APPENDIX 4

A-4. MUDDLETY CREEK

A-4.1 Watershed Information

Muddlety Creek is in the northern portion of the Gauley River watershed and drains approximately 66.8 square miles (42,761 acres), as shown in Figure A-4-1. The dominant landuse in the watershed is forest, which covers 79.0 percent of the watershed. Other important landuse types include grassland (10.0 percent), AML land (3.6 percent), urban/residential (3.3 percent), and mining (2.2 percent). All other individual land cover types account for less than 2 percent of the total watershed area. There are 10 impaired streams in the watershed, including Brushy Fork that was identified by WVDEP as a troutwater, which are addressed in this TMDL development effort. Figure A-4-2 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 41 stations (station locations can be viewed using the ArcExplorer project) throughout the Muddlety 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.

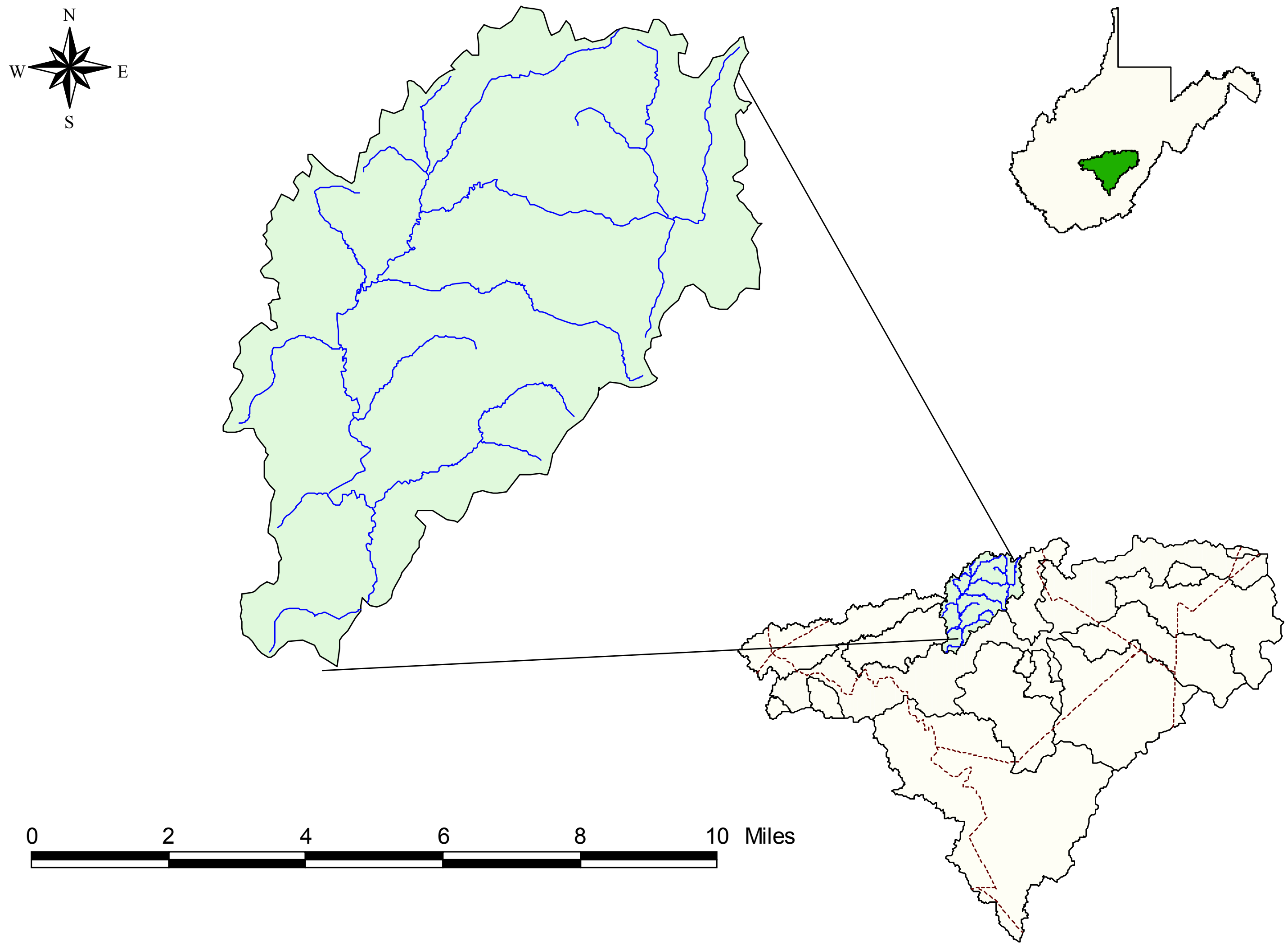
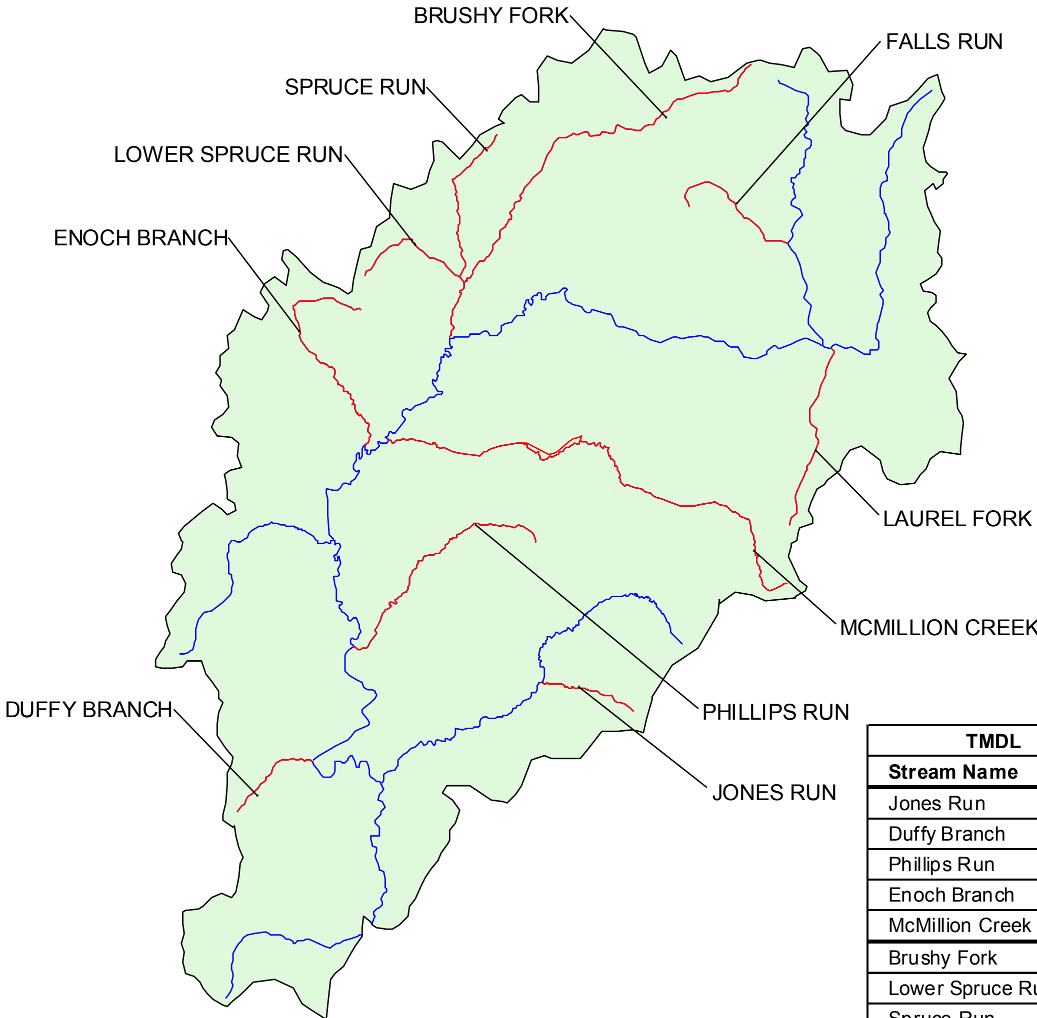


Figure A-4-1. Location of the Muddlety Creek watershed



TMDL	Impairment					
Stream Name	**Fe**	**Al**	**pH**	**Se**	**FC**	**BIO**
Jones Run					x	x
Duffy Branch	x					
Phillips Run	x					
Enoch Branch	x					
McMillion Creek	x					
Brushy Fork	x					
Lower Spruce Run	x					
Spruce Run	x	x	x			
Falls Run			x			
Laurel Fork	x					

Figure A-4-2. Waterbodies and impairments under TMDL development in the Muddlety Creek watershed

A-4.2 Metals and pH Sources

This section identifies and examines the potential sources of aluminum, iron, and pH impairment in the Muddlety 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 potential 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-4-3.

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-4-3 (e.g., agricultural areas and unpaved roads), specific details relative to these sources are discussed in section A-4.2.2.

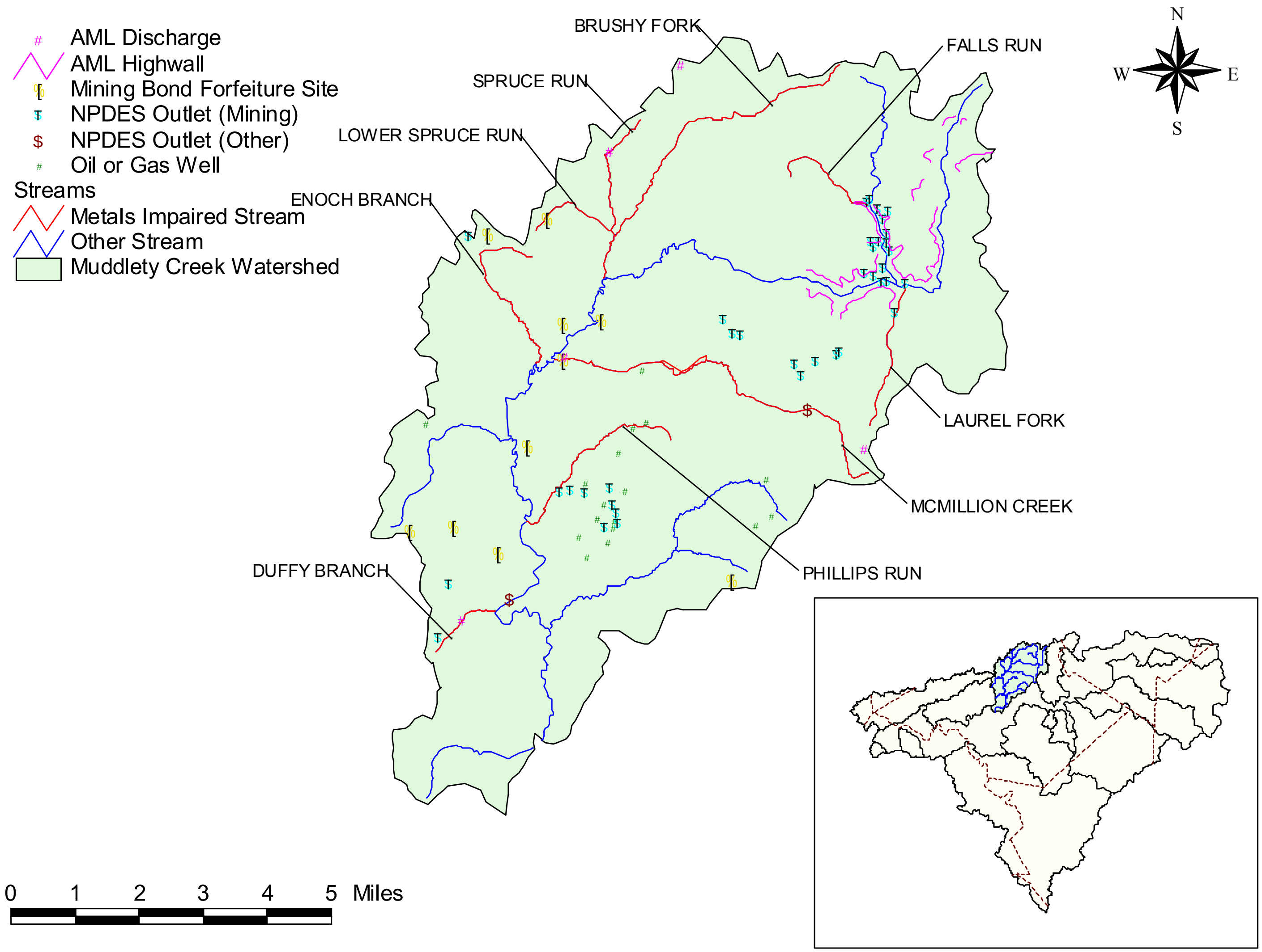
The pH impairment of Falls Run has been attributed to acid precipitation and low watershed buffering capacity. Pre-TMDL monitoring in that watershed demonstrated extremely low specific conductance and no iron, aluminum or biological impairments. In addition to water quality monitoring, WVDEP performed source tracking throughout the watersheds of the impaired streams and did not identify land based acidic pH sources.

A-4.2.1 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 Muddlety Creek watershed there are 11 mining-related NPDES outlets. 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 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 Muddlety Creek watershed. The Technical Report also contains specific data for each permitted outlet (including effluent type, drainage areas, and 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.

There is one non-mining point source present in the watershed. The Multi-Sector Stormwater General Permit regulates a discharge from the facility that is subject to a benchmark value for iron.



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

Figure A-4-3. Metals sources in the Muddlety Creek watershed

A-4.2.2 Metals Nonpoint Source Inventory

In addition to point sources, nonpoint sources also contribute to metals-related water quality impairments in the Muddlety 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 Muddlety 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 Muddlety 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 Muddlety Creek watershed. In addition, source tracking efforts by WVDEP’s Division of Water and Waste Management identified and characterized 6 abandoned mine sources (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. There are 3 bond forfeiture sites that comprise approximately 117 acres in the Muddlety Creek watershed.

Land-Disturbing Activities

Based on the modified modeling landuse coverage, only 210 acres of the Muddlety Creek watershed contain row crop agriculture, representing a very small fraction of the total watershed area. During the pre-TMDL sampling period there were no active timber harvest areas in the watershed. The watershed contains 7 active oil and gas wells, which, based on the survey by WVDEP’s Office of Oil and Gas, are estimated to comprise 10 acres. 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 150.8 miles of paved roads and 132.3 miles of unpaved roads in the Muddlety Creek watershed.

A-4.3 Fecal Coliform Bacteria Sources

Jones Run is the only stream in the watershed that has been identified as impaired pursuant to fecal coliform bacteria. This section identifies and examines the potential sources of fecal coliform bacteria in the Jones Run 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-4.3.1 Fecal Coliform Bacteria Point Sources

There are no point source discharges of fecal coliform bacteria in the Jones Run watershed.

A-4.3.2 Fecal Coliform Bacteria Nonpoint Sources

The only significant fecal coliform bacteria nonpoint sources in the Jones Run watershed are those associated with failing septic systems. Agricultural landuse is negligible, as are impacts from stormwater runoff from residential areas.

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.

A-4.4 Stressors of Biologically Impaired Streams

Jones Run is also the only identified biologically-impaired stream in the Muddlety Creek watershed. A stressor identification process was used to evaluate and identify the primary stressors of impaired benthic communities. The stressor identification process is detailed in the TMDL Report with additional information provided in the Technical Report

The biological impairment of Jones Run has been attributed to organic enrichment. WVDEP determined that implementation of Jones Run fecal coliform TMDL would remove untreated sewage and reduce the organic and nutrient loading causing the biological impairment. Therefore, the fecal coliform TMDL serves as a surrogate for the Jones Run biological impairment TMDL.

A-4.5 TMDLs for the Muddlety Creek Watershed

A-4.5.1 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 the TMDL Report for a detailed description of the allocation methodologies used in developing the pollutant specific TMDLs.

The TMDLs for iron, aluminum, and fecal coliform bacteria, are shown in Tables A-4-1 through A-4-6. The TMDLs for iron and aluminum are presented as annual average loads, in pounds per year. The TMDLs for fecal coliform bacteria are presented in number of colonies per year. All TMDLs are presented as average annual loads because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year.

A surrogate approach was used to develop the pH TMDL for Spruce Run. It was assumed that reductions in metals concentrations to iron and aluminum 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-4-3, are the TMDLs for the pH-impaired streams in the watershed. Refer to the Technical Report for a detailed description of the pH modeling approach.

The pH impairment in Falls Run is 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.

A-4.6 TMDL Tables: Metals and pH

Table A-4-1. Iron TMDLs for the Muddlety 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)
Muddlety Creek	WVKG-26-C	Duffy Branch	Iron	5.5	1.1	0.4	7.0
Muddlety Creek	WVKG-26-D	Phillips Run	Iron	19.5	3.6	1.2	24.3
Muddlety Creek	WVKG-26-H	Enoch Branch	Iron	13.5	3.9	0.9	18.3
Muddlety Creek	WVKG-26-I	McMillion Creek	Iron	55.2	4.7	3.2	63.1
Muddlety Creek	WVKG-26-K	Brushy Fork	Iron	32.2	0.8	1.7	34.7
Muddlety Creek	WVKG-26-K-1	Lower Spruce Run	Iron	10.6	0.2	0.6	11.4
Muddlety Creek	WVKG-26-K-1-A	Spruce Run	Iron	6.4	0.1	0.3	6.9
Muddlety Creek	WVKG-26-P	Laurel Fork	Iron	2.8	15.0	0.9	18.7

Table A-4-2. Aluminum TMDLs for the Muddlety 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)
Muddlety Creek	WVKG-26-K-1-A	Spruce Run	Aluminum	6.6	NA	0.3	7.0

Table A-4-3. pH TMDLs for the Muddlety Creek watershed

Major Watershed	Stream Code	Stream Name	Parameter	pH* (Under TMDL conditions)
Muddlety Creek	WVKG-26-K-1	Spruce Run	pH	7.01

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

Table A-4-4. Acid deposition TMDLs for Falls Run

Major Watershed	Stream Name	Stream Code	Baseline Average Annual Net Acidity Load (ton/yr)	Allocated Average Annual Net Acidity Load (ton/yr)
Muddlety Creek	Falls Run	WVKG-26-O-2	0.91	0.50

A-4.7 TMDL Tables: Fecal Coliform Bacteria

Table A-4-5. Fecal coliform bacteria TMDLs for the Muddlety Creek watershed

Major Watershed	Stream Code	Stream Name	Parameter	Load Allocation (counts/day)	Wasteload Allocation (counts/day)	Margin of Safety (counts/day)	TMDL (counts/day)
Muddlety Creek	WVKG-26-B-2	Jones Run	Fecal coliform	4.14E+09	NA	2.18E+08	4.36E+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-4.8 TMDL Tables: Biological

Table A-4-6. Biological TMDLs for the Muddlety Creek watershed

Stream	Biological Stressor	Parameter	Load Allocation	Wasteload Allocation	Margin of Safety	TMDL	Units
Jones Run	Organic enrichment	Fecal coliform	4.14E+09	NA	2.18E+08	4.36E+09	(counts/day)

NA = not applicable