionic strength cause toxicity
- Increased total suspended solids (TSS)/erosion and altered hydrology cause sedimentation and other habitat alterations
- Altered hydrology causes higher water temperature, resulting in direct impacts
- Altered hydrology, nutrient enrichment, and increased biochemical oxygen demand (BOD) cause reduced dissolved oxygen (DO)
- Algal growth causes food supply shift
- High levels of ammonia cause toxicity (including increased toxicity due to algal growth)
- Chemical spills cause toxicity

A conceptual model was developed to examine the relationship between candidate causes and potential biological effects. The conceptual model (Figure 7-1) depicts the sources, stressors, and pathways that affect the biological community.

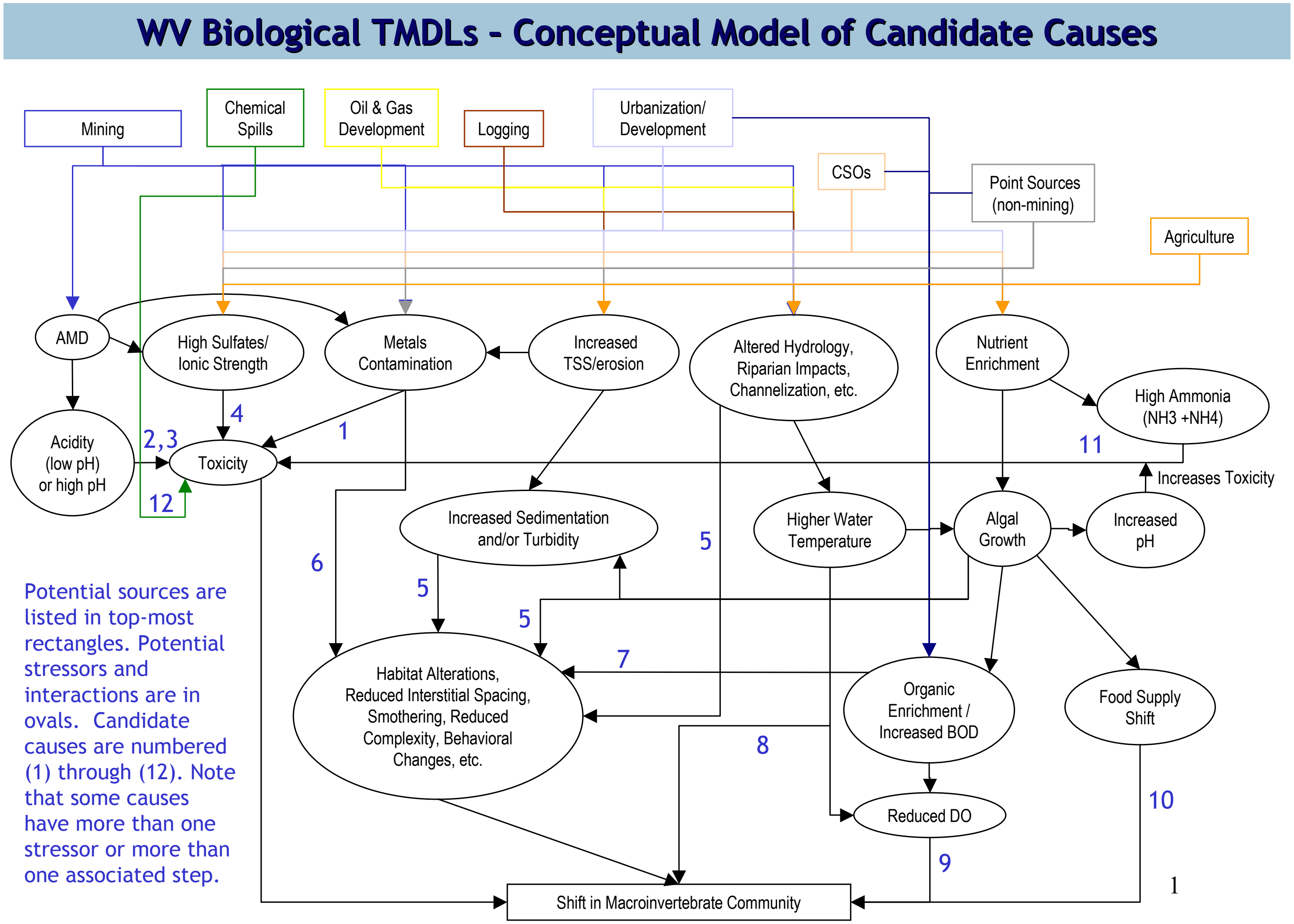


Figure 7-1. Conceptual model of candidate causes and potential biological effects

7.4 Stressor Identification Results

The SI process determined the significant causes of biological impairment. Biological impairment was linked to a single stressor in some cases and multiple stressors in others. The SI process identified the following stressors for the biologically impaired waters of the Gauley River watershed:

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

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

The SI process identified metals toxicity 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 organic enrichment was identified as the biological stressor, the waters also demonstrated violations of the numeric criteria for fecal coliform bacteria. The predominant source of fecal coliform bacteria in the watershed is inadequately treated sewage. WVDEP determined that implementation of fecal coliform TMDLs would remove untreated sewage and thereby reduce the organic and nutrient loading causing the biological impairment. Therefore, fecal coliform TMDLs will serve as a surrogate where organic enrichment was identified as a stressor.

The SI process indicated sedimentation as a causative stressor for four biologically impaired streams. WVDEP initially pursued the development of TMDLs directly for sediment for those streams. 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. All of the sediment-impaired waters also were 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 would be necessary under the reference approach. As such, the iron TMDLs are an acceptable surrogate for biological impairments from sedimentation.

Rader Fork (WVKG-5-R) was selected as the reference stream as it shares similar landuse, ecoregion and geomorphologic characteristics with the sediment impaired streams. The Rader Fork watershed is not without anthropogenic impacts, but its WVSCI score of 75.42 indicates that the biological community is not impaired. The location of Rader Fork is shown in Figure 7-2.

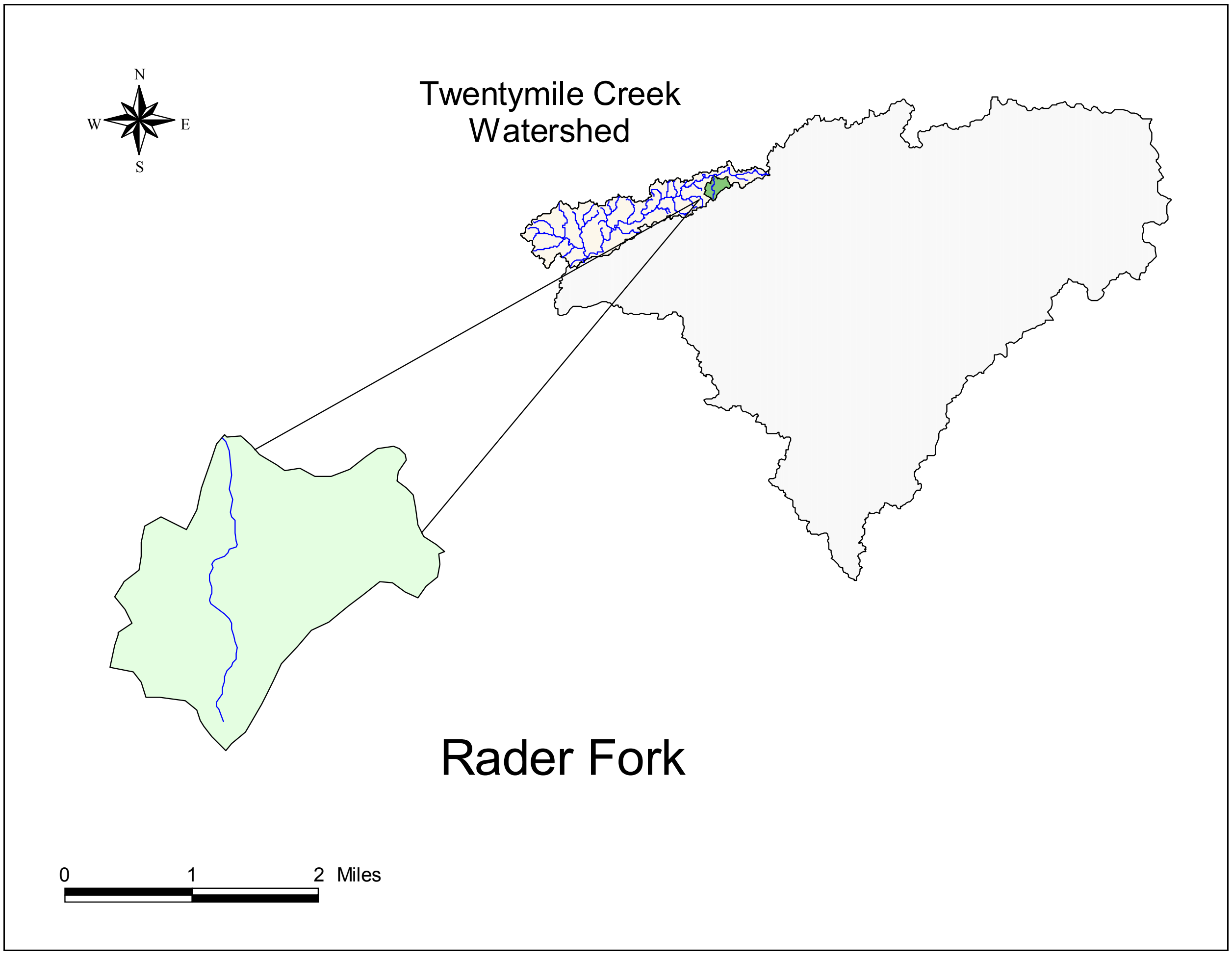


Figure 7-2. Location of the reference stream, Rader Fork

In certain waters (Scrabble Creek, Left Fork/Scrabble Creek, Boardtree Branch, Sugarcamp Branch, Stillhouse Branch, and Robinson Fork), the SI process determined ionic toxicity as the significant stressor. There is insufficient information available regarding the causative pollutants and their associated impairment thresholds for biological TMDL development for ionic toxicity at this time. Therefore, WVDEP is deferring biological TMDL development for ionic toxicity stressed streams and retaining those waters on the Section 303(d) list.

Table 7-1 summarizes the significant stressors' contributions to biological impairment in the Gauley River watershed.

Table 7-1. Significant stressors of biologically impaired streams in the Gauley River watershed

Major Watershed	Stream	Biological Stressors	TMDLs Developed
Twentymile Creek	Twentymile Creek	Sedimentation Organic enrichment	Total iron (surrogate) Fecal coliform
	Bells Creek	Sedimentation Organic enrichment	Total iron (surrogate) Fecal coliform
	Open Fork	Metals toxicity (Aluminum) pH toxicity (acidity)	Dissolved aluminum pH
	Sangamore Fork	Metals toxicity (Aluminum) pH toxicity (acidity)	Dissolved aluminum pH
	Campbell Fork	Organic enrichment Sedimentation	Fecal coliform Total iron (surrogate)
	Rockcamp Fork (WVKG-5-F)	Metals toxicity (Aluminum) pH toxicity (acidity)	Dissolved aluminum pH
	Spring Branch	Metals toxicity (Aluminum, Iron) pH toxicity (acidity)	Dissolved aluminum Total iron pH
Muddlety Creek	Jones Run	Organic enrichment	Fecal coliform
Big Beaver Creek	Bearpen Fork	Sedimentation	Total iron (surrogate)

8. MODELING PROCESS

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

8.1 Modeling Technique for Total Iron, Dissolved Aluminum, and Fecal Coliform Bacteria

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 bacterial impairments are temporally variable and occur at low, average, and high flow conditions and dissolved aluminum impairments are related to pH water quality
- 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 metals, pH, and fecal coliform bacteria in West Virginia are presented in Section 2, Table 2-1. Compliance with the criteria requires attaining conditions that protect against both short-term (acute) effects and long-term (chronic) effects. 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 chronic and acute criteria.

The TMDL development approach must also consider the dominant processes affecting pollutant loadings and instream fate. In the Gauley 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 MDAS was developed specifically for TMDL application in West Virginia to facilitate large scale, data intensive watershed modeling applications. The MDAS is a system designed to support TMDL development for areas affected by nonpoint and point sources. The MDAS component most critical to TMDL development is the dynamic watershed model because it provides the linkage between source contributions and instream response. The MDAS is used to simulate watershed hydrology and pollutant transport as well as stream hydraulics and instream water quality. It is capable of simulating different flow regimes and pollutant loading variations.

A key advantage of the MDAS' development framework is that it has no inherent limitations in terms of modeling size or upper limit of model operations. In addition, the MDAS model allows for seamless integration with modern-day, widely available software such as Microsoft Access and Excel. Sediment, total iron, total aluminum and fecal coliform bacteria were modeled using the MDAS.

8.1.1 MDAS Setup

Configuration of the MDAS model involved subdividing the Gauley River watershed 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 watershed was broken into 15 separate watershed units based on the watershed groupings of impaired streams shown in Figure 3-2. These subwatersheds were further subdivided 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. The 447 individual subwatershed units across all of the 15 TMDL watersheds are shown in Figure 8-1.

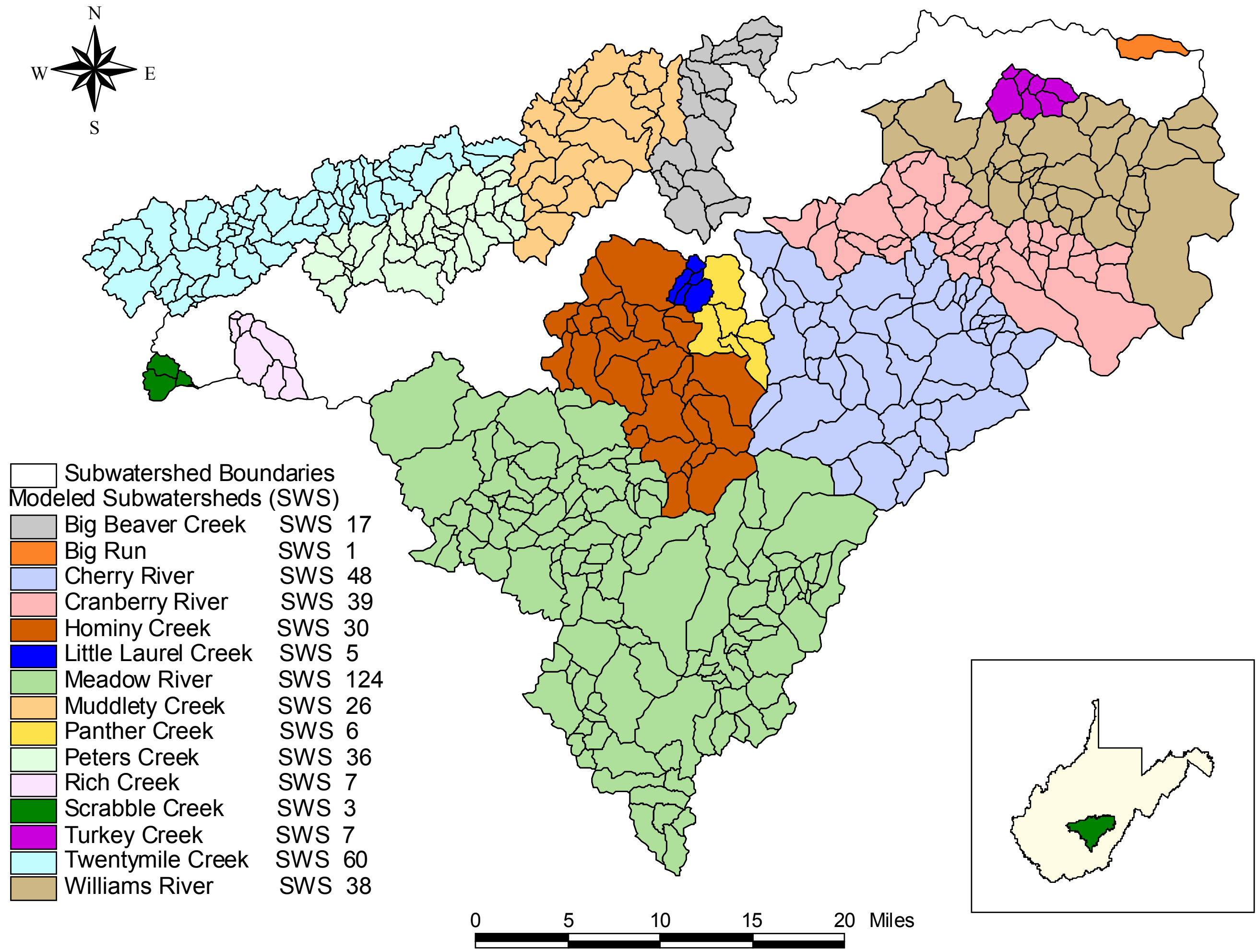


Figure 8-1. Gauley River subwatershed delineation

The modeled landuse categories contributing to metals loads include forest, pastures, cropland, wetlands, barren, residential/urban impervious, and residential/urban pervious. These sources were represented explicitly by consolidating existing GAP2000 landuse categories to create modeled landuse groupings. Several additional landuse categories were created to account for landuses either not included in the GAP2000 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. 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.

Modeled landuse categories contributing to bacteria loads include pasture, grassland, cropland, urban/residential pervious lands, urban/residential impervious lands, and forest (including barren and wetlands). Other sources, such as failing septic systems, straight pipes, and permitted sources, were modeled as direct, continuous-flow sources in the model.

MDAS was configured to model hydrology, sediment, and water quality for fecal coliform bacteria, total iron and total aluminum. In the Gauley River watershed, pollutant loads are delivered to the tributaries with surface runoff, subsurface flows, and direct discharges to the streams. Sediment-producing landuses and bank erosion are also sources of iron and aluminum, since both metals are associated with sediment. MDAS provides mechanisms for representing all of these various pathways of pollutant delivery.

Generation of sediment depends on the intensity of surface runoff. It also varies by land use and the characteristics of the land. Sediment delivery paths modeled were surface runoff erosion, direct point sources, and in-stream bank erosion. Surface sediment sources were modeled using average sediment runoff concentrations by landuse. These concentrations were applied to the corresponding surface runoff flows. Direct point sources were modeled using constant flows and TSS concentrations. 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. Sediment produced during bank erosion episodes is also dependent on the stability of the banks, as defined by the total bank stability score.

Statistical analyses using pre-TMDL monitoring data collected throughout the Gauley River watershed were performed to establish the correlation between sediment loads and metals loads and to evaluate the spatial variability of this correlation. The results were then applied to the sediment from sediment-producing landuses to calculate the amount of iron and aluminum loads delivered to the streams along with the sediment loads.

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.

The basis for the initial bacteria loading rates for landuses and direct sources are described in the Technical Report. The initial estimates were further refined during the model calibration. A variety of modeling tools were used to develop the fecal coliform bacteria TMDLs, including the MDAS, and a customized spreadsheet to determine the fecal loading from failing residential septic systems identified during source tracking efforts by the WVDEP. Section 5.2.1 describes the process of assigning flow and fecal coliform concentrations to failing septics. The failing septic analysis provides initial values for model input; however, these values are further refined during the model calibration process.

After model configuration, calibration of the hydrology, followed by sediment and water quality was performed. The goal of the calibration was to obtain realistic model prediction by selecting parameter values that reflect the unique characteristics of the watershed. Spatial and temporal aspects were evaluated through the calibration process.

Metals are modeled in the MDAS in the total recoverable form. To appropriately address dissolved aluminum TMDLs for the Gauley River watershed, it was necessary to link the MDAS with an additional model capable of representing instream aluminum speciation. The Dynamic Equilibrium In-stream Chemical Reactions (DESC-R) model was used in conjunction with the MDAS to address and develop dissolved aluminum TMDLs where necessary in the watershed. DESC-R was also used to represent the source-response linkage for pH. The model selection process, modeling methodologies, and technical approaches are discussed further in the Technical Report.

8.1.2 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 to instream flow observations from USGS flow gauging stations throughout the watershed. There are three USGS flow gauging station in the Gauley River watershed with adequate data records for hydrology calibration. The model was calibrated to the observed data recorded at the three USGS gages: USGS 03189100 Gauley River near Craigsville, USGS 03186500 Williams River at Dyer, and USGS 03187500 Cranberry River near Richwood. Hydrology calibration was based on observed data from those stations and the landuses present in the watersheds at that time. Key considerations for hydrology calibration included the overall water balance, the high-flow/low-flow distribution, storm flows, and seasonal variation. The hydrology was validated for the time period of January 1, 1991, to September 30, 2004. 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 Gauley River watershed. A detailed description of the hydrology calibration and a summary of the results and validation are presented in the Technical Report.

8.1.3 Water Quality Calibration

Water quality calibration was performed after the hydrology calibration was complete, starting with the sediment processes, and followed by the other pollutants.

Sediment Calibration

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, respectively. These concentrations were defined for each modeled landuse. Initial values for these parameters were based on available landuse-specific storm-sampling monitoring data.

Besides land-based sources of sediment, streambank erosion was also modeled. 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. If no other information was available, 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 reaches' stability factor (S-value).

Sediment calibration consisted of adjusting the sediment surface runoff concentrations by landuse, and the coefficient of scour for bank-erosion. Initial values were adjusted so that the model's suspended solids output closely matched observed instream data in watersheds with predominately one source type.

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 user-specified 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. Stream bank 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 8-2). 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 the 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.

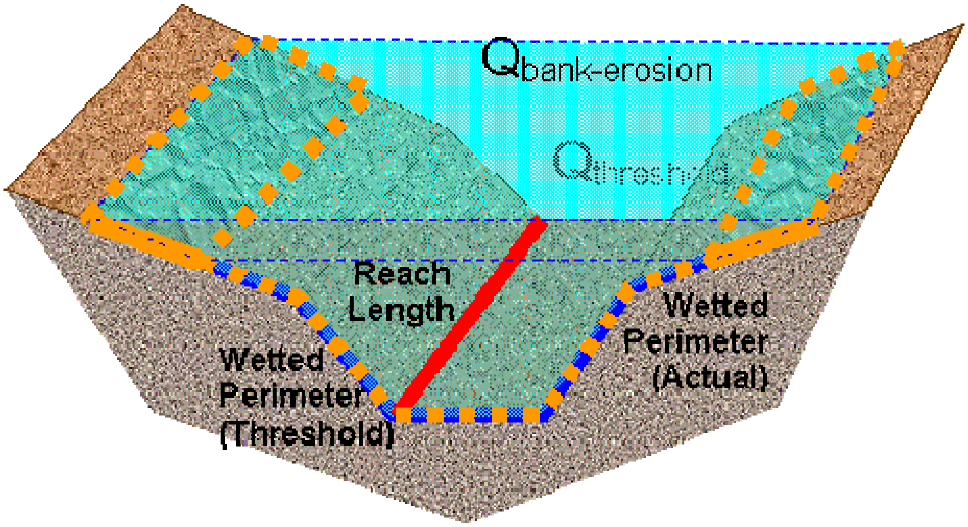


Figure 8-2. Conceptual diagram of bank erosion model

Total Iron, Total Aluminum, and Fecal Coliform Bacteria Calibration

The water quality was calibrated by comparing modeled versus observed instream metals and fecal coliform bacteria 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. Available monitoring data in the watershed was 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 TSS and to enhance the representation of background conditions from undisturbed areas. The results of the storm sampling fecal coliform and TSS calibration are shown in Figures 8-3 and 8-4.

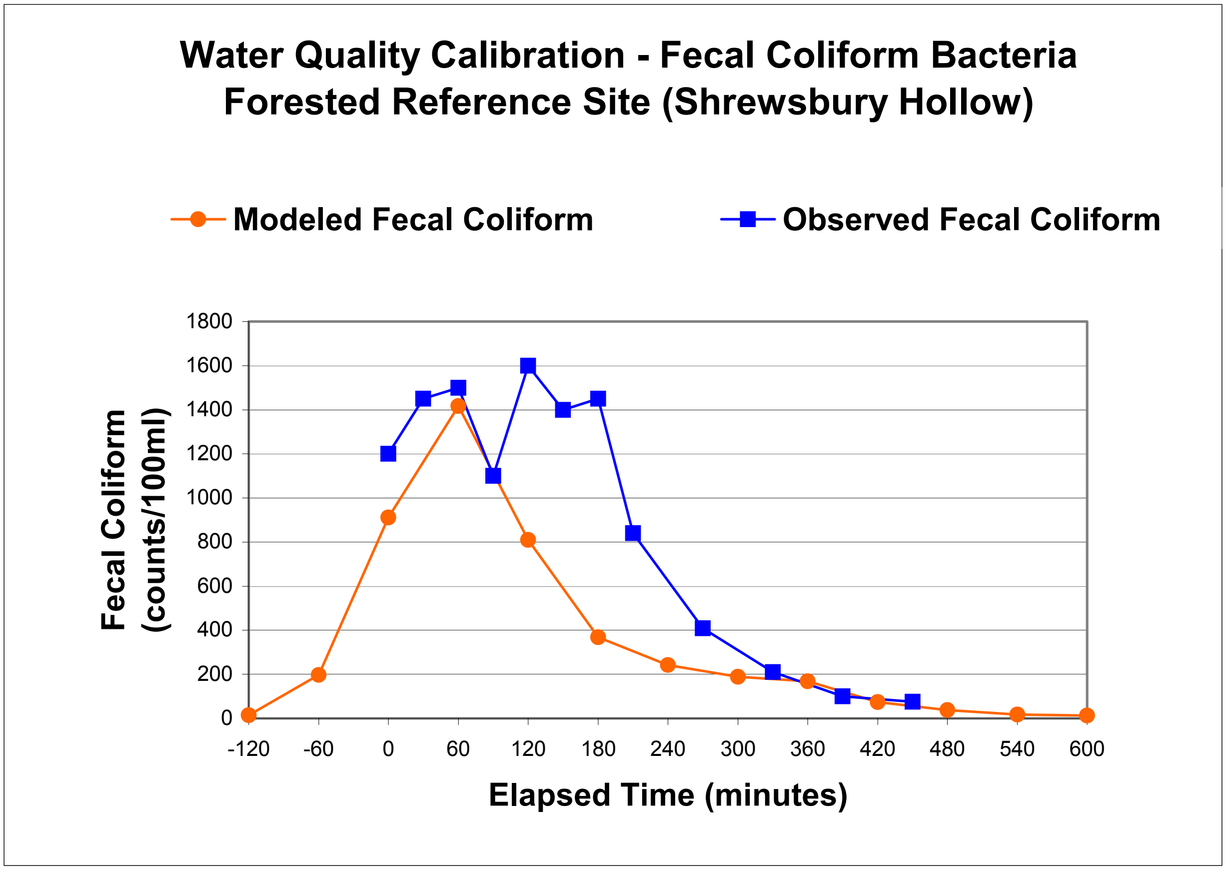


Figure 8-3. Shrewsbury Hollow fecal coliform observed data

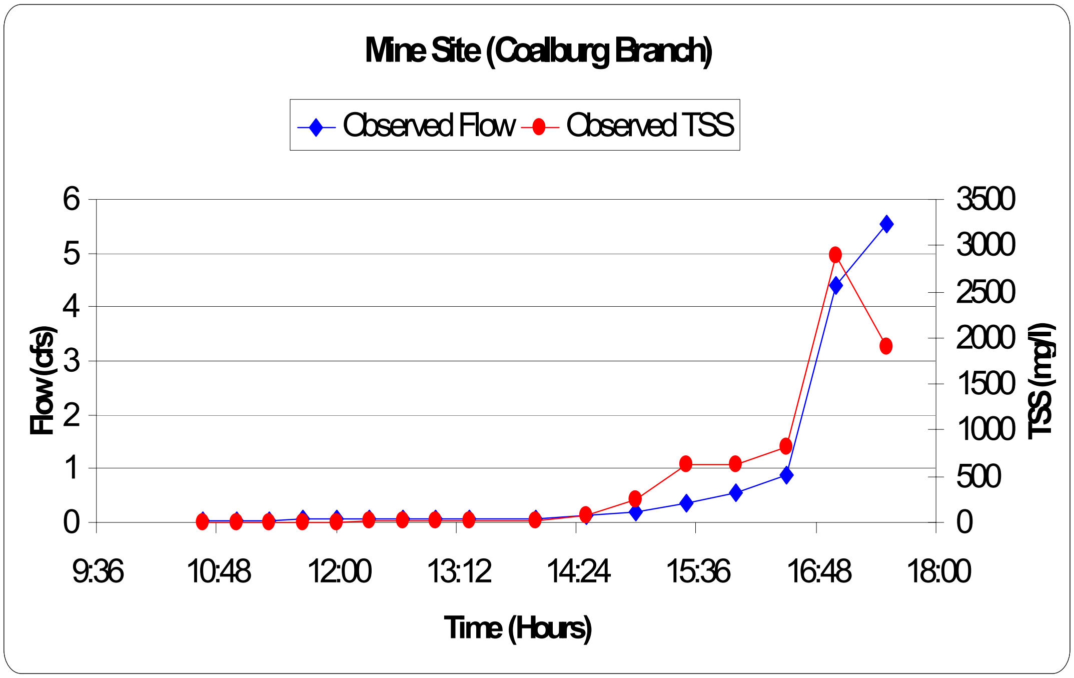


Figure 8-4. Coalburg Hollow TSS observed data

DESC-R Calibration

As stated previously, it was necessary to link the MDAS with DESC-R to appropriately address dissolved aluminum TMDLs in the Gauley River watershed. DESC-R was calibrated by adjusting water quality parameters to match the observed instream water quality data.

The DESC-R model is equipped with an optimization function for automatic calibration to observed water quality data (dissolved aluminum). The DESC-R model uses the simulated total recoverable metal output from the MDAS as input and, therefore, the MDAS model must be calibrated for total metals (primarily, total iron and total aluminum) prior to executing the DESC-R optimization function. The DESC-R model was calibrated against observed dissolved aluminum at key monitoring locations in watersheds impaired for dissolved aluminum. Key locations included the mouths of impaired streams, sites upstream and downstream of potential metals sources, and the mouths of significant tributaries. An example of a DESC-R calibration analysis is shown in Figure 8-5. Further description and a summary of the results of the DESC-R water quality calibration and validation are presented in the Technical Report.

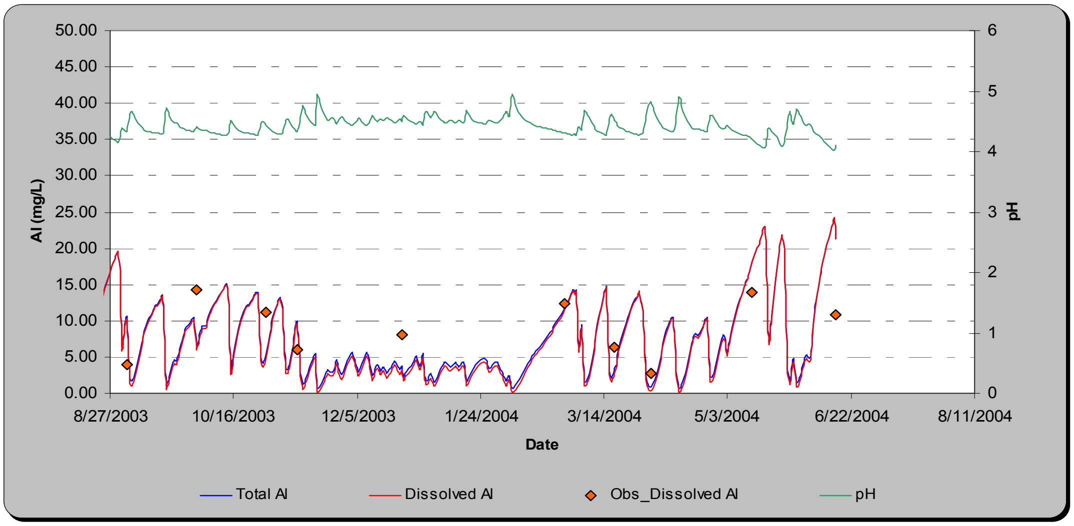


Figure 8-5. Example dissolved aluminum calibration analysis in DESC-R

8.2 Modeling Technique for pH

The pH impairments in the Gauley watershed have been attributed to two separate source categories. In areas where historical, unregulated mining occurred, discharges from AMLs 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 low buffering capacity of the watershed. WVDEP source tracking and pre-TMDL water quality monitoring were used to determine the causative sources and different TMDL development methodologies were employed for each.

Where the discharges from historical mining activities were determined to be the cause of low pH impairments, iron and/or aluminum impairments also existed. Because of the complex chemical interactions that occur between dissolved metals and acidity, the TMDL approach focused on reducing metals concentrations, using the MDAS and DESC-R models 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.

To address low pH impairments associated solely with acid precipitation and low watershed buffering capacity, the MDAS was updated to include the atmospheric deposition module from the Hydrologic Simulation Program Fortran (HSPF) model. With this addition, the model is able to simulate dry and wet deposition. Six additional modules were also created to better simulate pH in the subsurface and in stream reaches by modeling sulfate and nitrogen species. The six modules include: (1) the nitrogen soil transformation module, (2) the nitrogen stream module, (3) the sulfate adsorption/desorption module, (4) the sulfate stream module, (5) the soil chemical reaction module, and (6) the aqueous (stream) chemical reaction module. In addition, the Moisture Storage and Transport in Soil Layers (MSTLAY) module was added to estimate moisture storage and flux in the four soil layers. The functionality of each module is described in the Technical Report.

The updated MDAS model was applied to streams where low pH impairments are associated solely with acid precipitation. The existing MDAS framework described in Section 8.1.1 was configured to represent the variability of acidic soils and geologic formations with low buffering capacity (i.e., Pottsville Sandstone). Simulation results (sulfate and nitrogen oxides) from USEPA's air quality model served as wet and dry atmospheric deposition inputs to the model.

Model calibration consisted of executing the MDAS model and adjusting water quality parameters in six modules described above by comparing model results to available in-stream pH observations. An example of a pH calibration for most stations is shown in Figure 8-6. WVDEP provided results of continuous hourly pH monitoring at two locations in the Turkey Creek watershed. Figure 8-7 shows an hourly pH calibration at the mouth of Right Fork/Turkey Creek.

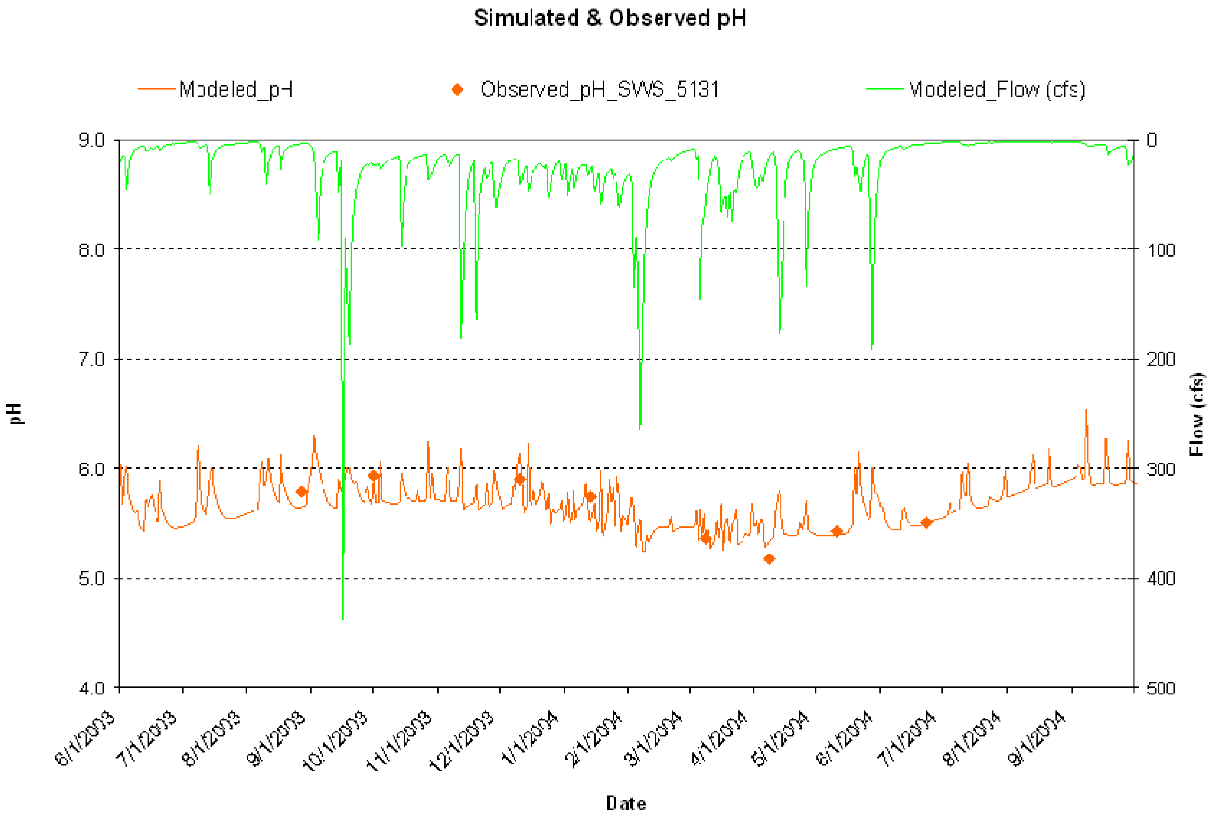


Figure 8-6. Example pH calibration

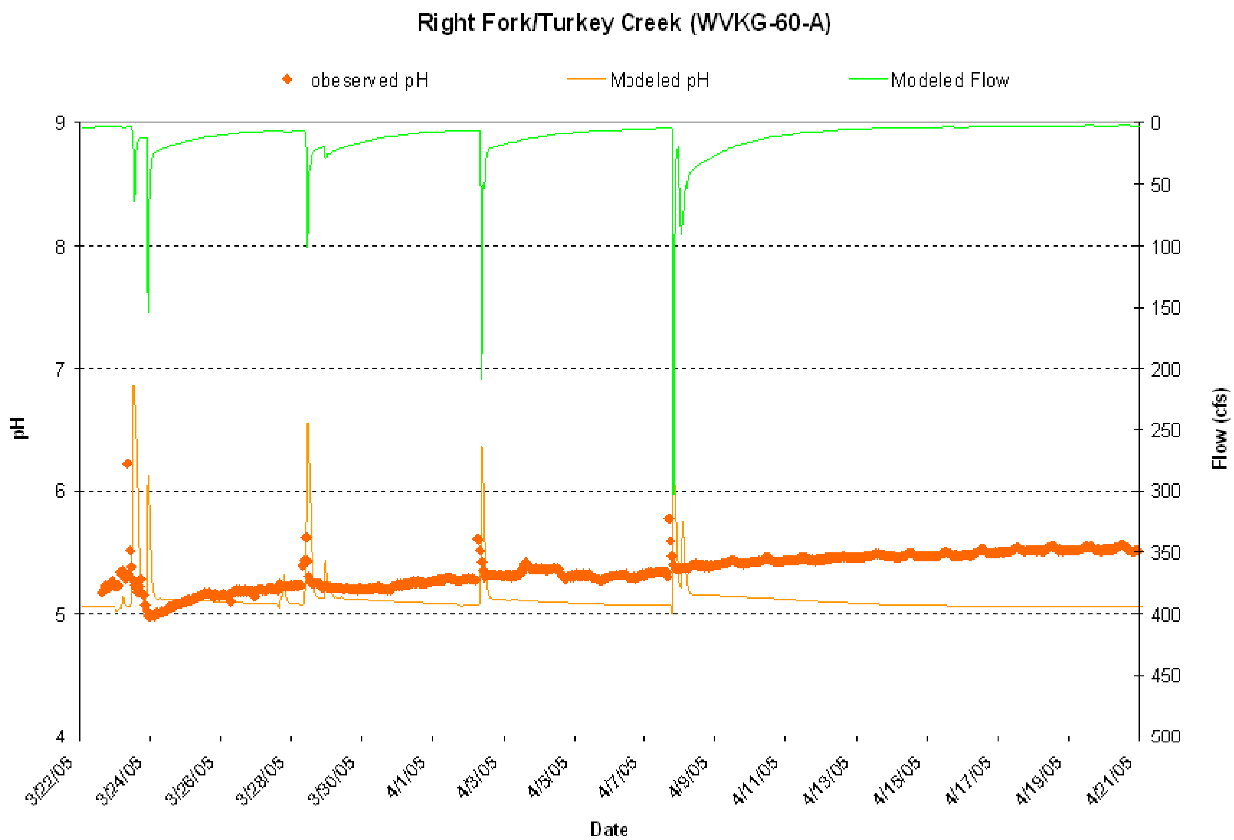


Figure 8-7. Hourly pH calibration for Right Fork/Turkey Creek

8.3 Modeling Technique for Sediment

The SI process discussed in Section 7 indicated a need to reduce the contribution of excess sediment to certain biologically impaired streams in the Gauley River watershed.

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 was used as the TMDL endpoint for the impaired streams. Given these parameters and a non-impaired WVSCI score, Rader Fork was selected as the reference watershed. The location of the reference watershed is shown in Figure 7-2.

Adequately representing erosion processes and nonpoint source loads in the watershed was a primary concern in selecting the appropriate modeling system. The MDAS model was integrated with a stream routing model that examined streambank erosion and depositional processes.

Upon finalization of modeling, it was determined that all of the sediment-impaired streams exhibited impairments pursuant to total iron water quality criteria, and that the sediment reductions that are necessary to ensure compliance with iron criteria exceed those necessary to resolve biological impairments. As such, the iron TMDLs presented for the subject waters are appropriate surrogates for necessary sediment TMDLs. For affected streams, Table 8-1 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 8-1. Sediment loadings using different modeling approaches in the Gauley River watershed

Stream Name	Stream Code	Allocated Sediment Load Iron TMDL (tons/yr)	Allocated Sediment Load Rader Fork Reference Approach (tons/yr)
Twentymile Creek	WVKG-5	1,606.5	2,686.4
Bells Creek	WVKG-5-B	676.1	999.8
Campbell Fork	WVKG-5-B-7	7.6	26.8
Bearpen Fork	WVKG-30-L	23.0	35.9

8.4 Selenium TMDL Approach

Hughes Fork of Bells Creek of Twentymile Creek (WVKG-5-B-4) is impaired pursuant to West Virginia's water quality criteria for selenium. Extensive surface mining operations exist in the Hughes Fork watershed, and active mining is the dominant landuse. Given the high selenium content of coals in this region, and the prevalence of mining activity, the subsurface disturbances associated with the existing mining operations were initially assumed to be the cause of the selenium impairment. Subsequent review of Discharge Monitoring Report results for permitted discharges in the watershed confirmed the presence of selenium in concentrations exceeding the chronic aquatic life protection criterion.

Nonpoint sources associated with surface disturbances (i.e., barren areas, unpaved roads, harvested forest, and oil and gas well operations) were considered to be negligible sources of selenium because these land disturbances typically do not disturb subsurface strata that contain selenium and because they were not significantly present in the selenium impaired watersheds. In prior TMDL development efforts, WVDEP conducted extensive selenium monitoring and did not identify selenium impairments in streams where surface-disturbing nonpoint sources were prevalent in the watershed and mining activities were absent.

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

The approach is consistent with the applicable water quality-based effluent limitation development protocol for the instream treatment structures that are present in the watershed. The permitted discharges from instream treatment structures are located in waters of the state where numeric water quality criteria are applicable. The level of control necessary to achieve criteria during low flow conditions is also protective during higher flow periods.

8.5 Allocation Analysis

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 dissolved aluminum, total iron, total selenium, pH, and fecal coliform bacteria TMDLs for each of the waterbodies 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

8.5.1 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 (identified in Section 2) and an explicit five percent MOS were used to identify endpoints for TMDL development.

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

An implicit MOS was included in the Hughes Fork selenium TMDL, where WLAs were prescribed for the surface mining point sources at water quality criteria at the end-of-pipe. Under these conditions, there will be no excessive contribution of selenium at the low flow 7Q10 condition when assimilative capacity is lowest. Determination of an explicit MOS is not necessary for this TMDL because compliance with the WLAs will assure attainment of the water quality standards.

The TMDL endpoints for the various criteria are displayed in Table 8-2.

Table 8-2. 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)
Fecal Coliform	Water Contact Recreation and Public Water Supply	200 counts / 100mL (Monthly Geometric Mean)	190 counts / 100mL (Monthly Geometric Mean)
Fecal Coliform	Water Contact Recreation and Public Water Supply	400 counts / 100mL (Daily, 10% exceedance)	380 counts / 100mL (Daily, 10% exceedance)
Selenium	Aquatic Life	0.005 mg/L (4-day average)	0.005 mg/L (4-day average)
pH	Aquatic Life	6.00 Standard Units (Minimum)	6.02 Standard Units (Minimum)

With the exception of selenium, TMDLs are presented as average annual loads because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year. 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. Equivalent, daily average TMDLs are also presented.

Because the selenium impairment of Hughes Fork has been attributed to point source discharges from instream treatment structures, the TMDL is presented as an equation for the maximum daily load that is variable with receiving stream flow.

For pH impairments associated with atmospheric deposition, TMDLs are presented as the annual net acidity load associated with maintenance of the pH TMDL endpoint of 6.02.

pH Impairments Associated with Mining Activity

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 (Fe^{2+}) ions can become acidic after oxidation and precipitation of the iron (PADEP, 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 applying DESC-R. By executing DESC-R under TMDL conditions (conditions in which TMDL endpoints for metals were met), the equilibrium pH could be predicted. The Technical Report contains a detailed description of the pH modeling approach. The TMDLs for the pH-impaired streams are presented as the median equilibrium pH that is calculated based on the daily equilibrium pH output (6-year simulation period) from DESC-R.

8.5.2 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 6-year simulation period (January 1, 1987 through December 31, 1992). 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 to the TMDL endpoints. Using the model linkage described in Section 8.1, total aluminum was simulated using MDAS, and DESC-R was used to compare predicted dissolved aluminum concentrations to the TMDL endpoint. 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.

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 8-3. The concentrations displayed in table 8.3 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 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 8-3. Metals concentrations used in representing permitted conditions for mines

Pollutant	Technology-based Permits	Water Quality-based Permits
Aluminum, total	1.39 mg/L (90th percentile DMR values)	1.39 mg/L (90th percentile DMR values)
Iron, total	3.2 mg/L	1.5 mg/L or 0.5 mg/L

Permitted conditions for fecal coliform bacteria point sources were represented during baseline conditions using the design flow for each facility and the monthly average effluent limitation of 200 counts/100 mL.

Sediment producing nonpoint sources and non-mining point sources were represented using precipitation, drainage area and the iron loading associated with their predicted sediment contributions.

Figure 8-8 presents the annual rainfall totals for the years 1980 through 2003 at the Beckley Airport weather station in Beckley, West Virginia. The years 1987 to 1992 are highlighted to indicate that a range of precipitation conditions was used for TMDL development in the Gauley River watershed.

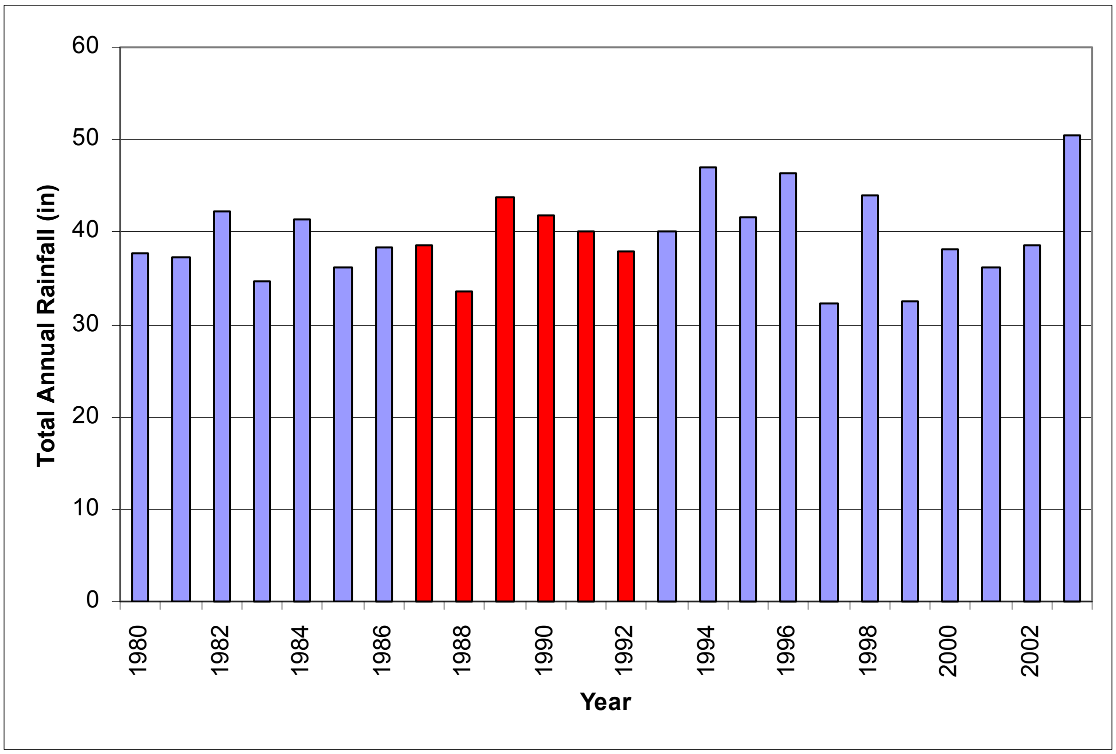


Figure 8-8. Annual precipitation totals and percentile ranks for the Beckley Airport weather station in Beckley, West Virginia

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 abandoned mines and other nonpoint sources were individually adjusted; the modeled instream concentrations were then evaluated.

Multiple allocation scenarios were run for the impaired waterbodies. Successful scenarios were those which achieved the TMDL endpoints under all flow conditions throughout the modeling period. For dissolved aluminum scenario development, the DESC-R output was compared directly with the TMDL endpoint. If the predicted dissolved aluminum concentrations exceeded the TMDL endpoint, the total aluminum sources represented in the MDAS were reduced. 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 8-9 shows an example of model output for a baseline condition and a successful TMDL scenario.

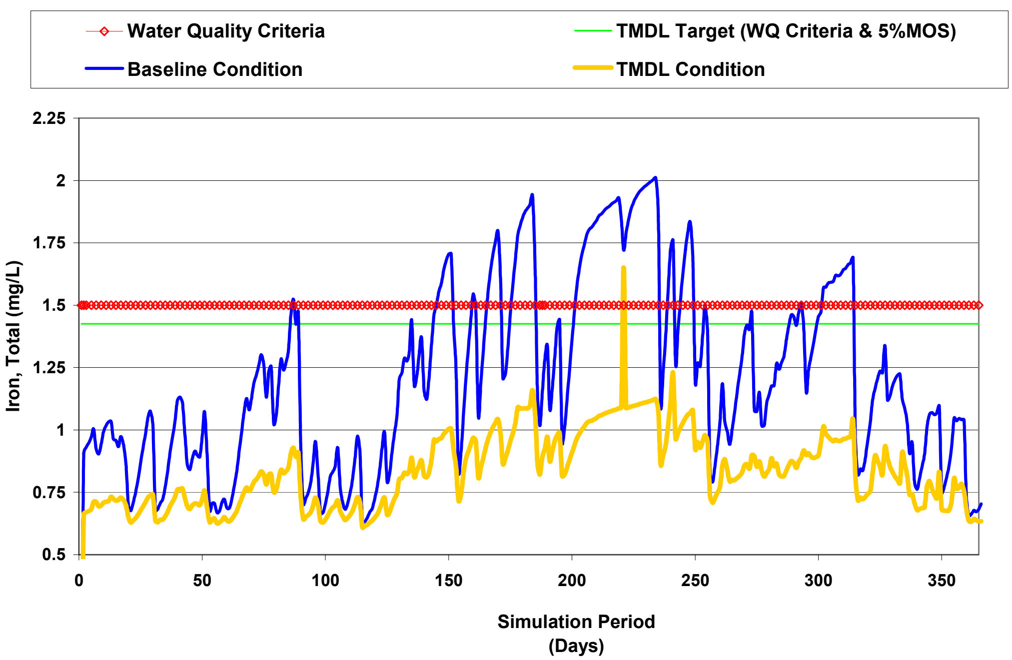


Figure 8-9. Example of baseline and TMDL conditions for total iron

8.6 TMDLs and Source Allocations

8.6.1 Dissolved Aluminum and Total Iron TMDLs

TMDLs and source allocations were developed on a subwatershed basis for each of the 15 TMDL watersheds in the Gauley River watershed shown in Figure 3-2. A top-down methodology was followed to develop these TMDLs and allocate loads to sources. Headwaters were analyzed first because their loading affects downstream water quality. Loading contributions were reduced from applicable sources in these waterbodies, and TMDLs were developed. The loading contributions of unimpaired headwaters and the reduced loadings for impaired headwaters were then routed through downstream waterbodies. Using this method, contributions from all sources were weighted equitably. 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 loadings less than natural conditions, and point source allocations were not more stringent than numeric water quality criteria.

The following general methodology was used when allocating to iron and aluminum sources in the Gauley River watershed TMDLs. Deviation occurred in a limited number of subwatersheds where the preponderance of a specific source or source category contradicted the practicality of the general approach.

- For subwatersheds where iron impairments are associated with elevated sediment loadings and where streambank erosion was determined to be a significant source of sediment, the loading from streambank erosion was first reduced to the loading characteristics of the reference stream, Rader Fork

- For watersheds with AMLs but no permitted point sources or bond forfeiture sites, AML loads were reduced first until instream water quality criteria were met or until conditions were no less than those of undisturbed forest. If further reductions were required, the loads from sediment-contributing nonpoint sources were reduced until water quality criteria were met.

- For watersheds with AMLs and point sources and/or bond forfeiture sites, point sources and bond forfeiture sites were set at the loads defined by applicable permit limits and AML loads were subsequently reduced. Loads from AMLs were reduced until instream water quality criteria were met, if possible. If further reduction was required once loads from AMLs were reduced, sediment sources were reduced. If even further reduction was required, the technology-based loadings from point sources and bond forfeiture sites were reduced

- For watersheds where dissolved aluminum TMDLs were developed, 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. If the dissolved aluminum TMDL endpoint was not attained after source reductions to iron, the total aluminum source loadings were reduced based on the methodology described above.

Implementation of the described methodology for troutwater iron TMDLs does not assure complete attainment of the chronic aquatic life protection iron criterionNon-attainment is predicted when large precipitation events elevate instream TSS concentrations and has been attributed to the relatively high iron content of the soils in those watersheds. The magnitudes of the predicted exceedances under TMDL conditions are not extreme, but exceedances are predicted more often than the once per three years average frequency prescribed by the criterion. In the allocation process, sediment producing non-point sources were reduced to the maximum practical extent and wasteload allocations for point sources were set equal to the chronic water quality criterion.

Wasteload Allocations

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

Active Mining Operations

WLAs are provided for all existing outlets of WVNPDES 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.

Dissolved aluminum TMDLs were based on a dissolved aluminum TMDL endpoint; however, sources were represented in terms of total aluminum. WLAs for aluminum are also provided in total metal form.

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 WVNPDES permit.

Non-mining Point Sources
Individual registrations under the general permit for stormwater associated with industrial activity (Multi-sector Stormwater Permit) may require compliance with TSS and/or iron benchmark values. Facilities that are compliant with such limitations are not considered to be significant sources of sediment or iron. Facilities that are present in the watersheds of iron-impaired streams are assigned WLAs that allow for continued discharge under existing permit conditions.

Construction Stormwater
Only three sites are registered under the Construction Stormwater General Permit in the watersheds of the iron-impaired streams for which TMDLs are presented. Although the existing level of activity under the Construction Stormwater General Permit is minimal and impacts are negligible, specific WLAs for future activity are provided and are described in Section 9.1. An allocation of 0.5 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. Because the existing site registrations under the General Permit conform to the subwatershed allowances provided, specific WLAs are not presented.

Load Allocations (LAs)
LAs were made for the dominant nonpoint source categories as follows:

- AMLs: loading from abandoned mine lands, including loads from disturbed land, highwalls, deep mine discharges and seeps
- Bond forfeiture sites: loading from mining facilities that have not effectively reclaimed mining sites and have forfeited their SMCRA bonds
- Sediment sources: loading associated with sediment contributions from barren land, harvested forest, oil and gas well operations, unpaved roads, and streambank erosion processes

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

8.6.2 Fecal Coliform Bacteria TMDLs

TMDLs and source allocations were developed for impaired segments of selected steams and their tributaries on a subwatershed basis for each of the 15 TMDL watersheds in the Gauley River watershed shown in Figure 3-2. As described in Section 7.5.1, 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. All point sources in the watershed were set at the existing effluent limitations of applicable WVNPDES Permits (200 counts/100 mL monthly geometric mean). Because West Virginia Bureau for Public Health regulations prohibit the discharge of raw sewage into surface waters, all illicit, non-disinfected discharges of human waste (from failing septic systems and straight pipes) were eliminated. SSOs are illegal under NPDES regulations; all such discharges were also eliminated. If further reduction was necessary, CSOs and 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 described below. Applicable fecal coliform effluent limitations are more stringent than water quality criteria; therefore, all permitted fecal coliform sources were represented by the monthly average fecal coliform limit of 200 counts/100 mL and no reductions were applied.

Load Allocations (LAs)
LAs were assigned as required to the following the source categories:

- Pasture

- Onsite Sewage Systems — loading from all illicit, non-disinfected discharges of human waste (including failing septic systems and straight pipes)

- Residential — loading associated with urban/residential runoff

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

8.6.3 Atmospheric Deposition pH TMDLs

Because the source of impairment is limited to atmospheric deposition, these TMDLs incorporate only a gross load allocation. The TMDLs represent the annual net acidity loads that can be present at the downstream extent of impaired streams while maintaining the pH TMDL endpoint.

8.6.4 Seasonal Variation

The TMDL must consider seasonal variation. For the Gauley River watershed metals and fecal coliform TMDLs, 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 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.

8.6.5 Critical Conditions

TMDL developers must select the environmental conditions that will be used for defining allowable loads. Many TMDLs are designed around the concept of a "critical condition." The critical condition is the set of environmental conditions, under which, if the objectives are met, the attainment of objectives for all other conditions will be ensured. Nonpoint source loading is typically precipitation-driven. Instream impacts tend to occur during wet weather and storm events that cause surface runoff to carry pollutants to waterbodies. During dry periods little or no land-based runoff occurs, and elevated instream pollutant levels may be due to point sources (Novotny and Olem, 1994). Analysis of water quality data for the Gauley River watershed shows high pollutant concentrations during both high and low flow, indicating that there are both point and nonpoint source impacts. 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.

8.6.6 TMDL Presentation

TMDLs, LAs, and WLAs are shown in the allocation spreadsheets associated with this report. TMDLs are also presented in the TMDL watershed appendices for the impaired streams within each of those TMDL watersheds.

Except for the Hughes Fork selenium TMDL, TMDLs and their components are presented as average annual loads because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year. The Hughes Fork Selenium TMDL is presented as an equation for the maximum daily load that is variable with receiving stream flow.

The iron and aluminum WLAs for active mining operations 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 non mining activities registered under general WVNPDES permits are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are operable, and because they are equivalent to existing effluent limitations/benchmark values, they are to be directly implemented.

The selenium WLAs for active mining operations in the Hughes Fork watershed are presented as concentrations that are to be implemented by conversion to monthly average and daily maximum effluent limitations using USEPA's Technical Support Document for Water Quality-based Toxics Control (USEPA, 1991).

The dissolved aluminum TMDLs are based on a dissolved aluminum TMDL endpoint; however, sources are represented in terms of total aluminum. The WLAs and LAs for aluminum are also provided in the form of total metal.

The WLAs for individual NPDES permits for fecal coliform bacteria 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.

9. FUTURE GROWTH AND WATER QUALITY TRADING

9.1 Metals and pH

With the exception of allowances provided for Construction Stormwater General Permit registrations discussed below, this TMDL does not include specific future growth allocations for metals or sediment. 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 or pH TMDLs have been developed. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits must be "consistent with the assumptions and requirements of any available 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 discharger could be issued under the following scenarios:

1. 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. For iron and selenium, the West Virginia water quality criteria 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 watershed of a dissolved aluminum-impaired stream if total aluminum effluent limitations are based on the dissolved aluminum, chronic, aquatic life protection criterion and a dissolved/total aluminum translator 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.

2. 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.

3. 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.

Subwatershed-specific future growth allowances have been provided for site registrations under the Construction Stormwater General Permit. In general, the successful TMDL allocation provides 0.5 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 tighter controls will result in a loading condition commensurate with that afforded by the management practices associated with the general permit.

9.2 Fecal Coliform Bacteria

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

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

9.3 Water Quality Trading

This TMDL neither prohibits nor authorizes trading in the watersheds addressed in the document. WVDEP generally endorses the concept of trading and recognizes that it might become an effective tool for TMDL implementation. However, significant regulatory framework development is necessary before large-scale trading in West Virginia can be realized. Furthermore, WVDEP supports program development assisted by a consensus-based stakeholder process. Before the development of a formal trading program, it is conceivable that the regulation of specific point source-to-point source trading might be feasible under the framework.

10. PUBLIC PARTICIPATION

10.1 Public Meetings

Informational public meetings were held on May 6, 2003 and October 26, 2005 at the public library in Summersville, West Virginia. The May 6, 2003 meeting occurred prior to pre-TMDL stream monitoring and pollutant source tracking and included a general TMDL overview and a presentation of planned monitoring and data gathering activities. The October 26, 2005 meeting occurred prior to allocation of pollutant loads and included presented WVDEP allocation strategies. A third public meeting was held to present the draft TMDLs on June 14, 2007, at the public library in Summersville. The meeting was intended to facilitate comments on the draft TMDLs, however no one attended the meeting.

10.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised in various local newspapers between May 29, 2007 and June 1, 2007. Interested parties were encouraged to submit comments during the public comment period, which began on June 1, 2007 and ended July 2, 2007. WVDEP did not receive any comments on the draft TMDLs for the Gauley River watershed. The electronic documents are available on the WVDEP's internet site at http://www.wvdep.org.

11. REASONABLE ASSURANCE

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

11.1 Permit Reissuance

WVDEP DWWM is responsible for issuing non-mining NPDES permits within the State. WV 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. 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 timeframes. Existing permit reissuance in the Gauley watershed is scheduled to begin in July 2007 for non-mining facilities and in January 2008 for mining facilities. Therefore, the WLAs for existing activities will be promptly implemented. New facilities will be permitted in accordance with future growth provisions.

11.2 Watershed Management Framework Process

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

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

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

Among other things, the Framework includes a management schedule for integration and implementation of TMDLs. In 2000, the schedule for TMDL development under Section 303(d) was merged with the Framework process. The Framework identifies a six-step process for developing integrated management strategies and action plans for achieving the state's water quality goals. Step 3 of that process includes "identifying point source and/or nonpoint source management strategies - or Total Maximum Daily Loads - predicted to best meet the needed [pollutant] reduction.” Following development of the TMDL, Steps 5 and 6 provide for preparation, finalization, and implementation of a Watershed Based Plan to improve water quality. Development of Watershed Based Plans for priority watersheds is based on the efforts of local project teams. These teams are composed of Network members and stakeholders having interest in or residing in the watershed. Team formation is based on the type of impairment(s) occurring or protection(s) needed within the watershed. In addition, teams have the ability to use the TMDL recommendations to help plan future activities.

Each year, the Framework is included on the agenda of the Network to prioritize watersheds within a certain Hydrologic Group. This selection process includes a review and evaluation of TMDL recommendations for the watersheds under consideration. The Network last prioritized Hydrologic Group C watersheds in March 2006. Although no impaired streams in the Gauley watershed were selected as priority watersheds in that process, the formation of a local project team and the development of a Watershed Based Plan would be possible if local interest is demonstrated. The WVDEP point of contact for assistance in this regard is the Nonpoint Source Program’s Southern Basin Coordinator, Alvin Gale (agale@wvdep.org).

11.3 Public Sewer Projects

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

11.4 AML Projects

Within WVDEP, the primary entity that deals with abandoned mine drainage issues is the Division of Land Restoration. Within the Division, the Office of Abandoned Mine Lands and Reclamation (AML&R) was created in 1981 to manage the reclamation of lands and waters affected by mining prior to passage SMCRA in 1977. A fee placed on coal mined in West Virginia funds the Office of AML&R’s budget. Allocations from the AML fund are made to state and tribal agencies through the congressional budgetary process. AML&R has recently increased its emphasis on correcting water quality problems at sites that were primarily chosen for protection of public health, safety, and property. This new emphasis on improving water quality, in conjunction with Framework participation, will aid in the cleanup of sites already selected for remediation activities.

11.5 Special Reclamation Projects

The Office of Special Reclamation is part of the Division of Land Restoration. Since August 1997, Special Reclamation has been mandated by the State of West Virginia to protect public health, safety, and property by reclaiming and treating water on all bond-forfeited coal mining sites in an expeditious and cost-effective manner. Funding for this program is obtained from collection of forfeited bonds, civil penalties, and the Special Reclamation Tax placed on mined coal. Table 11-1 displays 14 bond forfeiture sites in the watersheds addressed in this report.

Table 11-1. Gauley River watershed bond forfeiture sites with water treatment needs

Original Permittee	Permit No.	TMDL Watershed	Subwatershed ID	Stream
B & S CONTRACTING, INC.	R-668	Muddlety Creek	2613	McMillion Creek
B & S CONTRACTING, INC.	U-3055-87	Muddlety Creek	2612	Enoch Branch
C. C. CONLEY & SONS, INC.	S-3046-91	Peters Creek	1325	Buck Garden Creek
CLASSIC RES., INC.	S-55-81	Meadow River	1978	Sewell Creek
CRADDOCK & SON COAL CO.	S-68-83	Peters Creek	1319	UNT
H & D COAL CORP.	U-69-85	Meadow River	1971	Little Sewell Creek
JOCARR RESOURCES, INC.	U-3059-86	Peters Creek	1325	Buck Garden Creek
JODIE MINING, INC.	U-211-83	Rich Creek	603	Rich Creek
K & B COAL CO.	U-3054-86	Peters Creek	1336	Peters Creek
LODESTAR ENERGY, INC.	S-3083-86	Muddlety Creek	2618	Lower Spruce Run
ROYAL SCOT MINERALS, INC.	31-72	Meadow River	2003	UNT/Little Clear Creek RM 7.5
ROYAL SCOT MINERALS, INC.	R-3078-86	Meadow River	2005	Cutlip Branch
ROYAL SCOT MINERALS, INC.	S-90-82	Meadow River	2014	Little Clear Creek
WILLIAMS CONSTRUCTION	S-3061-88	Peters Creek	1301	Peters Creek

Representation of the baseline condition for bond forfeiture sites incorporates the disturbed area associated with the forfeited permit and technology-based NPDES effluent limitations. The Office of Special Reclamation is charged with providing reclamation as required by the forfeited permit. Where the load allocation for bond forfeitures indicates a reduction from baseline conditions, pollutant reduction beyond technology-based effluent limitations and the responsibility of Office of Special Reclamation were determined to be necessary to meet water quality criteria.

11.6 Limestone Treatment of Streams by WVDNR

The West Virginia Division of Natural Resources (WVDNR) has a program that places limestone sand in selected streams with low pH due to acid precipitation. The purpose of the limestone additions is to raise the pH in the adjacent stream segment and allow the stream to support native brook trout populations. Partial funding for limestone application comes from a Clean Air Act lawsuit settlement with Dominion Power. Management of this fund includes provisions to ensure that money is available to finance perpetual treatment at all sites where application is initiated.

WVDNR is currently applying limestone sand in many sites in the Gauley watershed with additional sites expected in the future. Limestone addition has been initiated or is planned in the following streams associated with this TMDL development effort: Barrenshe Run and Dogway Fork of Cranberry River, Middle Fork of Williams River, Left Fork of Tea Creek of Williams River, Sugar Creek of Williams River, Turkey Creek of Gauley River, and Right Fork of Turkey Creek of Gauley River. WVDNR also operates rotary drum-type liming stations on Dogway Fork and North Fork of Cranberry River.

Both the limestone sand stations and rotary drum stations have demonstrated extremely positive results in fishery restoration. WVDNR and WVDEP will coordinate the expansion of limestone application to additional waters impaired by acid precipitation to the extent allowed by available resources.

12. MONITORING PLAN

The following monitoring activities are recommended:

12.1 NPDES Compliance

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

12.2 Nonpoint Source Project Monitoring

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

12.3 TMDL Effectiveness Monitoring

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

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