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Water Quality in the Kanawha–New River Basin

West Virginia, Virginia, and North Carolina, 1996–98

U.S. Department of the Interior
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Front cover: The Kanawha River at Kanawha Falls, West Virginia. *(Photograph by David Fattaleh, West Virginia Division of Tourism, and used by permission.)*

Back cover: Left, Electrofishing on Sewell Creek at East Rainelle, West Virginia *(photograph by Edward Vincent, USGS)*; right, Mountaintop coal mine near Kayford, West Virginia *(photograph by James H. Eychaner, USGS)*.

Water Quality in the Kanawha–New River Basin

West Virginia, Virginia, and North Carolina, 1996–98

By Katherine S. Paybins, Terence Messinger, James H. Eychaner, Douglas B. Chambers, *and* Mark D. Kozar

U.S. GEOLOGICAL SURVEY CIRCULAR 1204

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2000

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Library of Congress Cataloging-in-Publications Data

Water Quality in the Kanawha-New River Basin, West Virginia, Virginia, and North Carolina, 1996–98 / by Katherine S. Paybins [et al.].
p. cm. -- (U.S. Geological Survey Circular ; 1204)
Includes bibliographical references.
ISBN 0-607-95412-4 (alk. paper)
1. Water quality--West Virginia--Kanawha River. 2. Water quality--Virginia. 3. Water quality--North Carolina. I. Paybins, Katherine S., 1966- II. Geological Survey (U.S.) III. Series.

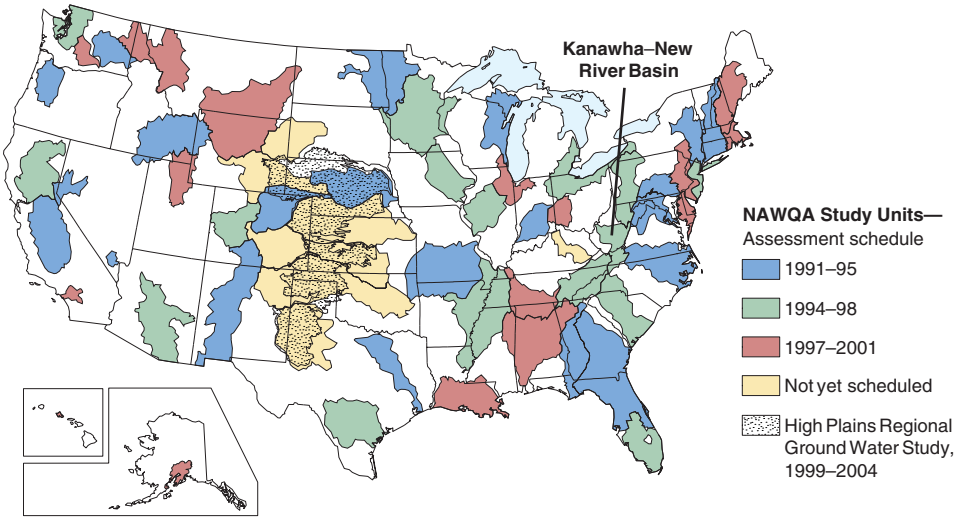
TD224.W4 W36 2000
363.739'42'097543--dc21

00-049459

CONTENTS

THIS REPORT summarizes major findings about water quality in the Kanawha–New River Basin that emerged from an assessment conducted between 1996 and 1998 by the U.S. Geological Survey (USGS) National Water–Quality Assessment (NAWQA) Program. Water quality is discussed in terms of local and regional issues and compared to conditions found in all 36 NAWQA study areas, called Study Units, assessed to date. Findings also are explained in the context of selected national benchmarks, such as those for drinking-water quality and the protection of aquatic organisms. The NAWQA Program was not intended to assess the quality of the Nation's drinking water, such as by monitoring water from household taps. Rather, NAWQA assessments focus on the quality of the resource itself, thereby complementing many ongoing Federal, State, and local drinking-water monitoring programs. Comparisons made in this report to drinking-water standards and guidelines are only in the context of the available untreated resource. Finally, this report includes information about the status of aquatic communities and the condition of instream habitats as elements of a complete water-quality assessment.

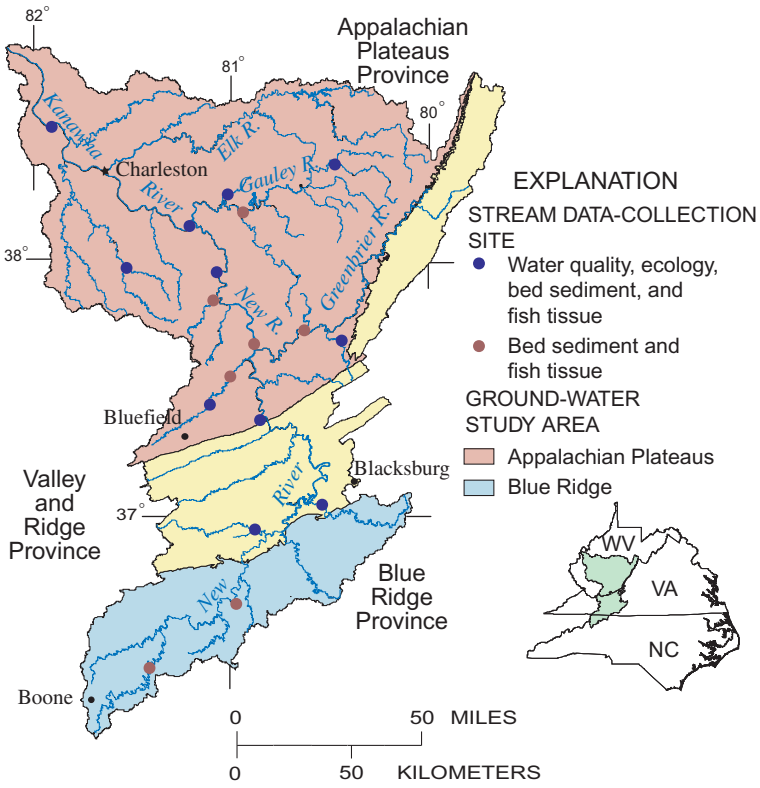
Many topics covered in this report reflect the concerns of officials of State and Federal agencies, water-resource managers, and members of stakeholder groups who provided advice and input during this water-quality assessment. Residents of West Virginia, Virginia, and North Carolina who wish to know more about water quality in the areas where they live will find this report informative as well.



THE NAWQA PROGRAM of the USGS seeks to improve scientific and public understanding of water quality in the Nation's major river basins and ground-water systems. Better understanding facilitates effective resource management, accurate identification of water-quality priorities, and successful development of strategies that protect and restore water quality. Guided by a nationally consistent study design and shaped by ongoing communication with local, State, and Federal agencies, NAWQA assessments support the investigation of local issues and trends while providing a firm foundation for understanding water quality at regional and national scales. The ability to integrate local and national scales of data collection and analysis is a unique feature of the USGS NAWQA Program.

The Kanawha–New River Basin is one of 51 water-quality assessments initiated since 1991, when the U.S. Congress appropriated funds for the USGS to begin the NAWQA Program. As indicated on the map, 36 assessments have been completed, and 15 more assessments will conclude in 2001. Collectively, these assessments cover about one-half of the land area of the United States and include water resources that are available to more than 60 percent of the U.S. population.

SUMMARY OF MAJOR FINDINGS



The Kanawha–New River Basin is generally mountainous, forested, humid, and rural. Agriculture is concentrated in the southern half of the basin; major products are cattle and hay. Seven percent of all coal mined in the United States is produced from the Appalachian Plateaus Physiographic Province within the basin.

Stream and River Highlights

The generally low population and intensity of agriculture and urban land uses throughout the Kanawha–New River Basin are reflected in low concentrations of nutrients and pesticides in streams and rivers.

Streams in the coal region of the Appalachian Plateaus Physiographic Province generally improved between about 1980 and 1998 with respect to pH, total iron, total manganese, and sedimentation. These improvements were among the regulatory goals of the Surface Mining Control and Reclamation Act of 1977 (SMCRA). Other unregulated factors, however, show the effects of continued mining. Mine drainage in the basin is rarely acidic but has high concentrations of sulfate, which decrease slowly after mining ends. Stream-bottom sedimentation in mined basins remains greater than in undisturbed basins.

- Streams draining basins that have been mined since 1980 show increased dissolved sulfate, decreased median bed-sediment particle size, and impaired benthic-invertebrate communities compared to streams not mined since 1980. (p. 5–11)

- In all basins studied where more than 100,000 tons of coal per square mile have been mined, the stream benthic-invertebrate community is impaired in comparison to rural parts of the basin where less than 10,000 tons of coal per square mile have been mined since 1980. Some basins in which the benthic-invertebrate community is impaired, however, were not heavily mined. Benthic invertebrates are sensitive indicators of many types of disturbance and respond to impairment of either stream chemistry or physical habitat. (p. 7–8)

- Effects on stream benthic-invertebrate communities caused by coal mining were of similar magnitude to the effects caused by urban development and agriculture elsewhere in the Nation. (p. 11)

- Kanawha Falls is the upstream limit for the range of several fish species. Non-native fish continue to expand their range in tributaries of the New and Gauley Rivers. (p. 12–14)

- *Escherichia coli* (*E. coli*) bacteria concentrations exceeded the national guideline for public swimming areas in 26 percent of samples from major rivers and in 43 percent of samples from tributary streams, but no outbreak of waterborne disease was reported during 1991–98. Inadequate sewage treatment and manure management contribute to elevated *E. coli* concentrations. (p. 14–15)

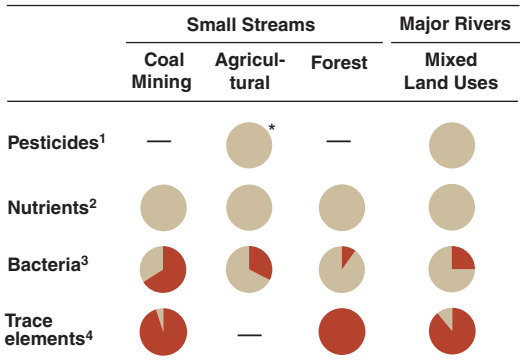
- Volatile organic compounds (VOCs) continue to be detected in the Kanawha River downstream from the Charleston metropolitan area. (p. 16)

- Nickel, chromium, zinc, and certain toxic organic compounds were found in bed sediment in concentrations that could harm aquatic life. Elevated concentrations of cadmium, mercury, nickel, selenium, and zinc were measured in fish tissue at some sites. (p. 12)

Major Influences on Streams and Rivers

•Coal mining
•Improper disposal of human and animal wastes
•Past industrial activities

Selected Indicators of Stream-Water Quality



Percentage of samples with concentrations **greater than or equal to** health-related national guidelines for drinking water, protection of aquatic life, or contact recreation; or above a national goal for preventing excess algal growth

Percentage of samples with concentrations **less than** health-related national guidelines for drinking water, protection of aquatic life, or contact recreation; or below a national goal for preventing excess algal growth

Percentage of samples with **no detection**
(* Detected in 1 percent or less of samples)

— Not assessed

[1] Insecticides, herbicides, and pesticide metabolites, sampled in water.
[2] Phosphorus and nitrogen, sampled in water.
[3] *Escherichia coli* (*E. coli*) bacteria, sampled in water.
[4] Nickel, chromium, zinc, and lead, sampled in streambed sediment.

Ground-Water Highlights

Ground water in the Appalachian Plateaus and Blue Ridge Physiographic Provinces moves mostly in a network of narrow fractures within a few hundred feet of the land surface, and drains toward the nearest stream. Wells normally tap only a few of the many local fractures. The ridgetops bound each local aquifer, which generally are affected only by local contaminant sources. In small areas of the basin where caves and solution cavities in limestone bedrock are common, wells can have high yields but are susceptible to contamination from fecal bacteria, pesticides, and other toxic chemicals.

- Radon concentrations in the Blue Ridge were among the highest in the Nation. Almost 90 percent of wells sampled there exceeded the proposed U. S. Environmental Protection Agency (USEPA) primary drinking-water standard of 300 picocuries per liter (pCi/L). One-third of these wells contained more than 4,000 pCi/L, the proposed alternate drinking-water standard. Radon is a radioactive gas that forms during the decay of natural uranium. (p. 18–19)

- Modern well construction can prevent fecal bacteria from reaching drinking water in most areas of the basin. Bacteria were frequently detected only at older wells. (p. 19)

- Potentially explosive concentrations of methane were found in water at 7 percent of wells in the coal region of the Appalachian Plateaus. (p. 17)

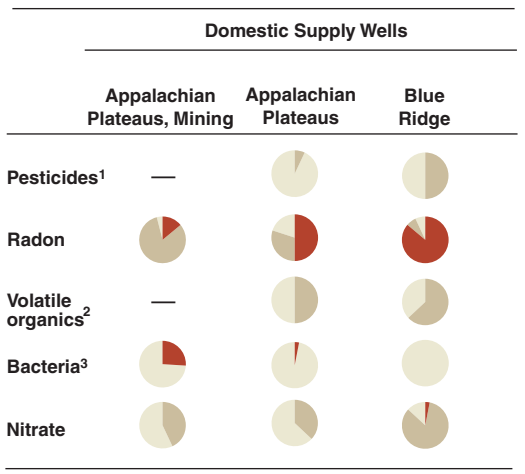
- Nutrients, pesticides, and VOCs were detected in low concentrations throughout the basin. In the Blue Ridge, however, water from more than 50 percent of wells contained pesticides, an indication that the ground water is vulnerable to contamination. (p. 19)

- In the Appalachian Plateaus, iron and manganese concentrations exceeded USEPA drinking-water guidelines in at least 40 percent of the wells and in about 70 percent of wells near reclaimed surface coal mines. Elevated sulfate concentration and slightly acidic water were more common at wells within 1,000 feet of reclaimed mines than elsewhere. (p. 10 and 17)

Major Influences on Ground Water

- Composition of soils and bedrock
- Improper disposal of human and animal wastes
- Current and past mining practices
- Pesticide usage and other toxic chemical releases

Selected Indicators of Ground-Water Quality



Percentage of samples with concentrations **greater than or equal to** health-related national guidelines for drinking water

Percentage of samples with concentrations **less than** health-related national guidelines for drinking water

Percentage of samples with **no detection**

— Not assessed

[1] Insecticides, herbicides, and pesticide metabolites, sampled in water.
[2] Solvents, refrigerants, fumigants, gasoline, and gasoline additives, sampled in water.
[3] Fecal coliform bacteria, sampled in water.

Population and Human Activities

The Kanawha River and its major tributary, the New River, drain 12,223 mi^2 in North Carolina, Virginia, and West Virginia (Messinger and Hughes, 2000). Most of the total basin population of 870,000 (1990 data) live in rural areas, and industrial and residential areas cover less than 5 percent of the total area in the basin (fig. 1). Only about 30 percent of the population live in towns larger than 10,000 people, including the 25 percent who live in the Charleston, W. Va., metropolitan area. The total population has not changed substantially since the 1950s, mostly because of emigration from rural parts of the basin to urban centers in the Midwest and the South.

The only major industrial area in the basin is along the terrace of the Kanawha River, within about 20 miles of Charleston (fig. 2). Chemical industry practices that profoundly polluted the Kanawha River during the 1950s and 1960s have changed, and discharge of pollutants to streams has greatly decreased, although bed sediment and fish remain contaminated with dioxin and other industrial chemicals (Henry, 1981; Kanetsky, 1988; West Virginia Division of Environmental Protection, 2000).

In the Kanawha–New River Basin, most coal is mined in the Appalachian Plateaus in West Virginia (McColloch, 1998). About 7 percent of the coal mined in the United States comes from the Kanawha–New River Basin (Fedorko and Blake, 1998; Messinger and Hughes, 2000). Most coal mined in the basin has a low sulfur content. Coal production has increased since passage of the Clean Air Act amendments of 1990, which mandated a reduction of sulfate emissions to decrease acid precipitation.

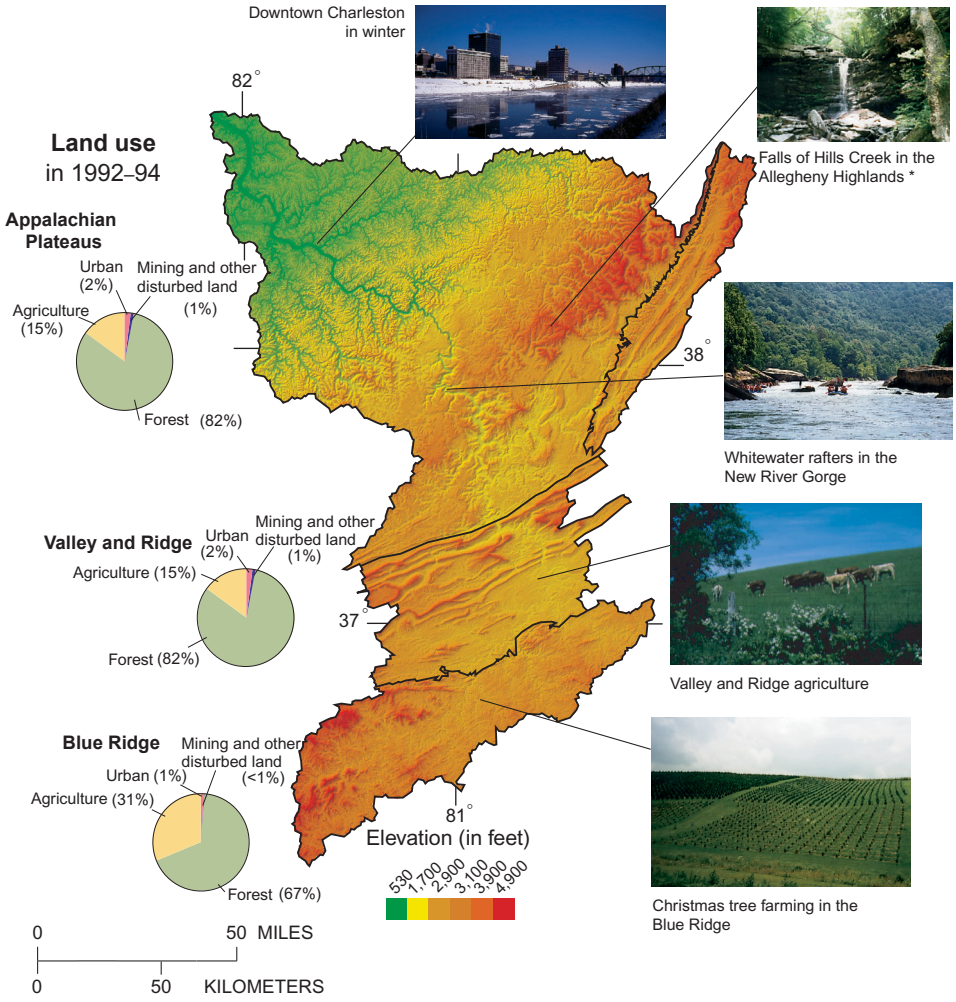


Figure 1. In the mountainous Kanawha–New River Basin, elevation ranges from over 4,000 feet in the Allegheny Highlands of the Appalachian Plateaus Province and the Blue Ridge Province to about 560 feet at the mouth of the river at Point Pleasant, W. Va. Forest accounted for 81 percent of the land cover in 1993 (Multi-Resolution Land Characteristics Interagency Consortium, 1997). Logging is a major industry throughout the basin. The entire basin was logged by the early 20th century, and no undisturbed areas remain (Clarkson, 1964). Coal mining is prevalent in the Appalachian Plateaus. The Blue Ridge Province contains proportionally more agricultural land than the Appalachian Plateaus and Valley and Ridge Provinces. Cattle, hay, and corn grown as cattle feed are the primary agricultural products (National Agriculture Statistics Service, 1999). Physiographic provinces from Fenneman, 1938.
* *Photograph by Julie Archer, and used by permission.*

Physiography

The streams and rivers of the basin drain areas in three physiographic provinces: the Blue Ridge (17 percent), the Valley and Ridge (23 percent), and the Appalachian Plateaus (60 percent). In the Appalachian Plateaus, little of the land is flat, and most flat land is in the flood plains and terraces of streams.

Figure 2. Coal and motor fuel commonly are transported by barge on the Kanawha River, downstream from Kanawha Falls.

The Valley and Ridge is characterized by strongly folded ridges separated by relatively flat, broad valleys. These two regions are underlain by sedimentary rocks. The Blue Ridge is characterized by igneous and metamorphic rocks that have been folded and faulted.

Water Use

In 1995, 61 percent of the basin's population depended on surface-water supplies for domestic needs (Solley and others, 1998). Thirty percent relied on domestic water wells. The remaining nine percent used public-supply water wells. In 1995, total withdrawal of water was about 1,130 Mgal/d (million gallons per day); total consumptive use was about 118 Mgal/d.

Hydrologic Conditions and Features

With some exceptions, mean streamflow during the study was within about 10 percent of long-term mean flows at most gaging stations (see records from a representative station in fig. 3). Major flooding occurred throughout the Appalachian Plateaus in January 1996, seven months before sampling began, and streamflow at several gaging stations within the Kanawha–New River Basin exceeded the 100-year flood flow (Ward and others, 1997). A thunderstorm in June 1998 caused flooding in the northwestern part of the basin where flow on a few small streams exceeded the 100-year recurrence interval (Ward and others, 1999). With the exception of these floods, no other flows exceeded the 10-year recurrence interval. No streams in the basin were in drought conditions during the study.

Streamflow varies most through the year in the western Appalachian Plateaus, and it varies least through the year in the Blue Ridge. On average, streamflow throughout the basin is greatest in February and March and least in September through October. Maximum streamflow does not coincide with maximum precipitation because summer vegetation uses a large fraction of the precipitation.

The river system in the Kanawha–New River Basin is regulated by four major flood-control dams, three navigation dams, and several smaller dams. The two largest dams are on the Gauley River (Summersville Dam) and Elk River (Sutton Dam). The other two major dams are on the New River. The navigable reach of the Kanawha River is in backwater caused by the navigation dams. In this reach, stream depth is greater and velocity is less than in the undammed reaches of the major rivers. All pools behind dams in the basin collect sediment. Dams are also major barriers to fish movement.

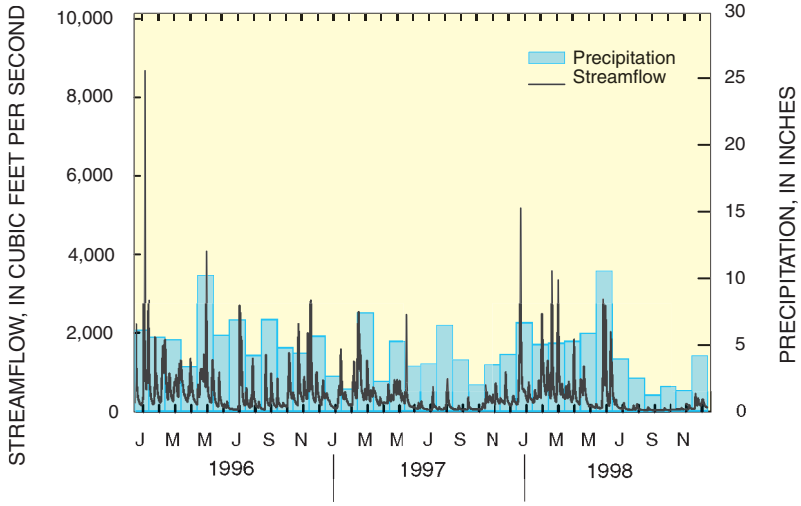


Figure 3. After a major flood in January 1996, streamflow from Williams River at Dyer, W. Va., and precipitation from Richwood, W. Va., were normal throughout the study period. The long-term average annual streamflow at Williams River at Dyer, W. Va. is 336 cubic feet per second. Long-term average precipitation at the Richwood, W. Va. location is 48 inches per year.