# APPENDIX 6

## A-6. SPRUCE FORK

### A-6.1 Watershed Information

Spruce Fork is in the southwestern portion of the Coal River watershed and drains approximately 126.4 square miles (80,889 acres), as shown in Figure A-6-1. The dominant landuse in the watershed is forest, which covers 70.2 percent of the watershed. Other important landuse types include urban/residential (0.96 percent) and barren/mining land (16.8 percent). All other individual land cover types account for less than 13 percent of the total watershed area. There are 26 impaired streams, including Spruce Fork, in the watershed. Figure A-6-2 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 Coal River watershed to better characterize water quality and refine impairment listings. Monthly samples were taken at 70 stations (station locations can be viewed using the ArcExplorer project) throughout the Spruce Fork watershed from July 1, 2002, through June 30, 2003. 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, total manganese, 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.

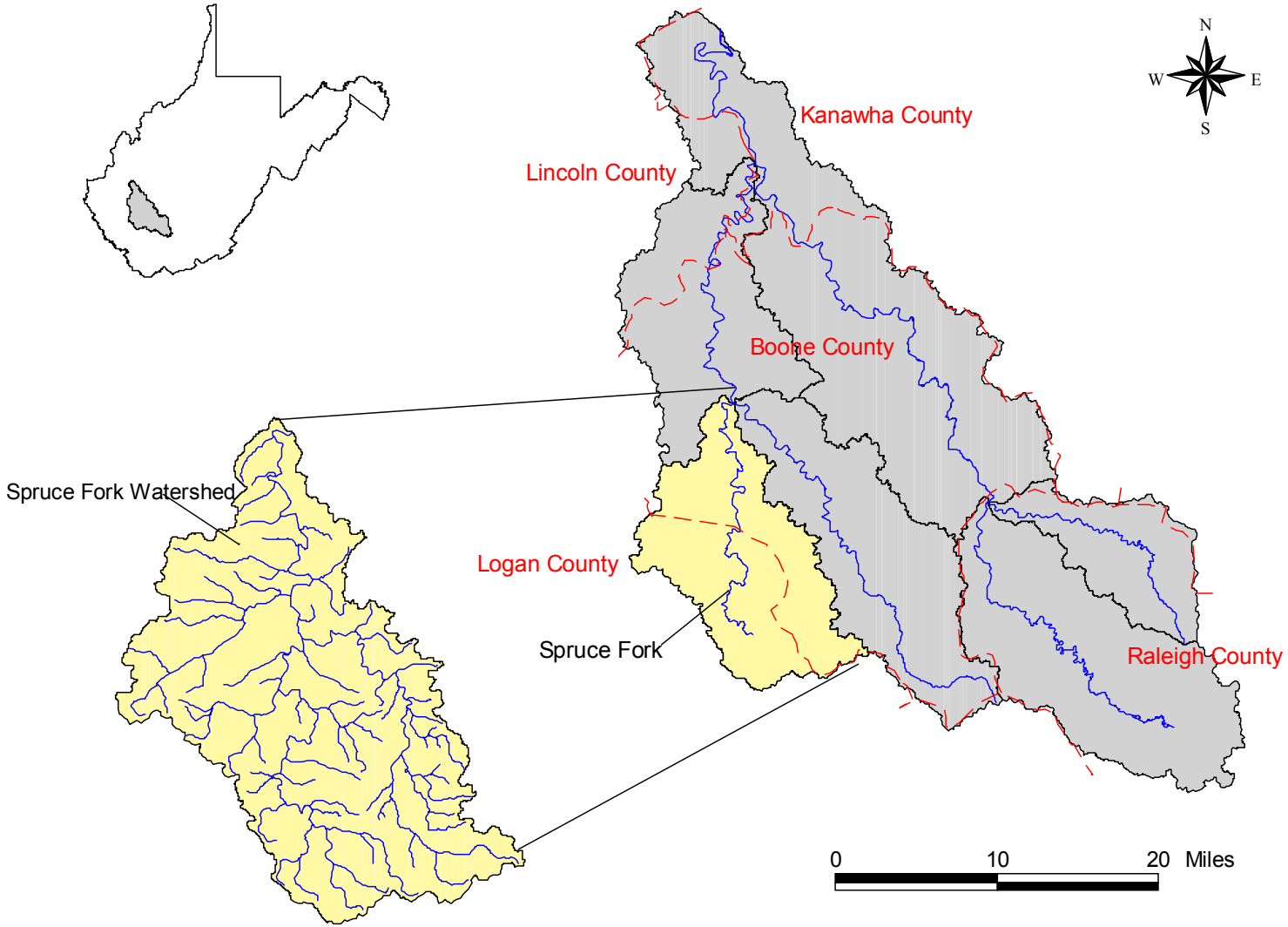
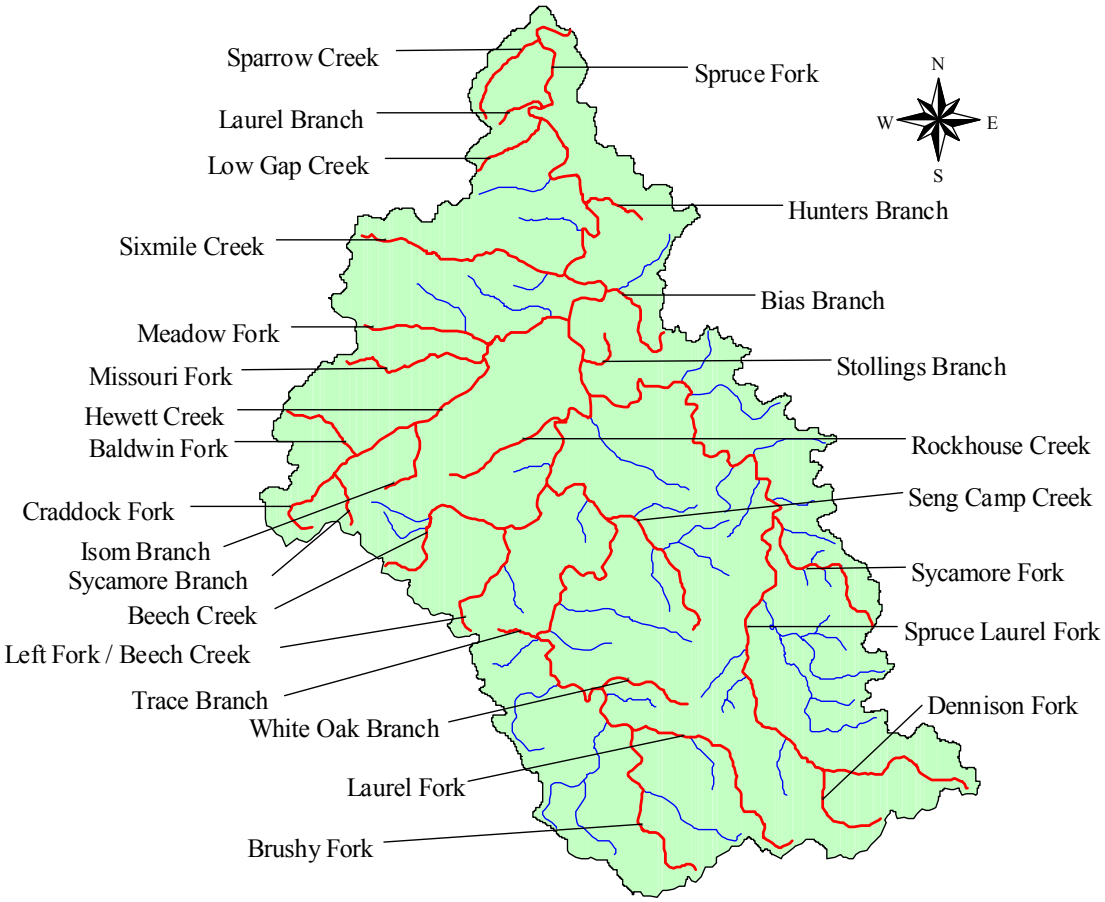



**Figure A-6-1.** Location of the Spruce Fork watershed.




| Stream | Aluminum | Iron | pH | Selenium | Biological | Fecal Coliforms | Sediment |
|---|---|---|---|---|---|---|---|
| Spruce Fork | X | X | | | | X | |
| Sparrow Creek | | | | | | X | |
| Laurel Branch | | | | | | X | |
| Low Gap Creek | | | | | | X | |
| Hunters Branch | X | X | X | | | | |
| Sixmile Creek | | | | | | X | |
| Bias Branch | | X | | | X | X | |
| Hewett Creek | X | X | | | | X | |
| Meadow Fork | | | | | | X | |
| Missouri Fork | | | | | X | X | |
| Isom Branch | | | | | | X | |
| Craddock Fork | | X | | | | X | |
| Sycamore Branch | | | | | | X | |
| Baldwin Fork | | X | | | X | X | X |
| Stollings Branch | | | | | | X | |
| Spruce Laurel Fork | X | X | | | X | | X |
| Sycamore Fork | | X | | | | | |
| Dennison Fork | | X | | | | | |
| Rockhouse Creek | | X | | | | X | |
| Beech Creek | | X | | X | | | |
| Left Fork/Beech Creek | | X | | X | | | |
| Seng Camp Creek | | X | | | | | |
| Trace Branch | | X | | X | | | |
| White Oak Branch | | X | | | | | |
| Laurel Fork | | X | | | | | |
| Brushy Fork | | X | | | | | |

**Figure A-6-2.** Waterbodies and impairments under TMDL development in the Spruce Fork watershed.

## A-6.2 Metals and pH Sources

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

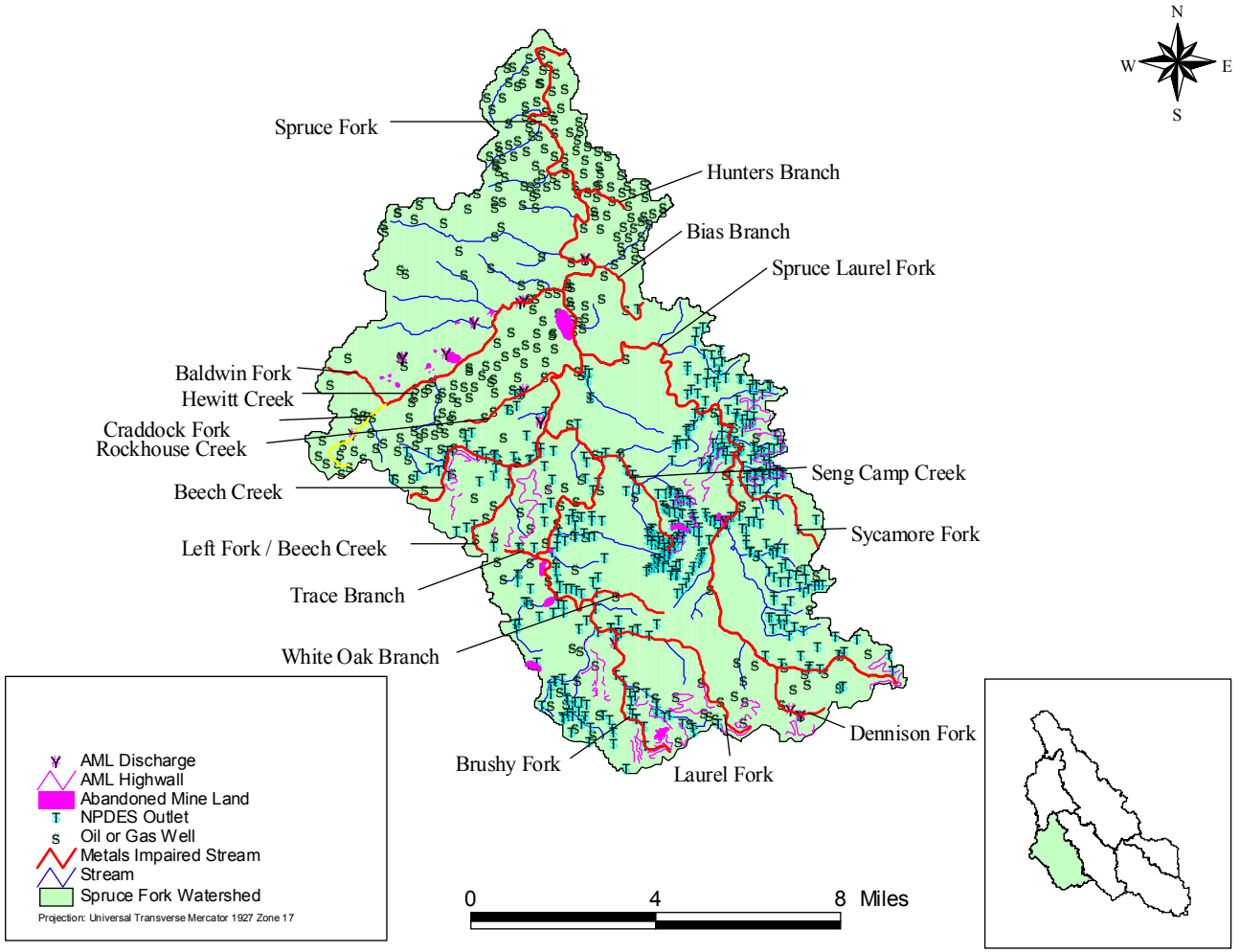
Pollutant sources were identified using statewide geographic information system (GIS) coverages of point and non-point sources, and through field reconnaissance. As part of the TMDL process, WVDEP documented pollution sources by describing the pollutant source in detail, collecting Global Positioning 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-6-3.

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. Control of sediment-producing sources might be necessary to meet water quality criteria for dissolved aluminum and total iron during critical high flow conditions. Although some of these sediment-producing sources are not shown in Figure A-6-3 (e.g., harvested forest areas and unpaved roads), specific details relative to these sources are discussed in section A-6.2.2.

There are three streams in the Spruce Fork watershed that are impaired for selenium: Beech Creek, Left Fork of Beech Creek, and Trace Branch. Selenium is a naturally occurring element that is found in marine sedimentary rocks, coal and other fossil fuel deposits. In West Virginia, coals that contain the highest selenium concentrations are found in a region of south central West Virginia where the Allegheny and upper Kanawha Formations of the Middle Pennsylvanian are mined (WVGES 2002). As stated in Section 4.3, sources of selenium impairment are limited to mining-related point sources.

### A-6.2.1 Metals Point Source Inventory

As described in the main 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.




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

**Figure A-6-3.** Metals sources in the Spruce Fork watershed.

In the Spruce Fork watershed, all NPDES permits for metals effluents are 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. There are 517 mining-related NPDES outlets in the Spruce Fork watershed. 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 Spruce Fork 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.

### A-6.2.2 Metals Non-point Source Inventory

In addition to point sources, non-point sources also contribute to metals-related water quality impairments in the Spruce Fork watershed. Non-point 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 non-point 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 Spruce Fork watershed are discussed below.

#### *Abandoned Mine Lands and Bond Forfeiture Sites*

Based on the identification of a number of abandoned mining activities in the Spruce Fork 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 Spruce Fork watershed. In addition, source-tracking efforts by WVDEP's Division of Water and Waste Management identified and characterized 16 abandoned mine sources (discharges, seeps, portals, and ponds).

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 no bond forfeiture sites in the Spruce Fork watershed.

#### *Land-Disturbing Activities*

Based on the GAP 2000 landuse coverage, there are no agricultural areas in the Spruce Fork watershed. There are three active logging operations in the watershed. The disturbed areas associated with these operations are estimated to cover 228 acres (0.3 percent) of the total watershed area. The watershed contains 141 active oil and gas wells, which, based on the survey by WVDEP's Office of Oil and Gas, are estimated to comprise 195 acres (0.2 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 474.4 miles of paved roads and 60.4 miles of unpaved roads in the Spruce Fork watershed.

## A-6.3 Fecal Coliform Bacteria Sources

This section identifies and examines the potential sources of fecal coliform bacteria in the Spruce Fork watershed. Sources can be classified as point sources (specific sources subject to a permit) or non-point sources (diffuse sources). Point sources of fecal coliform bacteria are classified by several different types of sewage permits and the point source discharges regulated in them. Non-point sources are diffuse, non-permitted sources.

### A-6.3.1 Fecal Coliform Bacteria Point Sources

Permitted sources of fecal coliform bacteria that experience effluent overflows or that do not comply with permit limits can cause occasional high loadings of fecal coliform bacteria in receiving streams. In the Spruce Fork watershed there is one discharge permit, which is a general sewage permit (WVG551110) for Ramage Elementary School.

### A-6.3.2 Non-point (Non-permitted) Fecal Coliform Bacteria Sources

Pollutant source-tracking by WVDEP personnel identified scattered areas of high population density without access to public sewers in the Spruce Fork 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). The West Virginia Bureau for Public Health estimates the septic tank failure rate in this area to be 70 percent in the first 10 years after installation (WV Bureau for Public Health 2003). An analysis of census data from the 1990 Census combined with WVDEP source-tracking information yielded an estimate of 3,998 people living in the unsewered homes in the Spruce Fork watershed. Figure A-6-4 shows the estimated distribution of the unsewered population in the watershed.

Stormwater runoff is another potential non-point 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 Spruce Fork watershed that consists of residential and agricultural areas, and the low fecal coliform bacteria accumulation rates for forested areas, stormwater runoff from these areas is not considered a significant non-point source of fecal coliform bacteria, except in localized areas.

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 the Division of Natural Resources. Although wildlife contributions of fecal coliform bacteria were considered in modeling, they were not found to be a significant source.

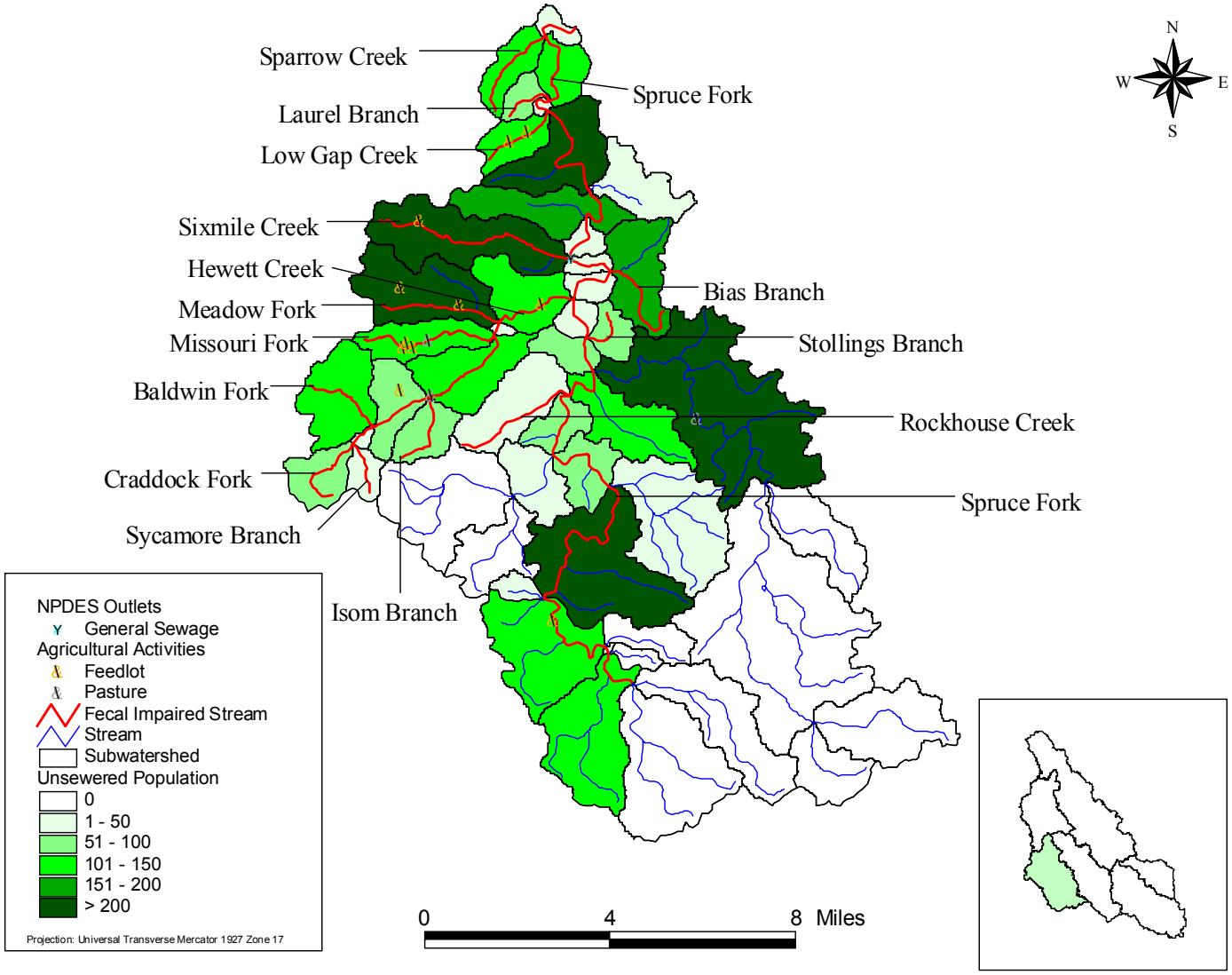



**Figure A-6-4.** Fecal coliform sources in the Spruce Fork watershed.

## A-6.4 Stressors of Biologically Impaired Streams

The Spruce Fork watershed has four biologically impaired streams for which TMDLs have been developed. These streams are identified in Table A-6-1 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. Refer to the main report for a detailed description of the stressor identification process. WVDEP is deferring biological TMDL development for Rockhouse Creek and Left Fork/Beach Creek. The information available on the causative pollutants and associated impairment thresholds is insufficient to support TMDL development at this time.

**Table A-6-1.** Primary stressors of biologically impaired streams in the Spruce Fork watershed

| Stream | Biological Stressors | TMDLs Required |
|---|---|---|
| Bias Branch | Organic enrichment | Fecal coliform |
| Missouri Fork | Organic enrichment | Fecal coliform |
| Baldwin Fork | Organic enrichment<br>Sedimentation | Fecal coliform<br>Sediment |
| Spruce Laurel Fork | Metal toxicity (iron)<br>Sedimentation | Iron<br>Sediment |

TMDLs for each specific biological stressor are shown in Table A-6-7. Sediment TMDLs are required only when the stressor identification process indicates that a sedimentation problem is impairing the biological community. Sediment TMDLs are presented for Baldwin Fork, and Spruce Laurel Fork. Refer to section A-6.2.2 for additional sediment source information.

## A-6.5 TMDLs for the Spruce Fork Watershed

### A-6.5.1 TMDL Development

TMDLs and source allocations were developed for impaired streams in the Spruce Fork watershed. 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 7.5 of the main report for a detailed description of the allocation methodologies used in developing the pollutant-specific TMDLs.

The TMDLs for iron, aluminum, selenium, pH, fecal coliform bacteria, and sediment are shown in Tables A-6-2 through A-6-7. The TMDLs for iron and aluminum are presented as annual average loads, in pounds per year. The TMDLs for sediment are presented of tonnes 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.

Because the primary sources contributing to selenium impairments are the point sources at a low flow 7Q10 condition of 0 cfs, the non-point source contributions of selenium were considered negligible. Therefore, the TMDLs were based on wasteload allocations assigned at water quality criteria for selenium (5.0 ug/L) at end-of-pipe for the surface mining discharging upstream of the 7Q10 condition of 0 cfs. The selenium TMDLs are shown in Table A-6-4.

As stated in Section 7.4.1, 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 In-stream Chemical Reactions model (DESC-R) was run for an extended period under TMDL conditions—conditions in which 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-6-5, 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.

## A-6.6 TMDL Tables: Metals and pH

**Table A-6-2.** Iron TMDLs for the Spruce Fork watershed

| Major Watershed | Stream Code | Stream Name | Metal | Load Allocation (lbs/yr) | Wasteload Allocation (lbs/yr) | Margin of Safety (lbs/yr) | TMDL (lbs/yr) |
|---|---|---|---|---|---|---|---|
| Spruce Fork | WVKC-10-T | Spruce Fork | Iron | 114,052 | 176,246 | 15,279 | 305,577 |
| Spruce Fork | WVKC-10-T-11 | Spruce Laurel Fork | Iron | 26,834 | 76,332 | 5,430 | 108,595 |
| Spruce Fork | WVKC-10-T-11-F | Sycamore Fork | Iron | 1,337 | 8,197 | 502 | 10,036 |
| Spruce Fork | WVKC-10-T-11-K | Dennison Fork | Iron | 1,994 | 12 | 106 | 2,111 |
| Spruce Fork | WVKC-10-T-13 | Rockhouse Creek | Iron | 1,897 | 6,663 | 451 | 9,010 |
| Spruce Fork | WVKC-10-T-15 | Beech Creek | Iron | 5,574 | 26,259 | 1,675 | 33,508 |
| Spruce Fork | WVKC-10-T-15-A | Left Fork/Beech Creek | Iron | 2,015 | 299 | 122 | 2,437 |
| Spruce Fork | WVKC-10-T-16 | Seng Camp Creek | Iron | 2,018 | 16,812 | 991 | 19,821 |
| Spruce Fork | WVKC-10-T-19 | Trace Branch | Iron | 129 | 1,925 | 108 | 2,162 |
| Spruce Fork | WVKC-10-T-22 | White Oak Branch | Iron | 1,002 | 1,555 | 135 | 2,691 |
| Spruce Fork | WVKC-10-T-24 | Brushy Fork | Iron | 4,363 | 10,743 | 795 | 15,901 |
| Spruce Fork | WVKC-10-T-25 | Laurel Fork | Iron | 4,012 | 1,182 | 273 | 5,467 |
| Spruce Fork | WVKC-10-T-5 | Hunters Branch | Iron | 1,751 | NA | 92 | 1,843 |
| Spruce Fork | WVKC-10-T-8 | Bias Branch | Iron | 2,524 | 1,633 | 219 | 4,376 |
| Spruce Fork | WVKC-10-T-9 | Hewett Creek | Iron | 24,301 | NA | 1,279 | 25,580 |
| Spruce Fork | WVKC-10-T-9-C | Craddock Fork | Iron | 3,159 | NA | 166 | 3,325 |
| Spruce Fork | WVKC-10-T-9-D | Baldwin Fork | Iron | 3,050 | NA | 161 | 3,211 |

NA = not applicable.

**Table A-6-3.** Aluminum TMDLs for the Spruce Fork watershed

| Major Watershed | Stream Code | Stream Name | Metal | Load Allocation (lbs/yr) | Wasteload Allocation (lbs/yr) | Margin of Safety (lbs/yr) | TMDL (lbs/yr) |
|---|---|---|---|---|---|---|---|
| Spruce Fork | WVKC-10-T | Spruce Fork | Aluminum | 18,512 | 41,915 | 3,180 | 63,608 |
| Spruce Fork | WVKC-10-T-11 | Spruce Laurel Fork | Aluminum | 3,684 | 14,591 | 962 | 19,236 |
| Spruce Fork | WVKC-10-T-5 | Hunters Branch | Aluminum | 300 | NA | 16 | 316 |
| Spruce Fork | WVKC-10-T-9 | Hewett Creek | Aluminum | 4,162 | NA | 219 | 4,382 |

NA = not applicable.

**Table A-6-4.** Selenium TMDLs for the Spruce Fork watershed

| Major Watershed | Stream Code | Stream Name | Metal | Load Allocation (ug/L) | Wasteload Allocation (ug/L) | Margin of Safety (ug/L) | TMDL (ug/L) |
|---|---|---|---|---|---|---|---|
| Spruce Fork | WVKC-10-T-15 | Beech Creek | Selenium | NA | 5.0 | Implicit | 5.0 |
| Spruce Fork | WVKC-10-T-15-A | Left Fork/Beech Creek | Selenium | NA | 5.0 | Implicit | 5.0 |
| Spruce Fork | WVKC-10-T-19 | Trace Branch | Selenium | NA | 5.0 | Implicit | 5.0 |

NA = not applicable.

**Table A-6-5.** pH TMDLs for the Spruce Fork watershed

| Major Watershed | Stream Code | Stream Name | Parameter | pH* (Under TMDL conditions) |
|---|---|---|---|---|
| Spruce Fork | WVKC-10-T-5 | Hunters Branch | pH | 7.23 |

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

## A-6.7 TMDL Tables: Fecal Coliform Bacteria

**Table A-6-6.** Fecal coliform bacteria TMDLs for the Spruce Fork watershed

| Major Watershed | Stream Code | Stream Name | Parameter | Load Allocation (counts/yr) | Wasteload Allocation (counts/yr) | Margin of Safety (counts/yr) | TMDL (counts/yr) |
|---|---|---|---|---|---|---|---|
| Spruce Fork | WVKC-10-T | Spruce Fork | Fecal coliform | 1.15E+14 | 2.77E+10 | 6.06E+12 | 1.21E+14 |
| Spruce Fork | WVKC-10-T-1 | Sparrow Creek | Fecal coliform | 8.04E+11 | NA | 4.23E+10 | 8.47E+11 |
| Spruce Fork | WVKC-10-T-10 | Stollings Branch | Fecal coliform | 9.61E+11 | NA | 5.06E+10 | 1.01E+12 |
| Spruce Fork | WVKC-10-T-13 | Rockhouse Creek | Fecal coliform | 3.73E+12 | NA | 1.96E+11 | 3.92E+12 |
| Spruce Fork | WVKC-10-T-2 | Laurel Branch | Fecal coliform | 3.70E+11 | NA | 1.95E+10 | 3.89E+11 |
| Spruce Fork | WVKC-10-T-3 | Low Gap Creek | Fecal coliform | 1.07E+12 | NA | 5.62E+10 | 1.12E+12 |
| Spruce Fork | WVKC-10-T-7 | Sixmile Creek | Fecal coliform | 2.70E+12 | NA | 1.42E+11 | 2.84E+12 |
| Spruce Fork | WVKC-10-T-8 | Bias Branch | Fecal coliform | 1.49E+12 | NA | 7.82E+10 | 1.56E+12 |
| Spruce Fork | WVKC-10-T-9 | Hewett Creek | Fecal coliform | 1.59E+13 | NA | 8.39E+11 | 1.68E+13 |
| Spruce Fork | WVKC-10-T-9-A | Meadow Fork | Fecal coliform | 2.15E+12 | NA | 1.13E+11 | 2.26E+12 |
| Spruce Fork | WVKC-10-T-9-B | Missouri Fork | Fecal coliform | 1.43E+12 | NA | 7.51E+10 | 1.50E+12 |
| Spruce Fork | WVKC-10-T-9-B.5 | Isom Branch | Fecal coliform | 9.85E+11 | NA | 5.19E+10 | 1.04E+12 |
| Spruce Fork | WVKC-10-T-9-C | Craddock Fork | Fecal coliform | 1.24E+12 | NA | 6.51E+10 | 1.30E+12 |
| Spruce Fork | WVKC-10-T-9-C-2 | Sycamore Branch | Fecal coliform | 3.67E+11 | NA | 1.93E+10 | 3.87E+11 |
| Spruce Fork | WVKC-10-T-9-D | Baldwin Fork | Fecal coliform | 1.89E+12 | NA | 9.93E+10 | 1.99E+12 |

NA = not applicable.

## A-6.8 TMDL Tables: Biological

**Table A-6-7.** Biological TMDLs for the Spruce Fork watershed

| Stream | Biological Stressor | Parameter | Load Allocation | Wasteload Allocation | Margin of Safety | TMDL | Units |
|---|---|---|---|---|---|---|---|
| Bias Branch WVKC-10-T-8 | Organic enrichment | Fecal coliform | 1.49E+12 | NA | 7.82E+10 | 1.56E+12 | counts/yr |
| | | | | | | | |
| Missouri Fork WVKC-10-T-9-B | Organic enrichment | Fecal coliform | 1.43E+12 | NA | 7.51E+10 | 1.50E+12 | counts/yr |
| | | | | | | | |
| Baldwin Fork WVKC-10-T-9-D | Organic enrichment | Fecal coliform | 1.89E+12 | NA | 9.93E+10 | 1.99E+12 | counts/yr |
| | Sedimentation | Sediment | 454.4 | NA | 23.9 | 478.4 | tonnes/yr |
| | | | | | | | |
| Spruce Laurel Fork WVKC-10-T-11 | Metal toxicity | Iron | 26,834 | 76,332 | 5,430 | 108,595 | lbs/yr |
| | Sedimentation | Sediment | 2863.8 | 2472.4 | 280.9 | 5617.1 | tonnes/yr |