January 2005

TMDLs for Selected Streams in the Upper Kanawha Watershed, West Virginia

FINAL APPROVED REPORT

Prepared for:

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Division of Water and Waste Management
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EXECUTIVE SUMMARY

The Upper Kanawha River watershed is in southwestern West Virginia and encompasses approximately 521 square miles. Portions of the watershed lie within Kanawha, Fayette, and Raleigh counties, and major tributaries include Campbell's Creek, Witcher Creek, Kelly's Creek, Hughes Creek, Smithers Creek, Loop Creek, Armstrong Creek, Paint Creek, Cabin Creek, Slaughter Creek, Fields Creek, and Lens Creek.

This report includes Total Maximum Daily Loads (TMDLs) for various impaired streams in the Upper Kanawha 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 taking the actions needed to restore water quality.

In West Virginia, water quality standards are codified at Title 46 of the *Code of State Rules* (CSR), Series 1, and titled *Legislative Rules of the Environmental Quality Board: 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 to criteria and reports impaired waters every 2 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 final 2004 Section 303(d) list includes 96 impaired streams in the watershed. The impairments are related to numeric water quality criteria for fecal coliform bacteria, dissolved aluminum, total iron, total manganese, and pH. Table 2-1 portrays applicable numeric criteria. Many of the listed waters are also biologically impaired based on the narrative water quality criterion of 46 CSR 1 - 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. TMDLs are developed herein for 80 of the listed waters. The impaired waters and applicable impairments are presented in Table 3-3.

Since 1997 the U.S. Environmental Protection Agency (USEPA), Region 3, has 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. This report accommodates the timely development of the remaining Upper Kanawha River watershed TMDLs that were required to be developed by the consent decree.

Impaired waters were organized into17 TMDL subwatersheds. Those watersheds were further divided into 502 subwatersheds for modeling purposes. The subwatershed delineation provided a basis for georeferencing pertinent source information and monitoring data, and for presenting TMDLs.

The Mining Data Analysis System (MDAS) was used to represent the source-response linkage for total aluminum, manganese, iron, and fecal coliform bacteria. 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 in-stream processes. TMDLs for pH impairments were developed using a surrogate approach where 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 the Dynamic Equilibrium In-stream Chemical Reactions model (DESC-R). MDAS was linked with the DESC-R model to appropriately address dissolved aluminum TMDLs in the watershed. West Virginia's numeric water quality criteria and an explicit margin of safety were used to identify endpoints for TMDL development.

Sediment TMDLs were developed under a reference watershed approach. The Generalized Watershed Loading Functions (GWLF) watershed-loading model was integrated with a stream routing model (Tetra Tech Stream Module) that examined stream bank erosion and depositional processes. Load reductions for sediment-impaired waters were based on the sediment loading present in the unimpaired reference watershed.

Sources contributing to metals and pH impairments include an array of nonpoint sources (diffuse sources), as well as discrete point sources (permitted discharges). Most of the point sources in the watershed that discharge metals are mining-related. The most significant nonpoint sources are abandoned mine lands and bond forfeiture sites, but land disturbance activities that introduce excess sediment are additional problematic sources of metals in the watershed.

Both point and nonpoint sources contribute to the fecal coliform bacteria impairments in the watershed. Overflows from publicly owned treatment works (POTW) collection systems, known as sanitary sewer overflows (SSOs), are problematic point sources. By far, the most significant nonpoint sources are those related to the inadequate treatment of sewage. Failing onsite systems and direct discharges of untreated sewage result in fecal coliform criteria exceedances in many waters. Agricultural sources of fecal coliform bacteria are rare because only minimal agricultural land use is present in the watershed.

Point sources of sediment include permitted mining activities and stormwater discharges from construction sites greater than 1 acre. Nonpoint sources of sediment include abandoned mine lands, bond forfeiture sites, roads, oil and gas operations, timbering, agriculture, and urban and residential land disturbance. The presence of individual nonpoint source categories and their relative significance of impact vary by subwatershed.

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. Section 6 discusses the stressor identification process. Identified causative stressors to the benthic communities include metals toxicity, pH toxicity, organic enrichment, sedimentation, and ionic toxicity.

Stressor identification was followed by stream-specific determinations of the pollutants for which TMDLs must be developed. Metals toxicity and pH toxicity biological stressors were identified in waters that also demonstrated violations of the iron, aluminum, or pH numeric aquatic life protection water quality criteria. It was determined that 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. It was determined that implementation of fecal coliform TMDLs would remove untreated sewage and thereby reduce the organic and nutrient loading causing the biological impairment. Where the stressor identification process indicated sedimentation as a causative stressor, sediment TMDLs were developed. In certain waters, ionic toxicity was identified as the primary stressor. Information available regarding the ionic toxicity causative pollutants and their associated impairment thresholds was insufficient in this TMDL development 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, provides assurance that the TMDLs are achievable, 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. The employed methodologies prescribe allocations that achieve water quality criteria throughout the watershed. Various provisions attempt equity between categories of sources and the targeting of pollutant reductions from the most problematic sources. Nonpoint source reductions did not result in loading contributions less than the natural conditions, and point source allocations were not more stringent than numeric water quality criteria.

The subwatershed appendices provide additional detail relative to their respective impaired waters and the applicable TMDLs (sum of wasteload allocations + sum of load allocations + margin of safety). Applicable TMDLs are displayed in Section 6 of each Appendix. Accompanying spreadsheets provide applicable TMDLs, wasteload allocations to individual point sources, and example allocations of loads to categories of nonpoint sources that achieve the TMDL load allocations. Also provided is an interactive ArcExplorer geographic information system (GIS) project that allows exploration of the spatial relationships of the source assessment data and expedient determination of subwatershed allocations.

This report and one developed simultaneously for the impaired waters of the Upper Ohio North watershed represent the first West Virginia TMDLs developed by WVDEP. Considerable resources were applied to generate the recent and robust water quality and pollutant source information on which the TMDLs are based. The applied 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 geographic information system (GIS) application, and spreadsheet data tables. The main section describes the overall TMDL development process for the Upper Kanawha watershed, identifies impaired streams, and outlines source assessment of metals, pH, fecal coliform, and biological stressors. It also describes the modeling process and Total Maximum Daily Load (TMDL) allocations, and it lists actions that will be taken to ensure that the TMDLs are met. The main section is followed by 17 appendices that describe specific conditions in each of the 17 subwatersheds for which TMDLs were developed. The applicable TMDLs are displayed in Section 6 of each these appendices. The main section and appendices are supported by a compact disc (CD). The CD contains an interactive ArcExplorer GIS project that allows the user to explore the spatial relationships of the source assessment data, as well as further details related to the data. Users can "zoom in" on 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. In addition, a Technical Report that describes the detailed technical approaches used throughout the TMDL development process is available.

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 40 CFR Part 130) require states to identify waterbodies not meeting 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 taking the actions needed to restore water quality.

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

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

Since 1997 West Virginia's TMDLs have been developed by USEPA Region 3, 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. 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 2004 TMDLs should be pursued in Hydrologic Group A, which includes the Upper Kanawha watershed. Figure 2-1 depicts the hydrologic groupings of West Virginia's watersheds; the legend includes the year of each TMDL finalization target.

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 generation and gathering effort to produce scientifically defensible TMDLs. It also allows ample time for modeling, report finaling, 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 Final 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 final TMDL is submitted to USEPA for approval. The TMDLs contained in this report are scheduled to be finalized by December 31, 2004.

This document provides TMDLs for most Upper Kanawha watershed stream/impairment listings from West Virginia's most recent Clean Water Act Section 303(d) list. All remaining Upper Kanawha impairments for which USEPA committed to TMDL development by 2008 are addressed.

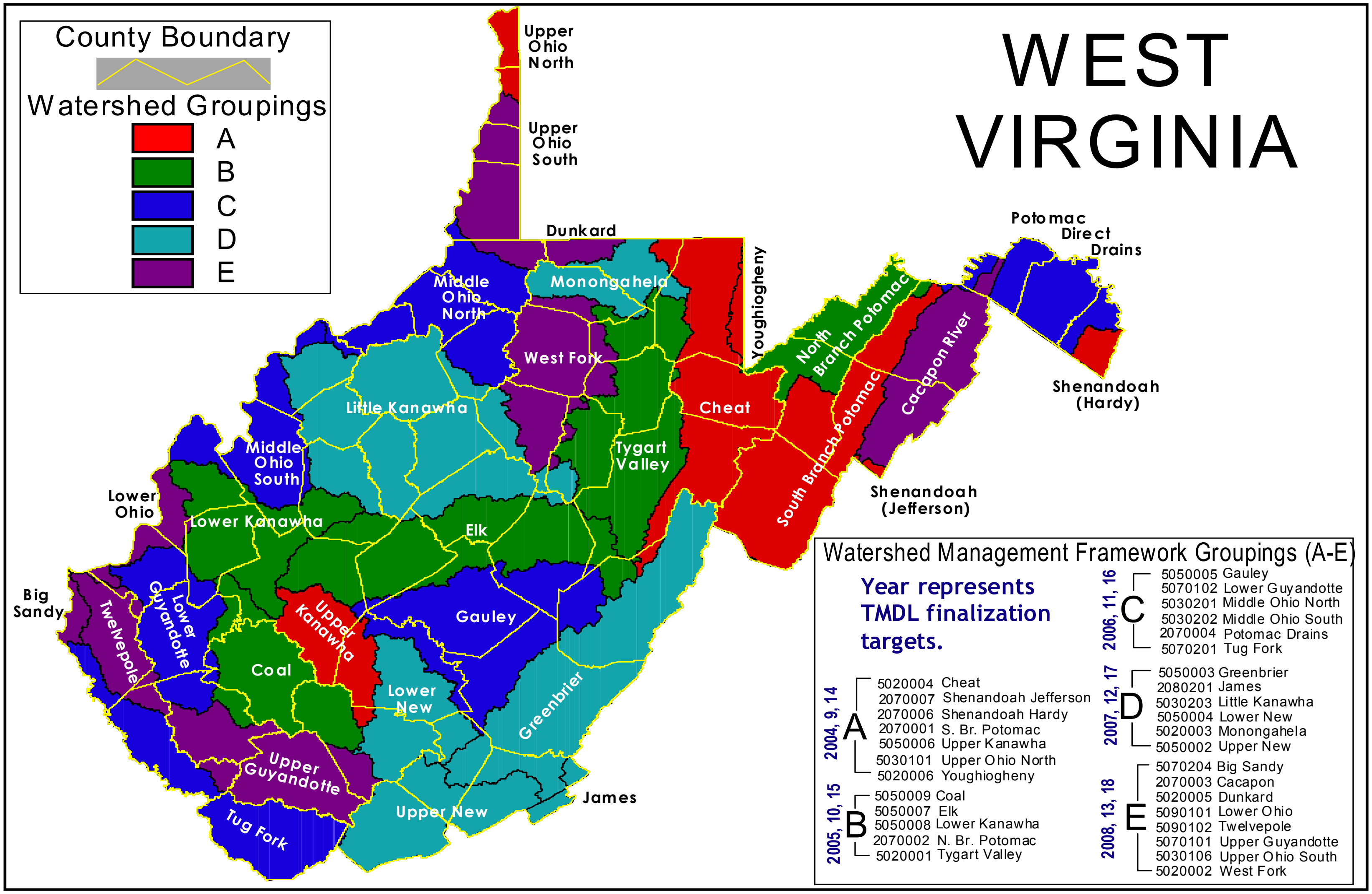

Figure 2-1. Hydrologic groupings of West Virginia's watersheds

2.2 Water Quality Standards

The determination of impaired waters involves comparing in-stream conditions to applicable water quality standards. In West Virginia, water quality standards are codified at Title 46 of the *Code of State Rules* (CSR), Series 1, titled *Legislative Rules of the Environmental Quality Board: Requirements Governing Water Quality Standards* (Standards). The Standards can be obtained online from the West Virginia Secretary of State Web site (http://www.wvsos.com/csr/verify.asp?TitleSeries=46-01).

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 displays the numeric water quality criteria for a wide range of parameters, while Section 3 contains narrative water quality criteria.

The Standards include numeric criteria for aquatic life protection for dissolved aluminum, total iron, and pH. Human health protection criteria are provided for fecal coliform bacteria, total manganese, and pH. Applicable numeric criteria are shown in Table 2-1.

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	87	750	87	--
Iron, total (mg/L)	--	1.5	--	0.5	1.5
Manganese, total (mg/L)	--	--	--	--	1.0[c]
pH	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0
Fecal coliform bacteria	**Human Health Criteria** Maximum allowable level of fecal coliform content for Primary Contact Recreation (either MPN [most probable number] or MF [membrane filter counts/test]) shall not exceed 200/100 mL as a monthly geometric mean based on not less than 5 samples per month; nor to exceed 400/100 mL in more than 10 percent of all samples taken during the month.				

[a] One-hour average concentration not to be exceeded more than once every 3 years on the average.
[b] Four-day average concentration not to be exceeded more than once every 3 years on the average.
[c] Not to exceed.
Source: West Virginia Water Quality Standards, 2003.

The applicable designated uses for all the waters subject to this report are aquatic life protection, water contact recreation, and public water supply. Most of the waters are designated as warmwater fisheries. Loop Creek is the only stream in the Upper Kanawha watershed considered a troutwater. For the impaired waters of this report, West Virginia numeric water quality criteria for warmwater fisheries and troutwaters vary only with respect to iron and Loop Creek is not impaired pursuant to the troutwater iron criterion.

All West Virginia waters are subject to the narrative criteria in Section 3 of the Standards. That section, titled "Conditions Not Allowable in State Waters," contains various general provisions related to water quality. The narrative water quality criterion at 46 CSR Series 1 - 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 it is discussed in detail in Section 6.

3. WATERSHED DESCRIPTION AND DATA INVENTORY

3.1 Watershed Description

The Upper Kanawha watershed (U.S. Geological Survey [USGS] 8-digit hydrologic unit code 05050006) is in portions of Boone, Kanawha, Fayette, and Raleigh counties in southern West Virginia, as shown in Figure 3-1. The watershed, a component of the Kanawha River watershed, encompasses nearly 521 square miles. The Upper Kanawha River runs through the watershed; major tributaries include Campbells Creek, Witcher Creek, Kelly's Creek, Hughes Creek, Smithers Creek, Loop Creek, Armstrong Creek, Paint Creek, Cabin Creek, Slaughter Creek, Fields Creek, and Lens Creek. The average elevation in the watershed is 1,448 feet. The highest point is at 3,132 feet on Paint Mountain, which is along the southwestern boundary of the watershed. The minimum elevation is 561 feet at the surface of the Kanawha River.

Land use and land cover estimates were obtained from vegetation data gathered from the West Virginia Gap Analysis Land Cover Project (GAP), produced by the Natural Resource Analysis Center and the West Virginia Cooperative Fish and Wildlife Research Unit of West Virginia University. The GAP database for West Virginia was derived from satellite imagery taken during the early 1990s, and it includes detailed vegetative spatial data. 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 six land use categories, summarized in Table 3-1.

As Table 3-1 shows, the Upper Kanawha watershed's dominant land use type is forest, which constitutes 89.65 percent. Other important land use types are urban/residential (5.08 percent) and barren/mining land (2.56 percent). Individually, all other land cover types compose less than 2 percent of the total watershed area.

The total population for the Upper Kanawha watershed, approximately 70,509, was derived from the 2000 U.S. Census data. The majority of the population (84 percent) resides in the urban/residential areas surrounding Charleston.

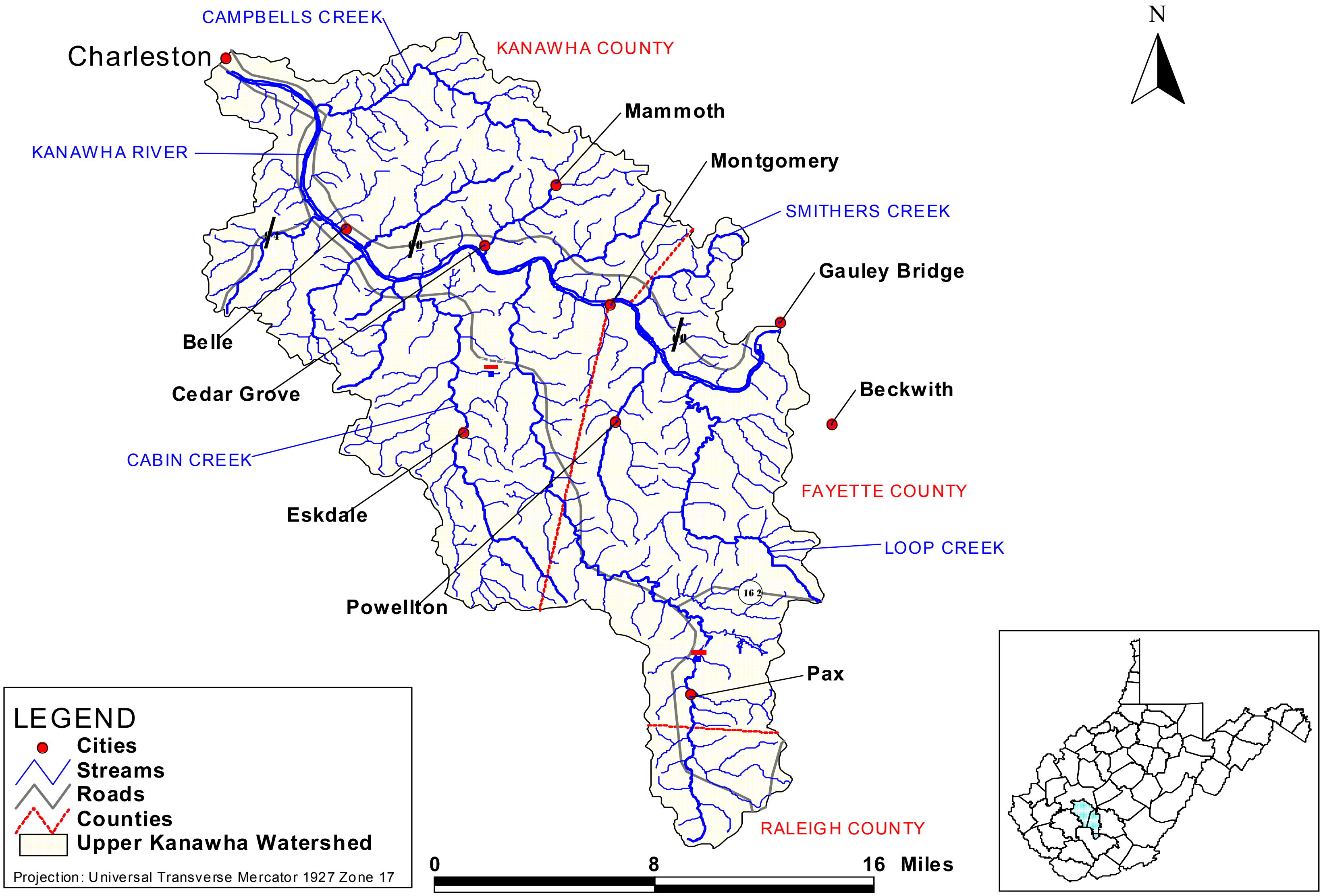

Figure 3-1. Location of the Upper Kanawha watershed

Table 3-1. Land use according to GAP analysis for the Upper Kanawha watershed

Land Use Type	Area of Watershed		
	Acres	Square Miles	Percentage
Agriculture	91	0.1	0.03
Barren/Mining	8,485	13	2.56
Forest	297,374	464	89.65
Pasture	3,965	6	1.20
Urban/Residential	16,838	25	5.08
Water	4,949	8	1.49
Total	**331,702**	**516**	**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 Upper Kanawha 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.

3.3 Impaired Waterbodies

WVDEP conducted extensive water quality monitoring from July 2001 through June 2002 in the Upper Kanawha watershed. The results of that effort were used to confirm the listing of waterbodies not meeting applicable water quality criteria and to identify impaired waterbodies that were not previously listed as such. TMDLs will be developed for these impaired waterbodies.

TMDLs were developed for impaired waters in 17 subwatersheds (Figure 3-2): Armstrong Creek, Boomer Branch, Cabin Creek, Campbells Creek, Carroll Creek, Fields Creek, Hicks Hollow, Jarrett Branch, Lens Creek, Loop Creek, Mile Branch, Morris Creek, Slaughter Creek, Smithers Creek, Staten Run, Watson Branch, and Witcher Creek. The impaired waters for which TMDLs are developed are presented in Table 3-3. The table includes the stream code, subwatershed, stream name, and impairments for each stream. Table 3-4 provides a cross-reference for all unnamed tributaries that were renamed during the development of West Virginia's 2004 Section 303(d) list.

Table 3-2. Datasets used in TMDL development

Type of Information		Data Source(s)
Watershed physiographic data	Stream network	West Virginia Division of Natural Resources (DNR)
	Land use	WV Gap Analysis Project (GAP)
	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	USDA, Forest Service (FS)
	Oil and gas operations coverage	WVDEP Office of Oil and Gas (OOG)
	Abandoned mining coverage	WVDEP DMR
Monitoring data	Physical data	WVDEP DNR
	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

Table 3-2. (continued)

Type of Information		Data Source(s)
Regulatory or policy information	Applicable water quality standards	WVDEP
	Section 303(d) list of impaired waterbodies	WVDEP, USEPA
	Nonpoint Source Management Plans	WVDEP

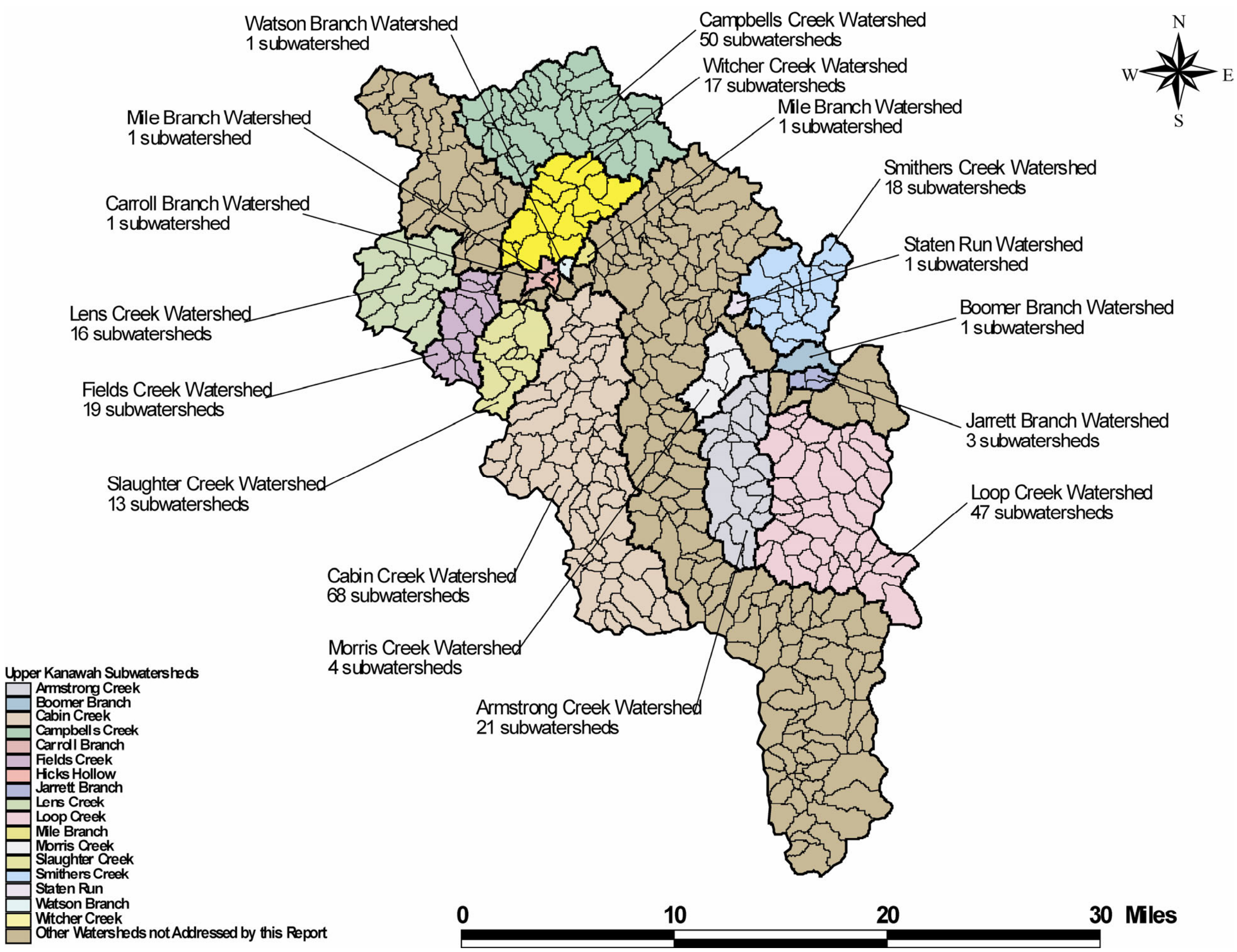

Figure 3-2. Impaired waterbodies in the 17 subwatersheds of the Upper Kanawha watershed

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

Subwatershed	Stream Code	Stream Name	Al	Fe	Mn	pH	Bio	FC
Campbells Creek	WVK-49	Campbells Creek					X	X
	WVK-49-A	Dry Branch	X				X	X
	WVK-49-B	Spring Fork	X					X
	WVK-49-B-2-A	UNT/Left Fork/Spring Fork		X				
	WVK-49-D	Coal Fork						X
	WVK-49-F	Point Lick Fork						X
	WVK-49-F.5	Wash Branch						X
	WVK-49-G	Cline Branch						X
	WVK-49-G.2	Big Bottom Hollow		X			X	X
	WVK-49-I	Rattlesnake Hollow			X			
	WVK-49-I.3	UNT/Campbells Creek						X
Lens Creek	WVK-53	Lens Creek		X			X	X
	WVK-53-A	Left Fork of Lens Creek		X				X
	WVK-53-A-0.4	UNT/Left Fork/Lens Creek	X	X	X	X		
	WVK-53-B	Ring Hollow						X
	WVK-53-C	Four Mile Fork of Lens Creek					X	X
Witcher Creek	WVK-57	Witcher Creek	X	X	X	X	X	X
	WVK-57-A	Dry Branch	X	X			X	X
	WVK-57-C	Left Fork of Witcher Creek						X
	WVK-57-D	Counterfeit Branch		X				
	WVK-57-D.5	UNT/Witcher Creek	X			X		
Fields Creek	WVK-58	Fields Creek	X				X	X
	WVK-58-B	Scott Branch						X
	WVK-58-B.1	Wolfpen Hollow	X	X	X	X	X	X
	WVK-58-B.3	Coopers Hollow						X
	WVK-58-B.8	Mill Branch	X					
	WVK-58-B.8-1	NW Hollow of Mill Branch	X	X	X			
	WVK-58-C	South Hollow					X	
Carroll Branch	WVK-59	Carroll Branch	X	X	X	X	X	
Slaughter Creek	WVK-60	Slaughter Creek	X		X			
	WVK-60-A	Little Creek	X		X	X	X	
	WVK-60-A-1	UNT/Little Creek	X		X	X		
	WVK-60-B	Bradley Fork	X		X	X		
	WVK-60-B.1	UNT/Slaughter Creek	X		X	X		

Table 3-3. (continued)

Subwatershed	Stream Code	Stream Name	Al	Fe	Mn	pH	Bio	FC
Cabin Creek	WVK-61	Cabin Creek	X	X	X	X	X	X
	WVK-61-B	Dry Branch		X				X
	WVK-61-B-1	Coalburg Branch	X			X	X	
	WVK-61-E	Paint Branch		X				
	WVK-61-F	Longbottom						X
	WVK-61-F-1	Left Fork of Long Bottom Creek					X	
	WVK-61-G	Greens Branch				X		X
	WVK-61-H	Coal Fork	X					
	WVK-61-H-1	Laurel Fork of Coal Fork	X	X	X		X	
	WVK-61-H-1-A	Left Fork of Laurel Fork					X	
	WVK-61-H-3	UNT/Coal Fork	X	X	X			
	WVK-61-I	Bear Hollow	X			X	X	X
	WVK-61-I-1	1st UNT/Bear Hollow	X		X	X	X	X
	WVK-61-J	Cane Fork	X	X	X	X	X	
	WVK-61-K	Toms Fork	X					
	WVK-61-L	10 Mile Fork	X	X			X	
	WVK-61-L-0.5	1st UNT/10 Mile Fork	X					
	WVK-61-L-5	10th UNT/10 Mile Fork		X				
	WVK-61-O	15 Mile Fork	X	X	X	X		
	WVK-61-O-1	Abbott Creek	X	X	X	X		
Hicks Hollow	WVK-61.5	Hicks Hollow	X	X	X	X	X	
Watson Branch	WVK-62	Watson Branch	X		X	X		
Mile Branch	WVK-63	Mile Branch	X	X			X	X
Morris Creek	WVK-70	Morris Creek		X	X	X	X	
	WVK-70-A	Schuyler Fork	X		X	X		
Staten Run	WVK-71	Staten Run		X			X	
Smithers Creek	WVK-72	Smithers Creek	X					
	WVK-72-A	Blake	X					X
	WVK-72-A-1	Fish Hook Fork	X		X			
	WVK-72-B	Bullpush Fork	X					
	WVK-72-B-2	Burnett Hollow	X					

Table 3-3. (continued)

Subwatershed	Stream Code	Stream Name	Al	Fe	Mn	pH	Bio	FC
Armstrong Creek	WVK-73	Armstrong Creek	**X**			**X**	**X**	
	WVK-73-A	Tucker Hollow	**X**			**X**		
	WVK-73-D	Jenkins Fork	**X**		**X**	**X**	**X**	
	WVK-73-D-1	Craig Hollow	**X**		**X**	**X**		
	WVK-73-E	Powellton Fork	**X**	**X**				
	WVK-73-E-1	Laurel Fork of Powellton Fork		**X**	**X**			
	WVK-73-E-2	Woodrum Branch		**X**				
	WVK-73-F	Right Fork of Armstrong Creek	**X**		**X**	**X**		
Boomer Branch	WVK-74	Boomer Branch	**X**				**X**	
Jarrett Branch	WVK-75	Jarrett Branch	**X**	**X**	**X**	**X**	**X**	
	WVK-75-A	UNT/Jarrett Branch	**X**		**X**	**X**		
Loop Creek	WVK-76	Loop Creek						**X**
	WVK-76-C	Mulberry Fork						**X**
	WVK-76-D	Beards Fork	**X**					
	WVK-76- K	Ingram Branch	**X**			**X**	**X**	

Note: UNT = unnamed tributary.

WVDEP attempted to develop the TMDLs necessary to address all impairments in each listed waterbody; however, circumstances prevented comprehensive TMDL development in certain areas. Severe flooding in the summer of 2001 scoured benthic habitat in the Smithers Creek and Loop Creek watersheds and prevented WVDEP from collecting the representative biological data necessary for development of certain TMDLs. In other instances, the biological stressor identification process did not singularly identify causative pollutants or tolerance thresholds. All waters and impairments excluded from TMDL development in this effort are retained on West Virginia’s Section 303(d) list of impaired waters.

Table 3-4. Cross-reference for all renamed unnamed tributaries per 2004 Section 303(d) list

Stream Code	Work Directive Stream Name	2004 303(d) List Stream Name
WVK-49-I.3	UNT/Campbells Creek	UNT/Campbells Creek RM 7.5
WVK-53-A-0.4	UNT/Left Fork/Lens Creek	UNT/Left Fork RM 1.8/Lens Creek
WVK-57-D.5	UNT/Witcher Creek	UNT/Witcher Creek
WVK-60-A-1	UNT/Little Creek	UNT/Little Creek RM 0.4
WVK-60-B.1	UNT/Slaughter Creek	UNT/Slaughter Creek RM 3.1
WVK-61-B-1	Coalburg Branch	UNT/Dry Branch RM 0.7 (Coalburg Branch)
WVK-61-H-3	UNT/Coal Fork	UNT/Coal Fork RM 4.6
WVK-61-I-1	1st UNT/Bear Hollow	UNT/Bear Hollow RM 0.3
WVK-61-L- 0.5	1st UNT/10 Mile Fork	UNT/Tenmile Fork RM 1.2
WVK-61-L-5	10th UNT/10 Mile Fork	UNT/Tenmile Fork RM 4.2
WVK-75-A	UNT/Jarrett Branch	UNT/Jarrett Branch RM 1.1

4. METALS AND pH SOURCE ASSESSMENT

This section identifies and examines the potential sources of aluminum, iron, manganese, and pH impairment in the Upper Kanawha watershed. Sources can be classified as point (permitted) or nonpoint (nonpermitted) sources.

A point source, according to Title 40 of the *Code of Federal Regulations* (CFR), Section 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, nonpermitted sources. They most often result from precipitation-driven runoff. For the purposes of these TMDLs only, wasteload allocations are given to NPDES-permitted discharge points and load allocations are given to discharges from activities that do not have an associated NPDES permit, such as mine forfeiture sites and abandoned mine lands, including tunnel discharges, seeps, and surface runoff. The decision to assign load allocations to abandoned and reclaimed mine lands does not reflect any determination by WVDEP or USEPA as to whether there are, in fact, unpermitted point source discharges within these land uses. In addition, by establishing these TMDLs with mine drainage discharges treated as load allocations, 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; the resulting information was supplemental to the other available source characterization data. WVDEP staff recorded physical descriptions of pollutant sources and the general condition of the stream 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 and pH Point Sources

Metals and pH 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 SMCRA.

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

- Restoring the land affected 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 (that is, they are acidic) and contain high concentrations of metals (iron, aluminum, and manganese). Mining-related activities are commonly issued NPDES discharge permits that contain effluent limits for total iron, total manganese, nonfilterable residue, and pH. Most permits also include effluent monitoring requirements for total aluminum. WVDEP's Division of Mining and Reclamation (DMR) provided a spatial coverage of the mining-related NPDES permit outlets,; the related permit limit and discharge data were acquired from West Virginia's *ERIS* database system. The spatial coverage was used to determine the location of the permit outlets; however, additional information was needed to determine the areas of the mining activities. WVDEP DMR also provided a spatial coverage of the mining permit areas and related SMCRA Article 3 permit information. This information includes both active and inactive mining facilities, which are classified by type of mine and facility status. The mines are classified into eight different categories: coal surface mine, coal underground mine, haul road, coal preparation plant, coal reprocessing, prospective mine, quarry, and other. The haul road and prospective mine categories represent mining access roads and potential coal mining areas. The permits were also classified into seven categories describing the mining status of each permitted discharge. WVDEP DMR provided a brief description regarding classification and associated potential impacts on water quality.

To characterize the mining point sources properly, the type, status, and area of each SMCRA Article 3 permit had to be associated/related with the location of each mining-related NPDES outlet. WVDEP DMR assisted with this process. The mining point sources were then represented in the model and assigned individual wasteload allocations for metals.

There are a total of 143 mining-related NPDES permits, with 938 associated outlets, in the 17 TMDL watersheds. A complete list of the permits and outlets is provided in the appendices of the Technical Report. Figure 4-1 illustrates the extent of the mining NPDES outlets in the 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.

Non-mining point sources of metals may include the wastewater discharges from water treatment plants and industrial manufacturing operations. In addition, the discharges from construction activities that disturb more than 1 acre of land are legally defined as point sources. The sediment introduced from such discharges may contribute metals. Four non-mining NPDES-permitted outlets in the watershed have effluent limits for metals and pH. Columbia Alloys (WVG610985) is permitted to discharge iron from one industrial storm water outlet into Armstrong Creek. The Jarrett Branch Landfill (WV0111732) is permitted to discharge wastewater containing limited amounts of aluminum, iron, and manganese at a pH between 6.0 and 9.0 from one outlet location and aluminum only from three other outlets. Based on the types of activities and the minimal flow of their discharges, these permitted non-mining sources are believed to be negligible. Under these TMDLs, these minor discharges are assumed to operate under their current permit limits and will be assigned WLAs that allow them to discharge at their current permit limits.

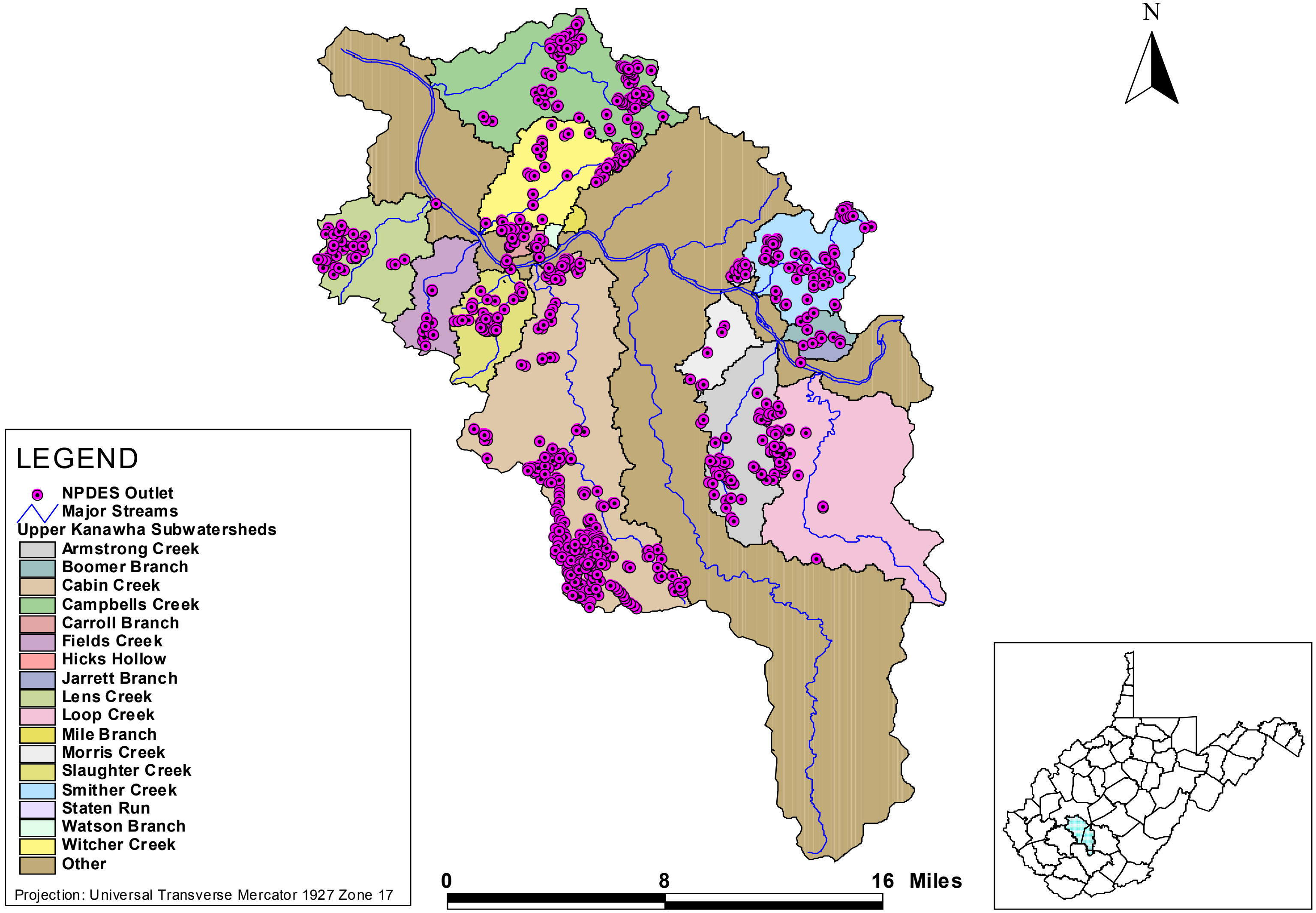

Figure 4-1. Mining NPDES outlets in the 17 selected subwatersheds of the Upper Kanawha watershed

4.1.3 Construction Stormwater Permits

WVDEP issued a general NPDES permit (permit WV0115924) to regulate stormwater flowing into streams from discharges associated with construction activities. Registration under the permit is required for construction activities with a land disturbance of greater than 1 acre. These permits require that the site have properly installed best management practices (BMPs, such as silt fences, sediment traps, seeding and mulching, and riprap) to prevent or reduce erosion and sediment runoff. Both the land disturbance and the permitting process associated with construction activities are transient in nature. After construction is completed and sites are stabilized, water quality impacts are minimized. Individual registrations under the General Permit are generally limited to a period of less than 1 year. There are two construction stormwater permits in the watersheds addressed by this report. Because the total disturbed area associated with these permits is small (less than 15 acres), they were considered a negligible source of metals.

4.2 Metals and pH Nonpoint Sources

In addition to point sources, nonpoint sources can contribute to metals- and pH-related water quality impairments. Abandoned mines contribute acid mine drainage (AMD), which produces low pH and high metals concentrations in surface and subsurface water. Similarly, facilities that were subject to the SMCRA during active operations and subsequently forfeited their bonds and abandoned operations can be a significant metals and low-pH source. Land disturbance activities that introduce excess sediment are additional 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. The mission of the Office 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. Allocations from the AML fund are made to state and tribal agencies through the congressional budgetary process.

WVDEP's Office of AML&R identified locations of AMLs in the Upper Kanawha watershed. 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 locate these sources and characterize their impact on water quality. Based on this work, AMLs represent a significant source of metals in selected subwatersheds of the Upper Kanawha.

Abandoned mine lands were modeled in the Upper Kanawha TMDLs. In total, 1,306.9 acres of AML area, 158 AML seeps, and 117.6 miles of highwall were identified in the Upper Kanawha watershed and incorporated into the TMDL model.

4.2.2 Bond Forfeiture

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. Information and data associated with bond forfeiture sites were made available by the Office of Special Reclamation in WVDEP's Division of Land Restoration. There are 24 bond forfeiture sites in the Upper Kanawha watershed.

4.2.3 Sediment Sources

Based on previous watershed modeling (e.g., *Metals and pH TMDLs for the Elk River Watershed* [USEPA, 2001] and *Metals and pH TMDLs for the Tug Fork River Watershed* [USEPA, 2002]), which evaluated sediment/metal interactions and general soil properties in West Virginia, it was concluded that certain sediments contain high levels of aluminum, iron, and to a lesser extent, manganese (Watts et al., 1994). Land disturbance can increase sediment loading to impaired waters, and the control of sediment-producing sources might be necessary to meet water quality criteria for metals during high-flow conditions. Potential sediment-related nonpoint sources of metals are forestry operations, oil and gas operations, roads, agriculture, and barren lands. The number and size of these sources in the Upper Kanawha watershed are summarized below and presented in detail in the appendices of this report.

Forestry
The West Virginia Bureau of Commerce's Division of Forestry provided information on forest industry sites (registered logging sites) in the Upper Kanawha River watershed. This information included the harvested area and the subset of land disturbed by roads and landings.

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. This act requires the use of BMPs to reduce sediment loads to nearby waterbodies. Without properly installed BMPs, logging and the land disturbance associated with creation and use of roads to serve logging sites 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 (registered logging sites) throughout West Virginia. These illicit operations do not have properly installed BMPs and can contribute to sediment loading to streams.

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, manages the Abandoned Well Plugging and Reclamation Program, and 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 778 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. Although oil and gas operations are present in the metals-impaired streams addressed by the report, they were not considered a significant source of metals loading because their impact relative to other sources was small.

Roads

Runoff from paved and unpaved roadways can contribute significant sediment loads to nearby streams. Heightened stormwater runoff from paved roads 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 produce increased sediment loads if BMPs are not properly employed.

Information on roads was obtained from various sources, including the 2000 TIGER/Line shapefiles from the U.S. Census Bureau and the *WV Roads* GIS coverage prepared by West Virginia University (WVU). Unpaved roads that were not included in either GIS coverage were digitized from topographic maps.

Agriculture

Agricultural activities can contribute sediment loads to nearby streams; however, there is very little agricultural activity in the Upper Kanawha watershed, as shown by the GAP data and source-tracking efforts throughout the watershed.

Other Land Disturbance Activities

As stated previously, WVDEP issues general NPDES permits to regulate sediment contributions to streams from discharges associated with construction activities that have surface disturbances greater than 1 acre. Construction activities disturbing less than 1 acre are not subject to construction stormwater permitting and are uncontrolled sources of sediment.

5. FECAL COLIFORM SOURCE ASSESSMENT

5.1 Fecal Coliform Point Sources

The most prevalent fecal coliform point sources are the permitted discharges from sewage treatment plants. All treatment plants are regulated by NPDES permits that require effluent disinfection and compliance with strict fecal coliform limitations (200 counts/100 milliliters [average monthly] and 400 counts/100 mL [maximum daily]). However, noncompliant discharges and collection system overflows can contribute loadings of fecal coliform bacteria to receiving streams. The following sections discuss the specific types of fecal coliform point sources that were identified in the Upper Kanawha 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.

Three POTWs discharge treated effluent into the fecal coliform-impaired waters of the Upper Kanawha watershed. POTW effluents are not a significant source of fecal coliform bacteria because they are permitted to discharge only at limits more stringent than water quality criteria.

5.1.2 Overflows

Combined sewer overflows (CSOs) are outfalls from POTW sewer systems that carry untreated domestic waste and surface runoff. CSOs contain fecal coliform bacteria and are permitted to discharge only during precipitation events. There are no CSOs into the fecal coliform-impaired waters addressed in the Upper Kanawha watershed. Sanitary sewer overflows (SSOs) are unpermitted overflows that occur as a result of excessive infiltration and/or inflow to POTW collection systems. There are two active SSOs in the Campbells Creek watershed.

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 is one designated MS4 municipality, the City of Marmet, in the watershed. Marmet's MS4 has discharges in the Lens Creek watershed, and the City has filed a Notice of Intent for MS4 permit issuance. The area within the corporate limits is assumed to be subject to MS4 stormwater permitting.

5.1.4 General Sewage Permits

General sewage permits are designed to cover similar 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. Within the watersheds addressed by this report, six facilities are registered under the "package plant" general permit and five 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 Upper Kanawha 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 16,423 homes in the watershed 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 load allocations to those sources does not reflect a determination by WVDEP or USEPA as to whether there are, in fact, nonpermitted point source discharges. In addition, 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.

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 land use was used to determine the number of acres of residential and urbanized areas in the Upper Kanawha watershed. Reference numbers were used to determine fecal accumulation rates for these areas. There are no significant urban areas in any of the 17 TMDL watersheds analyzed in this report.

Stormwater runoff from rural areas can transport significant loads of bacteria from livestock pastures, livestock and poultry feeding facilities, and manure storage and application. Natural background sources such as wildlife can also contribute bacteria loadings through runoff during storm events.

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, where the bacteria are 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 land use data, it was determined that agriculture is not prevalent in the impaired portions of the Upper Kanawha watershed. Although agriculture is not widespread, isolated instances of pastures and feedlots near impaired segments might have significant localized impacts on in-stream 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 WVDEP’s Division of Natural Resources (DNR). Based on the low fecal accumulation rates for forested areas, wildlife is not considered to be a significant nonpoint source of fecal coliform bacteria in the Upper Kanawha watershed.

6. 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 are known stressors in this watershed. The Technical Report discusses biological impairment and the stressor identification (SI) process in detail.

6.1 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 cause(s) 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 stressor identification process were used to evaluate and identify the primary 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 stressor identification process entailed reviewing available information, forming and analyzing possible stressor scenarios, and implicating causative stressors. The stressor identification method provides a consistent process for evaluating available information. TMDLs were established for the responsible pollutants at the conclusion of the stressor identification process. As a result, the TMDL process established a link between the impairment and benthic community stressor(s).

6.2 Data Review

WVDEP generated the primary data used in stressor identification 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, GAP 2000 land use information, Natural Resources Conservation Service (NRCS) STATSGO soils data, NPDES point source data, and literature sources.

6.3 Candidate Causes/Pathways

The first step in the stressor identification 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 6-1) depicts the sources, stressors, and pathways that affect the biological community.

6.4 Stressor Identification Results

The results of the stressor identification process determined the primary causes of biological impairment. In some cases, biological impairment was linked to a single stressor; in others, multiple stressors were responsible for the impairment. The stressor identification process identified the following stressors for the biologically impaired waters of the Upper Kanawha 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

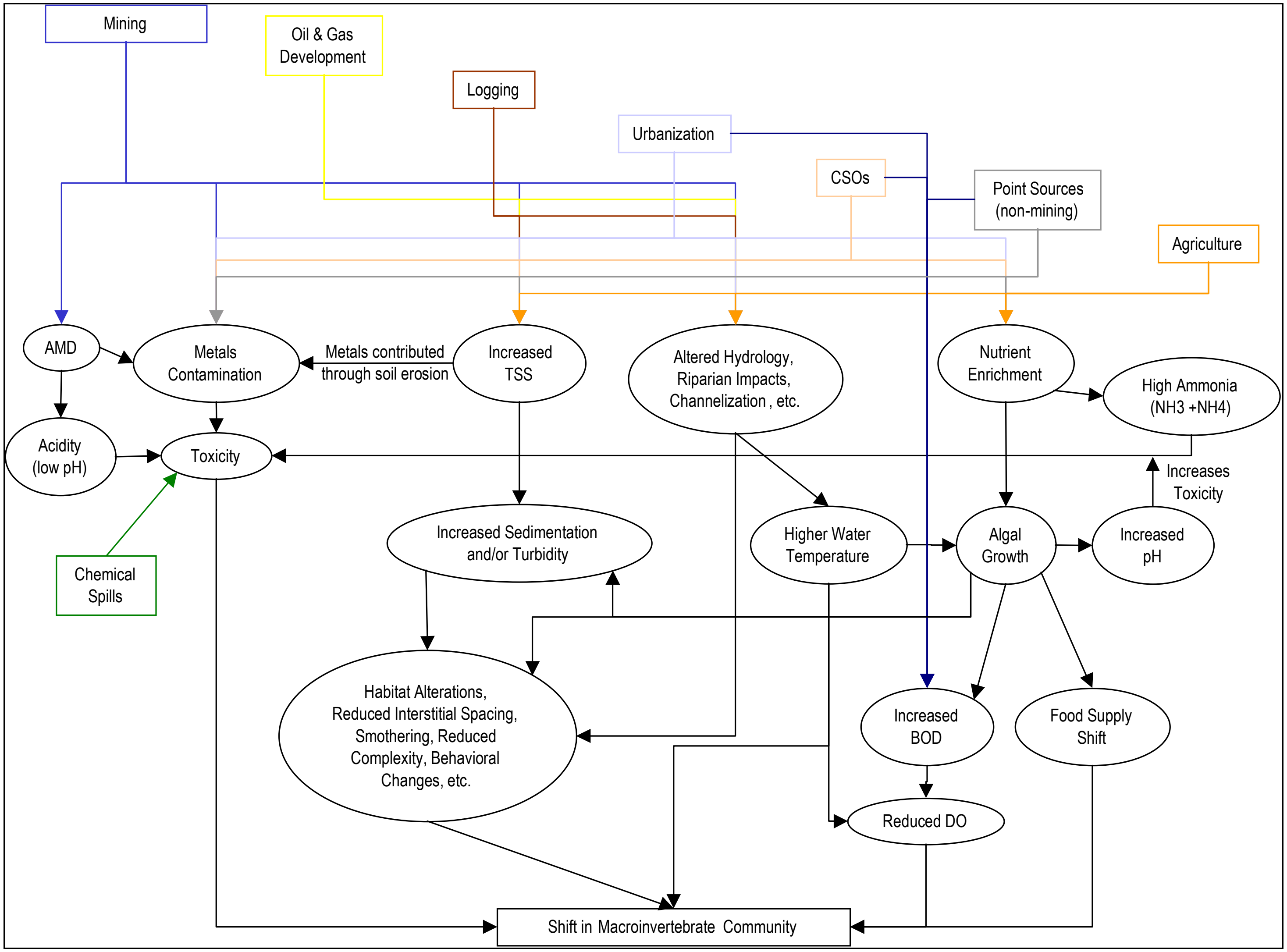

Figure 6-1. Conceptual model of candidate causes and potential biological effects.
(Note: all sources are listed along the top of the figure (in rectangles) except chemical spills, which is on the left side.)

After stressors were identified, WVDEP determined the pollutant(s) for which TMDLs were required to address the impairment.

The stressor identification 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 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.

Where the stressor identification process indicated sedimentation as a causative stressor, WVDEP developed sediment TMDLs.

In certain waters, the stressor identification process determined ionic toxicity as the primary stressor. Information available regarding the causative pollutants and their associated impairment thresholds is insufficient for TMDL development at this time. Therefore, WVDEP is deferring TMDL development and retaining those waters on the Section 303(d) list. Table 6-1 summarizes the primary stressors' contributions to biological impairment in the Upper Kanawha watershed.

Table 6-1. Primary stressors of biologically impaired streams in the Upper Kanawha watershed

Major Watershed	Stream	Primary Stressors	TMDLs Developed
Armstrong Creek	Armstrong Creek	Aluminum toxicity Acidity (pH)	Aluminum pH
	Jenkins Fork	Aluminum toxicity Acidity (pH)	Aluminum pH
Boomer Branch	Boomer Branch	Aluminum toxicity	Aluminum
Cabin Creek	Cabin Creek	Metals toxicity (Al, Fe) Acidity (pH) Sedimentation Organic enrichment	Aluminum, Iron pH Sediment Fecal coliform bacteria
	Coalburg Branch	Aluminum toxicity Acidity (pH)	Aluminum pH
	Left Fork of Long Bottom Creek	Sedimentation	Sediment
	Laurel Fork of Coal Fork	Metals toxicity (Al, Fe) Sedimentation	Aluminum, Iron Sediment
	Left Fork of Laurel Fork of Coal Fork	Metals toxicity (Al, Fe) Sedimentation	Aluminum, Iron Sediment

Table 6-1. (continued)

Major Watershed	Stream	Primary Stressors	TMDLs Developed
	Bear Hollow	Aluminum toxicity Acidity (pH) Organic enrichment	Aluminum pH Fecal coliform bacteria
	Unnamed tributary of Bear Hollow	Aluminum toxicity Acidity (pH) Organic enrichment	Aluminum pH Fecal coliform bacteria
	Cane Fork	Metals toxicity (Al, Fe) Acidity (pH)	Aluminum, Iron pH
	Tenmile Fork	Metals toxicity (Al, Fe) Sedimentation	Aluminum, Iron Sediment
Campbells Creek	Campbells Creek	Organic enrichment Sedimentation	Fecal coliform bacteria Sediment
	Dry Branch	Aluminum toxicity Organic enrichment	Aluminum Fecal coliform bacteria
	Big Bottom Hollow	Sedimentation Organic enrichment Iron toxicity possible (secondary)	Sediment Fecal coliform bacteria Iron
Carroll Branch	Carroll Branch	Metals toxicity (Al, Fe) Acidity (pH)	Aluminum, Iron pH
Fields Creek	Fields Creek	Sedimentation Organic enrichment AMD input from Wolfpen Hollow (secondary)	Sediment Fecal coliform bacteria
	Wolfpen Hollow	Aluminum toxicity Acidity (pH) Organic enrichment	Aluminum pH Fecal coliform bacteria
	South Hollow	Sedimentation Organic enrichment	Sediment Fecal coliform bacteria
Hicks Hollow	Hicks Hollow	Metals toxicity (Al, Fe) Acidity (pH	Aluminum, Iron pH
Jarrett Branch	Jarrett Branch	Metals toxicity (Al, Fe) pH	Aluminum, Iron pH
Lens Creek	Lens Creek	Sedimentation Organic enrichment Iron toxicity (secondary)	Sediment Fecal coliform bacteria Iron
	Four Mile Fork	Sedimentation	Sediment
Loop Creek	Ingram Branch	Aluminum toxicity Acidity (pH)	Aluminum pH
Mile Branch	Mile Branch	Organic enrichment Metals toxicity (secondary; Al, Fe)	Fecal coliform bacteria Aluminum, Iron

Table 6-1. (continued)

Major Watershed	Stream	Primary Stressors	TMDLs Developed
Morris Creek	Morris Creek	Iron toxicity Acidity (pH)	Iron pH
Slaughter Creek	Little Creek	Aluminum toxicity Acidity (pH)	Aluminum pH
Staten Run	Staten Run	Iron toxicity	Iron
Witcher Creek	Witcher Creek	Aluminum toxicity Acidity (pH)	Aluminum pH
	Dry Branch	Organic enrichment	Fecal coliform bacteria

Note: Al = aluminum; Fe = iron.

7. MODELING PROCESS

Establishing the relationship between the in-stream water quality targets and source loadings is a critical component of TMDL development. It allows for 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 in-stream response for TMDL development in the Upper Kanawha watershed.

7.1 Modeling Technique for Metals, pH, 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 is important.
- Point and nonpoint sources must be considered.
- Metals, pH, and 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 in-stream metals and bacteria concentrations.
- Metals and bacteria transport mechanisms are highly variable and often weather-dependent.

The primary regulatory factor that drove 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 standards 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 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 in-stream concentrations under a variety of flow conditions to evaluate critical flow periods for comparison to chronic and acute criteria.

The TMDL development approach must also consider the dominant processes affecting pollutant loadings and in-stream fate. For the Upper Kanawha watershed, primary sources contributing to metals, pH, and fecal coliform impairments include an array of point and nonpoint sources. Nonpoint sources are typically rainfall-driven with pollutant loadings primarily related to surface runoff. Point source discharges might or might not be induced by rainfall.

A variety of modeling tools were used to develop the TMDLs, including the Mining Data Analysis System (MDAS), the Dynamic Equilibrium In-stream Chemical Reactions model (DESC-R), and the Fecal Coliform Loading Estimation Spreadsheet (FCLES).

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 in-stream response. MDAS is used to simulate watershed hydrology and pollutant transport as well as stream hydraulics and in-stream water quality. It is capable of simulating different flow regimes and pollutant loading variations. Metals and fecal coliform bacteria were modeled using MDAS.

Metals are modeled in MDAS in total recoverable form. Therefore, it was necessary to link MDAS with the DESC-R to appropriately address dissolved aluminum TMDLs in the Upper Kanawha watershed. The 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.

FCLES is a spreadsheet tool used to quantify nonpoint source bacteria accumulation rates based on watershed-specific information. FCLES (Fecal Tool) is a Microsoft Excel spreadsheet tool that estimates the fecal coliform bacteria contribution from multiple sources. Inputs to the Fecal Tool can be generated manually or by using various functions of the Watershed Characterization System. Output from the Fecal Tool is used as input to MDAS. The tool estimates the monthly accumulation rate of fecal coliform bacteria on four land uses (cropland, forest, built-up, and pastureland), as well as the asymptotic limit for that accumulation should no washoff occur. The tool also estimates the direct input of fecal coliform bacteria to streams from grazing agricultural animals and failing septic systems. The Fecal Tool provides starting values for model input; however, a thorough calibration of the model is still necessary.

7.1.1 MDAS Setup

Configuration of the MDAS model involved subdivision of the Upper Kanawha watershed into modeling units. Continuous simulation of flow and water quality for those units was accomplished by using meteorological, land use, point source loading, and stream data.

The watershed was broken into 17 separate watershed units based on the watershed groupings of impaired streams shown in Table 3-1. 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 subwatershed delineation for each of the 17 watersheds is shown in Figure 7-1.

Modeled land uses contributing to metals loads include forest, cropland, pasture, urban/residential pervious lands, urban/residential impervious lands, barren areas, roads, harvested forest, and abandoned mines. These sources were represented explicitly by consolidating existing GAP2000 land use categories to create model land use groupings. Several additional land use categories were created to account for recent land disturbance activities (e.g., harvested forest, oil and gas operations, unpaved roads, and active mining) that are not represented in the GAP2000 land use coverage. The process of consolidating and updating the modeled land uses is explained in further detail in the Technical Report. Other sources, such as AML seeps identified by WVDEP's source-tracking efforts, were modeled as direct, continuous-flow sources in the model.

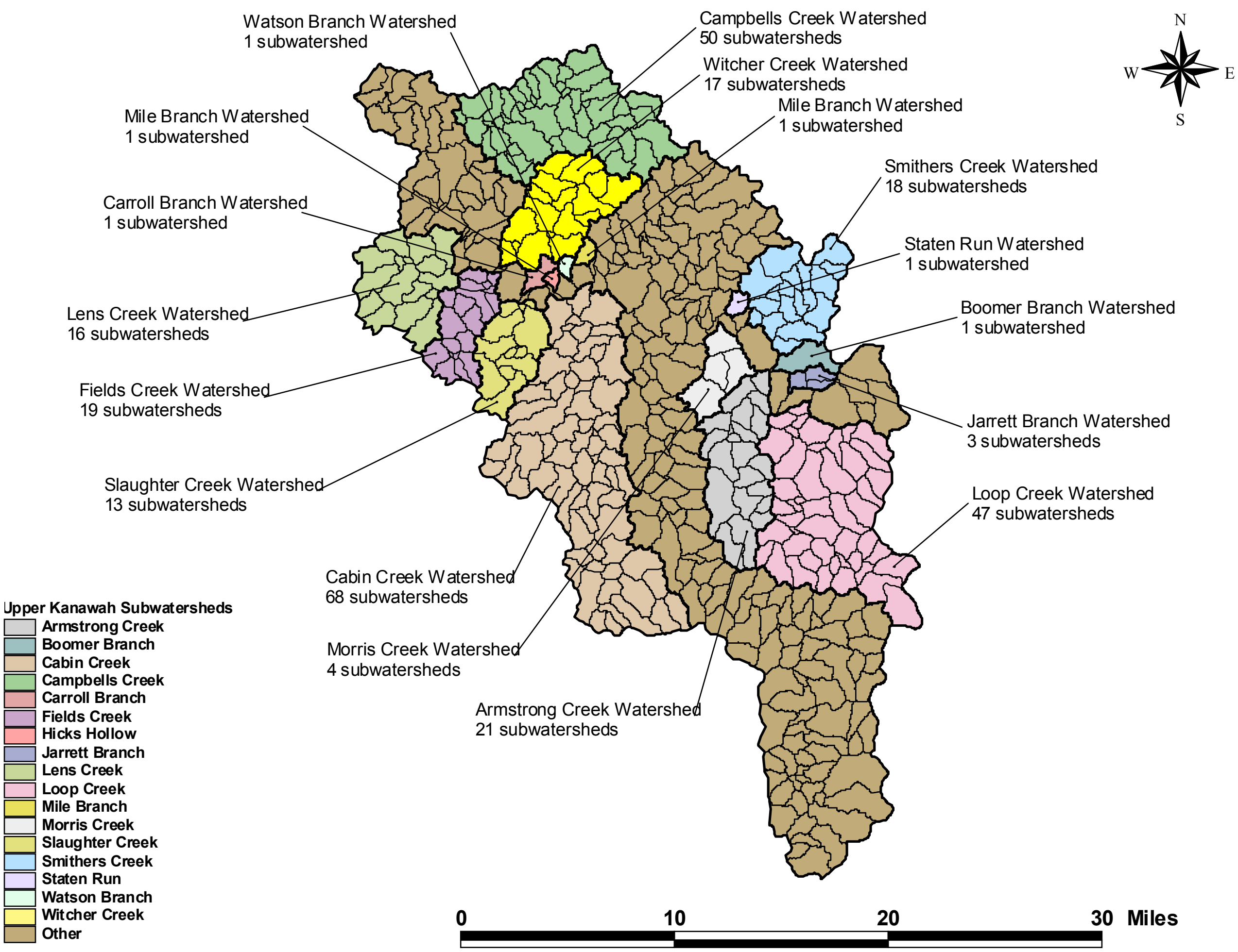

Figure 7-1. Upper Kanawha subwatershed delineation

Modeled land uses contributing bacteria loads include pasture, 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. The basis for the initial loading rates for land uses and direct sources is described in the Technical Report. The initial estimates were further refined during the model testing (calibration).

7.1.2 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 in-stream flow observations from USGS flow gauging stations throughout the watershed. However, there are no USGS flow gauging stations in the Upper Kanawha watershed with adequate data records for hydrology calibration. Therefore, hydrology calibration was performed on a nearby watershed (Rock Creek watershed near Danville, West Virginia) and the model parameters were then applied to the Upper Kanawha watershed. A USGS gauging station operated on Rock Creek from 1979 to 1984. Hydrology calibration was based on observed data from that station and the land uses present in the watershed 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 model was calibrated to the observed data recorded on the Rock Creek watershed from March 1, 1979, to February 28, 1980. The hydrology was validated for the longer time period of October 1, 1979, to September 30, 1984. Final adjustments to model hydrology were based on flow measurements obtained during WVDEP's pre-TMDL monitoring in the Upper Kanawha watershed. Further description and a summary of the results of the hydrology calibration and validation are presented in the Technical Report.

7.1.3 Water Quality Calibration

Following hydrology calibration, the water quality was calibrated by comparing modeled versus observed in-stream 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. Ranges were based on previous watershed modeling experience in West Virginia (*pH and Metals TMDLs for the Tug Fork River Watershed, 2002* and *Metals, pH, and Fecal Coliform TMDLs for the Upper Kanawha River Watershed, West Virginia, 2004*). Parameters for background conditions were established using observations from undisturbed areas.

As stated in Section 7.1, it was necessary to link MDAS with the DESC-R to appropriately address dissolved aluminum TMDLs in the Upper Kanawha watershed. The DESC-R was calibrated by adjusting water quality parameters to match the observed in-stream water quality data. Further description and a summary of the results of the DESC-R water quality calibration and validation are presented in the Technical Report.

7.2 Modeling Technique for Sediment

Stressor identification results indicated a need to reduce the contribution of excess sediment to certain biologically impaired streams in the Upper Kanawha watershed, as discussed in Section 6. As a result, sediment TMDLs were developed by integrating a watershed loading model that quantified land-based loads and a stream routing model that examined stream bank erosion and depositional processes.

Selection of this modeling system for the development of sediment TMDLs was based on the evaluation of available technical and regulatory criteria. The key technical factors listed in Section 7.1 were also considerations in the model selection process for sediment TMDL development. The adequate representation of erosion processes and nonpoint source loads in the watershed were of primary concern in selecting the appropriate modeling system.

Narrative criteria are included in West Virginia's water quality standards (Title 46 CSR Series 1 - 3.2.i), as discussed in Section 2 of this report. The narrative water quality criterion prohibits the presence in state waters of wastes 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. WVDEP assesses compliance with the narrative criteria by monitoring of the benthic macroinvertebrate community. Sediment reductions are required to restore water quality and habitat conditions in many of the biologically impaired streams in the Upper Kanawha watershed.

A reference watershed approach was used to establish the acceptable level of sediment loading for each impaired stream on a watershed-specific basis. This approach was based on selecting a non-impaired watershed that shares similar land use, 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 stream to attain its designated uses. Given these parameters and a non-impaired West Virginia Stream Condition Index (WVSCI) score, the Beards Fork watershed in the Loop Creek watershed was selected as the reference watershed. The location of the Beards Fork watershed is shown in Figure 7-2.

Sediment loading rates were determined for impaired and reference watersheds. Both point and nonpoint sources were considered in the analysis, and numeric endpoints were based on the calculated sediment loading from the reference watershed. Sediment load reductions necessary to meet these endpoints and TMDL allocations were then determined. TMDL allocation scenarios were based on an analysis of the degree to which contributing sources could be reasonably reduced.

TMDLs were developed using BasinSim 1.0 (Dai et al., 2000), the Generalized Water Loading Functions (GWLF) model (Haith and Shoemaker, 1997), and the Stream Module (Tetra Tech, 2003). A variety of GIS tools, local watershed data, and observations were used to develop the input data needed for modeling and TMDL development.

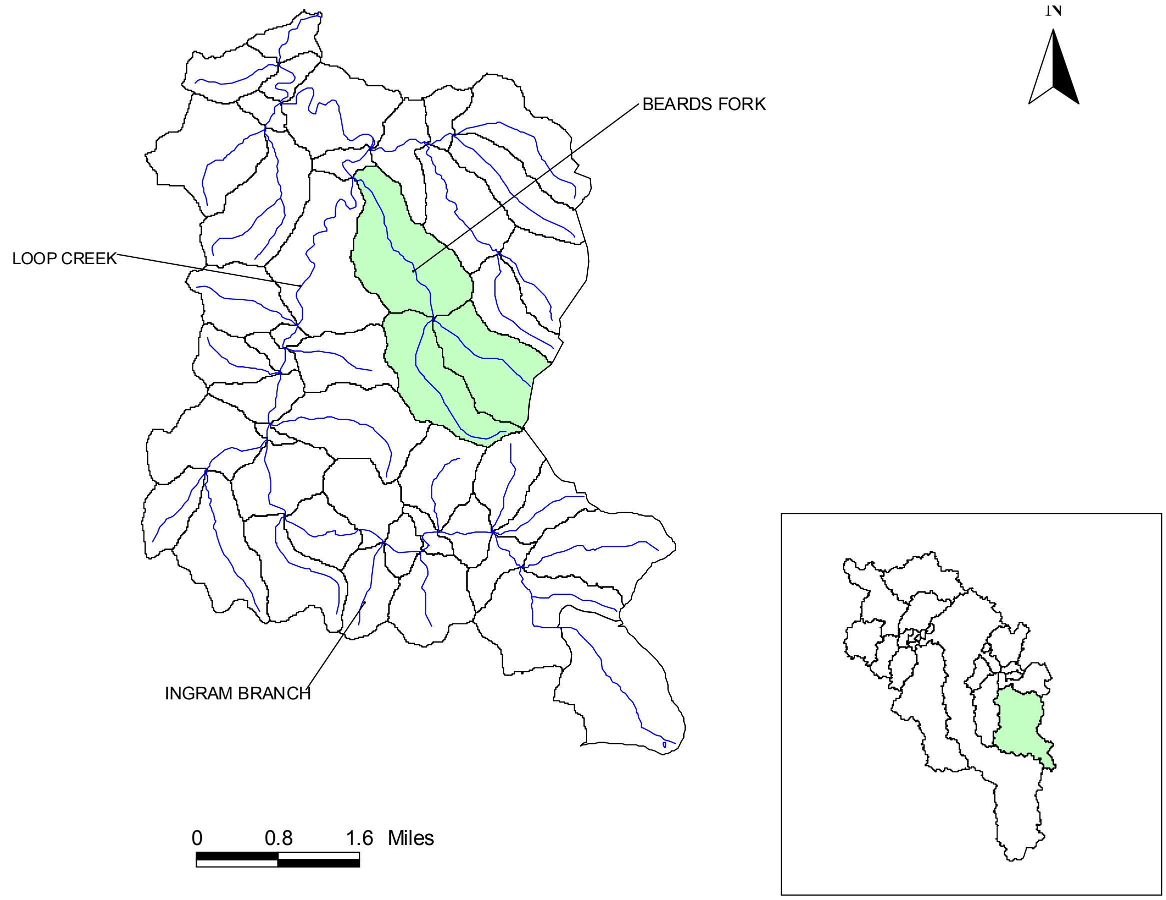

Figure 7-2. Location of the Beards Fork watershed

The GWLF model was used to estimate the sediment loads contributed by each modeled watershed. GWLF is a continuous-simulation model that simulates runoff, sediment, and nutrient loadings. GWLF modeling was accomplished using the BasinSim 1.0 watershed simulation program. BasinSim 1.0 is a Windows-based GIS platform that facilitates the execution of the GWLF model and development of model input data.

The Stream Module was used to model sediment transport/routing and stream bank erosion/deposition processes. The stream bank erosion simulation module employed the algorithm used in the Annualized Agricultural Nonpoint Source (AnnAGNPS) model (Bingner and Theurer 2000). Subwatershed loads calculated by GWLF and point source loads were input into the Stream Module to calculate the sediment loading to each stream channel and the load routed downstream. The Technical Report provides more detailed discussions on the technical approaches used for sediment modeling

7.2.1 GWLF/Stream Module Setup

The GWLF/Stream Module was configured for each impaired and reference stream in the Upper Kanawha watershed. Modeled watersheds were subdivided to simulate hydrologic and sediment loading characteristics using available meteorological, land use, point source loading, and stream data. Stream channel observational data provided by WVDEP were used to set up the Stream Module for the simulation of stream routing and erosion/deposition processes.

Similar to the MDAS approach, a continuous simulation period of 6 years was used in the hydrologic simulation analysis. An important factor driving model simulations is precipitation data. The pattern and intensity of rainfall affects erosion and the contribution of sediment from the land to the stream. In the GWLF model, the nonpoint source load calculation is affected by terrain conditions, such as the amount of forested land, land slope, soil erosion potential, and land disturbance activities, used in each modeled watershed. Various parameters can be adjusted in the model to account for these conditions and practices.

Modeled land uses include forest (including wetlands), cropland, pasture, urban/residential pervious lands, urban/residential impervious lands, barren areas, roads, oil and gas operations, harvested forest, surface mines, deep mines, and abandoned mines.

7.2.2 Hydrology Calibration

Hydrology and water quality calibration were performed in sequence because water quality modeling is dependent on an accurate hydrology simulation. The modeling period was determined based on the availability of weather and flow data that were collected during the same time period. As stated in Section 7.1.1, there are no USGS flow gauging stations in the Upper Kanawha watershed with adequate data records for hydrology calibration. As with MDAS, the GWLF hydrology calibration was performed on a nearby watershed (Rock Creek watershed near Danville, West Virginia) and the model parameters were then applied to the Upper Kanawha subwatersheds. Further description and a summary of the results of the hydrology calibration and validation are presented in the Technical Report. The model was calibrated to the observed data recorded on the Rock Creek watershed from March 1, 1979, to February 28, 1980.

7.2.3 Water Quality Calibration

GWLF is an empirical model that was developed based on established relationships between rainfall, erosion, and sediment transport. The Universal Soil Loss Equation (USLE) and runoff curve numbers developed by the NRCS form the basis of the GWLF model. Given proper model setup and sediment source representation, water quality calibration is usually not required for this empirically based model. Water quality calibration was performed, however, to verify the accurate representation of land uses in each watershed and the parameter values used in model simulations. GWLF predicted average annual and monthly sediment loads for each modeled watershed. Those results were compared to available water quality data (total suspended solids and turbidity data) and habitat data collected by WVDEP for each stream.

7.3 Allocation Analysis

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

TMDL = sum of WLAs + sum of LAs + MOS

To develop aluminum, iron, manganese, pH, fecal coliform bacteria, and sediment 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.

7.3.1 TMDL Endpoints

TMDL endpoints represent the water quality targets used to quantify TMDLs and their individual components. Different TMDL endpoints are necessary for dissolved aluminum, total iron, total manganese, pH, fecal coliform bacteria, and sediment. West Virginia's numeric water quality criteria for the subject pollutants (identified in Section 2) and an explicit MOS were used to identify endpoints for TMDL development. Where applicable, 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. Therefore, because such variability is present throughout the Upper Kanawha watershed, the TMDLs are presented as average annual loads.

Dissolved Aluminum, Total Iron, and Total Manganese

The TMDL endpoints for dissolved aluminum were selected as 712.5 micrograms per liter (µg/L; based on the 750 µg/L acute criterion for aquatic life minus a 5 percent MOS) and 82.7 µg/L (based on the 87 µg/L chronic criterion for aquatic life minus a 5 percent MOS). The endpoint for total iron was selected as 1.425 mg/L (based on the 1.5 mg/L criterion for aquatic life in warmwater fisheries minus a 5 percent MOS). The endpoint for total manganese was selected as 0.95 mg/L (based on the 1.0 mg/L criterion for human health minus a 5 percent MOS).

Components of the TMDLs for aluminum, iron, and manganese are presented as average annual loads in terms of pounds of pollutant per year.

Fecal Coliform Bacteria

The endpoint for fecal coliform bacteria was selected as the instantaneous endpoint of 380 counts/100 mL (based on the 400 counts/100 mL criterion for human health minus a 5 percent

MOS) and the geometric mean endpoint of 190 counts/100 mL (based on the 200 counts/100 mL geometric mean criterion minus a 5 percent MOS). The instantaneous criterion is more stringent and more difficult to obtain; however, both criteria are satisfied in this TMDL. Components of the TMDLs for fecal coliform bacteria are presented as average annual loads in terms of total counts (fecal coliform colonies) pollutant per year.

pH

The water quality criteria for pH allow no values below 6.0 or above 9.0. With respect to acid mine drainage, 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 in-stream 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 the DESC-R model. By executing the DESC-R model 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 was calculated based on the daily equilibrium pH output (6-year simulation period) from the DESC-R model.

Sediment

The endpoints for the sediment TMDLs were based on the simulated reference watershed sediment loading (from the Beards Fork of the Loop Creek watershed). A 5 percent MOS was applied to the reference sediment load, and the sediment load reductions necessary to meet those endpoints were then determined. TMDL allocation scenarios were developed based on an analysis of the degree to which contributing sources could be reasonably reduced.

Components of the TMDLs for sediment are presented as average annual loads in terms of tons of pollutant per year.

Margin of Safety

A 5 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 in-stream conditions that occurred during the simulation period. The explicit 5 percent MOS also accounts for those cases where monitoring data might not have captured the full range of in-stream conditions.

7.3.2 Baseline Conditions and Source Loading Alternatives

The calibrated model provided the basis for performing the allocation analysis. The first step in this analysis involved simulation of baseline conditions. Baseline conditions represent existing nonpoint source loadings and point sources loadings at permit limits. Baseline conditions allow for an evaluation of in-stream 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 time period (1987 to 1992). The precipitation experienced over this period was applied to the land uses and pollutant sources as they existed at the time of TMDL development. Predicted in-stream concentrations were compared directly to the TMDL endpoints. Using the model linkage described in Section 7.1, total aluminum was simulated using the MDAS model, and the DESC-R model 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.

Figure 7-3 presents the annual rainfall totals for the years 1980 through 2002 at the Charleston Yeager Airport weather station in Charleston, West Virginia. The years 1987 to 1992 are highlighted to indicate that a range of precipitation conditions was used for TMDL development in the Upper Kanawha watershed.

Permitted conditions for mining facilities were represented during baseline conditions using precipitation-driven flow estimations and the metals concentrations presented in Table 7-1. 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.

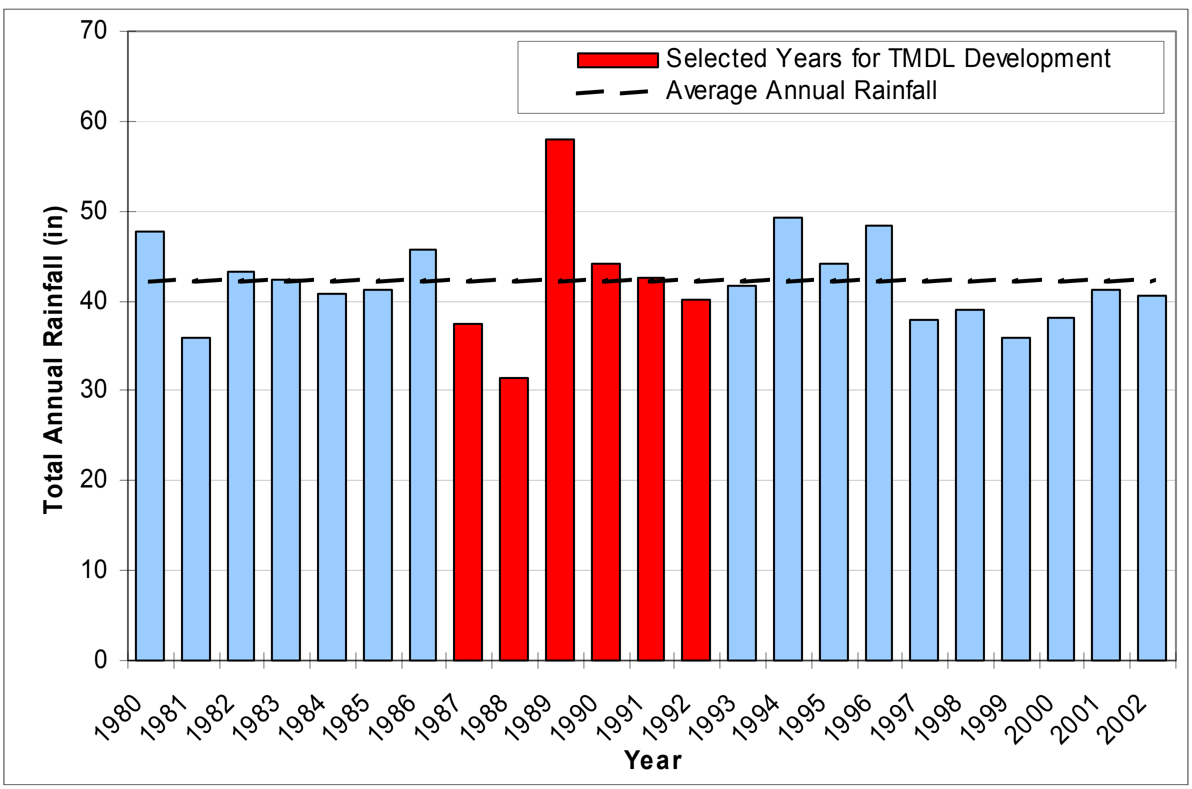

Figure 7-3. Annual precipitation totals and percentile ranks for the Charleston Yeager Airport weather station in Charleston, West Virginia

Table 7-1. Metals concentrations used in representing permitted conditions for mines

Pollutant	Technology-based Permits	Water Quality-based Permits
Aluminum, total	3.95 mg/L (98th percentile DMR values)	Monitor only
Iron, total	3.2 mg/L	1.5 mg/L
Manganese, total	2.0 mg/L	1.0 mg/L

Baseline Conditions for GWLF

The calibrated GWLF model provided the basis for performing the allocation analysis. The first step in the analysis involved simulation of baseline conditions. The baseline conditions allowed for an evaluation of in-stream water quality under the highest expected loading conditions. The pollutant loadings from nonpoint sources were modeled based on precipitation and runoff; non-mining point sources were represented at design flow and the total suspended solids limits of their permits. The GWLF model was run for baseline conditions using daily precipitation data for the representative period discussed earlier. The precipitation data were applied to the land uses and pollutant sources that existed at the time of TMDL development. The resultant predicted watershed loadings were then compared directly to the TMDL endpoint. Similar to MDAS, this comparison allowed evaluation of sediment loadings under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods.

Source Loading Alternatives

The simulation of baseline conditions allows 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 in-stream pollutant concentrations. The loading contributions from abandoned mines and other nonpoint sources were individually adjusted; the modeled in-stream 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 to the TMDL endpoint. If the predicted dissolved aluminum concentrations exceeded the TMDL endpoint, the total aluminum sources represented in 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 in-stream concentrations were reduced first. If additional load reductions were required to meet the TMDL endpoints, subsequent reductions were made to less significant source contributions.

An example of model output for a baseline condition and a successful TMDL scenario is displayed in Figure 7-4.

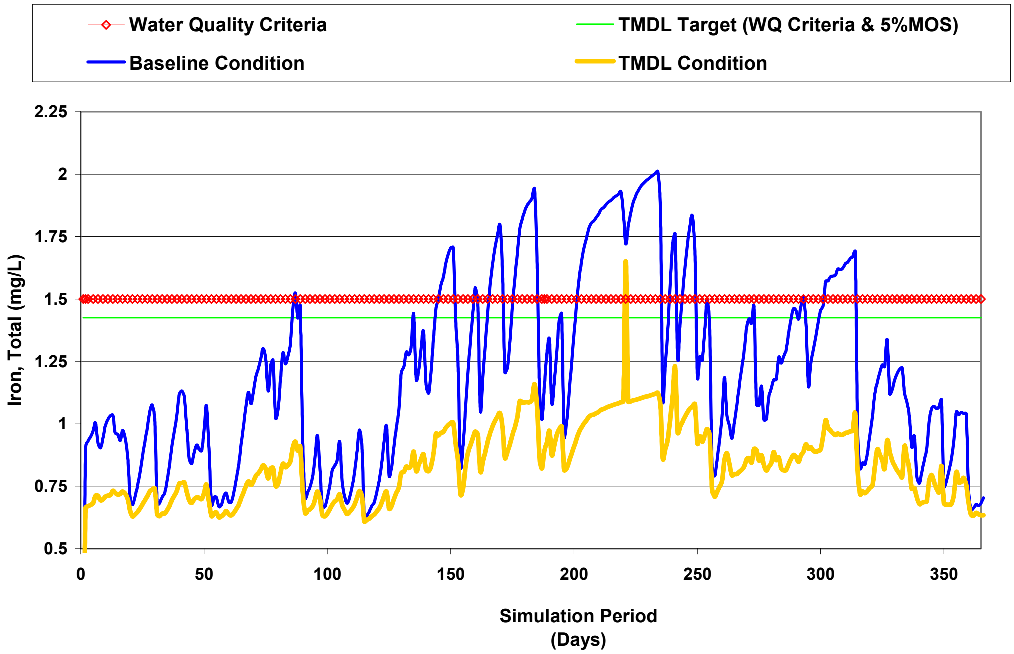

Figure 7-4. Example of baseline and TMDL conditions for iron

7.4 TMDLs and Source Allocations

7.4.1 Dissolved Aluminum, Total Iron, Total Manganese, and pH TMDLs

TMDLs and source allocations were developed on a subwatershed basis for each of the 17 watersheds in the Upper Kanawha watershed shown in Figure 3-3. 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 sources for the Upper Kanawha watershed TMDLs.

- For watersheds with AMLs but no permitted point sources, AML loads were reduced first, until in-stream water quality criteria were met or to conditions no less than those of undisturbed forest. If further reductions were required, the loads from sediment sources (harvested forest, burned forest, oil and gas operations, and roads) were reduced until water quality criteria were met.

- For watersheds with AMLs and point sources, point sources were set at the precipitation induced load defined by the permit limits and AML loads were subsequently reduced. Loads from AMLs and revoked mining permits were reduced (point sources were not reduced) until in-stream water quality criteria were met, if possible. If further reduction was required once loads from AMLs and revoked-permit mines were reduced, sediment sources were reduced. If even further reduction was required, the permitted point source discharge limits were reduced.

- For watersheds where dissolved aluminum TMDLs were developed, source allocations for total iron and manganese were developed first because their total in-stream concentrations (primarily iron) significantly reduce pH and consequently increase dissolved aluminum concentrations. If the dissolved aluminum TMDL endpoint was not attained after source reductions to iron and manganese, the total aluminum source loadings were reduced based on the methodology described above.

The watershed basis for this TMDL effort and the interrelationship between the parameters of concern required the execution of MDAS for all waters in the Upper Kanawha watershed. Source allocations are developed and presented for all modeled subwatersheds' waters for iron, aluminum, and manganese, regardless of the impairment status of individual waters as portrayed on the 303(d) list and in the work directive for this effort.

Wasteload Allocations (WLAs)

Wasteload allocations (WLAs) were made for all permitted mining operations except limestone quarries and those with a Completely Released or Phase Two Released SMCRA permit classification. Programmatic reclamation was assumed to have restored those permitted areas. Based on the types of activities and the nature of their discharges, permitted non-mining point sources were considered to have negligible impacts on water quality. These minor discharges were represented in the baseline condition based on existing permit requirements. The TMDLs assign WLAs that afford continued operation under those terms and conditions. Loading from revoked permitted facilities was assumed to be a nonpoint source contribution based on the absence of a permittee.[1]

The WLAs for individual NPDES permits for aluminum, iron, and manganese are shown in the allocation spreadsheets associated with this report. The dissolved aluminum TMDLs were based on a dissolved aluminum TMDL endpoint; however, sources were represented in terms of total aluminum. Wasteload allocations for aluminum are also provided in the form of total metal. The WLAs are presented as annual loads, in terms of pounds per year and as constant concentrations. The concentration allocations can be converted to monthly averages and daily maximum effluent

[1] The decision to assign load allocations to abandoned and reclaimed mine lands does not reflect any determination by WVDEP as to whether there are unpermitted point source discharges within these land uses. In addition, in establishing these TMDLs with mine drainage discharges treated as load allocations, WVDEP is not determining that these discharges are exempt from NPDES permitting requirements.

limitations using USEPA's *Technical Support Document for Water Quality-based Toxics Control* (USEPA, 1991). WLA concentration ranges are as follows: aluminum: 0.75–3.72 mg/L, iron:1.5–3.2 mg/L, manganese: 1.0–2.0 mg/L.

In certain instances, prescribed wasteload allocations may be less stringent than existing effluent limitations. The TMDLs are not intended to direct relaxation of effluent limitations developed under alternate bases.

WVDEP's implementation of the antidegradation provisions of the West Virginia water quality standards might sometimes result in more stringent allocations than those resulting from the TMDL process. Whereas TMDLs prescribe allocations that minimally achieve water quality criteria (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 and might result in more stringent allocations that limit the use of remaining assimilative capacity.

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 the permitting process, limitation development is based on the achievement/maintenance of water quality criteria at the point of discharge. Water quality-based effluent limitation development in the permitting process may dictate more stringent effluent limitations for upstream discharge locations.

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

- AMLs, including abandoned mines (surface and deep) and high walls
- Revoked permits: loading from revoked-permit facilities/bond forfeiture sites
- Sediment sources: metals loading associated with sediment contributions from harvested forest, oil and gas well operations, and roads
- Other nonpoint sources: urban/residential, agricultural, and forested land contributions (loadings from other nonpoint sources were not reduced)

The LAs for aluminum, iron, and manganese are presented in the allocation spreadsheets associated with this report. The dissolved aluminum TMDLs were based on a dissolved aluminum TMDL endpoint; however, sources were represented in terms of total aluminum. Load allocations for aluminum are also provided in the form of total metal. The LAs are presented as annual loads (pounds per year) because they were developed to meet TMDL endpoints under a range of flow conditions.

The iron, manganese, and aluminum TMDLs are presented in Appendix A (Tables A-X.4, A-X-5, and A-X-6) for the impaired streams within each of the selected Upper Kanawha watersheds.

As stated in Section 7.3.1, a surrogate approach was used for the pH TMDLs where it was assumed that reducing in-stream metals (iron and aluminum) concentrations to meet water quality criteria (or TMDL endpoints) would result in attainment of the water quality criterion. This assumption was verified by running the DESC-R model for an extended period (6 years) under conditions where TMDL endpoints for metals were met. A long-term daily average equilibrium pH was calculated based on the daily equilibrium pH output from the DESC-R model. These results are shown in Appendix A (Table A-X-7) for the pH-impaired streams within each of the selected Upper Kanawha watersheds. Refer to the Technical Report for a detailed description of the pH modeling approach.

7.4.2 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 17 watersheds in the Upper Kanawha watershed shown in Figure 3-2. As described in Section 7.4.1, 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 sources for the fecal coliform bacteria TMDLs; all point sources in the watershed were set at the permit limit (200 counts/100 mL monthly average). Because West Virginia Bureau for Public Health prohibits discharge of raw sewage into surface waters, all illicit, non-disinfected discharges of human waste (from failing septic systems and straight pipes) were eliminated. Sanitary sewer overflows (SSOs) are illegal under NPDES regulations; all such discharges were also eliminated. If further reduction was necessary, combined sewer overflows (CSOs) and nonpoint source loadings from agricultural lands and residential areas were subsequently reduced until in-stream water quality criteria were met.

Wasteload Allocations (WLAs)
WLAs were developed for all facilities permitted to discharge fecal coliform bacteria, including MS4s as described below. 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. The WLAs for individual NPDES permits for fecal coliform bacteria are shown in the Fecal Allocation spreadsheets associated with this report. The fecal coliform bacteria WLAs are presented as annual loads, in terms of counts per year. They are presented on an annual basis (as an average annual load) because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year.

Municipal Separate Storm Sewer System (MS4)
USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for all stormwater discharges from municipal separate storm sewer systems (MS4s). There is one designated MS4 municipality in the 17 TMDL watersheds within the Upper Kanawha watershed: the City of Marmet. This municipality has filed a Notice of Intent for MS4 permit issuance; the area within the corporate limits is therefore assumed to be subject to MS4 stormwater permitting. The City of Marmet's MS4 system was provided a fecal coliform wasteload allocation that is presented in Table 7-2. Stormwater permits and their relationship to TMDLs are discussed further in the appendices of the Technical Report.

Table 7-2. Individual fecal coliform MS4 WLAs for the City of Marmet

Town	Parameter	Baseline WLA (counts/yr)	WLA (counts/yr)	% Reduction
City of Marmet	Fecal coliform bacteria	1.59E+12	1.59E+12	0.0

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

- Grasslands - including pasture, succession grasslands, and croplands
- Failing septic 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
- Wildlife - loading associated with wildlife sources from forested land (contributions/loadings from wildlife sources were not reduced)

The fecal coliform bacteria LAs are presented as annual loads, in terms of counts per year, in the spreadsheets associated with this report. The fecal coliform bacteria TMDLs are presented in the subwatershed appendices for the impaired streams within each of the selected Upper Kanawha subwatersheds.

7.4.3 Sediment TMDLs

TMDLs and source allocations were developed for each of the sediment-impaired streams identified in Table 6-1. As described previously, headwaters were analyzed first, because their loading frequently has a profound effect on downstream water quality. Loading contributions were reduced from applicable sources for these waterbodies and TMDLs were developed. Source reductions never resulted in loading contributions less than those under the natural conditions represented by the undisturbed forest. Model results from the selected successful scenarios were then routed through downstream waterbodies using the Stream Module, which incorporated sediment transport/routing and stream bank erosion/deposition processes. If necessary, reductions were made in sediment contributions from stream bank erosion.

When allocating to land use-based sediment sources, a unit area loading approach was used to establish equitable source allocations. This approach was based on the assumptions that point sources subject to water pollution control permits provide the highest degree of sediment control and that activities that are subject to programmatic BMPs contribute less sediment than do uncontrolled sources. Therefore, sediment sources were reduced systematically in a stepwise fashion until the TMDL endpoint was achieved.

- Step 1: Loads from uncontrolled sediment sources (barren areas and unpaved roads) were reduced to the unit area loading of programmatic BMP sources (harvested forest and oil and gas operations).

- Step 2: If further reduction was required, loads from uncontrolled sediment sources and programmatic BMP sources were together reduced to the unit area loading of point sources.
- Step 3: If even further reduction was required to meet the TMDL endpoint, loads from all sediment sources were reduced equally to the extent necessary to achieve the reference watershed loading.

After the land use-based sources were reduced, sediment produced from in-stream processes (bank erosion/deposition) were evaluated on a subwatershed basis. In subwatersheds where bank erosion was significant, sediment reduction was prescribed for in-stream processes and the land use-based allocations were then adjusted accordingly.

Wasteload Allocations (WLAs)
WLAs were made for all permitted mining operations except limestone quarries and those with a Completely Released or Phase Two Released SMCRA permit classification. Programmatic reclamation was assumed to have restored those permitted areas.

Sediment modeling of active mining operations represented the contemporaneous reclamation practices employed by the industry and the removal efficiency associated with treatment structures. WLAs are presented as average annual loads and concentrations in the allocation spreadsheets associated with this report.

Within the sediment-impaired watersheds, there are sources that have industrial storm water and sewage permits. The industrial stormwater permitting procedures generally incorporate a 100 mg/L TSS benchmark value, and regulated facilities develop Stormwater Pollution Prevention Plans to achieve that goal. Wasteload allocations for these sources were based on the benchmark value. Wasteload allocations for sewage treatment facilities recognize the 30 mg/L monthly average TSS effluent limitations contained in permits. Under this TMDL, the wasteload allocations for these sources do not require pollutant reductions and are authorized to continue operation under existing permit conditions. The WLAs are presented as average annual loads, in terms of tons per year and are shown in the allocation spreadsheets associated with this report.

At the time of TMDL development, there were no existing construction stormwater permits in the sediment-impaired watersheds. A provision for future growth related to construction activity is provided and explained in Section 8.

Municipal Separate Storm Sewer System (MS4)
As stated previously, the City of Marmet is the only designated MS4 municipality in the 17 TMDL subwatersheds discussed in this report. The source loading associated with stormwater runoff from the urban and residential land uses within the corporate limits of the City of Marmet was included in the WLA for Lens Creek. The City of Marmet's allocation is shown in Table 7-3. Stormwater permits and their relationship to TMDLs are discussed further in the Technical Report.

Table 7-3. Individual sediment MS4 WLAs for the City of Marmet

Town	Parameter	Baseline WLA (ton/yr)	WLA (ton/yr)	% Reduction
Marmet	Sediment	5.4	5.4	0.0

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

- Grasslands - including pasture, succession grasslands, and croplands
- Barren land areas
- Harvested forest - including skid roads and landing areas
- Residential - sediment loading associated with urban/residential runoff
- Roads - including paved and unpaved roads
- In-stream processes - bank erosion and deposition
- Other nonpoint sources - forested land (loadings from other nonpoint sources were not reduced)

The Sediment LAs are presented as average annual loads, in terms of tons per year, and are shown in the allocation spreadsheets associated with this report.

7.4.4 Seasonal Variation

The TMDL must consider seasonal variation. For the Upper Kanawha 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 to TMDL endpoints. Allocations that met these endpoints throughout the modeling period were developed.

7.4.5 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, which, if met, will ensure the attainment of objectives for all other conditions. Nonpoint source loading is typically precipitation-driven. In-stream 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 in-stream pollutant levels may be due to point sources (Novotny and Olem 1994). Analysis of water quality data for the Upper Kanawha 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. FUTURE GROWTH AND WATER QUALITY TRADING

8.1 Metals and pH

This TMDL does not include specific future growth allocations to each subwatershed. However, the absence of specific future growth allocations does not prohibit new mining in the subwatersheds for which iron, aluminum, and manganese 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 manganese, 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.

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.

8.2 Fecal Coliform Bacteria

This TMDL does not include specific future growth allocations to each subwatershed. However, the absence of specific future growth allocations does not prohibit new development in the subwatersheds for which fecal coliform TMDLs have been developed or preclude 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.

8.3 Sediment

New mining point sources may be permitted anywhere in the sediment-impaired watersheds provided that the permit contains an annual average TSS effluent limitation of 120 mg/L. This value represents the most stringent WLA assigned to existing mining sources and is comparable to the background sediment loading associated with undisturbed forest. Consequently, WVDEP has concluded that discharges in compliance with this limitation will not cause or contribute to a violation of water quality standards.

Non-mining point source discharges are assigned technology-based TSS effluent limitations that would not cause biological impairment. For example, NPDES permits for sewage treatment and industrial manufacturing facilities contain monthly average TSS effluent limitations between 30 and 60 mg/L. New non-mining point sources may also be permitted in the sediment-impaired watersheds with the implementation of applicable technology-based TSS requirements.

Although there are no construction stormwater permits in the sediment-impaired watersheds, specific future growth allowances are provided. In general, the successful TMDL allocation scenarios allow for 0.5 percent of the area of sediment impaired watersheds to be disturbed subject to the terms and conditions of the Construction Stormwater General Permit. At least 10 acres are provided in smaller watersheds. The reserved acreage is expected to accommodate future development in the subject watersheds. If development projects are proposed in excess of the acreage provided, they may be permitted 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 the general permit area allocations provided in Table 8-1.

Table 8-1. Future growth for construction stormwater permits

Watershed	Total Watershed Area (acres)	Future Growth Area – 0.5% Total Watershed Area (Acres)
Cabin Creek	46, 736	234
Campbells Creek	25,516	128
Big Bottom Hollow	365	10
Fields Creek	7,763	39

Watershed	Total Watershed Area (acres)	Future Growth Area – 0.5% Total Watershed Area (Acres)
Lens Creek	13,008	65

8.4 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 trades might be feasible under the framework

9. PUBLIC PARTICIPATION

9.1 Public Meetings

The following is a list of meetings held with the Upper Kanawha Watershed to present information on the fundamental concepts of TMDL development and detailed information on WVDEP's proposed allocation strategies:

Date	Meeting Place	Location
September 22, 2003	Valley High School	Smithers
September 23, 2003	Valley High School	Smithers
September 24, 2003	Marmet Community Center	Marmet
September 25, 2003	Sharon Dawes Elementary School	Cabin Creek
October 2, 2003	Belle Town Hall	Belle

On September 2, 2004, a final public meeting to present draft TMDLs was held at the Riverside High School in Belle, West Virginia.

9.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised in local newspapers on various dates between August 16, 2004, and August 20, 2004. Interested parties submitted comments during the public comment period, which began on August 16, 2004, and ended on September 17, 2004.

9.3 Response Summary

The West Virginia Department of Environmental Protection (WVDEP) is pleased to provide this response to comments on the draft TMDLs developed for the Upper Kanawha watershed. The

WVDEP appreciates the efforts commenters have put forth to improve West Virginia listing and TMDL development processes.

The following entities provided written comments on the draft TMDLs:

- Independent Oil and Gas Association of West Virginia
- United States Environmental Protection Agency Region 3
- Morris Creek Watershed Association
- West Virginia Division of Forestry

Comments have been compiled and responded to in this response summary. Comments and comment summaries are in boldface and italic. Agency responses appear in plain text. Two commenters provided various suggested typographical/editorial revisions. Although those comments are not individually detailed in this summary, WVDEP considered all such comments and revised both the main report and subwatershed appendices, as appropriate.

One commenter provided information relative to the erosion and sedimentation impacts on Morris Creek (WVK-70) and questioned the absence of a sediment TMDL in relation to the biological impairment of the stream.

WVDEP does not dispute the existence of erosion and sedimentation in the watershed but has attributed the impairment evidenced by the benthic macroinvertebrate community to the significant metals and low-pH impacts present. To address biological impairment, WVDEP has instituted a rigorous protocol aimed at identifying the causative pollutants that, when reduced, would positively affect the community and abate the impairment. TMDLs are then developed for the causative pollutants.

For the mainstem of Morris Creek, the stressor identification process identified metals and pH as the primary causative pollutants. Although erosion and sedimentation exist, abatement of those impacts would not be expected to resolve the biological impairment. In response to the comment, WVDEP staff met with the commenter and other interested persons on September 20, 2004, and explained the biological stressor identification process and the Morris Creek benthic, habitat, and water quality data used in the process.

A more detailed explanation of the biological stressor identification process (than that which is provided in Section 6 of the report) was requested. The commenter also expressed interest in why a fecal coliform bacteria TMDL is used as a surrogate where organic enrichment was identified as a biological stressor.

Additional detail relative to the stressor pathways and the stressor identification process is contained in the Technical Report. The TMDL linkage between the organic enrichment stressor and a fecal coliform TMDL is described in Section 6.4. All waters where organic enrichment was identified as the biological stressor demonstrated exceedances of the numeric criteria for fecal coliform bacteria. In the Upper Kanawha watershed, source-tracking efforts clearly identified inadequately treated sewage as the predominant source of fecal coliform bacteria impairment. WVDEP determined that the surface water discharges from failing septic tanks and straight pipes must be eliminated to implement the fecal coliform TMDLs. Such action would thereby reduce the organic and nutrient loading causing the biological impairment.

Clarification of the difference between the number of Upper Kanawha watershed streams identified as impaired on the 2004 Draft Section 303(d) list (96) and the number addressed in this report (80) was requested.

The WVDEP TMDL development program is synchronized with the 5-year Watershed Management Framework (WMF) cycle. The WMF organizes the state's 32 watersheds in five hydrologic groups, and WVDEP annually selects streams in a specific hydrologic group for TMDL development.

Initially, WVDEP projected TMDL development needs for the 15-year period through 2018. The 5-year, five-hydrologic group WMF format provides three opportunities for TMDL development in each hydrologic group during that period. Program resources allow WVDEP to develop TMDLs for between 80 and 100 impaired waters, annually. The remaining commitments of the consent decree between USEPA and the Ohio Valley Environmental Coalition require that TMDLs for waters identified on the 1996 Section 303(d) list as impaired by mine drainage be developed by 2008. That, in turn, mandates TMDL development for those streams during the initial effort in each hydrologic group.

Given all those constraints, stream selection for this effort was initiated in January 2001. Approximately 100 impaired waters were selected in the Upper Kanawha and Upper Ohio North watersheds. All remaining "consent decree" impaired waters were selected and have TMDLs developed herein. For efficiency, geographically proximate impaired waters were also selected, and WVDEP attempted to develop TMDLs for all known or suspected impairments of selected waters.

Impaired waters in certain Upper Kanawha subwatersheds (e.g., Kellys, Simmons, Paint) were not selected for TMDL development at this time. Those waters remain on the 303(d) list, and WVDEP will develop TMDLs for them in either the second or third set of Hydrologic Group A TMDLs (i.e., TMDLS that will be developed in 2009 or 2014). In addition, certain waters were added to the 303(d) list based on new water quality information obtained during the 2004 process. For such streams (e.g., Kanawha River mainstem), the timing of the impairment identification in relation to the TMDL process precluded development in this effort. TMDLs are not being developed in this effort for certain other waters due to practical constraints relative to ionic toxicity and the flooding in 2001, as discussed in Section 3.3.

Identification of the biologically impaired waters where the stressor identification process determined ionic toxicity as the primary stressor was requested. (WVDEP did not develop TMDLs for such impairments, and the waters/impairments remain on the Section 303(d) list.)

The subject streams are Pointlick Fork of Campbells Creek (WVK-49-F), Rattlesnake Hollow of Campbells Creek (WVK-49-I), Wet Branch of Cabin Creek (WVK-61-C), and Coal Fork of Cabin Creek (WVK-61-H).

Identification of the biologically impaired waters where the severe flooding of 2001 precluded biological assessment in the pre-TMDL monitoring effort was requested. (WVDEP did not develop TMDLs for such impairments, and the waters remain on the Section 303(d) list.)

The subject streams are Smithers Creek (WVK-72), Bullpush Fork of Smithers Creek (WVK-72-B), and Dempsey Branch of Mulberry Fork of Loop Creek (WVK-75-C-1).

Comments were received relative to inconsistencies between the impairments identified in Table 3-3 and those identified on the Draft 2004 Section 303(d) list. The comments pertained to Mill Branch of Fields Creek (WVK-58-B.8) and New West Hollow of Mill Branch of Fields Creek (WVK-58-B.8-1).

For the subject waters, stream code revisions confused documentation of stream sampling locations and impairment decisions. The stream names, codes, and impairments shown in Table 3-3 are accurate. WVDEP will revise the incorrect listings on the Draft 2004 Section 303(d) list, so that they match the information shown in Table 3-3.

One commenter questioned the delisting of the iron impairment of Wolfpen Hollow (WVK-58-B.1) on the Draft 2004 Section 303(d) list in light of the iron TMDL developed for the stream in this effort.

The Draft Section 303(d) list will be revised to retain the iron impairment.

One commenter requested discussion of the method by which land use and Census data, which were generated during different periods, were reconciled to accurately represent current conditions.

Section 3 describes watershed characteristics and the data sources that were used in the characterization. Section 7.1.1 details model setup and has been updated to describe the process of reconciling recent data with the outdated GAP2000 land use coverage.

Two commenters requested technical support for the assumption that sediments in the watershed contain iron, aluminum, and manganese, and one questioned the inclusion of oil and gas operations as "significant sediment-related nonpoint sources of metals" in Section 4.2.3 of the draft report.

Section 4 attempted to identify all potential pollutant sources and to provide general information on their relative importance in this watershed. Because West Virginia soils are known to contain the subject metals, sediment-related nonpoint sources are potential sources of metals.

WVDEP agrees that the draft language of Section 4.2.3 was less than clear in its characterization of sediment-related nonpoint sources of metals and inaccurately portrayed the significance of oil and gas operations. Although oil and gas operations are present in the metals-impaired streams addressed by the report, they were not considered a significant source of metals loading because their impact relative to other sources was small. Metals loadings from sediment-related sources are less significant than the seeps from abandoned mine lands, and, overall, the amount of land disturbance from oil and gas operations is less than that from other sediment-related nonpoint sources. Section 4.2.3 was revised in the final document to accurately portray the relative impact of oil and gas operations and to provide the requested support for the sediment/metals association.

One commenter suggested that discharges from abandoned mine lands, bond forfeiture sites, failing septic tanks, and straight pipe sewage discharges are unpermitted point sources rather than nonpoint sources. The commenter recognized the practicality of the consideration of such sources as nonpoint sources for TMDL purposes but requested inclusion of a disclaimer to address this issue.

WVDEP revised Sections 4 and 5.2.1 to include the suggested language.

One commenter requested an explanation of why certain TMDL components are prescribed as average annual loads, as opposed to maximum daily loads.

Per 40 CFR 130.2(I), TMDLs may be expressed in terms of mass per time, toxicity, or other appropriate measure. The 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). This modeling approach inherently considers seasonal hydrologic and source loading variability. Because such variability is present throughout the Upper Kanawha watershed, presenting the TMDLs as average annual loads was deemed appropriate.

The introductory paragraph of Section 7.3.1 was updated to provide the above explanation.

One commenter expressed concern over the 95 percent to 99 percent sediment load reductions prescribed for oil and gas operations in sediment-impaired waterbodies. Additional information was requested regarding the model representation of oil and gas sources and assumptions made relative to implementation of required BMPs.

In response to the comment, WVDEP staff met with the commenter and other interested individuals on September 21, 2004, and explained the representation of oil and gas operations.

The active oil and gas operations present in the watershed were obtained from an inventory of wells sites maintained by WVDEP's Office of Oil and Gas. Representation of the sediment impacts from those operations required determination of the amount of land associated with well sites and the status of vegetation on that land. The information source used was an assessment conducted by the Office of Oil and Gas.

In 2000 and 2001, more than 400 randomly selected well sites were evaluated in the Little Kanawha and Elk River watersheds. Information obtained included the size of the site, the length and width of road associated with the site, the percent cover present on the site and road, and the BMP compliance status. From the study, it was determined that an average total of 1.38 acres of land should be associated with each well site and that 0.15 acre of the land should be considered unvegetated. The percentage of area vegetated is a function of BMP compliance. Approximately half of the assessed sites were in compliance with BMPs, which further justifies representation of an average condition.

The unvegetated portion was represented as barren land in the model, and the vegetated portion was represented as forest land. Pollutant reductions were applied to only the unvegetated portion of the associated land. This methodology is similar to that applied to forest harvesting operations, where pollutant reductions were applied to only the portion of the associated land in roads and landings.

In reviewing this comment, WVDEP found an inconsistency in the display of the load allocations for the oil and gas and harvested forest nonpoint source categories in the draft allocation spreadsheet. For harvested forest, the baseline load and allocated load for each subwatershed included all associated land (i.e., the harvest areas that were not reduced in the model, as well as the road and landing areas where pollutant reduction was concentrated). The subwatershed loads for the oil and gas category did not include the unreduced, vegetated portion of associated land. That land was categorized in the "Other NPS" columns of the spreadsheet. The inconsistency portrayed higher-than-necessary percent reductions from land associated with oil and gas operations. It was rectified in the final draft by relocating the loadings for the vegetated portion of land associated with oil and gas operations from the "Other NPS" columns to the "Oil and Gas" columns and recalculating the subwatershed percent reductions.

A commenter requested additional information regarding the conservative assumptions used in determining margins of safety.

The primary margins of safety are those which resulted from the establishment of TMDL endpoints at 95 percent of the value of water quality criteria (i.e., 5 percent explicit margins of safety). The explicit margins of safety are identical to those provided in West Virginia TMDLs developed by USEPA. The comment resulted from WVDEP's attempt to describe other conservative assumptions in the development process that might be construed as implicit margins of safety (e.g., the assumption that all point sources are continuously discharging at their maximum permit limitations). Although such assumptions do exist and provide added safety, Section 7.3.1 was modified to remove mention of an implicit margin of safety to avoid confusion.

The determination of impairment and the development of TMDLs pursuant to the dissolved aluminum water quality criteria were questioned in light of the recent criteria revision considerations of the Environmental Quality Board. The commenter requested guidance from WVDEP on how such revision would affect these TMDLs.

Fluidity in water quality criteria presents significant challenges in the TMDL development process. To be valid, TMDLs must be based on the water quality criteria that are in effect. USEPA must approve criteria revisions proposed by the Environmental Quality Board before they become effective.

The current dissolved aluminum criteria became effective while Upper Kanawha TMDLs were being developed for waters that were identified as impaired pursuant to the previously applicable total recoverable aluminum criterion. The mid-process shift caused WVDEP to reevaluate available water quality data and determine the waters that were impaired pursuant to the dissolved aluminum criteria. It further required the addition of a metals speciation component to the MDAS model that allowed prediction of dissolved aluminum water quality. WVDEP was successful in developing TMDLs for water impaired pursuant to the currently effective dissolved aluminum water quality criteria.

The Environmental Quality Board is considering suspension and reevaluation of the chronic aquatic life protection aluminum criterion for warmwater fisheries. Such revision has yet to be proposed to, or evaluated by, USEPA. If USEPA were to approve the revision, the aluminum TMDLs would be technically invalid and WVDEP would not act to implement them. Recognizing that the proposed revision is a suspension, and that the suspended criteria could again become effective, WVDEP would likely hold the TMDLs in abeyance pending the outcome of the standards process.

A commenter questioned the appropriateness of the source representation and allocation prescription in total aluminum terms for TMDLs that are based on a dissolved aluminum endpoint.

The aluminum TMDLs must be based on attainment of the dissolved aluminum water quality criteria. The fraction of the total metal that would be present in a stream in the dissolved form is a function of the stream's water chemistry. Given total metal and other water chemistry inputs, the Dynamic Equilibrium In-stream Chemical Reactions model (DESC-R) predicts in-stream water quality in dissolved terms. The modeling approach is consistent with NPDES rules that require effluent limitations to be prescribed in total recoverable form. For water quality criteria prescribed in dissolved form, effluent limitation development under the NPDES program requires the determination of a translator to predict the fraction of total metal that becomes dissolved in-stream. In effect, the DESC-R model addresses translation and TMDL allocations can be prescribed in terms of total aluminum. This, in turn, allows direct TMDL implementation without further translation consideration.

One commenter requested an explanation of the future growth provision for new aluminum discharges at criteria end-of-pipe and a translator of 1.

NPDES rules require the establishment of metals effluent limitations in the total recoverable form. Because aluminum water quality criteria are in dissolved form and NPDES effluent limitations must be prescribed in total recoverable form, a translator that predicts the percentage of total metal that becomes dissolved in-stream must be incorporated into the limitation development process. This future growth provision recognizes that new discharges that achieve water quality criteria end-of-pipe do not cause or contribute to violation of water quality standards. If a translator equal to 1 is used, it is assumed that all the aluminum in a discharge will become dissolved. Prior to TMDL implementation, WVDEP could not propose the use of a less protective translator in aluminum-impaired waters and universally ensure that new discharges would not contribute to the water quality standard violation.

One commenter questioned the timing of TMDL effectiveness monitoring and suggested that this component should commence upon TMDL development, not after some period of implementation.

WVDEP believes that the assessment of water quality improvements resulting from TMDL implementation is an important monitoring component that should be pursued when the agency has reason to believe that implementation is significant enough to cause measurable change. To arbitrarily begin effectiveness monitoring upon TMDL development would not be a prudent use of limited monitoring resources. The timing of assessment would be a stream-specific determination. Where targeted implementation activities have been accomplished in a stream with limited pollutant sources, WVDEP would schedule monitoring in the next available opportunity in the cycle or earlier. Conversely, WVDEP may not schedule effectiveness monitoring at the next cycle opportunity in a stream with a multitude of nonpoint sources and little implementation activity.

10. REASONABLE ASSURANCE

Reasonable assurance for maintenance and improvement of water quality in the affected watershed rests primarily with three separate programs. Two of these programs are wholly within WVDEP, and the third program is a cooperative effort involving many state and federal agencies. Within WVDEP, the programs involved in the effort include the NPDES Permitting Program and the Abandoned Mine Lands Program. In addition, WVDEP is involved with the West Virginia Watershed Management Framework, which includes many state and federal agencies dealing with the protection and restoration of water resources. The Framework process allows the resources of many entities to focus on the protection and/or restoration of water quality in selected streams.

Historically, mine drainage research has been a conducted by scientists at West Virginia University, the West Virginia Division of Natural Resources, the United States Office of Surface Mining, the National Mine Land Reclamation Center, the National Environmental Training Laboratory, and other agencies and individuals within West Virginia. In addition, USEPA 319 Grant funding has been used to address issues resulting from acid mine drainage.

10.1 Permit Reissuance

WVDEP's Division of Water and Waste Management is responsible for issuing non-mining NPDES permits within the State. The Division of Mining and Reclamation develops NPDES permits for mining activities. 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. Existing permit reissuance in the Upper Kanawha watershed is scheduled to begin in July 2005 for non-mining facilities and in January 2006 for mining facilities. Therefore, the wasteload allocations for existing activities will be promptly implemented. New facilities will be permitted in accordance with future growth provisions.

Existing sewage treatment facilities already have permit limitations for fecal coliform bacteria that satisfy the wasteload allocations of the TMDLs. A new MS4 permitting program is being implemented to address stormwater impacts from urbanized areas. DWWM also implements a program to control discharges from combined sewer overflows (CSOs). The CSO pollutant reductions specified will be implemented at the time of reissuance of the NPDES permit for the affected POTW.

10.2 Watershed Management Framework Process

The Watershed Management Framework consists of a group of state and federal agencies whose goal is to develop and implement watershed management strategies through a cooperative, long-range planning effort. The Framework is incorporated by reference into West Virginia's Continuing Planning Process. The Framework consists of representatives from the following partner agencies:

Bureau for Public Health
Department of Highways
Department of Environmental Protection
State Conservation Agency
Division of Forestry
Division of Natural Resources
West Virginia University Extension Services
ORSANCO (Ohio River Valley Water Sanitation Commission)
U.S. Geological Survey
U.S. Office of Surface Mining
Monongahela National Forest
U.S. Environmental Protection Agency
Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Department of Agriculture

The principal area of focus for the Framework is correcting problems related to nonpoint source pollution. Each of the partner agencies has placed a greater emphasis on identification and correction of nonpoint source pollution. The combined resources of these agencies are used to address all different types of nonpoint source pollution through both public education and on-the-ground projects. The Framework also incorporates as part of its priority selection criteria, the state's list of impaired waters under Section 303(d).

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. Chapter 3.2.2 of the Framework, entitled "Developing and Implementing Integrated Management Strategies," 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 an "action plan" that implements the TMDL and any other appropriate water quality improvement strategy.

The Framework uses the 5-year Watershed Cycle to identify watersheds where restoration efforts will be focused. Each year Framework agencies meet 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 Framework prioritized Hydrologic Group A watersheds in October 2003. Although the Upper Kanawha TMDLs were still in the development phase, preliminary information (gross pollutant reductions predicted by the calibrated models for individual subwatersheds) was provided to the framework to allow their consideration of Upper Kanawha watershed impaired waters. As a result, the Framework selected Tenmile Fork of Cabin Creek, Fifteenmile Fork of Cabin Creek, and Morris Creek as priority watersheds.

Development of "action plans" for priority watersheds is based on the efforts of local project teams. These teams are composed of Framework 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. The team's goal is to develop a project plan that allows the most efficient use of resources from all involved parties. Project teams have been established for the priority watersheds of Cabin Creek and Morris Creek and are working to implement the TMDLs for those waters.

10.3 Public Sewer Projects

Within WVDEP's Division of Water and Waste Management, 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. The following projects are under construction or planned in the Upper Kanawha watershed.

Cabin Creek

Phase II of a two-phase project was recently completed in the Cabin Creek watershed. The project extends public sewer to Leewood and serves approximately 1,000 customers along the mainstem of Cabin Creek and selected tributaries. As a result of this project, a significant reduction in fecal coliform load is expected for this section of the watershed. This project should improve the water quality in this section and help to begin resolution of the fecal coliform impairments in Cabin Creek.

Loop Creek

Page-Kincaid Public Service District (PSD) is expected to receive money to begin Phase I of a two-phase project. Phase I would extend public sewage to the Wriston and Ingram Branch area and serve approximately 220 customers. In addition, Phase II is in the planning stages and, when completed, is expected to serve the Mulberry Branch area. Both Ingram Branch and Mulberry

Branch have undergone TMDL development for fecal coliform impairment. The extension of public sewer to both of those areas should help to reduce the problems of untreated sewage in those watersheds.

Fields Creek

Chelyan PSD has proposed a sewer line extension project for a portion of the Fields Creek watershed. The project, known as the Winifred Hollow Project, would extend sewer to approximately 275 customers in the watershed. Currently, the Infrastructure Council has approved the project, but actual funding for the project is awaiting approval.

Lens Creek

A plan to extend sewer to areas in the Lens Creek watershed was part of a study conducted by the Kanawha County Regional Development Authority in 1998. The study examined the possibility of connecting approximately 436 customers to public sewer, with transport of wastewater to Chelyan PSD for treatment. However, for this to occur, Chelyan PSD would have to modify its service boundaries. No further action had occurred at the time of this report.

In addition to the projects noted above, a list of funded and pending water and wastewater projects in West Virginia can be found at http://www.wvinfrastructure.com/projects/index.html.

10.4 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 was created in 1981 to manage the reclamation of lands and waters affected by mining prior to passage of the Surface Mining Control and Reclamation Act (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. Currently, AML&R is implementing a $750,000 project to reclaim the Evans Portals in the Witcher Creek watershed. AML&R is also participating in the Framework process to address and remediate problematic AML sources in the Morris Creek watershed.

10.5 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.

There are 24 bond forfeiture sites in the watersheds addressed in this report. The Office of Special Reclamation has completed land reclamation at 21 of those sites; 5 of the sites have remaining water quality impacts to be addressed. Table 10-1 depicts sites where the Office of Special Reclamation will fund the construction of acid mine drainage treatment facilities. All projects are scheduled to begin construction by March 2007.

Table 10-1. Upper Kanawha bond forfeiture sites with water treatment needs

Original Permittee	Permit No.	Affected Subwatersheds
Hawks Nest Mining Co.	O-1-81	Witcher Creek/Carroll Branch
Princess Cindy Mining, Inc.	30-79	Loop Creek
Princess Susan Coal Co.	S-76-82	Watson Branch
Princess Susan Coal Co.	S-6033-86	Campbells Creek
Templeman Const. Co., Inc.	151-75	Campbells Creek

11. MONITORING PLAN

The following monitoring activities are recommended:

11.1 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 wasteload allocations 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 wasteload allocations.

11.2 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.

11.3 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.

12. ACRONYMS AND ABBREVIATIONS

7Q10	7-day, 10-year low flow
AMD	acid mine drainage
AML	abandoned mine land
AnnAGNPS	Annualized Agricultural Nonpoint Source
BMP	best management practice
BOD	biochemical oxygen demand
CFR	Code of Federal Regulations
CSO	combined sewer overflow
CSR	Code of State Regulations
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
FCLES	Fecal Coliform Loading Estimation Spreadsheet
FS	Forest Service
GAP	Gap Analysis Program Land Cover Program
GIS	geographic information system
gpd	gallons per day
GPS	global positioning system
GWLF	Generalized Watershed Loading Functions
HAU	Home Aeration Unit
LA	load allocation
MF	membrane filter counts per test
MOS	margin of safety
µg/L	micrograms per liter
mL	milliliter
MDAS	Mining Data Analysis System
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NOAA-NCDC	National Oceanic and Atmospheric Administration, National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NPS	nonpoint source
OOG	Office of Oil and Gas
ORSANCO	Ohio River Valley Water Sanitation Commission
OWR	Office of Water Resources
POTW	publicly owned treatment works
PSD	public service district

SMCRA	Surface Mining Control and Reclamation Act
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
UT	unnamed tributary
WAP	Watershed Assessment Program
WLA	wasteload allocation
WVDEP	West Virginia Department of Environmental Protection
WVSCI	West Virginia Stream Condition Index
WVU	West Virginia University

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