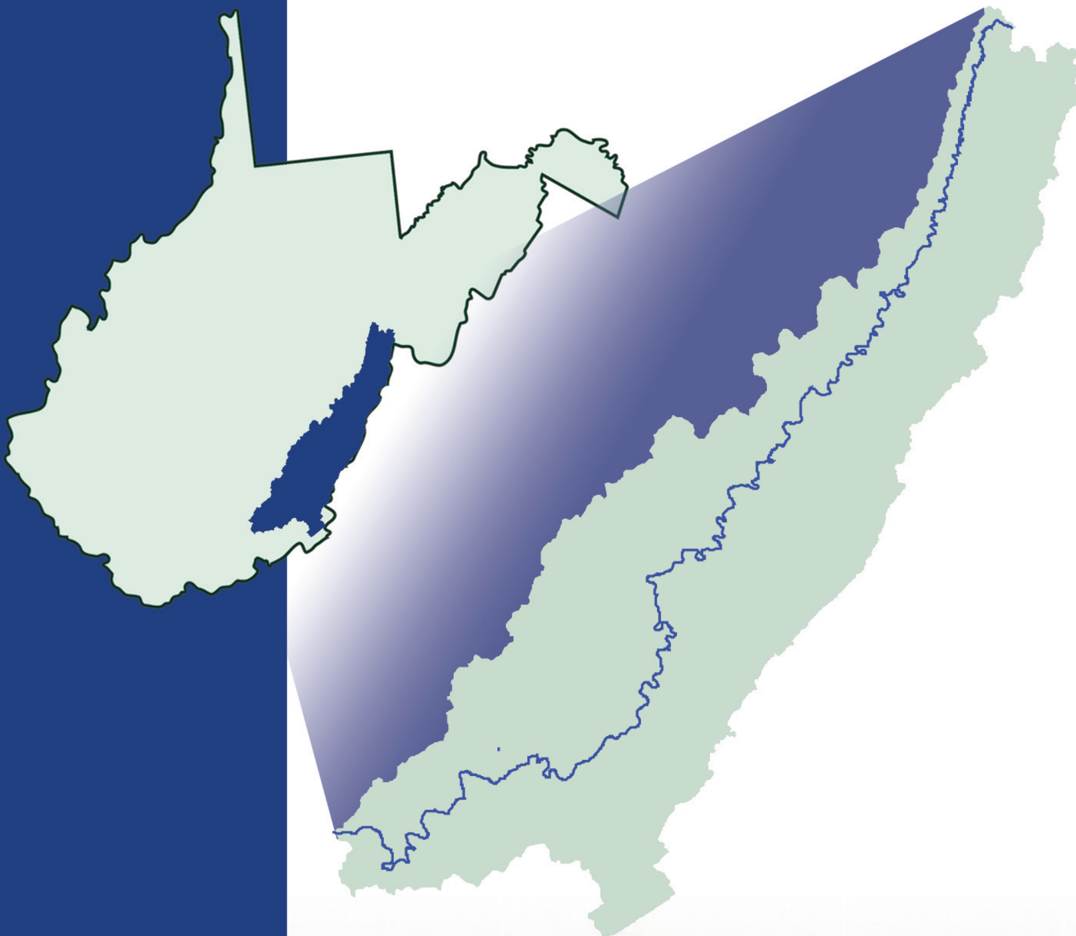

June 2008

Final Approved Report

Total Maximum Daily Loads for Streams in the Greenbrier River Watershed West Virginia

Prepared for:

West Virginia Department of Environmental Protection

Division of Water and Waste Management

Watershed Branch, TMDL Section

Prepared by:

Water Resources and TMDL Center

Tetra Tech, Inc.

405 Capitol Street, Suite 608

Charleston, WV 25301

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

FINAL APPROVED REPORT

June 2008

CONTENTS

FIGURES

TABLES

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 for 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	[WV DEP] 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 Greenbrier River watershed refers to the mainstem of the Greenbrier River and all of the tributary streams that eventually drain to the Greenbrier River (Figure I-1). The term "watershed" is also used more generally to refer to the land area that contributes precipitation runoff that eventually drains to the Greenbrier River.

TMDL watershed

This term is used to describe the total land area draining to an impaired stream for which a TMDL is being developed. This term also takes into account the land area drained by un-impaired tributaries of the impaired stream. There are 39 impaired streams, contained within 20 TMDL watersheds, in the Greenbrier River watershed (Figure 3-3).

Subwatershed

The subwatershed delineation is the most detailed scale of the delineation that breaks each TMDL watershed into numerous catchments for modeling purposes. The 20 TMDL watersheds in the Greenbrier River watershed have been subdivided into a total of 364 subwatersheds. All 364 subwatersheds 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.

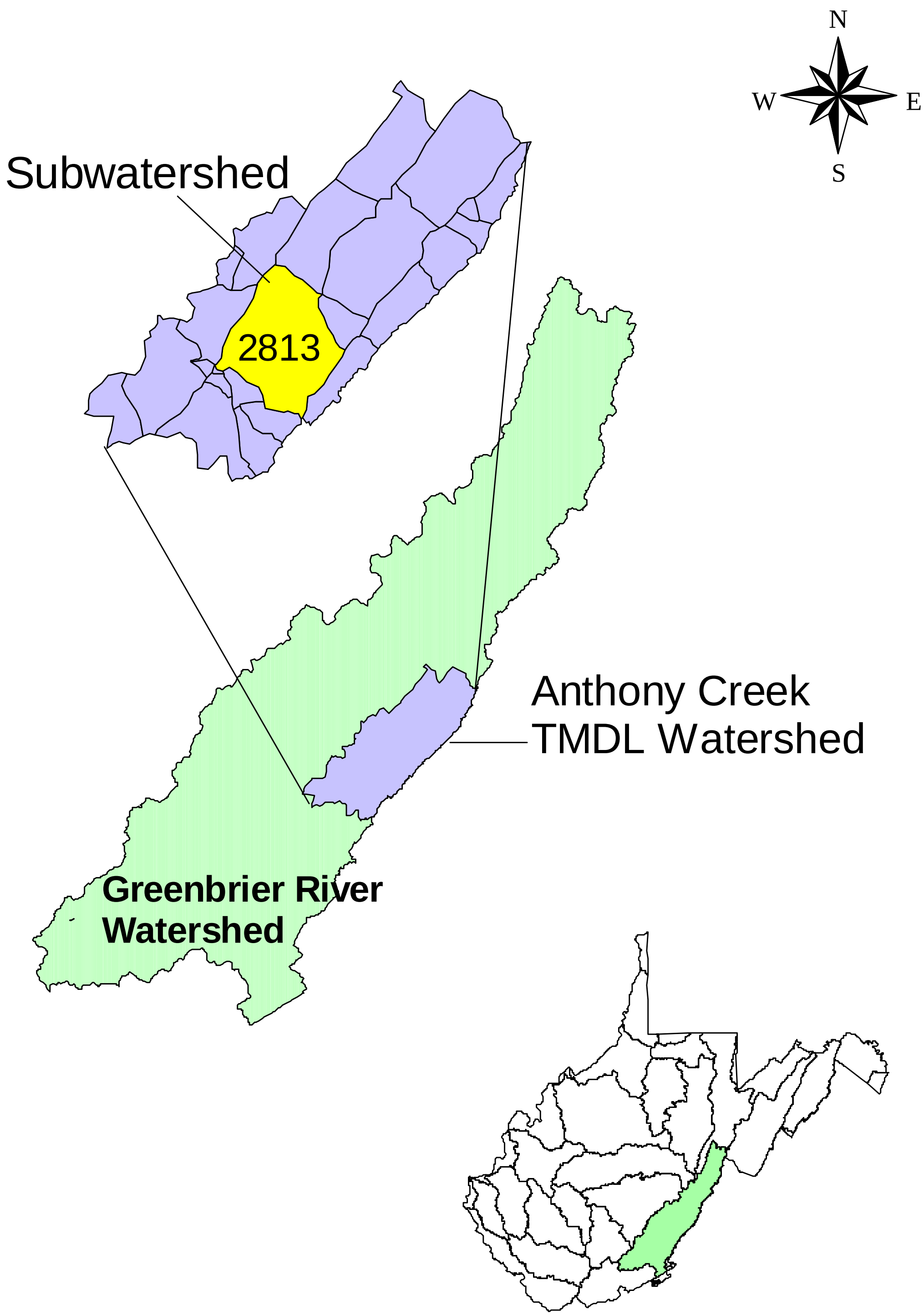

Figure I-1. Examples of a watershed, TMDL watershed, and subwatersheds

EXECUTIVE SUMMARY

The Greenbrier River watershed is in southeastern West Virginia and encompasses approximately 1,646 square miles. The majority of the watershed lies within Pocahontas, Greenbrier, Monroe and Summers counties. Major tributaries include, East Fork and West Fork of the Greenbrier River, Deer Creek, Sitlington Creek, Knapp Creek, Anthony Creek, Spring Creek, Howard Creek, Second Creek, and Muddy Creek.

This report includes Total Maximum Daily Loads (TMDLs) for various impaired streams in the Greenbrier River watershed. A TMDL establishes the maximum allowable pollutant loading for a waterbody while still complying 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 (WVDEP) 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 39 impaired streams in the Greenbrier River watershed. The impairments are related to numeric water quality criteria for fecal coliform bacteria. For hydrologic modeling purposes, impaired and unimpaired streams in the 20 TMDL watersheds were further divided into 364 subwatersheds. The subwatershed delineation provided a basis for georeferencing pertinent source information, monitoring data, and presentation of the TMDLs.

The Mining Data Analysis System (MDAS) was used to represent the source-response linkage for fecal coliform bacteria. Both point and nonpoint sources contribute to the fecal coliform bacteria impairments in the watershed. Failing on-site systems, direct discharges of untreated sewage and precipitation runoff from agricultural and residential areas are significant nonpoint sources of fecal coliform bacteria. Point sources of fecal coliform bacteria include the effluents of sewage treatment facilities and collection system overflows from publicly owned treatment works (POTWs).

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, describes allocation methodologies and documents the public participation. 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 wasteload allocations (WLAs) were no more stringent than numeric water quality criteria.

Accompanying spreadsheets provide TMDLs, WLAs for 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.

1.0 REPORT FORMAT

This report consists of the main TMDL report, a supporting geographic information system (GIS) application, and spreadsheet data tables. The main TMDL report describes the overall Total Maximum Daily Load (TMDL) development process for the Greenbrier River watershed, identifies impaired streams, and outlines the source assessment of fecal coliform bacteria. It also describes the modeling process, presents TMDL allocations, and lists measures that will be taken to ensure that the TMDLs are met. The main TMDL report is 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.

2.0 INTRODUCTION

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

2.1 Total Maximum Daily Loads

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

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

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

WVDEP is developing TMDLs in concert with a geographically-based approach to water resource management in West Virginia—the Watershed Management Framework. Adherence to the Framework ensures efficient and systematic TMDL development. Each year, TMDLs are developed in specific geographic areas. The Framework dictates that in 2007 TMDLs should be pursued in Hydrologic Group D, which includes the Greenbrier 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 the selection of streams to be addressed. The selected streams are then advertised for public comment. A meeting is held in the affected watershed to present the proposed sampling plan and to address any questions from the public. The next steps in the process are pre-TMDL water quality monitoring and source identification and characterization. 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 a draft TMDL report is 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 final TMDL is submitted to USEPA for approval.

This document provides TMDLs for the 39 Greenbrier River watershed stream/impairment listings from West Virginia’s 2006 Section 303(d) list.

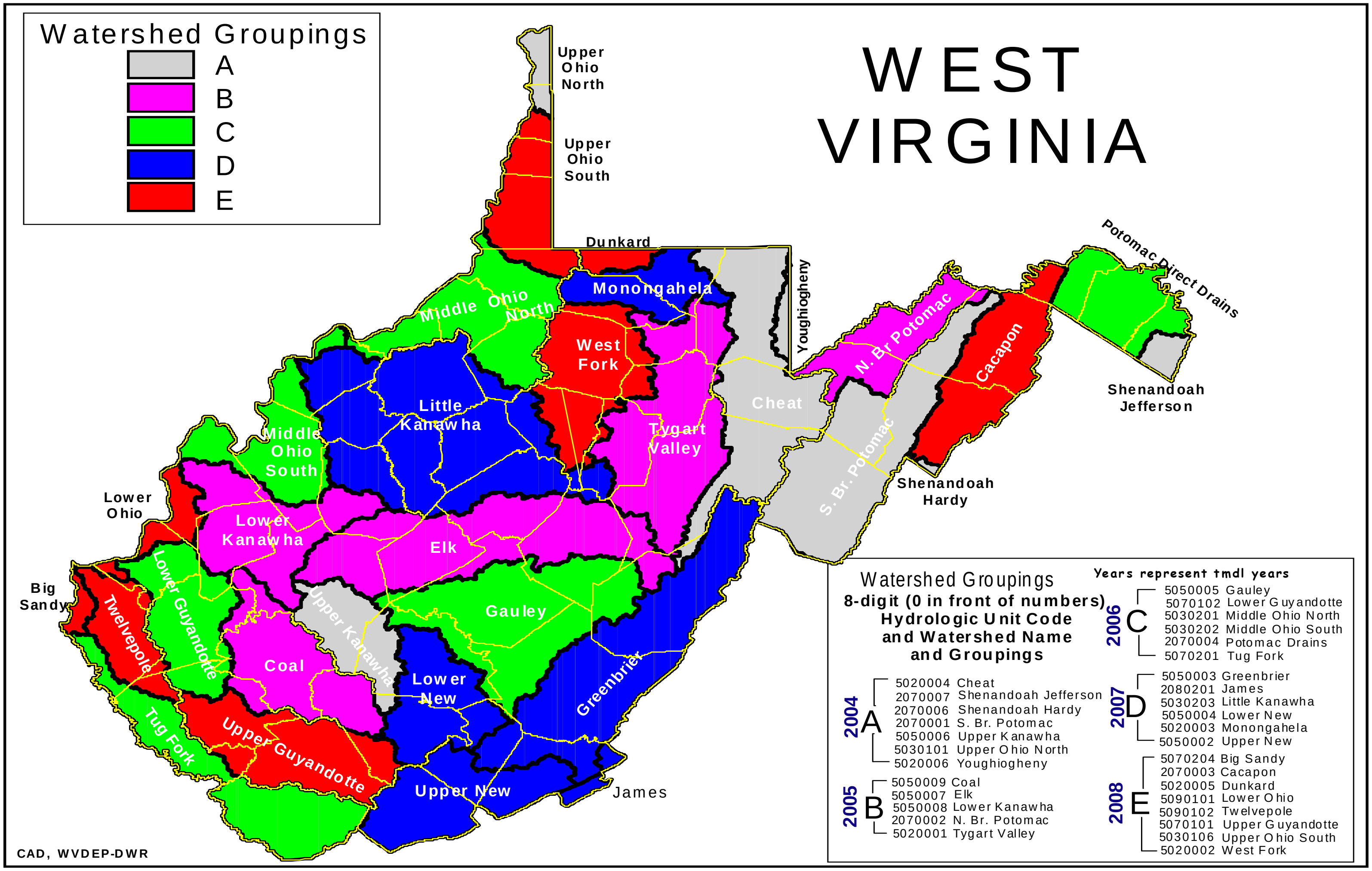

Figure 2-1. Hydrologic groupings of West Virginia's watersheds

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 of the Standards contains the narrative water quality criteria. Designated uses include: propagation and maintenance of aquatic life in warmwater fisheries and troutwaters, water contact recreation, and public water supply.

In the Greenbrier River watershed, water contact recreation and public water supply uses have been determined to be impaired pursuant to numeric water quality criteria for fecal coliform bacteria. The numeric water quality criteria for fecal coliform bacteria are shown in Table 2-1.

Table 2-1. Applicable West Virginia water quality criteria

POLLUTANT	**USE DESIGNATION** **Human Health** **Contact Recreation/Public Water Supply**
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.

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

3.0 WATERSHED DESCRIPTION AND DATA INVENTORY

3.1 Watershed Description

As shown in Figure 3-1, the Greenbrier River watershed lies mostly within Pocahontas, Greenbrier, Monroe, and Summers counties in southeastern West Virginia. As a component of the New/Kanawha River drainage, the Greenbrier River watershed encompasses nearly 1,646 square miles. Major tributaries include, East Fork and West Fork of the Greenbrier River, Deer Creek, Sitlington Creek, Knapp Creek, Anthony Creek, Spring Creek, Howard Creek, Second Creek, and Muddy Creek.

The average elevation in the watershed is 3,034 feet above mean sea level. 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 1,365 feet at the confluence of the Greenbrier River with the New River.

The total population for the entire Greenbrier River watershed was derived by area weighting Webster, Pocahontas, Greenbrier, and Nicholas counties populations from the 2000 U.S. Census data. The resulting population estimate is 38,402 people.

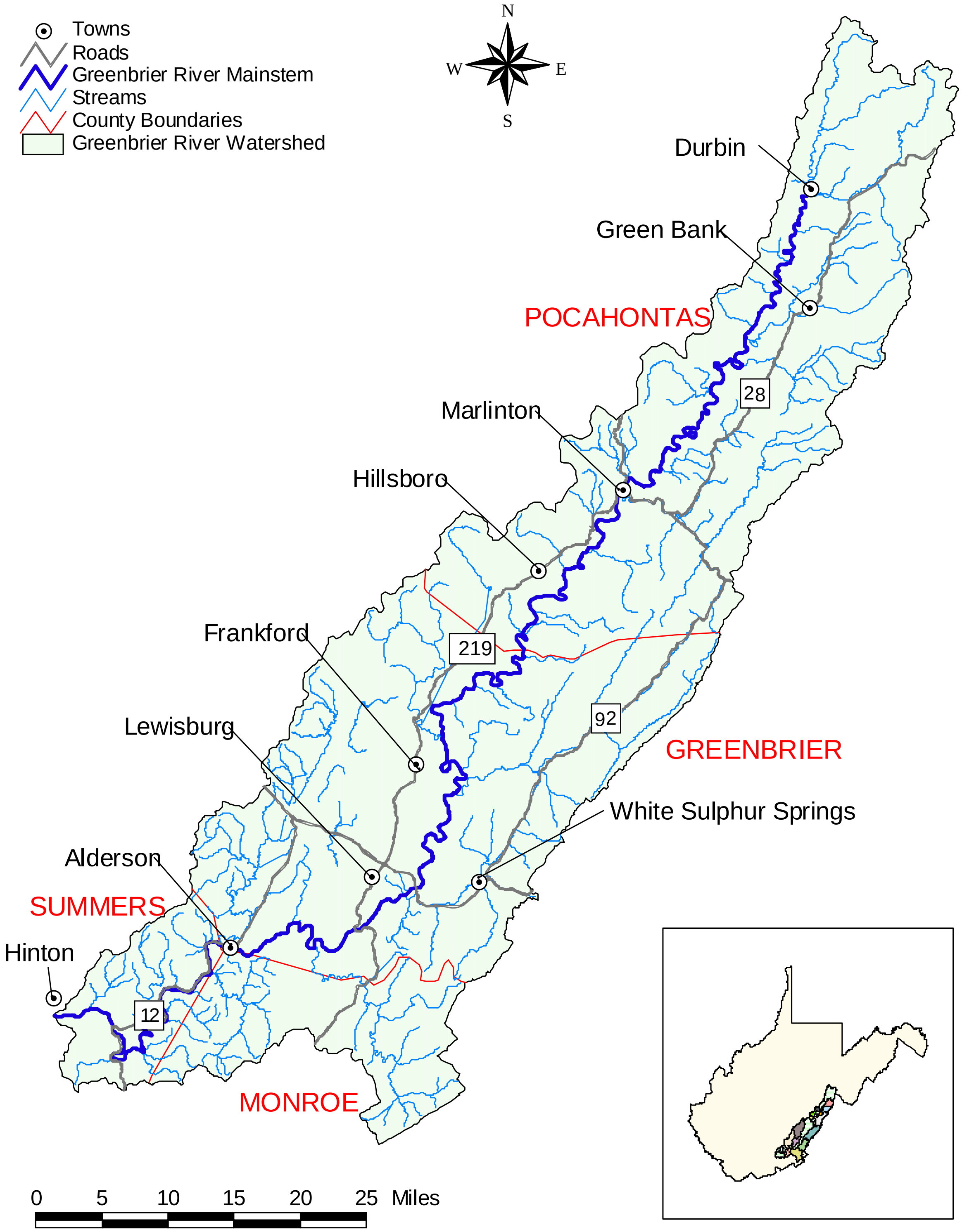

Figure 3-1. Location of the Greenbrier River watershed

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 modeled landuse manipulation is provided in Appendix C of the Technical Report. The GAP landuse categories were consolidated to create eleven modeled landuse categories, summarized in Table 3-1.

As shown in Table 3-1, the dominant modeled landuse type in the Greenbrier River watershed is forest. Other important modeled landuse types are pasture, karst pasture, grassland and karst grassland. Individually, all other land cover types compose less than one percent of the total watershed area.

Table 3-1. Modeled landuse type in the Greenbrier River watershed

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
Water	8,083.0	12.6	0.8%
Wetland	2,123.8	3.3	0.2%
Forest	820,767.4	1,282.4	77.9%
Barren	1,103.6	1.7	0.1%
Grassland	64,808.3	101.3	6.2%
Cropland	981.7	1.5	0.1%
Pasture	41,940.2	65.5	4.0%
Urban/Residential	7,122.2	11.1	0.7%
Karst Grassland	33,762.0	52.8	3.2%
Karst Cropland	1,097.4	1.7	0.1%
Karst Pasture	71,965.4	112.4	6.8%
Total Area	**1,053,754.9**	**1,646.5**	**100.0%**

Approximately 10.1 percent of the Greenbrier River watershed is characterized as karst landuse, as depicted in Figure 3-2. The karst landscape is formed by the dissolution of soluble limestone by groundwater that creates the following unique landforms: depressions such as sinkholes, disrupted surface water drainages (sunken streams) and large springs, and caves or underground drainage networks (Jones, 1997). Rapid recharge and flow rates through karst aquifers makes the groundwater extremely susceptible to contamination. Surface contaminants can quickly infiltrate through the land surface and be transmitted throughout a karst aquifer to interconnected springs (Jones, 1997). Cross basin transfer of contaminants can also occur easily if a surface contaminant source is connected by the groundwater aquifer. WVDEP conducted source tracking activities to determine and document karst drainage network patterns. Significant sources of information included *The Karst Hydrology Atlas of West Virginia*, West Virginia Association for Cave Studies and West Virginia Speleological Survey. Subwatershed boundaries were modified to incorporate the known karst drainage patterns.

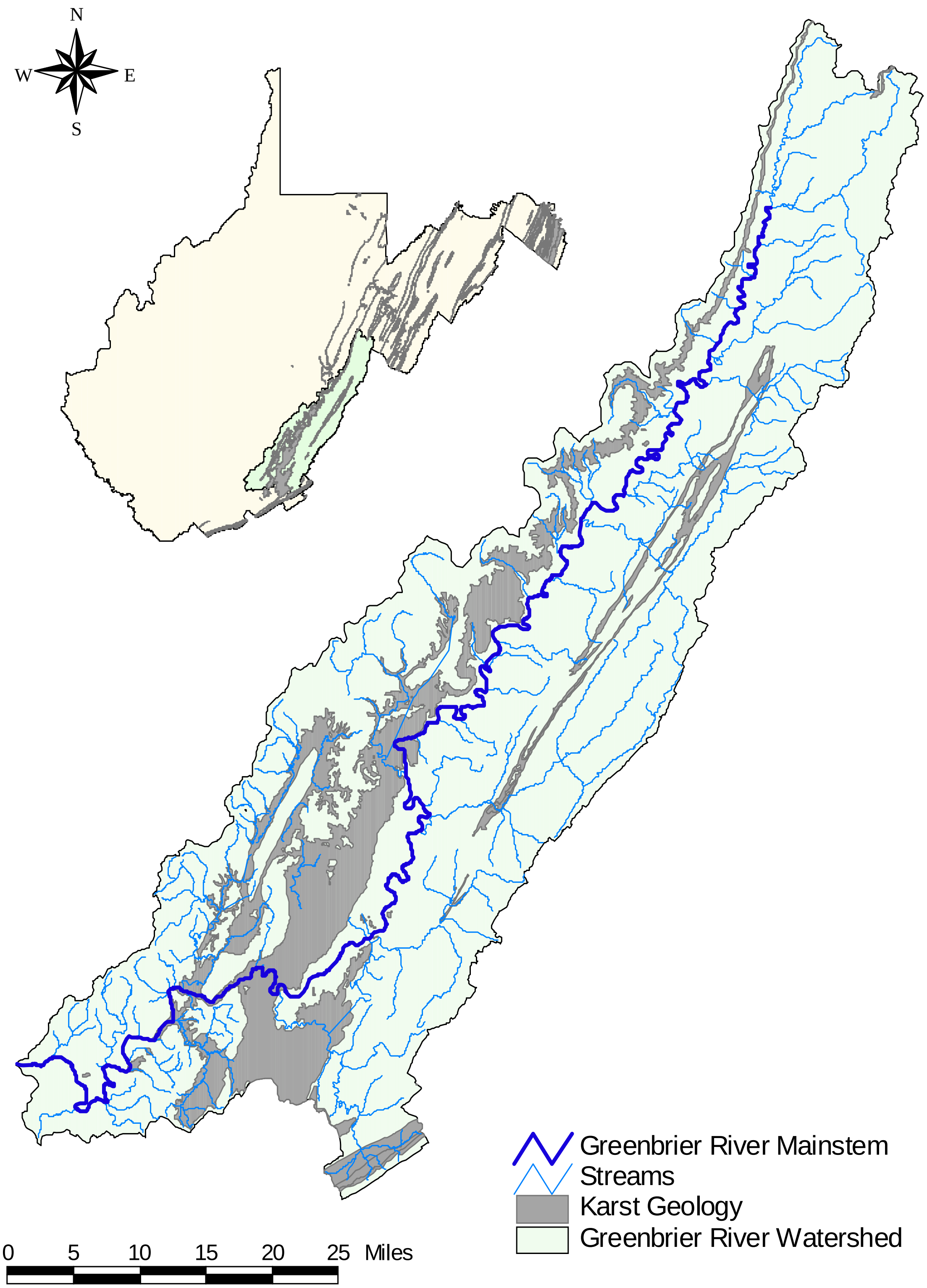

Figure 3-2. Karst geology of the Greenbrier River watershed

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 Greenbrier 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, Appendix I. The geographic information is provided in the ArcExplorer GIS project included on the CD version of this report.

Table 3-2. Data sets 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
	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	WV Division of Forestry
	Oil and gas operations coverage	WVDEP Office of Oil and Gas (OOG)
	Abandoned mining coverage	WVDEP DMR
	Karst Geology	WVDEP, DWWM, Groundwater/Underground Injection Control Programs The Karst Hydrology Atlas of West Virginia, West Virginia Association for Cave Studies, West Virginia Speleological Survey

Type of Information		Data Sources
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 DWWM
	Discharge Monitoring Report data	WVDEP DMR, Mining Companies
	Abandoned mine land data	WVDEP DMR, WVDEP DWWM
Regulatory or policy information	Applicable water quality standards	WVDEP
	Section 303(d) list of impaired waterbodies	WVDEP, USEPA
	Nonpoint Source Management Plans	WVDEP

3.3 Impaired Waterbodies

WVDEP conducted extensive water quality monitoring from July 2004 through June 2005 in the Greenbrier 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.

TMDLs were developed for impaired waters in 20 TMDL watersheds (Figure 3-3). The fecal coliform impaired waters for which TMDLs have been developed are presented in Table 3-3. The table includes the TMDL watershed, stream code, and stream name for each stream.

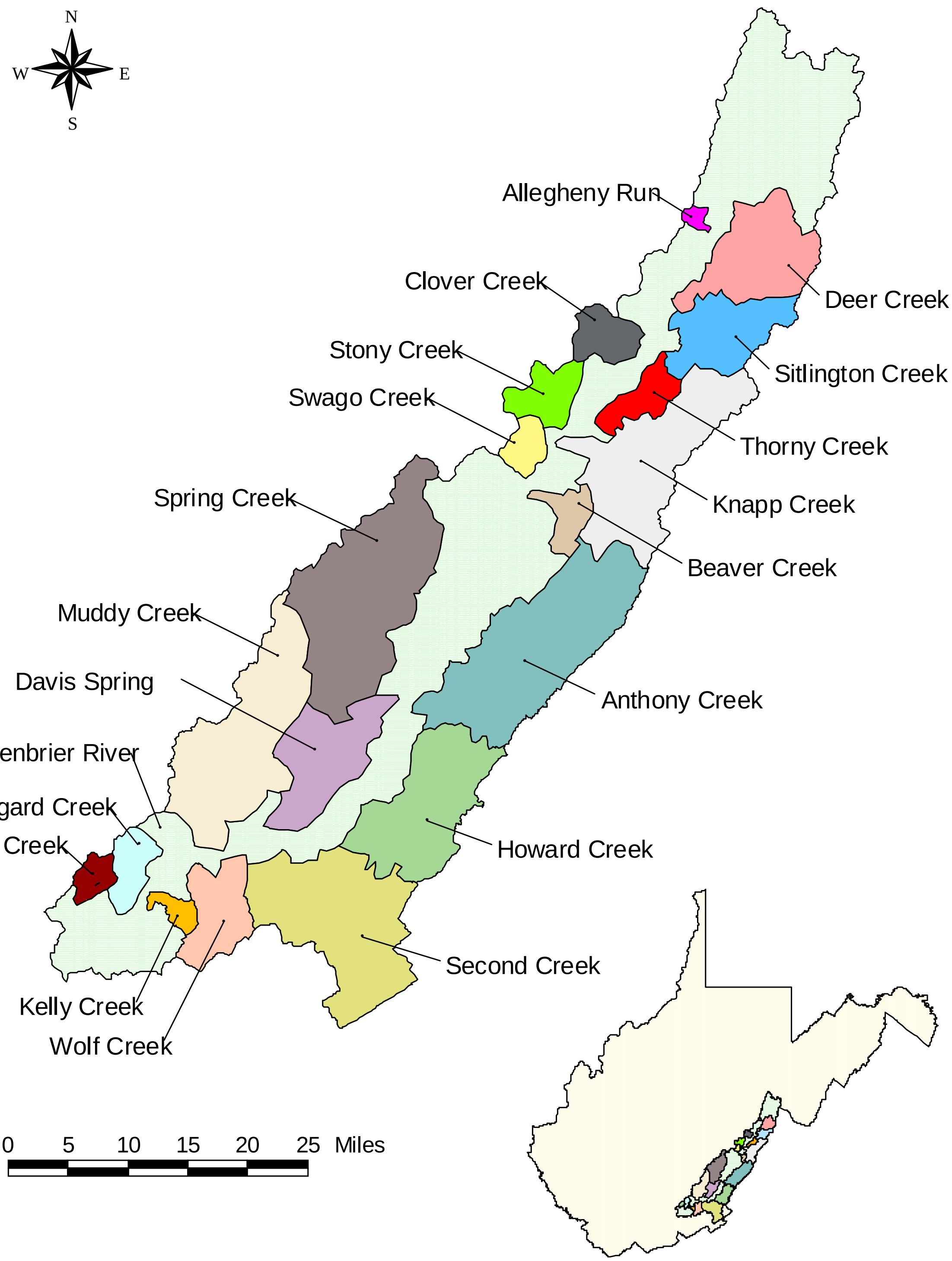

Figure 3-3. Greenbrier River TMDL watersheds

Table 3-3. Waterbodies for which fecal coliform TMDLs have been developed

TMDL Watershed	Stream Code	Stream Name
Greenbrier River	WVKNG	Greenbrier River
Big Creek	WVKNG-3	Big Creek
Hungard Creek	WVKNG-13	Hungard Creek
Kelly Creek	WVKNG-15	Kelly Creek
Kelly Creek	WVKNG-15-A	Flint Hollow
Wolf Creek	WVKNG-18	Wolf Creek
Wolf Creek	WVKNG-18-A	Laurel Creek
Wolf Creek	WVKNG-18-B	Broad Run
Muddy Creek	WVKNG-22	Muddy Creek
UNT/Greenbrier River RM 37.5 (Davis Spring)	WVKNG-22.7-A-1-(S)	Milligan Creek
Muddy Creek	WVKNG-22-A	Mill Creek
Muddy Creek	WVKNG-22-C	Kitchen Creek
Muddy Creek	WVKNG-22-E	UNT/Muddy Creek RM 19.8
Muddy Creek	WVKNG-22-E-1-(S)	Sinking Creek
Muddy Creek	WVKNG-22-E-1-A-(S)	Hughart Creek
Second Creek	WVKNG-23	Second Creek
Second Creek	WVKNG-23-G	Kitchen Creek
Second Creek	WVKNG-23-H	Back Creek
Howard Creek	WVKNG-25-A	Monroe Draft
Anthony Creek	WVKNG-28-D	Little Creek
Anthony Creek	WVKNG-28-F	Whites Draft
Anthony Creek	WVKNG-28-F-2	UNT/Whites Draft RM 2.0
Anthony Creek	WVKNG-28-Q	Meadow Creek
Spring Creek	WVKNG-30	Spring Creek
Beaver Creek	WVKNG-47	Beaver Creek
Swago Creek	WVKNG-49	Swago Creek
Knapp Creek	WVKNG-53	Knapp Creek
Knapp Creek	WVKNG-53-D	Browns Creek
Knapp Creek	WVKNG-53-H	Douthat Creek
Stony Creek	WVKNG-55	Stony Creek
Stony Creek	WVKNG-55-A	Indian Draft
Thorny Creek	WVKNG-59	Thorny Creek
Thorny Creek	WVKNG-59-E	UNT/Thorny Creek RM 9.3
Clover Creek	WVKNG-61	Clover Creek
Sitlington Creek	WVKNG-66-D	Shock Run
Sitlington Creek	WVKNG-66-E	Galford Run
Deer Creek	WVKNG-68	Deer Creek
Deer Creek	WVKNG-68-F	Buffalo Run
Allegheny Run	WVKNG-75	Allegheny Run

Note:
UNT = unnamed tributary, RM = river mile

4.0 FECAL COLIFORM SOURCE ASSESSMENT

4.1 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 Greenbrier River watershed.

4.1.1 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.

Six POTW permits are present in the Greenbrier River watershed, one of which, Greenbrier PSD No. 1, is a collection system that discharges into the City of Ronceverte POTW. Two additional individual permits for sewage treatment plants are located in the watershed. A portion of the City of Hinton’s sewage collection system extends into the watershed. However, Hinton’s effluent and CSOs do not discharge in the Greenbrier River watershed. Compliant POTW effluents do not cause fecal coliform bacteria impairments because they are permitted to discharge only at limits more stringent than water quality criterion.

4.1.2 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. There is one CSO associated with permit number WV0024473 (City of Marlinton) and one SSOs associated with permit number WV0084000 (City of White Sulphur Springs) in the watershed.

4.1.3 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. Both general permits contain fecal coliform effluent limitations identical to those in individual NPDES permits for sewage treatment facilities. In the Greenbrier River watershed, 24 facilities are registered under the “package plant” general permit and 4 are registered under the “HAU” general permit.

4.2 Nonpoint Sources

4.2.1 On-site Treatment Systems

Overall, failing septic systems and straight pipes represent a significant nonpoint source of fecal coliform bacteria in the Greenbrier River watershed. Information collected during source tracking efforts by WVDEP and using statewide 911 structures data yielded an estimate of 21,570 homes in the Greenbrier watershed that are not served by centralized sewage collection and treatment systems. Estimated septic system failure rates across the watershed range from 3 percent to 28 percent.

Source tracking information yielded an estimate of 5,964 homes in the watershed with completely or periodically failing septic systems. Due to a wide range of available literature values relating to the bacteria loading associated with failing septic systems, a customized Microsoft Excel spreadsheet tool was created to represent the fecal coliform bacteria contribution from failing on site septic systems. WVDEP’s pre-TMDL monitoring and source tracking data were used in the calculations. To calculate loads, values for both wastewater flow and fecal coliform concentration are needed.

To calculate failing septic wastewater flows, the TMDL watersheds were divided into four septic failure zones. During the WVDEP source tracking process, septic failure zones were delineated by soil characteristics (soil permeability, depth to bedrock, depth to groundwater and drainage capacity) as shown in USDA county soil survey maps. Two types of failure were considered, complete failure and periodic failure. For the purposes of this analysis, complete failure was defined as 50 gallons per house per day of untreated sewage escaping a septic system as overland flow to receiving waters; and periodic failure was defined as 25 gallons per house per day. Figure 4-1 shows the failing septic flows represented in the model by subwatershed.

Once failing septic flows had been modeled, a fecal coliform concentration was determined at the TMDL watershed scale. Based on past experience with other West Virginia TMDLs, a base concentration of 10,000 counts per 100 ml was used as a beginning concentration for failing septics. This concentration was further refined during model calibration at the subwatershed scale. A sensitivity analysis was performed by varying the modeled failing septic concentrations in multiple model runs, and then comparing model output to pre-TMDL monitoring data. Additional details of the failing septic analyses are elucidated in the Technical Report.

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

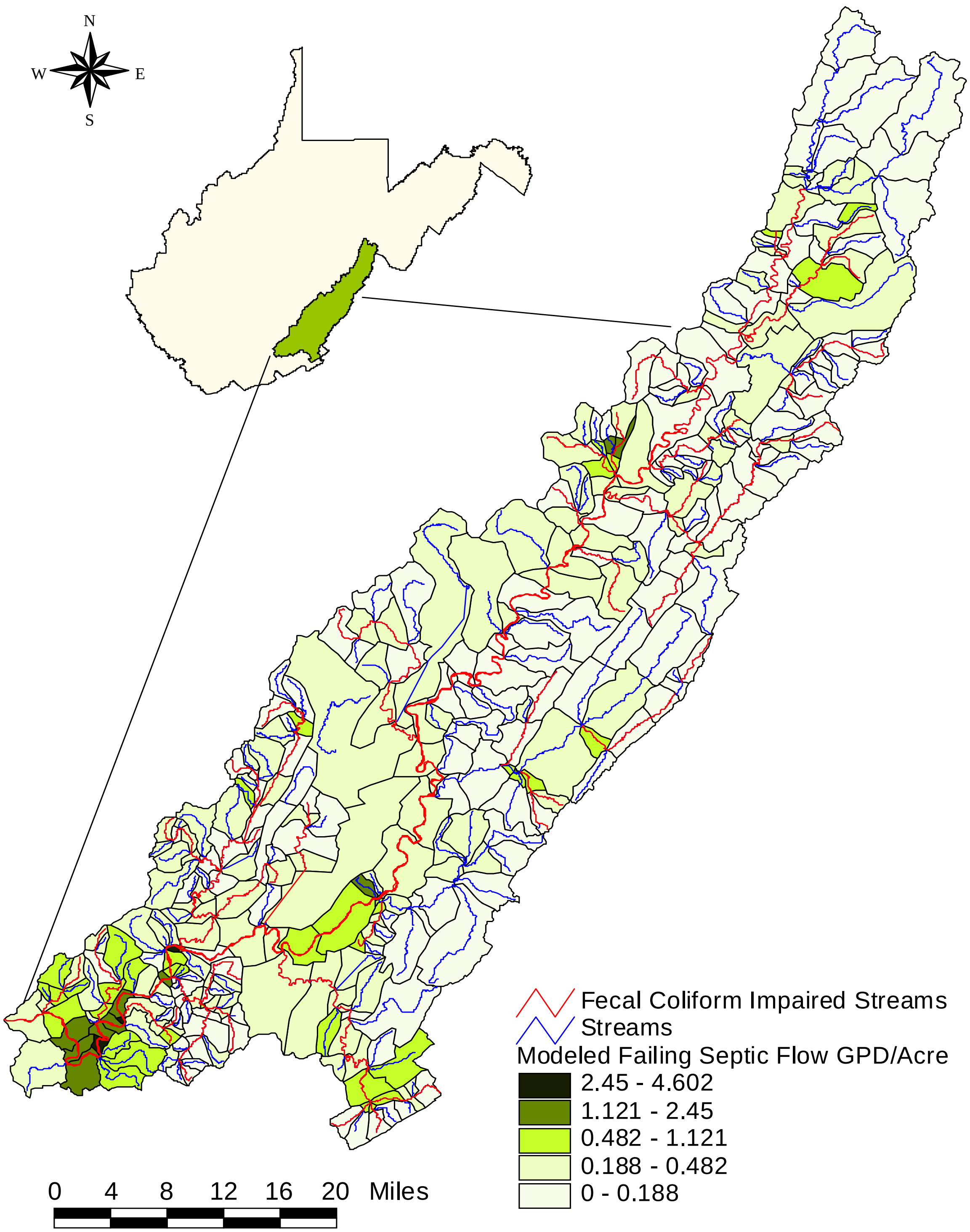

Figure 4-1. Greenbrier River failing septic flows

4.2.2 Urban/Residential 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 Greenbrier River watershed. Literature reference values were used to determine fecal accumulation rates for these areas.

4.2.3 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.

Agriculture is the most prevalent landuse within unforested portions of the Greenbrier River watershed. Source tracking efforts identified pastures and feedlots throughout the watershed that have significant impacts on instream bacteria levels. WVDEP source tracking assessments of livestock (density and access to streams) were used to develop fecal coliform bacteria loadings for agricultural sources.

4.2.4 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 Greenbrier River watershed.

5.0 MODELING PROCESS

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

5.1 Modeling Technique for 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
- Fecal coliform bacterial impairments are temporally variable and occur at low, average, and high flow conditions
- Time-variable aspects of land practices have a large effect on instream bacteria concentrations
- Bacterial transport mechanisms are highly variable and often weather-dependent

The primary regulatory factor that influenced the selection process was West Virginia 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 fecal coliform bacteria in West Virginia are presented in Section 2, Table 2-1. West Virginia water quality criteria are applicable at all stream flows greater than the 7-day, 10-year low flow (7Q10). The approach or modeling technique must permit representation of instream concentrations under a variety of flow conditions to evaluate critical flow periods for comparison with criteria.

The TMDL development approach must also consider the dominant processes affecting pollutant loadings and instream fate. In the Greenbrier River watershed, an array of point and nonpoint sources contributes to the various impairments. Most nonpoint sources are rainfall-driven with pollutant loadings primarily related to surface runoff, but some, such as inadequate on-site 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. Fecal coliform bacteria were modeled using the MDAS.

5.1.1 MDAS Setup

Configuration of the MDAS model involved subdividing the Greenbrier 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 20 separate TMDL watersheds based on the groupings of impaired streams shown in Figure 3-3. These TMDL watersheds were further subdivided into 364 individual subwatershed units 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 364 individual subwatershed units across all of the 20 TMDL watersheds are shown in Figure 5-1.

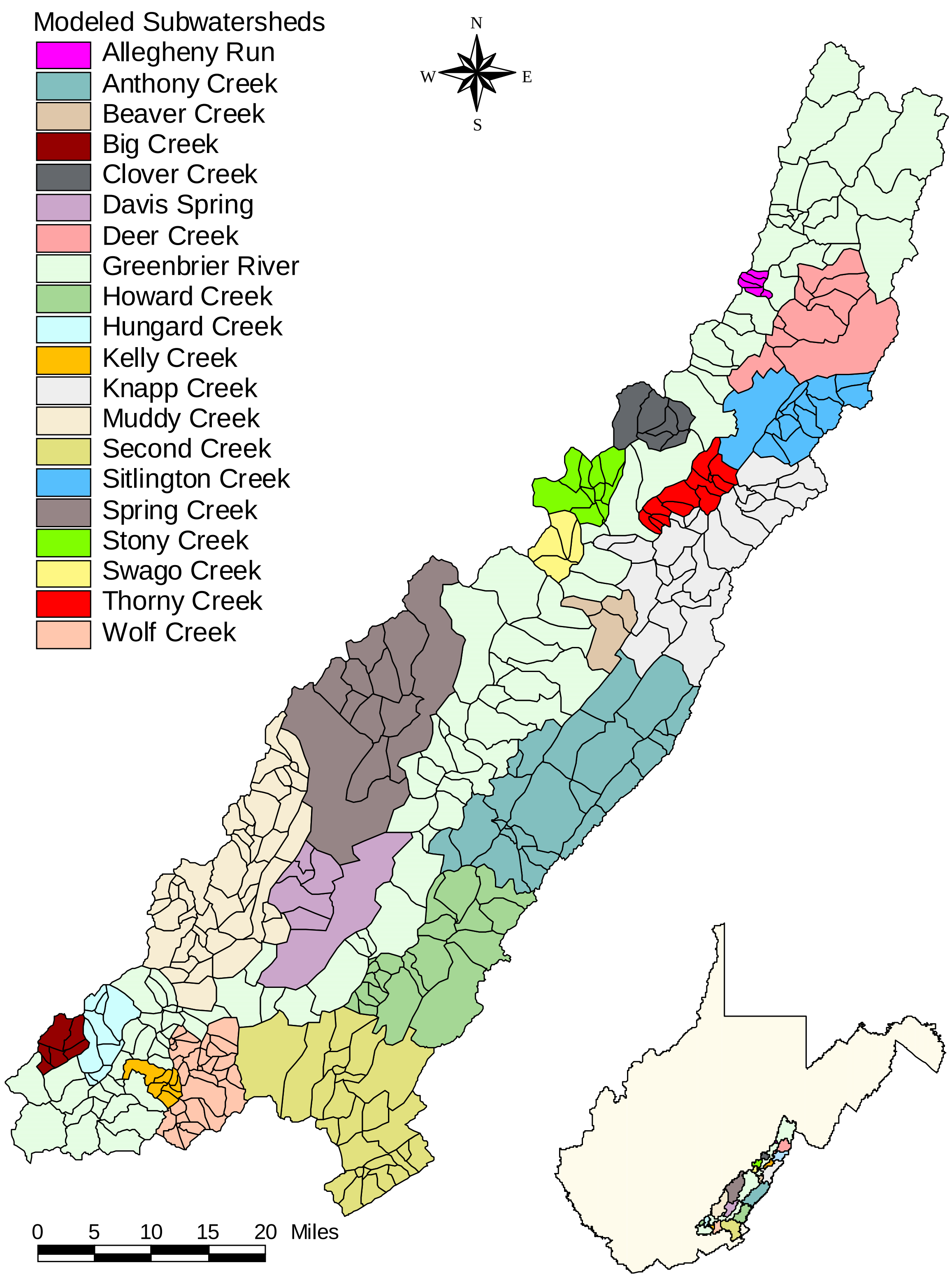

Figure 5-1. Greenbrier River subwatershed delineation

The modeled landuse categories contributing to bacteria loads include pasture, karst pasture, grassland, karst grassland, cropland, karst cropland, urban/residential pervious lands, urban/residential impervious lands, and forest (including barren and wetlands). Grassland, pasture, and cropland areas with limestone karst geology were identified and differentiated from non-karst agricultural landuses because drainage patterns are significantly different in karst areas. Other sources, such as failing septic systems, straight pipes, and permitted sources, were modeled as direct, continuous-flow sources in the model.

The MDAS was configured to model hydrology and water quality for fecal coliform bacteria. In the Greenbrier River watershed, pollutant loads are delivered to the tributaries with surface runoff, subsurface flows, and direct discharges to the streams.

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 4.2.1 describes the process of assigning flow and fecal coliform concentrations to failing septic systems. The failing septic analysis provided initial values for model input; however, these values were further refined during the model calibration process.

After model configuration, calibration of the hydrology followed by calibration of 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.

5.1.2 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 stations in the Greenbrier River watershed with adequate data records for hydrology calibration. The model was calibrated to the observed data recorded at the following USGS gages: USGS 03184000 Greenbrier River at Hill Dale, USGS 03183500 Greenbrier River at Alderson, and USGS 03182500 Greenbrier River at Buckeye.

Hydrology calibration was based on observed data from the three aforementioned USGS 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, 1992 to September 30, 2005. 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 Greenbrier River watershed. A detailed description of the hydrology calibration and a summary of the results and validation are presented in the Technical Report.

5.1.3 Fecal Coliform Bacteria Calibration

Following hydrology calibration, water quality calibration was performed for fecal coliform bacteria. The water quality was calibrated by comparing modeled versus observed instream 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 to enhance the representation of background conditions from undisturbed areas. The results of the storm sampling fecal coliform calibration are shown in Figure 5-2.

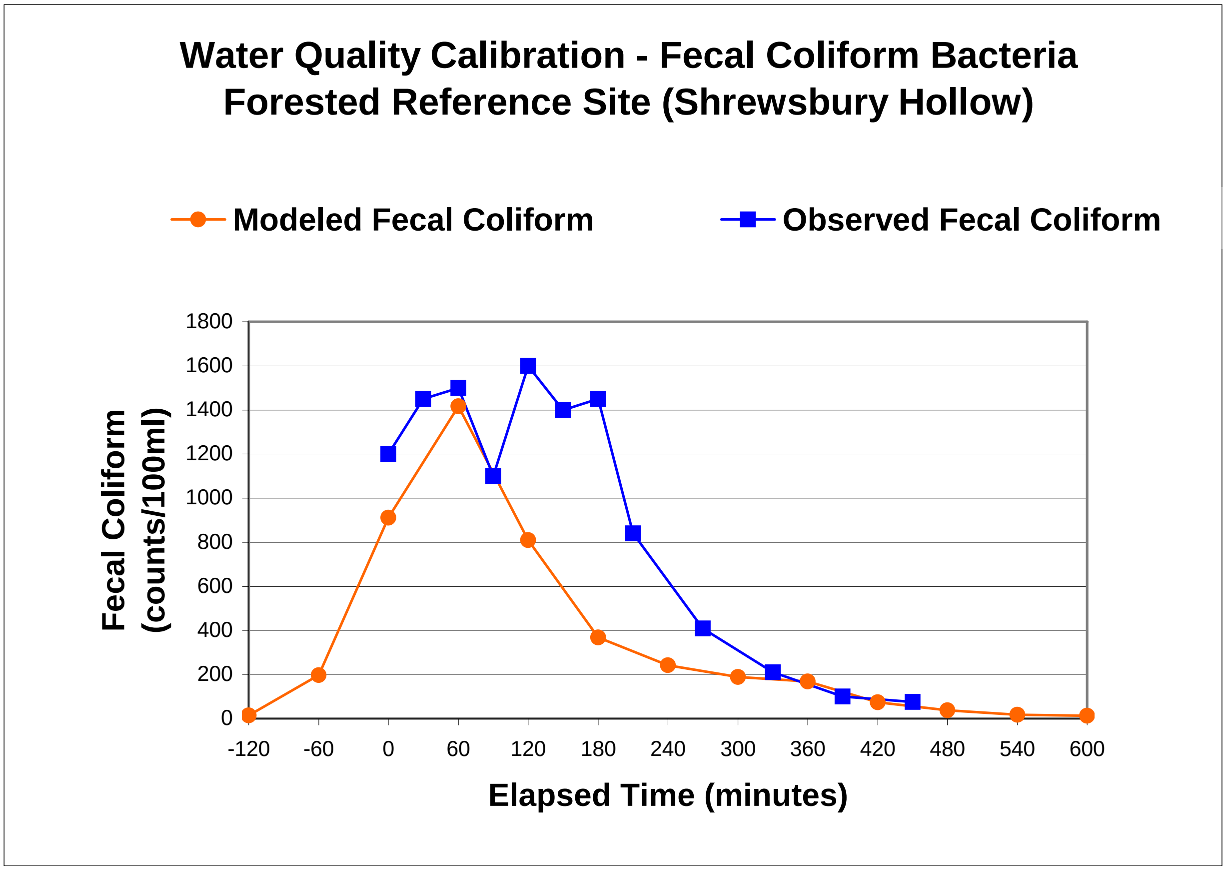

Figure 5-2. Shrewsbury Hollow fecal coliform bacteria observed data

5.2 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:

TMDL = sum of WLAs + sum of LAs + MOS

To develop 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

5.2.1 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 fecal coliform bacteria 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.

The TMDL endpoints for fecal coliform are displayed in Table 5-1.

Table 5-1. TMDL endpoints

Water Quality Criterion	Designated Use	Criterion Value	TMDL Endpoint
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)

5.2.2 Baseline Conditions and Source Loading Alternatives

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

Baseline Conditions for MDAS

The MDAS model was run for baseline conditions using hourly precipitation data for a representative six-year simulation period (January 1, 1998 through December 31, 2003). The precipitation experienced over this period was applied to the landuses and pollutant sources, as they existed at the time of TMDL development. Predicted instream concentrations were compared directly with the TMDL endpoints. This comparison allowed for the evaluation of the magnitude and frequency of exceedances under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods.

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.

Figure 5-3 presents the annual rainfall totals for the years 1980 through 2004 at the Marlinton, West Virginia (WV5672) weather station. The years 1998 to 2003 are highlighted to indicate the range of precipitation conditions that was used for TMDL development in the Greenbrier River watershed.

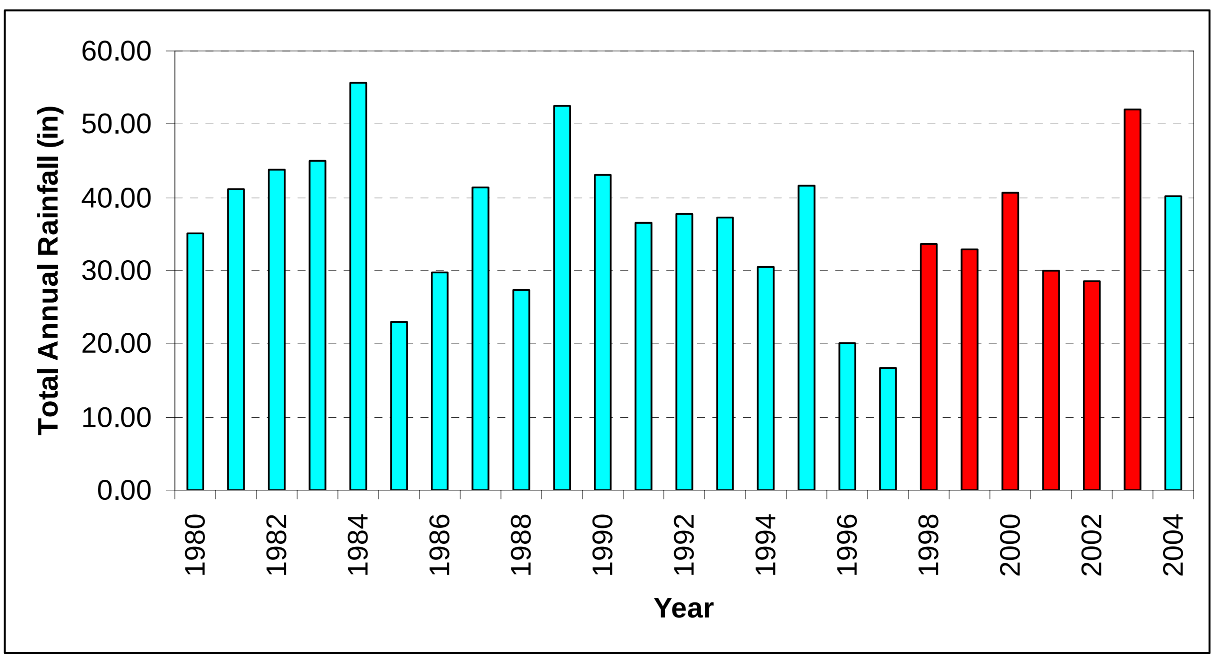

Figure 5-3. Annual precipitation totals for the Marlinton (WV5672) weather station

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 nonpoint sources were individually adjusted and the modeled instream concentrations were evaluated for compliance with TMDL endpoints.

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

Figure 5-4 shows examples of model output for a fecal coliform baseline condition and a successful TMDL scenario for both instantaneous output and the 30 day geometric mean of the output.

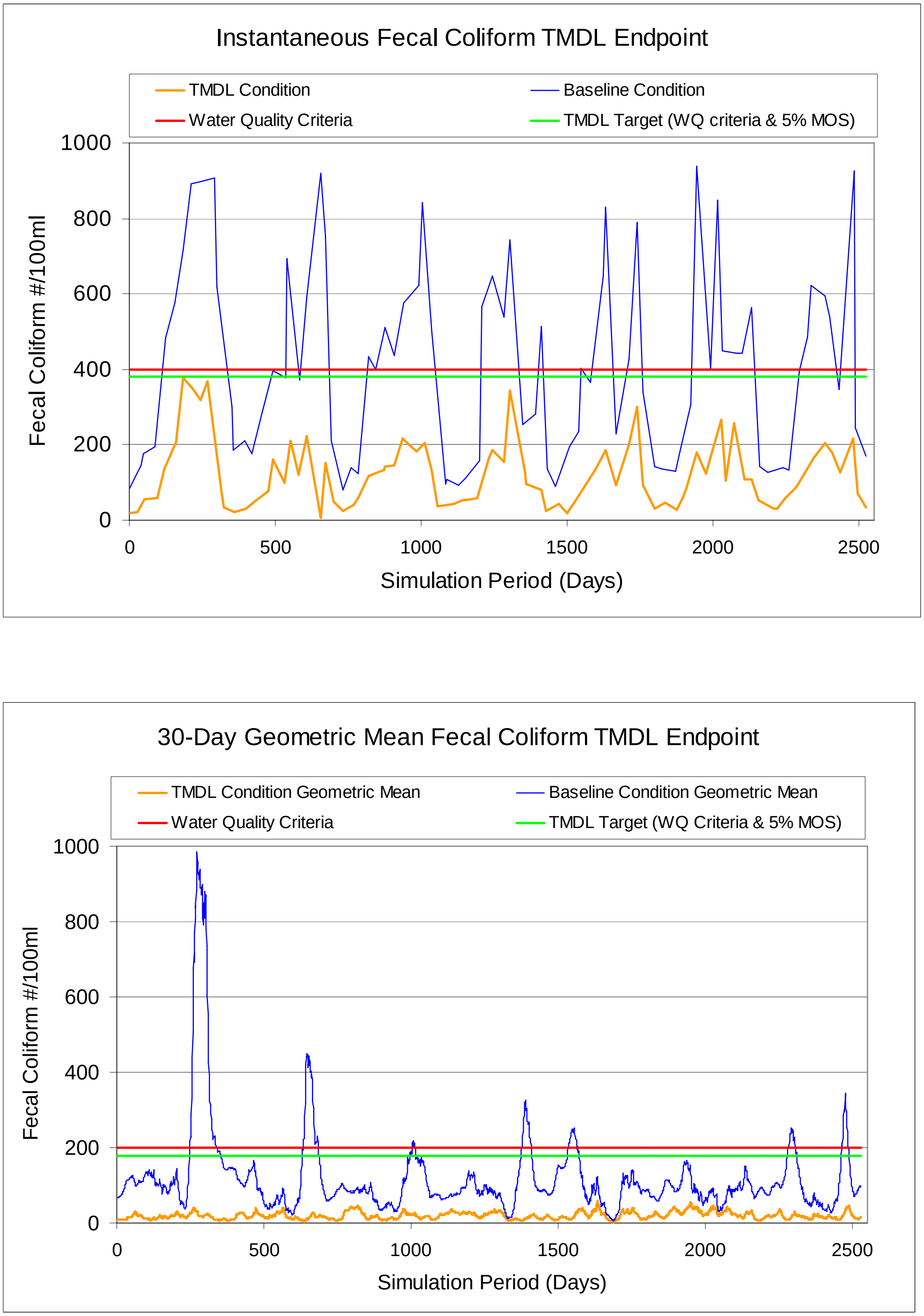

Figure 5-4. Examples of baseline and TMDL conditions (instantaneous and geometric mean) for fecal coliform

5.3 TMDLs and Source Allocations

5.3.1 Fecal Coliform Bacteria Source Allocations

TMDLs and source allocations were developed for impaired stream segments and their tributaries on a subwatershed basis. 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. 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 never more stringent than numeric water quality criteria.

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 NPDES 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 onsite systems were reduced by 100 percent in the model. SSOs are illegal under NPDES regulations; all such discharges were similarly reduced. 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. Existing, technology-based fecal coliform effluent limitations for sewage treatment facilities 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 source categories:

- Pasture
- On-site 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)

5.3.2 Seasonal Variation

The TMDL must consider seasonal variation. For the Greenbrier River watershed 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 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.

5.3.3 Critical Conditions

Nonpoint source loading is typically precipitation-driven and impacts tend to occur during wet weather and high surface runoff. During dry periods little or no land-based runoff occurs, and elevated instream pollutant levels may be due to point sources (Novotny and Olem, 1994). Also, failing on-site sewage systems (categorized as nonpoint sources but represented as continuous flow discharges) often have an associated low-flow critical condition, particularly where such sources are located on small receiving waters.

A critical condition represents a scenario where water quality criteria are most susceptible to violation. Analysis of water quality data for individual streams within the Greenbrier River watershed shows high pollutant concentrations during both high- and low-flow thereby precluding selection of a single critical condition. Both high-flow and low-flow periods were taken into account during TMDL development by using a long period of weather data that represented wet, dry, and average flow periods.

5.3.4 TMDL Presentation

TMDLs, LAs, and WLAs are shown in Table 6-1 and in the allocation spreadsheets associated with this report. TMDLs and their components are presented as average daily loads and average annual loads and were developed to meet TMDL endpoints throughout the range of conditions simulated over the design precipitation period.

Pollutant source representation attempted to capture the functionality and conveyance methods of both storm runoff from precipitation-induced sources and continuous discharges that are not directly related to precipitation. Simulation of baseline conditions on an hourly time-step provided a basis for evaluating in-stream response to varying source contributions under a wide range of precipitation and stream flow conditions. Hourly model outputs were aggregated into daily values. TMDL allocations were developed by reducing baseline pollutant contributions until model output at each subwatershed outlet demonstrated attainment of water quality criteria, exactly in accordance with the prescribed criterion value, averaging period and exceedance frequency. For each impaired stream, annual average TMDLs were derived by calculating the total pollutant load associated with the TMDL condition exiting the mouth subwatershed for each year simulated by the model and then averaging those annual loads. The average daily TMDLs were calculated by dividing the annual average loads by 365 days.

The filterable allocation spreadsheets include multiple display formats that allow comparison of pollutant loadings among categories and facilitate implementation. A brief description of presented information is included on the “Introduction” tab of the spreadsheet. Load allocations for nonpoint source categories are presented for each model subwatershed as annual average loads, along with the associated percentage pollutant reduction from baseline conditions. Wasteload allocations for individual and general NPDES permits for sewage treatment facilities 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.

6.0 TMDL RESULTS FOR FECAL COLIFORM BACTERIA

TMDLs and source allocations were developed for the impairments displayed in Table 3-3. The TMDLs for fecal coliform bacteria are shown in Table 6-1. The TMDLs for fecal coliform bacteria are presented in number of colonies (counts) per day.

Detailed source allocations are provided in the allocation spreadsheets associated with this report.

Table 6-1. Fecal coliform bacteria TMDLs for the Greenbrier River watershed

TMDL Watershed	Stream Code	Stream Name	Load Allocation (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Greenbrier River	WVKNG	Greenbrier River	2.96E+15	1.11E+13	1.57E+14	3.13E+15
Hungard Creek	WVKNG-13	Hungard Creek	3.82E+13	NA	2.01E+12	4.02E+13
Kelly Creek	WVKNG-15	Kelly Creek	1.74E+13	NA	9.14E+11	1.83E+13
Kelly Creek	WVKNG-15-A	Flint Hollow	8.41E+11	NA	4.43E+10	8.86E+11
Wolf Creek	WVKNG-18	Wolf Creek	8.29E+13	NA	4.36E+12	8.72E+13
Wolf Creek	WVKNG-18-A	Laurel Creek	1.00E+13	NA	5.28E+11	1.06E+13
Wolf Creek	WVKNG-18-B	Broad Run	1.87E+13	NA	9.84E+11	1.97E+13
Muddy Creek	WVKNG-22	Muddy Creek	2.42E+14	NA	1.27E+13	2.55E+14
Muddy Creek	WVKNG-22.7-A-1-(S)	Milligan Creek	6.00E+13	NA	3.16E+12	6.32E+13
Muddy Creek	WVKNG-22-A	Mill Creek	3.77E+13	NA	1.98E+12	3.96E+13
Muddy Creek	WVKNG-22-C	Kitchen Creek/Muddy Creek	1.21E+13	NA	6.37E+11	1.27E+13
Muddy Creek	WVKNG-22-E	UNT/Muddy Creek RM 19.8	6.90E+13	NA	3.63E+12	7.26E+13

TMDL Watershed	Stream Code	Stream Name	Load Allocation (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Muddy Creek	WVKNG-22-E-1-(S)	Sinking Creek	3.68E+13	NA	1.94E+12	3.88E+13
Muddy Creek	WVKNG-22-E-1-A-(S)	Hughart Creek	2.44E+13	NA	1.28E+12	2.57E+13
Second Creek	WVKNG-23	Second Creek	1.93E+14	2.07E+10	1.01E+13	2.03E+14
Second Creek	WVKNG-23-G	Kitchen Creek/Second Creek	2.22E+13	NA	1.17E+12	2.34E+13
Second Creek	WVKNG-23-H	Back Creek	1.88E+13	NA	9.88E+11	1.98E+13
Howard Creek	WVKNG-25-A	Monroe Draft	9.43E+12	NA	4.96E+11	9.93E+12
Anthony Creek	WVKNG-28-D	Little Creek	3.26E+13	NA	1.72E+12	3.44E+13
Anthony Creek	WVKNG-28-F	Whites Draft	5.49E+12	NA	2.89E+11	5.78E+12
Anthony Creek	WVKNG-28-F-2	UNT/Whites Draft RM 2.0	2.22E+12	NA	1.17E+11	2.33E+12
Anthony Creek	WVKNG-28-Q	Meadow Creek	1.22E+13	1.66E+11	6.52E+11	1.30E+13
Big Creek	WVKNG-3	Big Creek	1.31E+13	NA	6.90E+11	1.38E+13
Spring Creek	WVKNG-30	Spring Creek	3.54E+14	NA	1.86E+13	3.72E+14
Beaver Creek	WVKNG-47	Beaver Creek	1.99E+13	1.02E+10	1.05E+12	2.09E+13

TMDL Watershed	Stream Code	Stream Name	Load Allocation (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Swago Creek	WVKNG-49	Swago Creek	2.89E+13	5.53E+10	1.53E+12	3.05E+13
Knapp Creek	WVKNG-53	Knapp Creek	2.02E+14	1.05E+10	1.06E+13	2.13E+14
Knapp Creek	WVKNG-53-D	Browns Creek	1.97E+13	1.05E+10	1.04E+12	2.07E+13
Knapp Creek	WVKNG-53-H	Douthat Creek	3.92E+13	NA	2.07E+12	4.13E+13
Stony Creek	WVKNG-55	Stony Creek	7.29E+13	4.98E+10	3.84E+12	7.68E+13
Stony Creek	WVKNG-55-A	Indian Draft	2.96E+13	4.98E+10	1.56E+12	3.13E+13
Thorny Creek	WVKNG-59	Thorny Creek	3.07E+13	3.57E+11	1.63E+12	3.27E+13
Thorny Creek	WVKNG-59-E	UNT/Thorny Creek RM 9.3	4.95E+12	NA	2.61E+11	5.21E+12
Clover Creek	WVKNG-61	Clover Creek	4.81E+13	NA	2.53E+12	5.06E+13
Sitlington Creek	WVKNG-66-D	Shock Run	1.70E+13	NA	8.96E+11	1.79E+13
Sitlington Creek	WVKNG-66-E	Galford Run	4.52E+13	NA	2.38E+12	4.76E+13
Deer Creek	WVKNG-68	Deer Creek	1.95E+14	2.90E+10	1.03E+13	2.06E+14
Deer Creek	WVKNG-68-F	Buffalo Run	1.39E+13	NA	7.32E+11	1.46E+13

TMDL Watershed	Stream Code	Stream Name	Load Allocation (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Allegheny Run	WVKNG-75	Allegheny Run	6.10E+12	NA	3.21E+11	6.42E+12

NA = not applicable; UNT = unnamed tributary.

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

7.0 FUTURE GROWTH

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 some instances 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.

8.0 PUBLIC PARTICIPATION

8.1 Public Meetings

Informational public meetings were held on May 6, 2004 at the New River Community and Technical College and on June 11, 2007 at the public library in Lewisburg, West Virginia. The May 6, 2004 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 June 11, 2007 meeting occurred prior to the allocation of pollutant loads and included proposed WVDEP allocation strategies.

A public meeting was held to present the draft TMDLs on February 11, 2008 at the public library in Lewisburg. The meeting began at 7:00 PM. and provided information to stakeholders to facilitate comments on the draft TMDLs.

8.2 Public Notice and Public Comment Period

The availability of Draft TMDLs was advertised in various local newspapers between January 29, 2008 and January 31, 2008. Interested parties were invited to submit comments during the public comment period, which began on February 1, 2008 and ended March 3, 2008. WVDEP did not receive any comments on the Draft TMDLs. The electronic documents are available on the WVDEP’s internet site at http://www.wvdep.org/wvtmdl.

9.0 REASONABLE ASSURANCE

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

9.1 Permit Reissuance

WVDEP's Division of Water and Waste Management is responsible for issuing non-mining NPDES permits within the State. As part of the permit review process, permit writers have the responsibility to incorporate the required TMDL wasteload allocations 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 time frames. Permits for existing sewage treatment facilities in the Greenbrier River watershed will be reissued beginning in July 2008 and current effluent limitations satisfy the wasteload allocations of the TMDLs.

WVDEP also implements a program to control discharges from CSOs. Specified fecal coliform wasteload allocations for CSOs will be implemented in accordance with the provisions of the national Combined Sewer Overflow Control Policy and the state Combined Sewer Overflow Strategy. Those programs recognize that comprehensive CSO control may require significant resources and an extended period of time to accomplish. The wasteload allocation prescribed for CSOs are necessary to achieve current fecal coliform water quality criteria. However, the TMDL should not be construed to supersede the prioritization and scheduling of CSO controls and actions pursuant to the national CSO program.

9.2 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.

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 intends to prioritize Hydrologic Group D watersheds in March 2008. 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. Additional information regarding upcoming Network activities can be obtained from the Nonpoint Source Program Southern Basin Coordinator Jennifer DuPree (jdupree@wvdep.org).

There are four active watershed associations in the Greenbrier watershed, the Friends of Lower Greenbrier River (www.lowergreenbrierriver.org), Friends of the Second Creek, Greenbrier River Watershed Association (www.greenbrierriver.org), and the Upper Knapps Creek Watershed Association. For additional information concerning the associations contact the above mentioned Nonpoint Source Program Southern Basin Coordinator.

9.3 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.

Currently, White Sulphur Springs has received approval for funding of a new sixteen million dollar treatment plant. The new plant will have a dry weather treatment capacity of two and one half million gallons per day. In addition, approximately 4 million dollars will be expended on improvements to the current sewage collection system. The improvements will include separation of stormwater from sanitary sewer flows thereby reducing the hydraulic load on the new plant and possibly reducing the discharge of untreated or partially treated sewage to the Greenbrier River.

The Town of Marlington has submitted a proposal for funding to perform an Inflow and Infiltration (I/I) study. Results of the study would be used to guide efforts to minimize the amount of inflow and infiltration and the number and volume of CSO discharges.

10.0 MONITORING PLAN

The following monitoring activities are recommended:

10.1 NPDES Compliance

WVDEP's DWWM 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.

10.2 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.

10.3 TMDL Effectiveness Monitoring

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

11.0 REFERENCES

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

Jones, William K. 1997. Karst Hydrology Atlas of West Virginia. Special Publication 4, Karst Waters Institute. Charlestown, WV.

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

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