

## APPENDIX 5

### A-5. CARROLL BRANCH

#### A-5.1 Watershed Description

Carroll Branch is in the central portion of the Upper Kanawha watershed, as shown in Figure A-5-1, and drains approximately 1.3 square miles (855 acres). Figure A-5-2 shows the land use distribution for the watershed. The dominant land use is forest, which covers 91.44 percent of the watershed. Other important land use types include urban/residential (3.62 percent) and barren/mining land (4.19 percent). All other individual land cover types account for less than 2 percent of the total watershed area.

Carroll Branch, proper, is the one impaired stream segment in the watershed. Figure A-5-3 shows the impaired segment and the pollutants for which it is impaired.

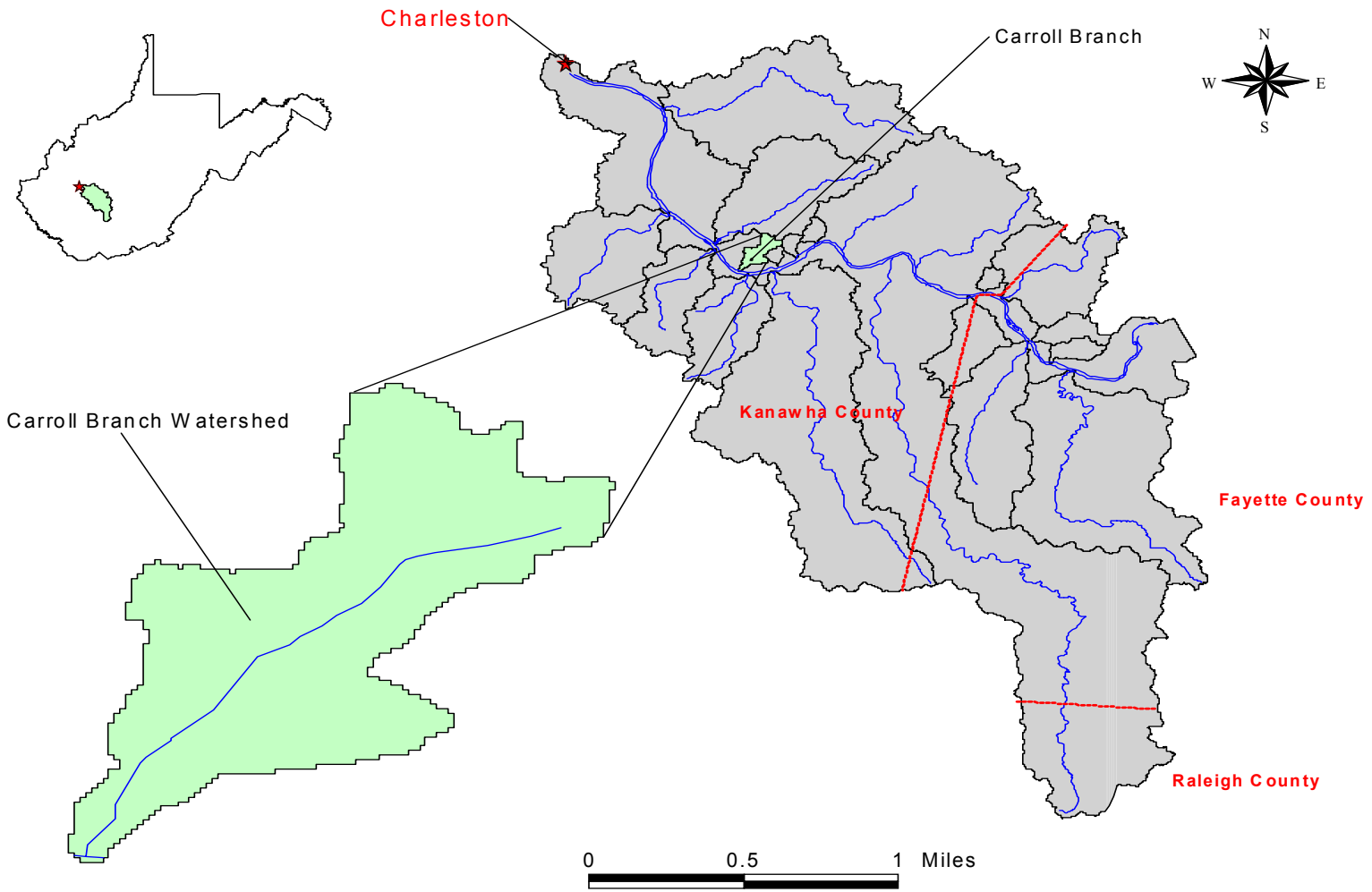


Figure A-5-1. Location of the Carroll Branch watershed

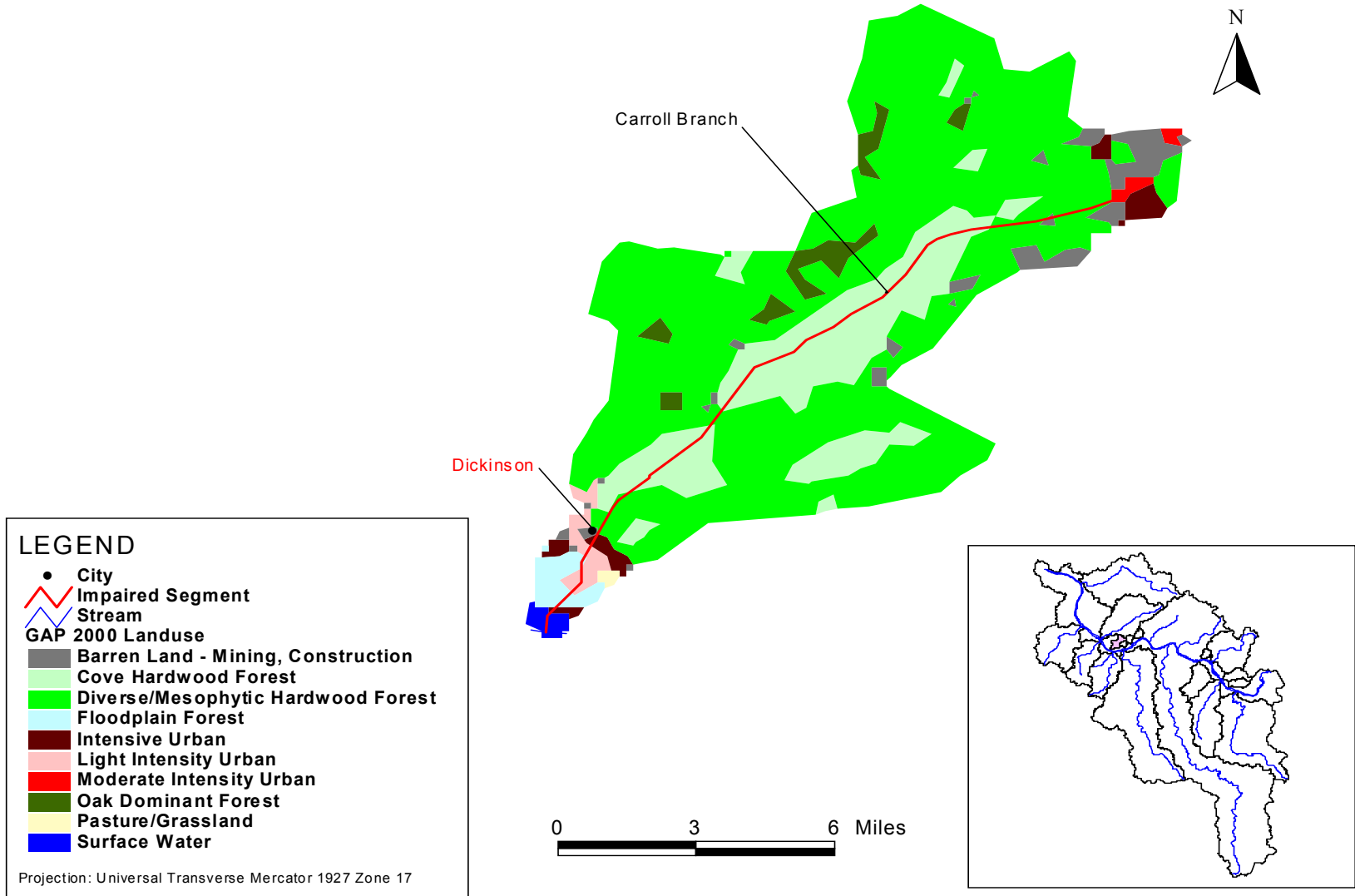


Figure A-5-2. Land use distribution in the Carroll Branch watershed

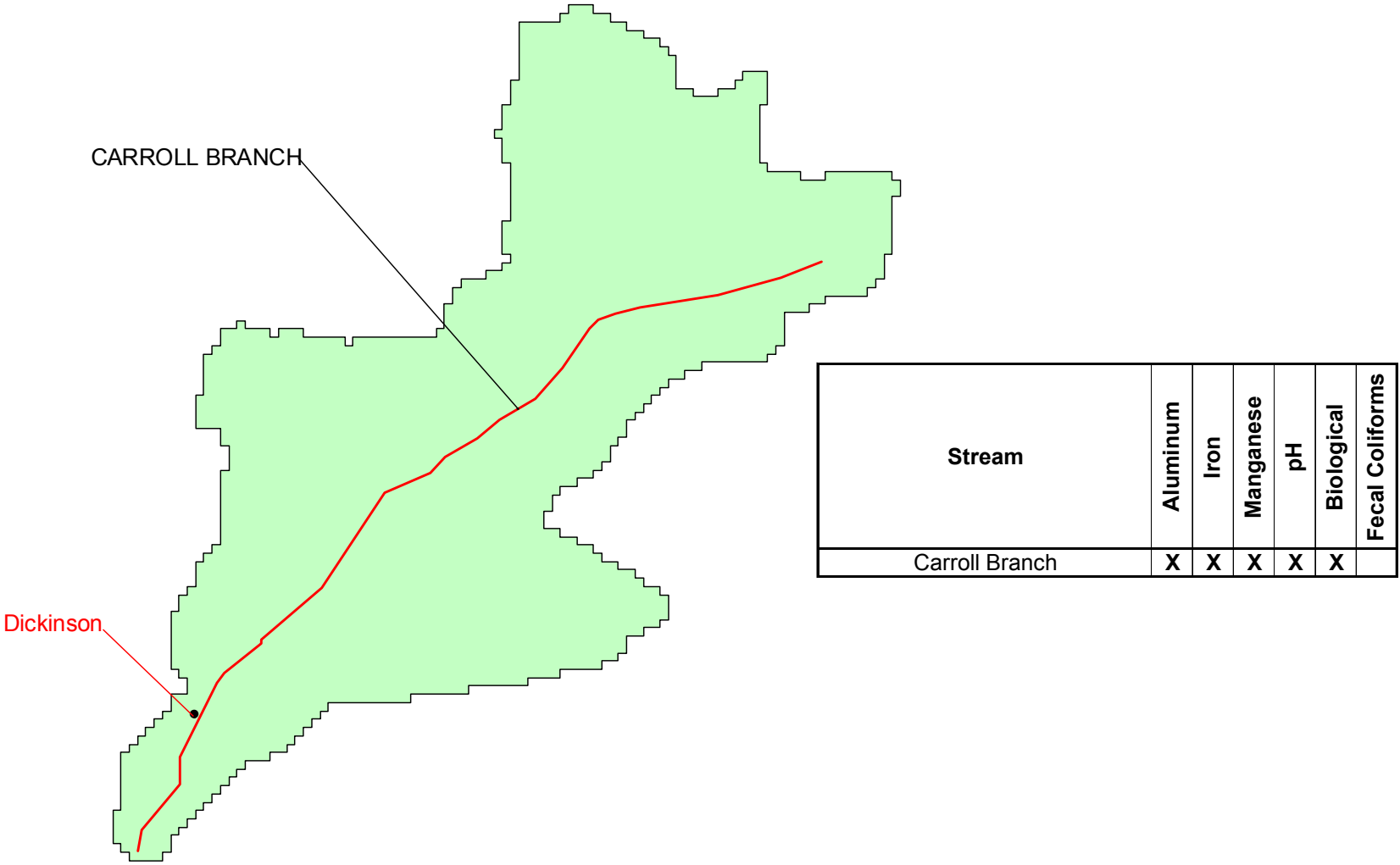


Figure A-5-3. The impaired waterbody in the Carroll Branch watershed

## A-5.2 Pre-TMDL Monitoring

Before establishing Total Maximum Daily Loads (TMDLs), WVDEP performed monitoring in each of the impaired streams in the Upper Kanawha watershed to better characterize water quality and to refine impairment listings. Monthly samples were taken at 339 stations throughout the watershed from July 1, 2001, through June 30, 2002. The locations of the pre-TMDL monitoring stations in the Carroll Branch watershed are shown in Figure A-5-4. Monitoring suites at each site were determined based on the types of impairments observed for each stream. Streams impaired by metals and low pH were sampled monthly and analyzed for a suite of parameters (including total iron, dissolved iron, total aluminum, dissolved aluminum, total manganese, total suspended solids, pH, sulfate, and specific conductance). Monthly samples from streams impaired by fecal coliform bacteria were analyzed for this parameter, pH, and specific conductance. Appropriate monitoring suites were selected for streams with multiple impairments. For example, if a stream was impaired by metals and fecal coliform bacteria, the samples were analyzed for total iron, dissolved iron, total aluminum, dissolved aluminum, total manganese, total suspended solids, pH, sulfate, specific conductance, and fecal coliform bacteria. In addition, benthic macroinvertebrate assessments were performed at specific locations on the biologically impaired streams during the pre-TMDL monitoring period. When conditions allowed, instantaneous flow measurements were also taken at the pre-TMDL sampling locations.

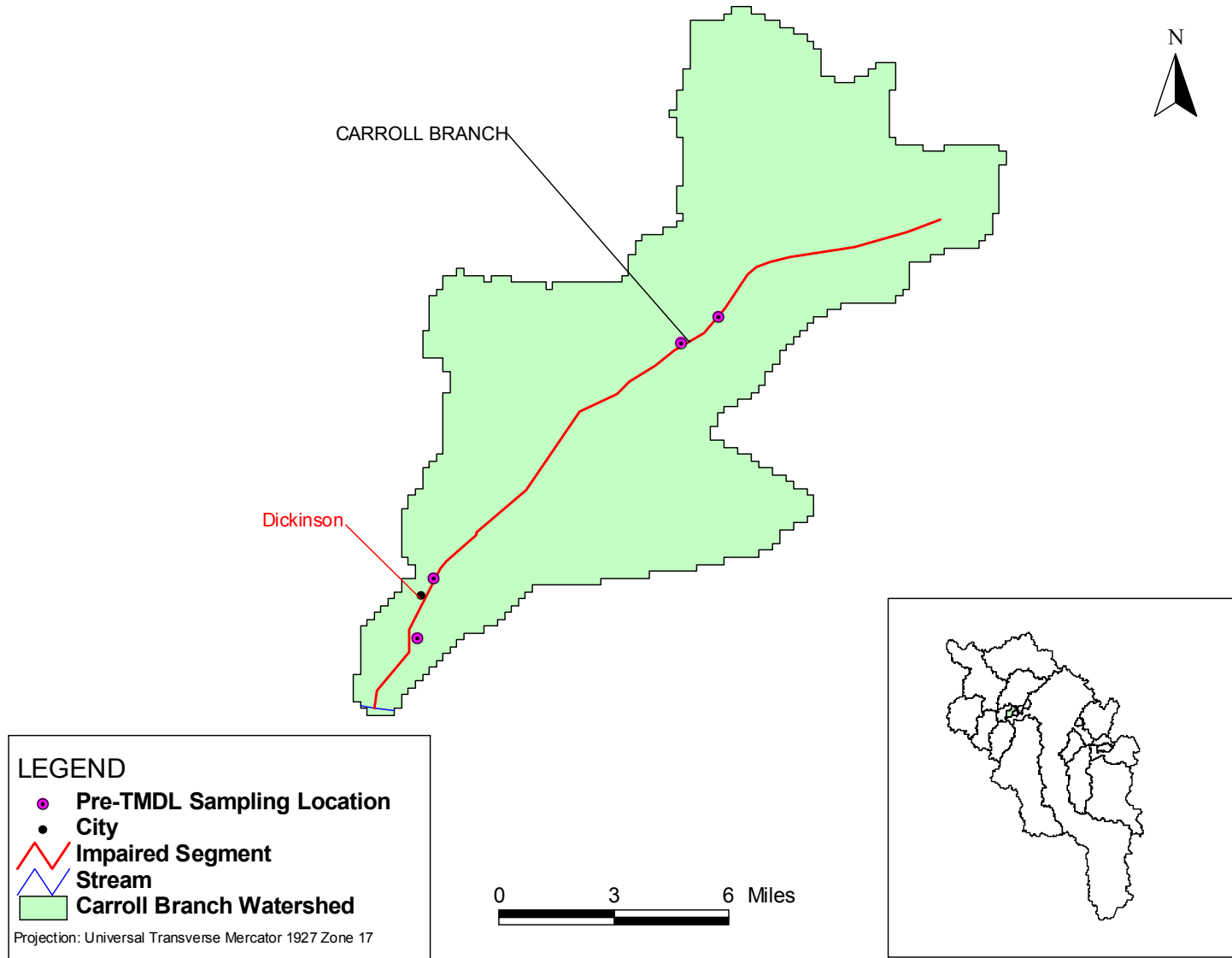


Figure A-5-4. Pre-TMDL monitoring stations in the Carroll Branch watershed

### A-5.3 Metals and pH Sources

This section identifies and examines the potential sources of aluminum, iron, manganese, and pH impairment in the Carroll Branch watershed. Sources can be classified as either point sources (specific sources subject to a permit) or nonpoint sources (diffuse sources). Mining- and non-mining-related permits are used to classify metals and pH point sources. Metals and pH nonpoint sources are diffuse, non-permitted sources such as abandoned or forfeited mine sites.

Pollution 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 pollution source in detail, collecting Global Positioning System data, and if necessary collecting water quality samples for laboratory analysis. WVDEP personnel recorded physical descriptions of the pollutant sources: 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.

Based on scientific knowledge of sediment/metal interaction and knowledge of soils in West Virginia, it is reasonable to conclude that sediments contain high levels of aluminum and iron, and, to a lesser extent, manganese. Control of sediment-producing sources may be necessary to meet water quality criteria for dissolved aluminum, total iron, and total manganese during critical high flow conditions.

#### A-5.3.1 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. Only mining-related point sources exist in the Carroll Branch watershed.

##### *Permitted Non-mining Metals Point Sources*

Non-mining NPDES permits are not present in the watershed.

##### *Permitted Mining Metals Point Sources*

WVDEP's HPU GIS coverage was used to determine the locations of the mining permits; detailed permit information was obtained from WVDEP's ERIS database system. Ten mining-related NPDES outlets were identified in the Carroll Branch watershed (Figure A-5-5). 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 Carroll Branch watershed. The Technical Report also contains detailed information regarding NPDES/Article 3 permit relationships, specific data for each permitted outlet, and permit limits for each mining-related NPDES outlet.

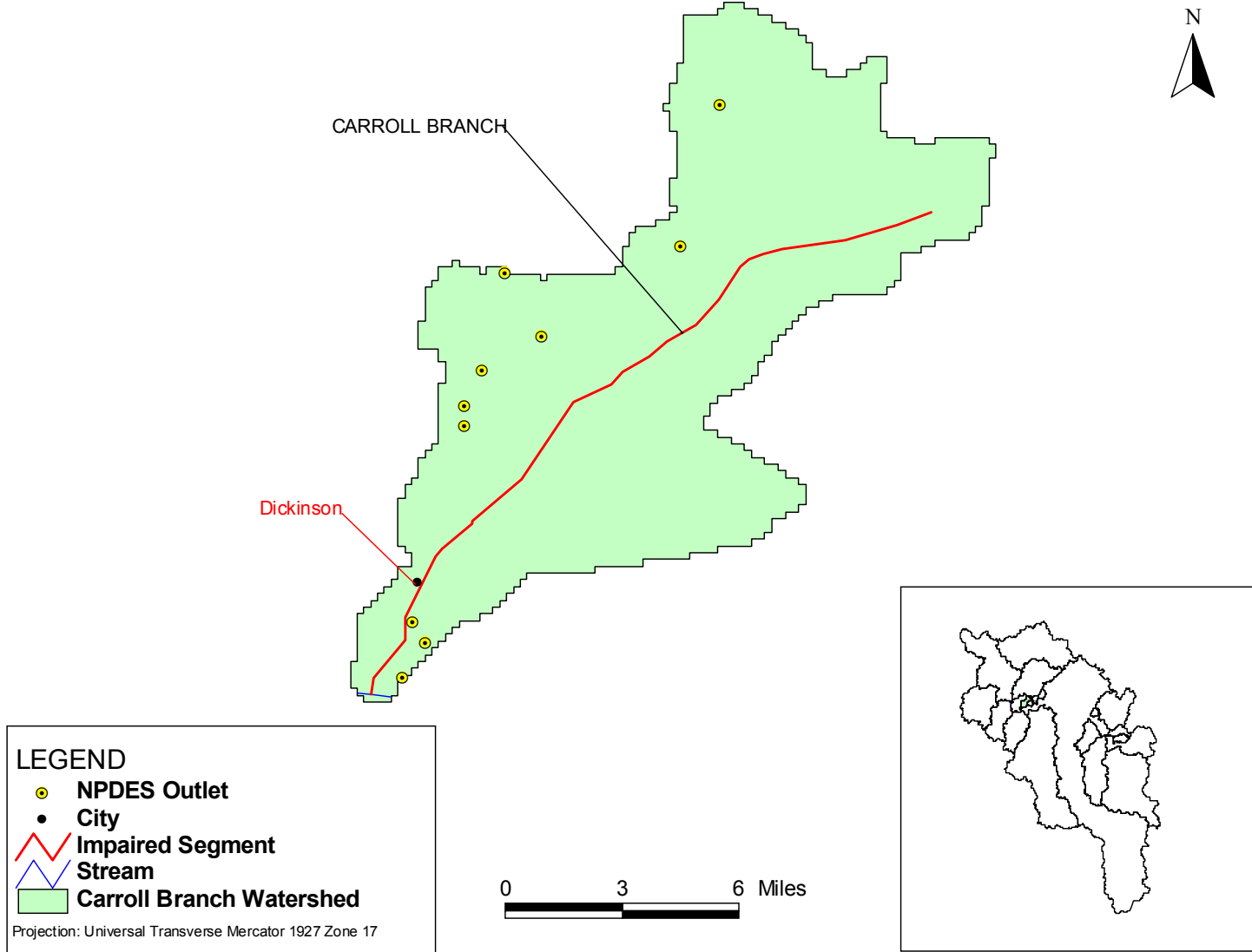


Figure A-5-5. NPDES outlets in the Carroll Branch watershed



### **A-5.3.2 Metals Nonpoint Source Inventory**

In addition to point sources, nonpoint sources contribute to metals-related water quality impairments in the watershed. Nonpoint sources are diffuse, non-permitted sources. Abandoned mines can create acid mine drainage, which contributes low pH and high metals concentrations to surface and subsurface waters; therefore, abandoned mine lands can be a significant non-permitted source of metals and pH impairment. Facilities that were subject to the Surface Mining Control and Reclamation Act of 1977 (SMCRA) and forfeited their bonds or abandoned operations can be a significant mining-related non-permitted source. 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.

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

Based on the identification of a number of abandoned mining activities in the Carroll Branch watershed, abandoned mine lands are a significant non-permitted source of metals and pH impairment. WVDEP's Office of Abandoned Mine Lands identified abandoned mine lands in the watershed. In addition, source-tracking efforts by WVDEP's Division of Water and Waste Management identified and characterized four abandoned mine sources (sources can include discharges, seeps, portals, culverts, refuse piles, diversion ditches, and ponds). The locations of abandoned mine lands sites are shown in Figure A-5-6. There are no bond forfeiture sites in the Carroll Branch watershed.

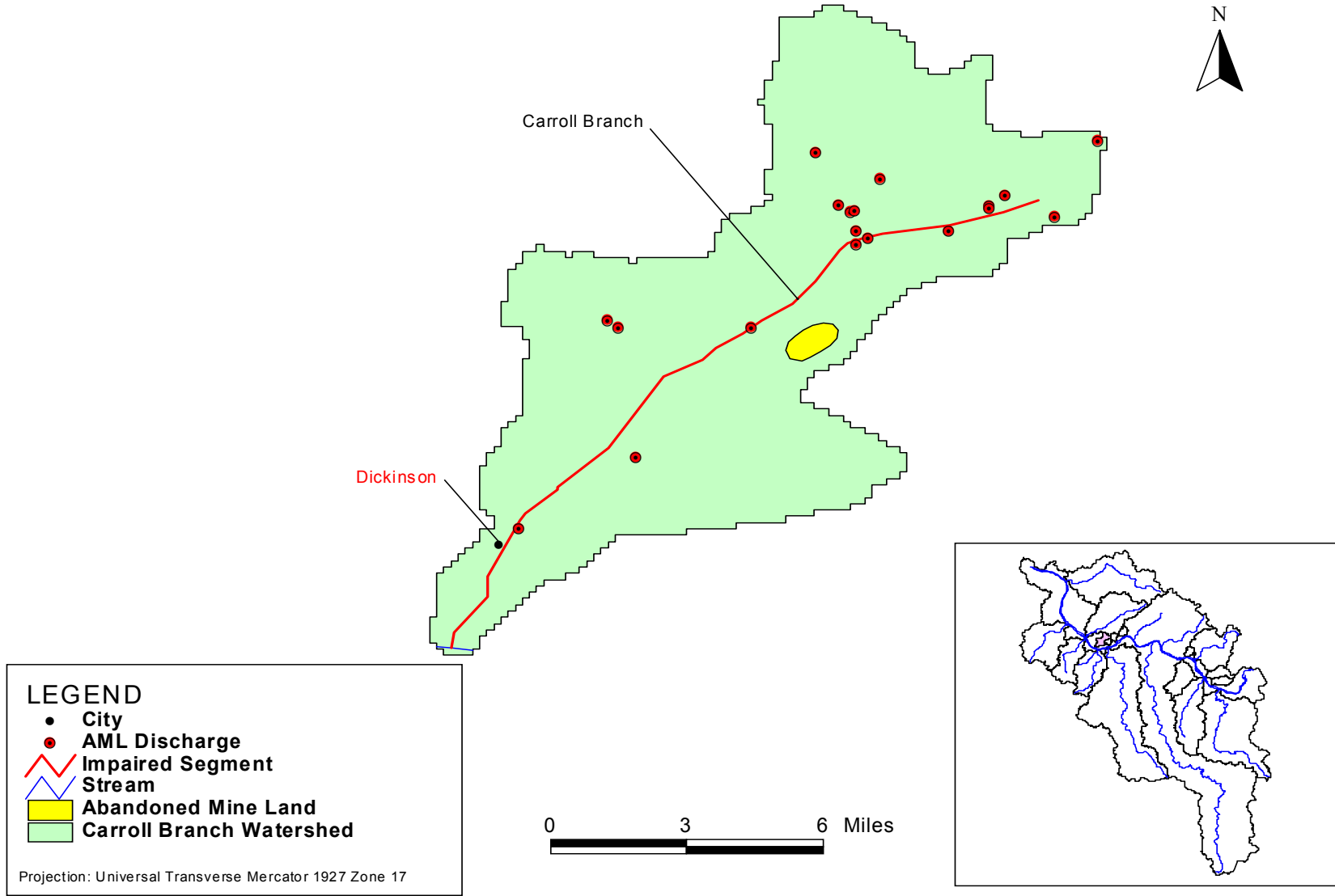


Figure A-5-6. Abandoned mine lands in the Carroll Branch watershed

### *Land Disturbance Activities*

Land disturbance resulting from agriculture, forestry, oil and gas operations, and the construction and use of roads can contribute metals to streams. The areas related to these activities and the number of sites in the Carroll Branch watershed are discussed below.

#### **Agriculture**

Based on the GAP 2000 land use coverage, agricultural areas cover 1.6 acres (0.18 percent) of the Carroll Branch watershed.

#### **Forestry**

The active logging operation in the Carroll Branch watershed is identified in Table A-5-1. The disturbed area associated with this operation is estimated to cover 220 acres (25.7 percent) of the total watershed area.

**Table A-5-1.** The logging site in the Carroll Branch watershed

<b>Logging Site ID</b>	<b>Area of Logging Site (acres)</b>	<b>Percentage of Watershed</b>	<b>Logged Area that Consists of Roads/Landings (acres)</b>	<b>Percentage of Total Logging Area that Consists of Roads/Landings</b>
K-59: L-1	220	25.7%	17.0	7.7%

#### **Oil and Gas Wells**

There are seven active oil and gas wells in the Carroll Branch watershed, the locations of which are shown in Figure A-5-7. Based on the survey by WVDEP's Office of Oil and Gas, it is estimated that 1.12 acres (0.13 percent) of the Carroll Branch watershed are disturbed by the active well sites (including areas associated with access roads).

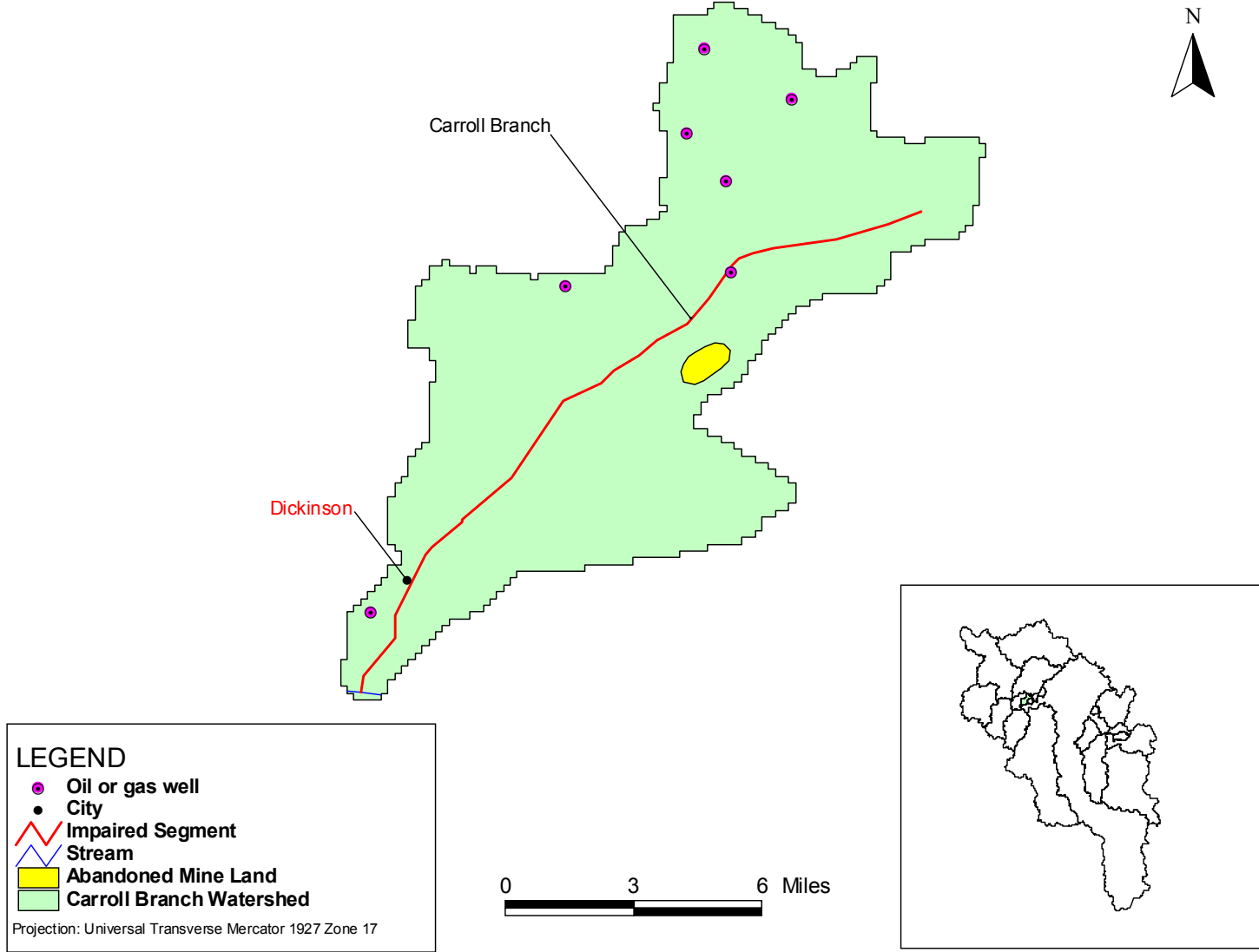


Figure A-5-7. Oil and gas wells in the Carroll Branch watershed

## Roads

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 on topographic maps that were not included in the TIGER shapefile. Table A-5-2 summarizes the length, area, and percentage of total watershed area of both paved and unpaved roads in the Carroll Branch watershed.

**Table A-5-2.** Road miles by type in the Carroll Branch watershed

Road Type	Road Distance (miles)	Road Area (acres)	Road Area as Percentage of Watershed
Total paved	2.34	5.08	0.59%
Total unpaved	7.80	12.02	1.41%

### A-5.4 Fecal Coliform Bacteria Sources

Fecal coliform bacteria impairments are not present in this watershed.

### A-5.5 Stressors of Biological Impairment

The Carroll Branch watershed has one biologically impaired stream for which TMDLs have been developed. This stream is identified in Table A-5-3 along with the primary stressors of the stream's benthic communities and the TMDLs required to address the cause of biological impairment. A stressor identification process was used to evaluate and identify the primary stressors to the impaired benthic communities.

**Table A-5-3.** Primary stressors of the biologically impaired stream in the Carroll Branch watershed

Stream	Primary Stressors	TMDLs Required
Carroll Branch	Metals toxicity (Al, Fe) Acidity (pH)	Aluminum Iron pH

The aluminum and iron TMDLs presented in Tables A-5-4 and A-5-6 address the metals toxicity biological stressor. Please refer to section A-5.3 for source information.

### A-5.6 TMDLs for the Carroll Branch Watershed

#### A-5.6.1 TMDL Development

TMDLs and source allocations were developed for the impaired stream in the Carroll Branch 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 in the waterbody and

TMDLs were developed. Refer to section 7.4 of the main report for a detailed description of allocation methodologies used in the development of the pollutant-specific TMDLs.

The TMDLs for iron, manganese, aluminum, and pH are shown in Tables A-5-4 through A-5-7. The TMDLs for iron, manganese, and aluminum are presented as annual loads, in terms of pounds per year. They are presented as average annual loads because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year.

As stated in section 7.4.1, a surrogate approach was used to develop the 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 (DESC-R) model 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 the DESC-R model. The result, shown in Table A-5-7, is the TMDL the pH-impaired stream in the watershed. Refer to the Technical Report for a detailed description of the pH modeling approach.

**A-5.6.2 TMDL Tables: Metals****Table A-5-4.** Iron TMDL for the Carroll Branch watershed

Major Watershed	Stream Code	Stream Name	Metal	Load Allocation (lb/yr)	Wasteload Allocation (lb/yr)	Margin of Safety (lb/yr)	TMDL (lb/yr)
CARROLL BRANCH	K-59	Carroll Branch	Iron	4,435	1,494	312	6,241

**Table A-5-5.** Manganese TMDL for the Carroll Branch watershed

Major Watershed	Stream Code	Stream Name	Metal	Load Allocation (lb/yr)	Wasteload Allocation (lb/yr)	Margin of Safety (lb/yr)	TMDL (lb/yr)
CARROLL BRANCH	K-59	Carroll Branch	Manganese	1,797	1,437	170	3,404

**Table A-5-6.** Aluminum TMDL for the Carroll Branch watershed

Major Watershed	Stream Code	Stream Name	Metal	Load Allocation (lb/yr)	Wasteload Allocation (lb/yr)	Margin of Safety (lb/yr)	TMDL (lb/yr)
CARROLL BRANCH	K-59	Carroll Branch	Total Aluminum	2,280	2,893	272	5,445

**Table A-5-7.** pH TMDL for the Carroll Branch watershed

Major Watershed	Stream Code	Stream Name	Parameter	pH* (Under TMDL conditions)
CARROLL BRANCH	K-59	Carroll Branch	pH	7.25

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

### A-5.6.3 TMDL Tables: Fecal Coliform Bacteria

**Table A-5-8.** Fecal coliform bacteria TMDLs for the Carroll Branch watershed

There are no fecal coliform bacteria impairments in this watershed.

### A-5.6.4 TMDL Tables: Sediment

**Table A-5-9.** Sediment TMDLs for the Carroll Branch watershed

There are no sediment impairments in this watershed.