

APPENDIX 1

A-1. TWENTYMILE CREEK

A-1.1 Watershed Information

Twentymile Creek is in the northwestern portion of the Gauley River watershed and drains approximately 86.6 square miles (55,454 acres), as shown in Figure A-1-1. The dominant landuse in the watershed is forest, which covers 73.6 percent of the watershed. Other significant landuse types include mining (23.6 percent), and urban/residential (1.7 percent). All other individual land cover types account for 1.1 percent of the total watershed area. There are 22 impaired streams in the watershed, including Twentymile Creek, which are addressed in this TMDL development effort. Figure A-1-2 shows the impaired segments and the pollutants for which each is listed as impaired.

Before establishing Total Maximum Daily Loads (TMDLs), WVDEP performed monitoring in each of the impaired streams in the Gauley River watershed to better characterize water quality and refine impairment listings. Monthly samples were taken at 57 stations (station locations can be viewed using the ArcExplorer project) throughout the Twentymile Creek watershed from July 1, 2003, through June 30, 2004. Monitoring suites at each site were determined based on the types of impairments observed in each stream. Streams impaired by metals and low pH were sampled monthly and analyzed for a suite of parameters including acidity, alkalinity, total iron, dissolved iron, total aluminum, dissolved aluminum, total suspended solids, pH, sulfate, total selenium, and specific conductance. Monthly samples from streams impaired by fecal coliform bacteria were analyzed for fecal coliform bacteria, pH, and specific conductance. In addition, benthic macroinvertebrate assessments were performed at specific locations on the biologically impaired streams during the pre-TMDL monitoring period. Instantaneous flow measurements were also taken at strategic locations during pre-TMDL monitoring.

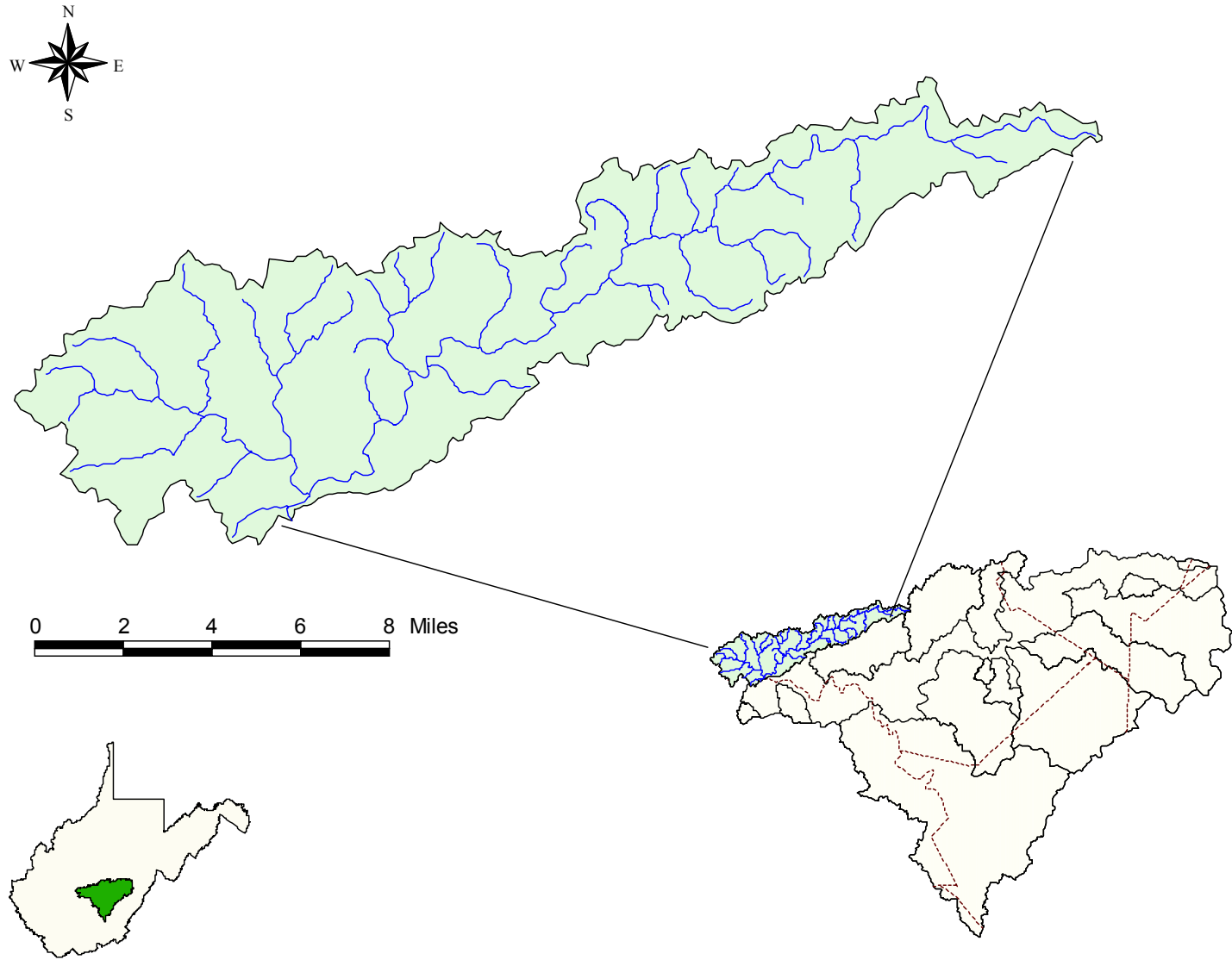


Figure A-1-1. Location of the Twentymile Creek watershed



TMDL	Impairment					
	Fe	Al	pH	Se	FC	BIO
Stream Name						
Twentymile Creek	x		x		x	x
Buckles Branch	x					
Bells Creek	x				x	x
Open Fork	x	x	x		x	x
Williams Hollow		x	x			
Sangamore Fork	x	x	x			x
Smith Branch					x	
Hughes Fork	x			x		
Rockcamp Fork					x	
Campbell Fork	x				x	x
Rockcamp Fork		x	x			x
Spring Branch	x	x	x			x
Lilly Branch	x					
Hardaway Branch	x					
UNT/Hardaway Branch	x					
Boardtree Branch	x					
Sugarcamp Branch	x					
Stillhouse Branch	x					
Robinson Fork	x					
UNT/Robinson Fork RM 1.22 (Wildcat Hollow)	x					
UNT/Twentymile Creek	x					
Rader Fork	x					

Figure A-1-2. Waterbodies and impairments under TMDL development in the Twentymile Creek watershed

A-1.2 Metals and pH Sources

This section identifies and examines the potential sources of aluminum, iron, selenium and pH impairment in the Twentymile Creek watershed. Sources can be classified as point sources (specific sources subject to a permit) or nonpoint sources (diffuse sources). Mining and non-mining-related permitted discharges are considered metals and pH point sources. Metals and pH nonpoint sources are non-permitted sources such as abandoned or forfeited mine sites.

Pollutant sources were identified using statewide geographic information system (GIS) coverages of point and nonpoint sources, and through field reconnaissance. As part of the TMDL process, WVDEP documented pollution sources by describing the pollutant source in detail, collecting Global Positioning System data, and if necessary, collecting a water quality sample for laboratory analysis. WVDEP personnel recorded physical descriptions of the pollutant sources, such as the number of outfalls, the source of the outfalls, and the general condition of the stream in the vicinity of each outfall. These records were compiled and electronically plotted on maps using GIS software. This information was used in conjunction with other information to characterize pollutant sources. Significant metals sources in the watershed are shown in Figure A-1-3.

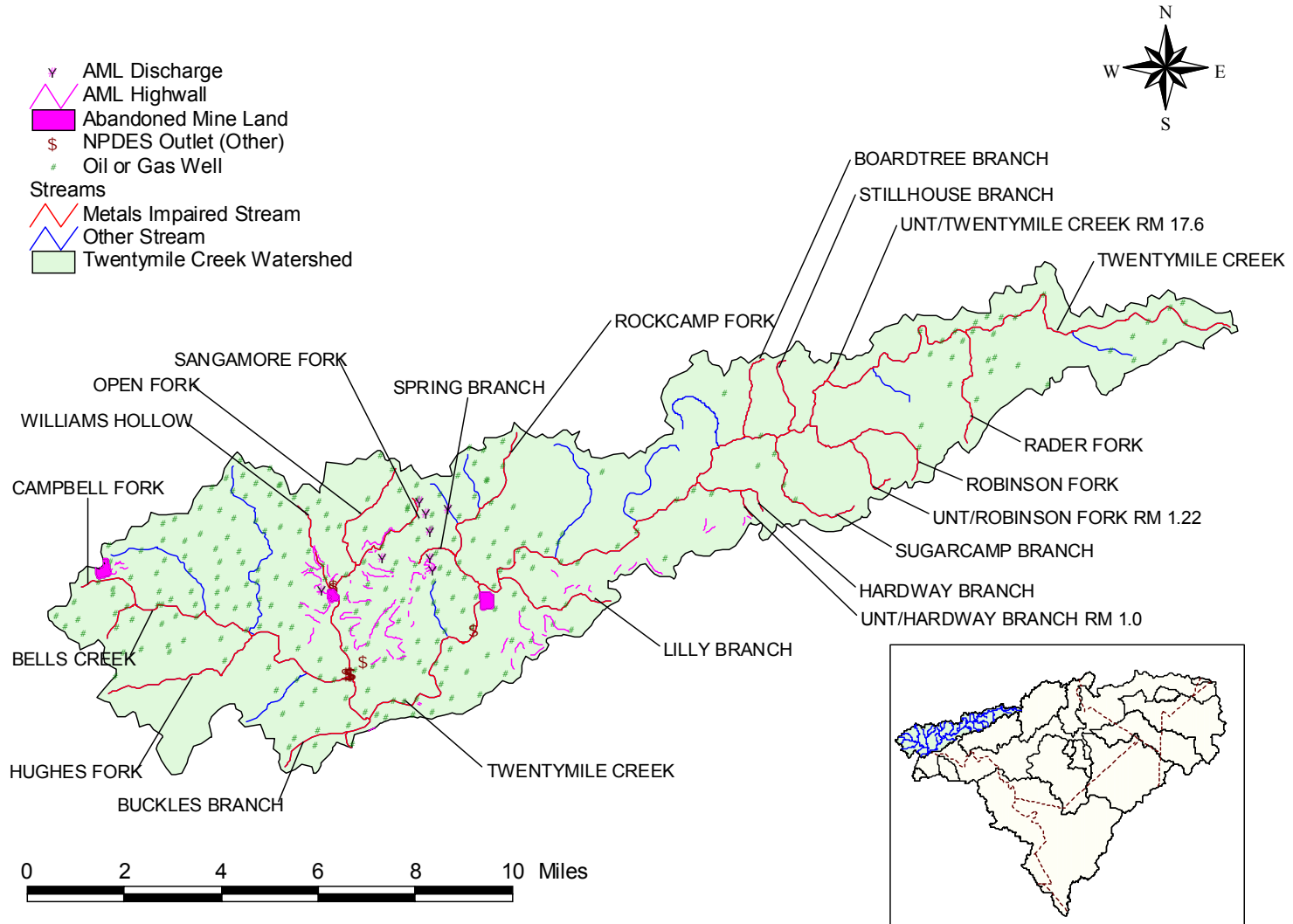
On the basis of scientific knowledge of sediment/metals interaction and knowledge of West Virginia's soils, it is reasonable to conclude that sediments contain high levels of aluminum and iron. Controls of sediment-producing sources were determined necessary to meet water quality criteria for total iron, during critical high-flow conditions. Although some of these sediment-producing sources are not shown in Figure A-1-3 (e.g., agricultural areas and unpaved roads), specific details relative to these sources are discussed in section A-1.2.2.

A-1.2.1 Metals Point Source Inventory

As described in the TMDL Report, 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. Metals and pH point sources can be classified into two major categories: permitted non-mining point sources and permitted mining point sources.

In the Twentymile Creek watershed there are 326 mining-related NPDES outlets, as well as nine metals effluent permits not related to mining. WVDEP's HPU GIS coverage was used to determine the locations of the mining permits; the detailed permit information came from WVDEP's ERIS database system. The non-mining metals permits are all industrial permits; permit information originated from WVDEP's NPDES GIS coverage. The permits related to these outlets are listed in the Technical Report, which shows the name of each responsible party and the total number of outlets that discharge to the Twentymile Creek watershed. The Technical Report also contains specific data for each permitted outlet including effluent type, drainage areas, pump capacities, and permit limits for each of the mining-related NPDES outlets. Because NPDES permits contain effluent limitations and/or monitoring requirements, the discharges from mining activities were determined to be contributing point sources of iron and aluminum.

Existing mining point sources also contribute to the selenium impairment of Hughes Fork of Bells Creek.



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

Figure A-1-3. Metals sources in the Twentymile Creek watershed

A-1.2.2 Metals Nonpoint Sources

In addition to point sources, nonpoint sources also contribute to metals-related water quality impairments in the Twentymile Creek watershed. Nonpoint sources are diffuse, non-permitted sources. Abandoned mine lands and facilities that were subject to the Surface Mining Control and Reclamation Act of 1977, and forfeited their bonds or abandoned operations can be a significant non-permitted source of metals. Non-mining land disturbance activities can also be a nonpoint source of metals, causing metals to enter waterbodies as a component of sediment. Examples of such land disturbance activities are agriculture, forestry, oil and gas wells, and the construction and use of roads. The applicable land-disturbing activities in the Twentymile Creek watershed are discussed below.

Abandoned Mine Lands and Bond Forfeiture Sites

Based on the identification of a number of abandoned mining activities in the Twentymile Creek watershed, abandoned mine lands are a significant non-permitted source of metals and pH impairment in the watershed. WVDEP's Office of Abandoned Mine Lands identified the locations of abandoned mine lands in the Twentymile Creek watershed. In addition, source tracking efforts by WVDEP's Division of Water and Waste Management identified and characterized eight abandoned mine sources (AML seeps).

WVDEP's Division of Land Restoration, Office of Special Reclamation, provided bond forfeiture information and data. This information included the status of both land reclamation and water treatment activities. No bond forfeiture sites were modeled as metals sources in the Twentymile Creek watershed.

Land-Disturbance Activities

Based on the GAP 2000 landuse coverage, there are only 2.5 acres of row crop agriculture in the Twentymile Creek watershed, representing 0.004 percent of the total watershed area. During the pre-TMDL sampling period there were 753 acres of active timber harvest in the watershed. The watershed also contains 269 active oil and gas wells, which, based on the survey by WVDEP's Office of Oil and Gas, are estimated to comprise 372.6 acres (0.7 percent). The length and area of paved roads were calculated using the Census 2000 TIGER/Line files roads coverage for West Virginia. Information on unpaved roads from TIGER was supplemented by digitizing any unpaved roads shown on topographic maps that were not included in the TIGER shapefile. There are 61 miles of paved roads and 102 miles of unpaved roads in the Twentymile Creek watershed.

Nonpoint sources associated with surface disturbances (i.e., barren areas, unpaved roads, harvested forest, and oil and gas well operations) were considered to be negligible sources of selenium because these land disturbances typically do not disturb subsurface strata that contain selenium and because they were not significantly present in the selenium impaired watersheds.

A-1.3 Fecal Coliform Bacteria Sources

This section identifies and examines the potential sources of fecal coliform bacteria in the Twentymile Creek watershed. Sources can be classified as either point sources or nonpoint sources. Potential point sources include effluent discharges of sewage treatment facilities and collection system overflows. Potential nonpoint sources of fecal coliform bacteria include failing

or nonexistent on-site sewage disposal systems, stormwater runoff from pasture and cropland, direct deposition of wastes from livestock, and stormwater runoff from residential and urban areas.

A-1.3.1 Fecal Coliform Bacteria Point Sources

There are no point-source discharges of fecal coliform bacteria in the Twentymile Creek watershed.

A-1.3.2 Fecal Coliform Bacteria Nonpoint Sources

Pollutant source tracking by WVDEP personnel identified scattered areas of high population density without access to public sewers in the Twentymile Creek watershed. Human sources of fecal coliform bacteria from these areas include sewage discharges from failing septic systems, and possible direct discharges of sewage from residences (straight pipes). WVDEP source tracking information yielded an estimate of 446 unsewered homes in the Twentymile Creek watershed. A septic system failure rate derived from geology and soil type was applied to the number of unsewered homes to calculate nonpoint source fecal coliform loading from failing septic systems. Figure A-1-4 shows the geographic distribution of estimated failing septic system nonpoint sources in the watershed.

Stormwater runoff is another potential nonpoint source of fecal coliform bacteria in both residential/urban and rural areas. Runoff from residential areas can deliver the waste of pets and wildlife to the waterbody. In addition, rural stormwater runoff can transport significant loads of bacteria from livestock pastures, livestock and poultry feeding facilities, and manure storage and application. Given the small portion of total land area in the Twentymile Creek watershed that consists of agricultural areas, stormwater runoff from these areas is not considered a significant nonpoint source of fecal coliform bacteria. Stormwater runoff from residential areas is a source of fecal coliform bacteria in the Twentymile Creek watershed. Fecal coliform bacteria reductions in stormwater runoff from residential/urban areas were prescribed in only one (subwatershed 518) of the 60 subwatersheds that compose the Twentymile Creek drainage area. WVDEP source tracking determined that contributions of fecal coliform bacteria in the Twentymile Creek watershed are predominantly from failing septic systems and/or straight pipe discharges. As a result, source reductions to failing septic systems were prescribed in 23 of the 60 subwatersheds in the Twentymile Creek watershed.

A certain “natural background” contribution of fecal coliform bacteria can be attributed to deposition by wildlife in forest and grassland areas. Accumulation rates for fecal coliform bacteria in those areas were developed using reference numbers from past TMDLs, incorporating wildlife estimates obtained from the Division of Natural Resources, and WVDEP fecal coliform sampling in Shrewsbury Hollow in the Kanawha State Forest. Although wildlife contributions of fecal coliform bacteria were considered in modeling, they were not found to be a significant source, and reductions were not prescribed.

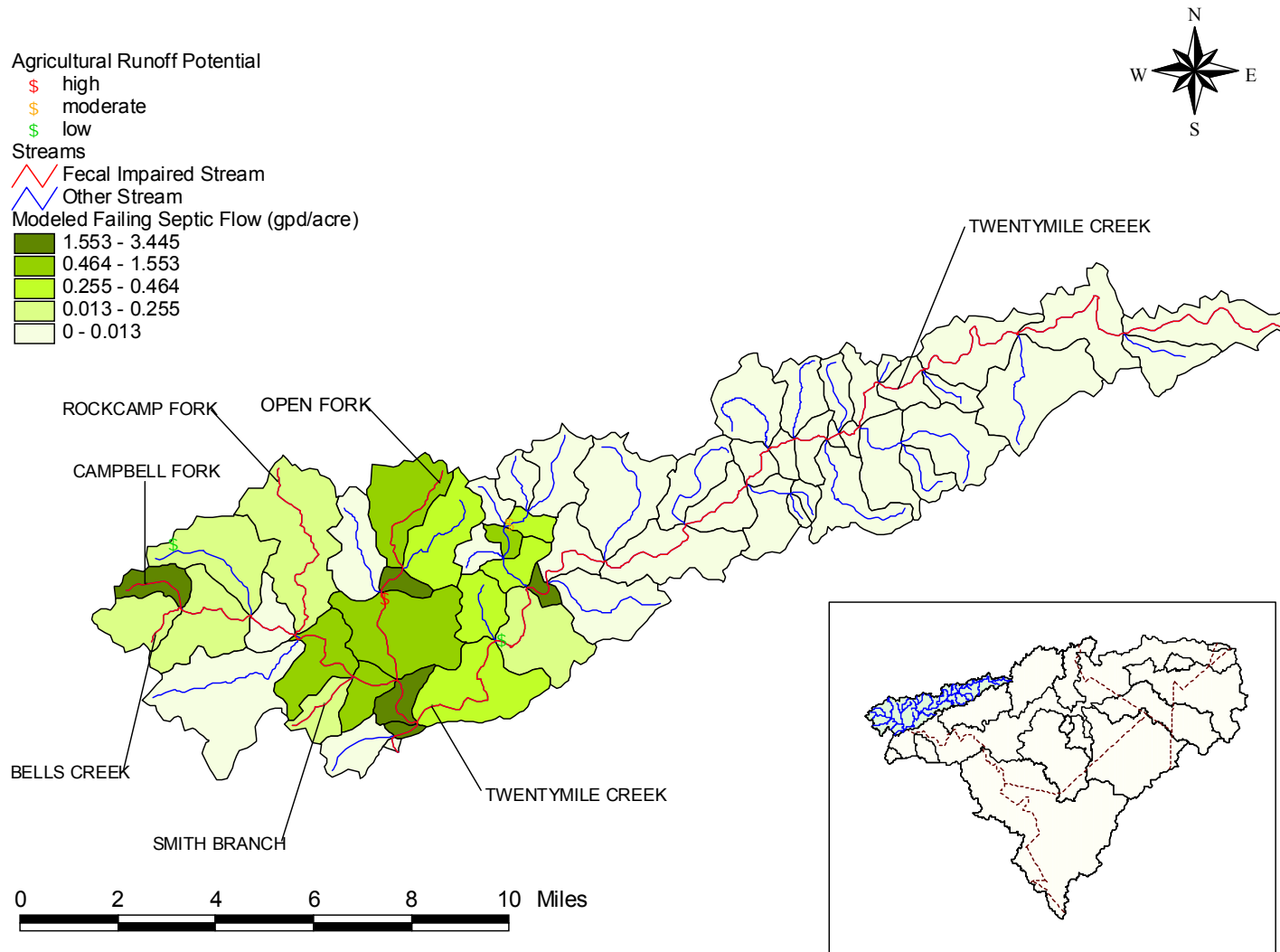


Figure A-1-4. Fecal coliform sources in the Twentymile Creek watershed

A-1.4 Stressors of Biologically Impaired Streams

The Twentymile Creek watershed has seven biologically impaired streams for which TMDLs have been developed. These streams are identified in Table A-1-1 along with the biological stressors of the streams’ benthic communities and the TMDLs required to address these impairments. A stressor identification process was used to evaluate and identify the primary stressors of impaired benthic communities. The stressor identification process is detailed in Section 7 of the main TMDL Report with additional information provided in the Technical Report. Where identified as the biological stressor, organic enrichment was linked to violations of the numeric criteria for fecal coliform bacteria. WVDEP determined that implementation of fecal coliform TMDLs would remove untreated sewage and animal waste, thereby reducing 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. All streams where the stressor identification process indicated sedimentation as a causative stressor also exhibited impairment pursuant to total iron water quality criteria. WVDEP determined that the sediment reductions that are necessary to ensure compliance with iron criteria exceed those necessary to resolve biological impairments. As such, the iron TMDLs presented for the subject waters are appropriate surrogates for necessary sediment TMDLs.

WVDEP is deferring biological TMDL development for Boardtree Branch, Sugarcamp Branch, Stillhouse Branch and Robinson Fork. The information available on the causative pollutants and associated impairment thresholds are insufficient to support TMDL development at this time.

Table A-1-1. Significant stressors of biologically impaired streams in the Twentymile Creek watershed

Stream	Biological Stressors	TMDLs Required
Twentymile Creek	Sedimentation Organic enrichment	Total iron (surrogate) Fecal coliform
Bells Creek	Sedimentation Organic enrichment	Total iron (surrogate) Fecal coliform
Open Fork	Metals toxicity (aluminum) pH toxicity (acidity)	Dissolved aluminum pH
Sangamore Fork	Metals toxicity (aluminum) pH toxicity (acidity)	Dissolved aluminum pH
Campbell Fork	Organic enrichment Sedimentation	Fecal coliform Total iron (surrogate)
Rockcamp Fork	Metals toxicity (aluminum) pH toxicity (acidity)	Dissolved aluminum pH
Spring Branch	Metals toxicity (aluminum, iron) pH toxicity (acidity)	Dissolved aluminum Total iron pH

A-1.5 TMDLs for the Twentymile Creek Watershed

A-1.5.1 TMDL Development

A top-down methodology was followed to develop these TMDLs and allocate loads to sources. Headwaters were analyzed first because they have a profound effect on downstream water quality. Loading contributions were reduced from applicable sources for these waterbodies, and TMDLs were developed. Refer to Section 8.5 of the TMDL Report for a detailed description of the allocation methodologies used in developing the pollutant-specific TMDLs.

The TMDLs for iron, aluminum, selenium, pH, and fecal coliform bacteria are shown in Tables A-1-2 through A-1-8. The TMDLs for iron and aluminum are presented as average daily loads, in pounds per day. Because the selenium impairment of Hughes Fork has been attributed to point source discharges from instream treatment structures, the TMDL is presented as an equation for the maximum daily load that is variable with receiving stream flow. The TMDLs for fecal coliform bacteria are presented in number of colonies per day. All TMDLs were developed to meet TMDL endpoints under a range of conditions observed throughout the year.

As stated in the TMDL Report, a surrogate approach was used to develop pH TMDLs. It was assumed that reductions in metals concentrations to TMDL endpoints would result in compliance with the pH water quality standard. To verify this assumption, the Dynamic Equilibrium Instream Chemical Reactions model (DESC-R) was run for an extended period under TMDL conditions—conditions where TMDL endpoints for metals were met. A median equilibrium pH was calculated based on the daily equilibrium pH output from DESC-R. The results, shown in Table A-1-5, are the TMDLs for the pH-impaired streams in the watershed.

For pH impairments associated with atmospheric deposition, TMDLs are presented as the annual net acidity load associated with maintenance of the pH TMDL endpoint. Because the source of impairment is limited to atmospheric deposition, these TMDLs incorporate only a gross load allocation. The TMDLs represent the annual net acidity loads that can be present at the downstream extent of impaired streams while maintaining the pH TMDL endpoint. Table A-1-6 shows the TMDLs for acid deposition.

A-1.6 TMDL Tables: Metals and pH

Table A-1-2. Iron TMDLs for the Twentymile Creek watershed

Major Watershed	Stream Code	Stream Name	Metal	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Twentymile Creek	WVKG-5	Twentymile Creek	Iron	242.9	331.9	30.3	605.0
Twentymile Creek	WVKG-5-A	Buckles Branch	Iron	0.4	11.2	0.6	12.1
Twentymile Creek	WVKG-5-B	Bells Creek	Iron	96.6	53.0	7.9	157.5
Twentymile Creek	WVKG-5-B-1	Open Fork	Iron	25.2	29.6	2.9	57.7
Twentymile Creek	WVKG-5-B-1-C	Sangamore Fork	Iron	6.0	15.4	1.1	22.5
Twentymile Creek	WVKG-5-B-4	Hughes Fork	Iron	16.2	15.1	1.6	32.9
Twentymile Creek	WVKG-5-B-7	Campbell Fork	Iron	1.6	NA	0.1	1.7
Twentymile Creek	WVKG-5-F-1	Spring Branch	Iron	2.0	NA	0.1	2.1
Twentymile Creek	WVKG-5-G	Lilly Branch	Iron	2.4	15.8	1.0	19.2
Twentymile Creek	WVKG-5-K	Hardaway Branch	Iron	2.7	9.3	0.6	12.6
Twentymile Creek	WVKG-5-K-2	UNT/Hardaway Branch	Iron	0.0	2.1	0.1	2.3
Twentymile Creek	WVKG-5-M	Boardtree Branch	Iron	0.0	13.2	0.7	13.9
Twentymile Creek	WVKG-5-N	Sugarcamp Branch	Iron	0.2	23.0	1.2	24.4
Twentymile Creek	WVKG-5-O	Stillhouse Branch	Iron	0.0	9.0	0.5	9.4
Twentymile Creek	WVKG-5-P	Robinson Fork	Iron	2.2	49.1	2.7	54.0
Twentymile Creek	WVKG-5-P.5	UNT/Twentymile Creek	Iron	0.0	2.3	0.1	2.5
Twentymile Creek	WVKG-5-P-4	UNT/Robinson Fork RM 1.22	Iron	1.5	3.2	0.2	5.0
Twentymile Creek	WVKG-5-R	Rader Fork	Iron	10.1	16.5	1.4	28.0

UNT = unnamed tributary, RM = river mile, NA = not applicable

Table A-1-3. Aluminum TMDLs for the Twentymile Creek watershed

Major Watershed	Stream Code	Stream Name	Metal	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	TMDL (lbs/day)
Twentymile Creek	WVKG-5-B-1	Open Fork	Aluminum	32.2	3.1	1.9	37.2
Twentymile Creek	WVKG-5-B-1-B	Williams Hollow	Aluminum	4.7	NA	0.2	4.9
Twentymile Creek	WVKG-5-B-1-C	Sangamore Fork	Aluminum	5.0	1.6	0.3	6.9
Twentymile Creek	WVKG-5-F	Rockcamp Fork	Aluminum	16.5	NA	0.9	17.4
Twentymile Creek	WVKG-5-F-1	Spring Branch	Aluminum	1.4	NA	0.1	1.4

UNT = unnamed tributary, RM = river mile, NA = not applicable

Table A-1-4. Selenium TMDL for the Twentymile Creek watershed

Major Watershed	Stream Code	Stream Name	Metal	Load Allocation (ug/l)	Wasteload Allocation (ug/l)	Margin of Safety (ug/l)	TMDL (ug/l)
Twentymile Creek	WVKG-5-B-4	Hughes Fork	Selenium	NA	5.0	Implicit	5.0

Table A-1-5. pH TMDLs for the Twentymile Creek watershed

Major Watershed	Stream Code	Stream Name	Parameter	pH*
				(Under TMDL conditions)
Twentymile Creek	WVKNG-5-B-1	Open Fork	pH	6.98
Twentymile Creek	WVKNG-5-B-1-B	Williams Hollow	pH	6.99
Twentymile Creek	WVKNG-5-B-1-C	Sangamore Fork	pH	6.95
Twentymile Creek	WVKNG-5-F	Rockcamp Fork	pH	6.96
Twentymile Creek	WVKNG-5-F-1	Spring Branch	pH	7.37

UNT = unnamed tributary

*Predicted pH assumes that all metals (aluminum, iron) meet TMDL endpoints.

Table A-1-6. Acid deposition TMDLs for the Twentymile Creek watershed

Major Watershed	Stream Name	Stream Code	Baseline Average Annual Net Acidity Load (ton/yr)	Allocated Average Annual Net Acidity Load (ton/yr)
Twentymile Creek	Twentymile Creek above Deal Fork	WVKG-5	1.30	1.01

A-1.7 TMDL Tables: Fecal Coliform Bacteria

Table A-1-7. Fecal coliform bacteria TMDLs for the Twentymile Creek watershed

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation	Wasteload Allocation	Margin of Safety	TMDL
				(counts/Day)	(counts/Day)	(counts/Day)	(counts/Day)
Twentymile Creek	WVKG-5	Twentymile Creek	Fecal coliform	1.81E+11	NA	9.54E+09	1.91E+11
Twentymile Creek	WVKG-5-B	Bells Creek	Fecal coliform	6.80E+10	NA	3.58E+09	7.16E+10
Twentymile Creek	WVKG-5-B-1	Open Fork	Fecal coliform	2.67E+10	NA	1.40E+09	2.81E+10
Twentymile Creek	WVKG-5-B-2	Smith Branch	Fecal coliform	1.93E+09	NA	1.02E+08	2.03E+09
Twentymile Creek	WVKG-5-B-5	Rockcamp Fork	Fecal coliform	6.87E+09	NA	3.62E+08	7.23E+09
Twentymile Creek	WVKG-5-B-7	Campbell Fork	Fecal coliform	2.31E+09	NA	1.21E+08	2.43E+09

NA = not applicable; UNT = unnamed tributary.

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

A-1.8 TMDL Tables: Biological

Table A-1-8. Biological TMDLs for the Twentymile Creek watershed

Stream	Biological Stressor	Parameter	Load Allocation	Wasteload Allocation	Margin of Safety	TMDL	Units
Twentymile Creek (WVKG-5)	Sedimentation	Total iron (surrogate)	242.9	331.9	30.3	605.0	lbs/day
	Organic enrichment	Fecal coliform	1.81E+11	NA	9.54E+09	1.91E+11	Counts/Day
Bells Creek (WVKG-5-B)	Sedimentation	Total iron (surrogate)	96.6	53.0	7.9	157.5	lbs/day
	Organic enrichment	Fecal coliform	6.80E+10	NA	3.58E+09	7.16E+10	Counts/Day
Open Fork (WVKG-5-B-1)	Metals toxicity	Total aluminum	32.2	3.1	1.9	37.2	lbs/day
	pH toxicity	pH (acidity)	Not Applicable			6.98	Standard Units
Sangamore Fork (WVKNG-5-B-1-C)	Metals toxicity	Total aluminum	5.0	1.6	0.3	6.9	lbs/day
	pH toxicity	pH (acidity)	Not Applicable			6.95	Standard Units
Campbell Fork (WVKG-5-B-7)	Organic enrichment	Fecal coliform	2.31E+09	NA	1.21E+08	2.43E+09	Counts/Day
	Sedimentation	Total iron (surrogate)	1.6	NA	0.1	1.7	lbs/day
Rockcamp Fork (WVKNG-5-F)	Metals toxicity	Total aluminum	16.5	NA	0.9	17.4	lbs/day
	pH toxicity	pH (acidity)	Not Applicable			6.96	Standard Units
Spring Branch (WVKNG-5-F-1)	Metals toxicity	Total aluminum	1.4	NA	0.1	1.4	lbs/day
		Total iron	2.0	NA	0.1	2.1	lbs/day
	pH toxicity	pH (acidity)	Not Applicable			7.37	Standard Units

NA = not applicable; UNT = unnamed tributary.

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