SELECTED HYDROLOGIC DATA FOR THE POWELL RIVER BASIN IN WISE COUNTY, VIRGINIA

By J. D. Larson

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CONVERSION FACTORS

For use of readers who prefer to use metric (International System) units, conversion factors for the inch-pound units used in this report are listed below.

Multiply Inch-pound Unit	By	To Obtain Metric Unit
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (Km^2)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (M^3/s)

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SELECTED HYDROLOGIC DATA FOR THE POWELL RIVER BASIN IN WISE COUNTY, VIRGINIA

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ABSTRACT

A compilation of selected water-quality data in the Powell River basin indicates less than 10 percent of existing water-quality data is available from Federal and State data bases. More than 90 percent of the data has been collected by coal-mining companies as part of the process required for mine permits.

Selected ground-water, surface-water, and water-quality data from five organizations were compiled for 61 ground-water and 86 surface-water sites in the study area. Well depths ranged from 8 to 600 feet and well yields ranged from 0 to 150 gallons per minute. Flow-duration statistics for a streamflow gaging station on the Powell River at Big Stone Gap indicates that streamflow is greater than or equal to 96.2 cubic feet per second 50 percent of the time, and flow equals or exceeds 12.8 cubic feet per second 95 percent of the time. Iron concentrations exceed USEPA (U.S. Environmental Protection Agency) recommended limits in 93 percent of ground-water samples and 64 percent of the surface-water samples. Manganese concentrations exceed USEPA recommended limits in 98 percent of ground-water samples and 81 percent of surface-water samples. Sulfate concentrations exceed USEPA recommended limits in less than 10 percent of ground-water and surface-water samples.

A bibliography of reports on the area and other pertinent reports from other coal-producing areas is presented.

INTRODUCTION

Hydrologic data have been collected by State and Federal agencies on a regular basis in the Powell River basin of Wise County, Virginia since 1944. In 1944, the U.S. Geological Survey installed a streamflow-measurement gage on the Powell River at Big Stone Gap. Since 1944, streamflow and miscellaneous water-quality data have been collected at the Big Stone Gap gage.

Congress enacted the Mine Land Reclamation Act in 1978 under Public Law 95-87, which requires extensive hydrologic monitoring by mining companies to obtain a mining permit. The information required for the permitting process includes precipitation, streamflow, ground-water levels, water quality, and water use data. Hydrologic data collected by governmental agencies have been documented in previous reports (see bibliography) but, to date, no attempt has been made to collate the type, quantity, and areal distribution of the data collected by both the coal-mining companies and governmental sources. The information and sources of information obtained in this study will enhance future hydrologic studies in the area by showing what, where, and how hydrologic data is filed and accessed.

Purpose and Scope

This report (1) assesses the availability of hydrologic data collected in the Powell River basin by governmental and private sources; (2) inventories, compiles, and evaluates data for preliminary analysis of the hydrologic system; (3) defines areas where data are lacking; and (4) identifies available pertinent literature.

The scope of the work included indexing the source and type of data available in the Powell River basin, accessing available computerized data bases for hydrologic data and evaluation and selection of hydrologic data in non-computerized data bases. Two governmental agencies and three coal-mining companies files were used to assess the types, quantity and areal distribution of hydrologic data in the basin. Selected well information and ground- and surface-water quality data were put into a microcomputer data base for evaluation.

Location and Physiographic Features

The Powell River basin of Wise County, Virginia, herein known as the study area, is located in southwestern Virginia (fig. 1). The study area is a 112 square mile area in the basin above Big Stone Gap, Virginia. The Kentucky-Virginia State line forms the western boundary of the drainage basin, parts of the Wise and Lee County lines form the southwestern boundary, and the drainage divide at the crest of Powell Mountain forms the southern and southeastern borders. Sally and Backbone ridge drainage divides are the eastern and northern borders of the study area. In addition to Big Stone Gap, other major towns in the basin are Appalachia and Norton. Many small communities -- remnants of old coal-company towns -- are located throughout the area. These communities are located in areas containing abandoned coal mines. The population of the study area was about 15,000 based on the 1980 census (U.S. Department of Commerce, 1981). Present water supplies for the area are obtained from small impoundments, abandoned underground mines, and wells.

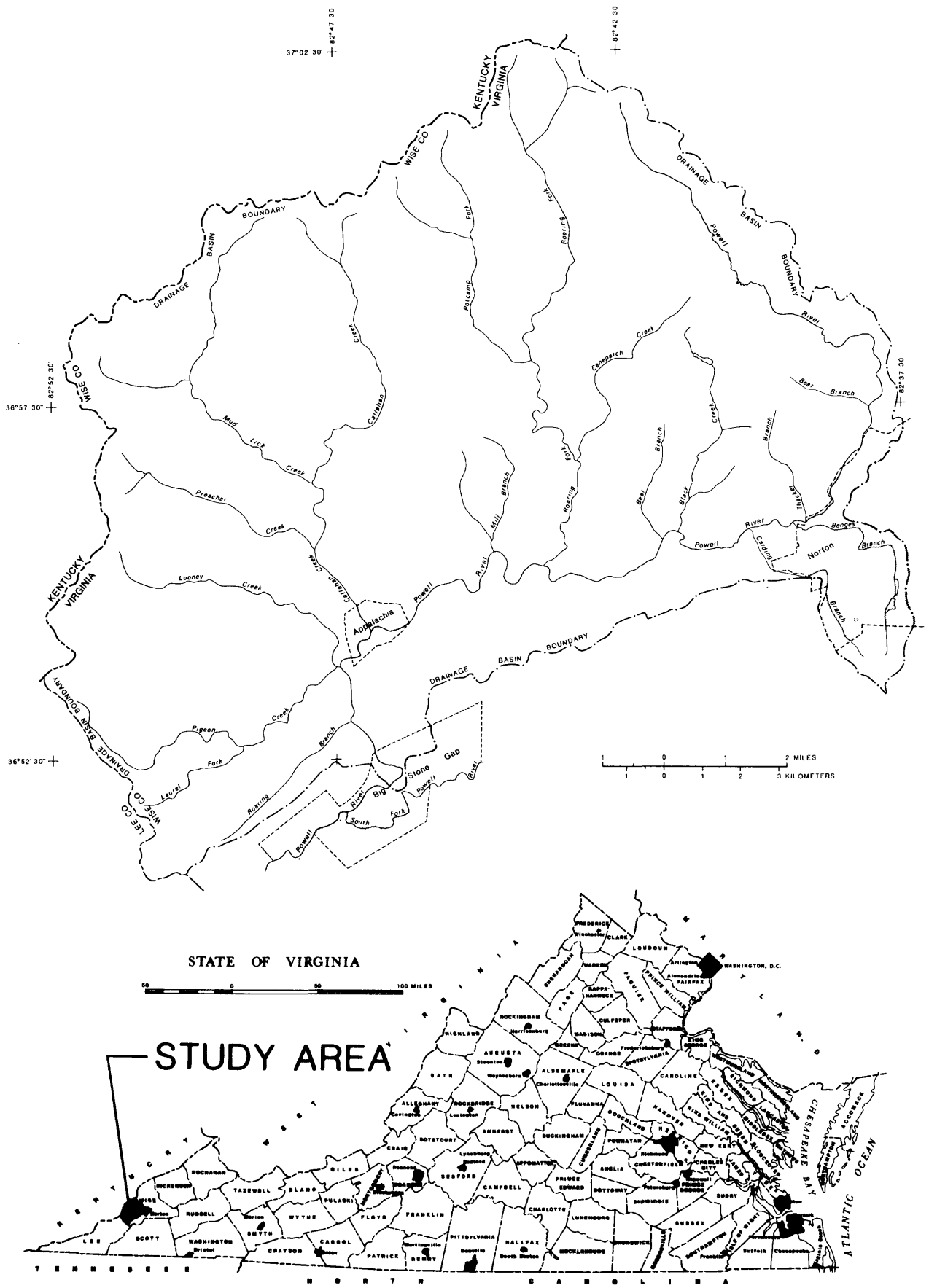

Figure 1.--Location of study area in southwestern Virginia.

The study area is located within the Appalachian Plateau physiographic province and is characterized by narrow valleys and steep hillsides commonly rising 600 to 1000 feet (ft) above the valley bottoms. The Powell River flows along the eastern and southern boundaries of the study area, and its major tributaries drain from the southwest, west, north and northwest, as shown in figure 1.

The area is heavily forested except where trees have been removed for mining operations, residences, and road installation. The forest consists predominantly of hardwoods; oak is the dominant species. The principal evergreens are mountain laurel and pine. The soils are thin on the hilltops and slopes; therefore, small-scale agriculture is confined mainly to valleys.

The study area is principally underlain by rocks of Pennsylvanian and Recent age, but also contains a small outlier of Mississippian rock on Little Stone Mountain in the southern part of the basin. The predominant Pennsylvanian rocks consist of coal-bearing sandstone, siltstone, and shale. The total thickness of these rocks exceeds 5,700 ft in the study area; they generally dip from the southeast to the northwest. Powell Mountain, in the southeastern part of the study area, is an anticlinal structure in which Pennsylvanian rocks on the flanks are tilted vertically, and older Paleozoic rocks are exposed at the core.

Rock material of Recent age consists of colluvium and alluvium on the hillsides and in the valley bottoms. These unconsolidated deposits generally are less than 20 feet thick and consist primarily of sand, silt, clay, and gravel with some large boulders.

Acknowledgments

The author would like to thank the personnel of Humphries Enterprises, Paramont Mining Company, and Westmoreland Coal Company, who allowed access to their hydrologic data files. Data were also provided by the following agencies and institutions: Virginia Division of Mine Land Reclamation (DMLR), Virginia State Water Control Board (VASWCB), Virginia Department of Health (VDH), Virginia Division of Mineral Resources (VDMR), Virginia Polytechnic Institute and State University (VPI&SU), Tennessee Valley Authority (TVA), U.S. Forest Service (USFS), and the towns of Appalachia, Big Stone Gap and Norton.

DESCRIPTION OF HYDROLOGIC DATA-BASE SYSTEMS

Two computerized indexing systems for hydrologic data are available in Virginia: NAWDEX (National Water Data Exchange) and CDB (Commonwealth Data Base).

The NAWDEX system is a national confederation of water-oriented organizations working together to make their data more readily accessible and to facilitate a more efficient exchange of data. NAWDEX services are available through a Program Office of the U. S. Geological Survey's National Assistance Centers located in 45 states and Puerto Rico, which provide local and convenient access to NAWDEX facilities.

NAWDEX is designed to assist organizations and individuals in identifying and locating sources of water data. To accomplish this service, NAWDEX main-

tains a computerized Master Water Data Index that identifies water data sites and the type of data available for each site. A Water Data Sources Directory is maintained within NAWDEX that identifies source organizations and the locations within these organizations where data may be obtained. In addition, direct access can be made through NAWDEX to other large water data bases. Most water data bases have reciprocal agreements with NAWDEX for the exchange of services.

CDB is the indexing system operated by the State of Virginia and is headquartered in Richmond, Virginia, under the Department of Taxation. CDB is designed to access all federal and state computer systems storing water data. A system of software is maintained which can manipulate data received from various computer data files.

Computerized Data

Four computerized hydrologic data-base systems are available in Virginia. These systems are: WATSTORE, STORET, HISARS, and VWUDS. Accessibility to these data systems is through the maintenance agency or by subscription to the system.

The National Water Data Storage and Retrieval System or WATSTORE is a data base maintained by the U.S. Geological Survey which contains files on groundwater, surface-water, and water-quality data. WATSTORE is designed to retrieve data in the form of graphs, charts, and tables. Statistical analyses can also be performed on the data.

STORET is a data base system maintained by the USEPA (U.S. Environmental Protection Agency). STORET contains hydrologic data compiled by USGS, TVA, VDH, and VASWCB. Data can be retrieved in the form of graphs, charts, and tables. Statistical analyses also can be performed on the data.

Hydrologic Information Storage and Retrieval System or HISARS is a data base system that contains hydrologic and climatic data for Virginia. The system is maintained by the Center for Water Resources at Virginia Polytechnic Institute and State University. HISARS can store, retrieve, manipulate, and plot data.

The Virginia Water Use Data System or VWUDS is a data base system that contains hydrologic data pertaining to water use within the state. VWUDS is maintained by VASWCB and is overseen by a water-use task force composed of personnel from various governmental agencies.

Noncomputerized Data

Within the Powell River basin, as well as in other surrounding coal-producing areas of southwestern Virginia, hydrologic data have been collected and are available in files maintained by the DMLR and coal mining companies. Additional hydrologic information for the area is also available from the local municipalities of Big Stone Gap, Appalachia, and Norton. The data contained by these sources are stored in the form of files and administrative and data reports.

A report entitled "Wise and Dickenson County Ground Water" (Virginia State Water Control Board, 1983) is available through that agency. The report dis-

cusses the occurrence of ground water in the study area as well as water quality and well construction data. The information in the VASWCB files is currently in STORET.

A summary list of the various governmental and private organizations currently collecting and maintaining hydrologic data in the Powell River basin is shown in table 1. Also listed is the type of data stored by each organization and the form in which the data is stored.

SELECTED HYDROLOGIC DATA

Three coal companies (Westmoreland Coal Company, Paramount Mining Company, and Humphries Enterprises) and two governmental agencies (U.S. Geological Survey and Virginia State Water Control Board) were chosen as representative sources of hydrologic data in the study area on the basis of the type and areal distribution of data stored in their data system or files. The three coal companies have permits that entail a wide variety of hydrologic data covering most of the study area. The U.S. Geological Survey maintains numerous widely distributed surface-water sites where discharge and water-quality data are collected and the State Water Control Board collects abundant well records and ground-water-quality data.

The percentages of surface-water and ground-water quality samples collected in the study area by the above organizations is shown in figure 2. More than 90 percent of the selected water-quality data available in the study area have been collected by the coal companies. A general statistical assessment was performed on ground- and surface-water quality data compiled during this study.

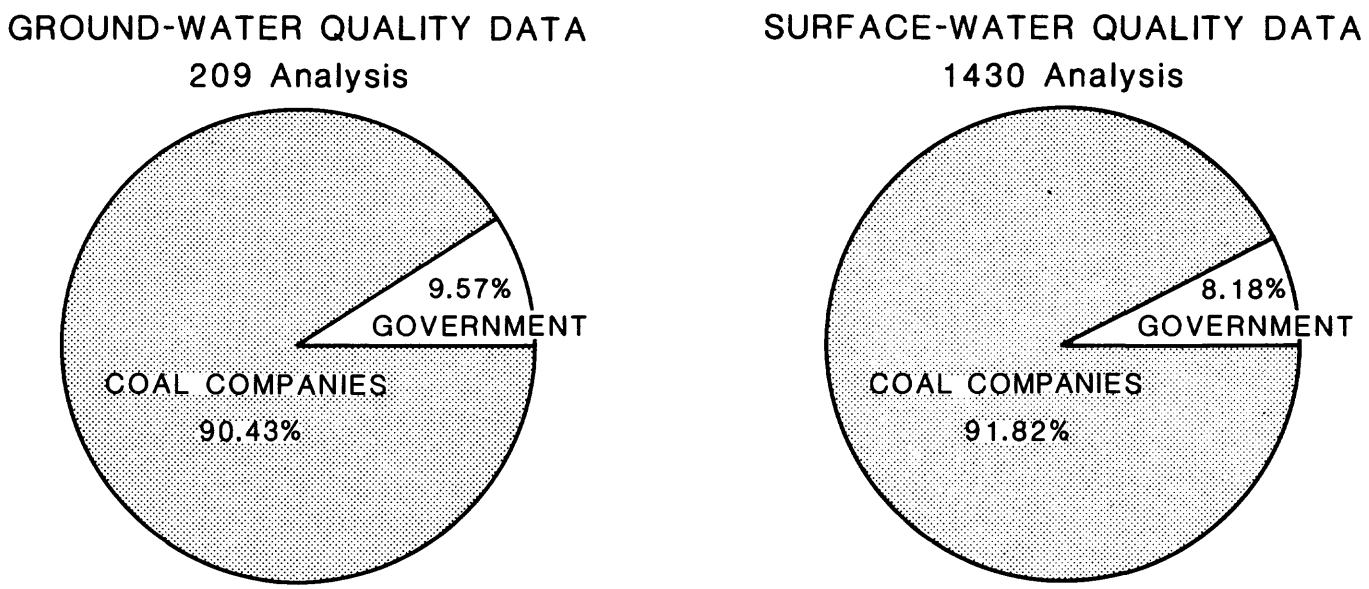

Figure 2.--Relative amounts of selected ground-water and surface-water quality data collected in the Powell River basin by coal companies and government agencies.

Table 1.--Organizations maintaining hydrologic data collected in the Powell River basin and their storage format.

Organization	Types of Data Collected 1/	Form Stored 2/
U.S. Geological Survey	G,S,Q,U	C
U.S. Forest Service	G,S,Q,P	N
National Weather Service	P	C
Tennessee Valley Authority	G,S,Q,P	C
Virginia State Water Control Board	G,S,Q,U	C&N
Virginia Department of Health	G,S,Q	N
Virginia Division of Minerals	G	N
Virginia Division of Mine Land Reclamation	G,S,Q,P	C&N
Mining Companies	G,S,Q,P	C&N
Town of Norton	G,S,Q,P	N
Town of Appalachia	G,S,Q,P	N
Town of Big Stone Gap	S,Q,P	N
Virginia Polytechnical Institute and State University	G,S,Q,P	C&N
Clinch Valley College	P	C&N
Mountain Empire College	S,Q	C&N

1/ G-ground water, S-surface water, Q-water quality, P-precipitation, U-water use

2/ C-computer, N-noncomputerized

Ground Water

Well-construction and water-quality data for 61 wells located within the study area were compiled. Locations of these wells within the basin are shown in figure 3. The depths of the wells ranged from 8 to 600 feet, and yields ranged from 0 to 150 gallons per minute (gal/min). Yield and depth data are available for 42 of the 61 wells (table 2). The wells inventoried were drilled primarily to monitor mines and for domestic, industrial, and public supply. Caution should be taken when evaluating the information in the table because of large variations in well yields based on topography and geologic conditions.

Table 2.--Relation of yield to depth of selected wells in the Powell River basin.

Yield (gal/min)	Range of Well depths (feet) 8-20	21-100	100-300	>300	Number of wells in well yield range
0	4	3	2	0	9
.1-10	10	2	6	1	19
10-25	4	0	1	0	5
25-50	0	3	2	0	5
>50	0	0	2	2	4
Number of wells in well yield range	18	8	13	3	42

Lineaments are linear topographic features that are believed to reflect subsurface structure; lineaments in the study area (fig. 4) are mapped by the Virginia Division of Mineral Resources and generally consist of stream valleys, and reflect the drainage patterns in the basin. Wells located on lineaments were compared with wells not on lineaments (fig. 5). A line in figure 5, drawn at the 50-percent distribution, shows that wells not on lineaments yield 1 gal/min or less, whereas wells on lineaments yield 20 gal/min or less.

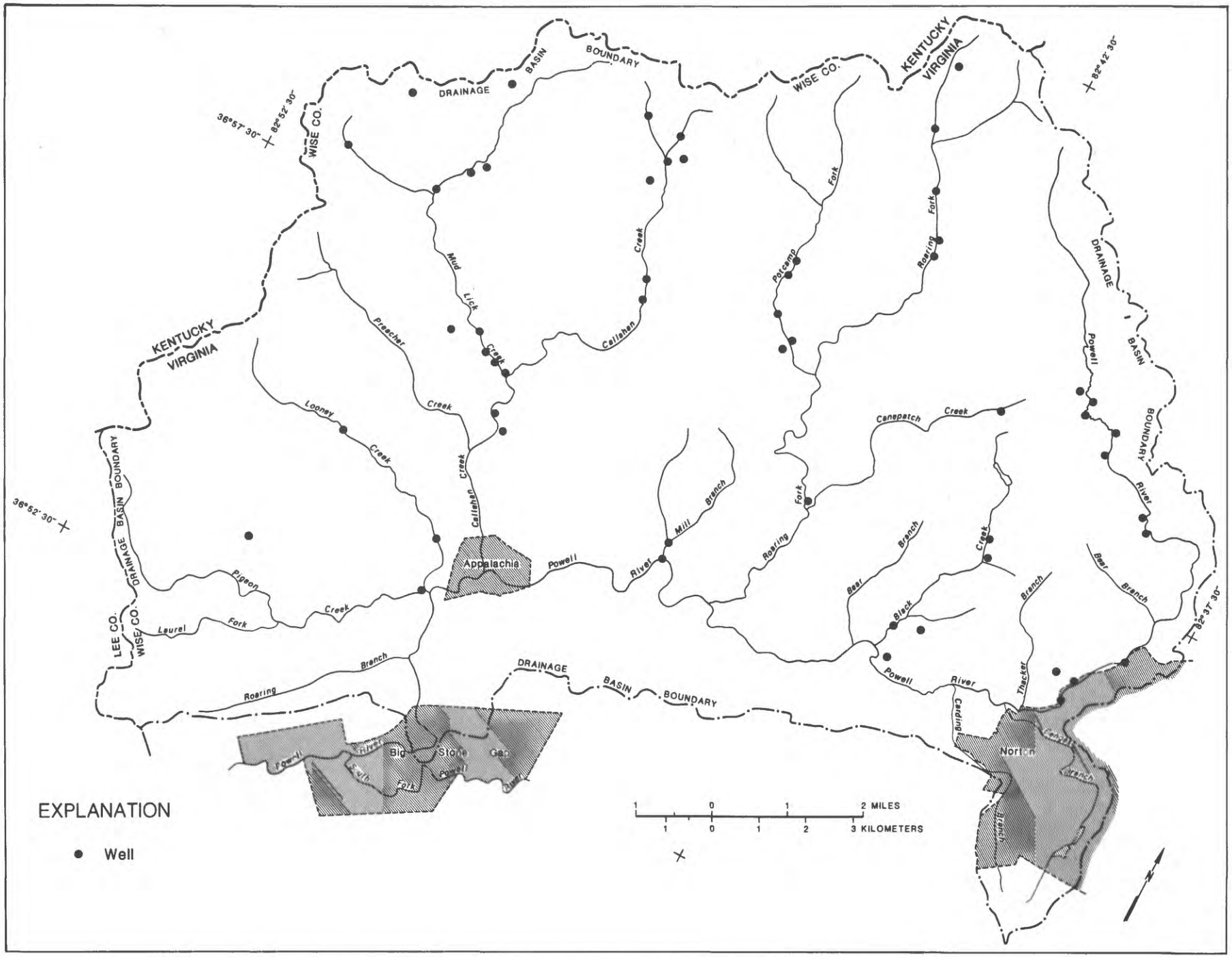

Figure 3.--Location of wells inventoried in the Powell River basin.

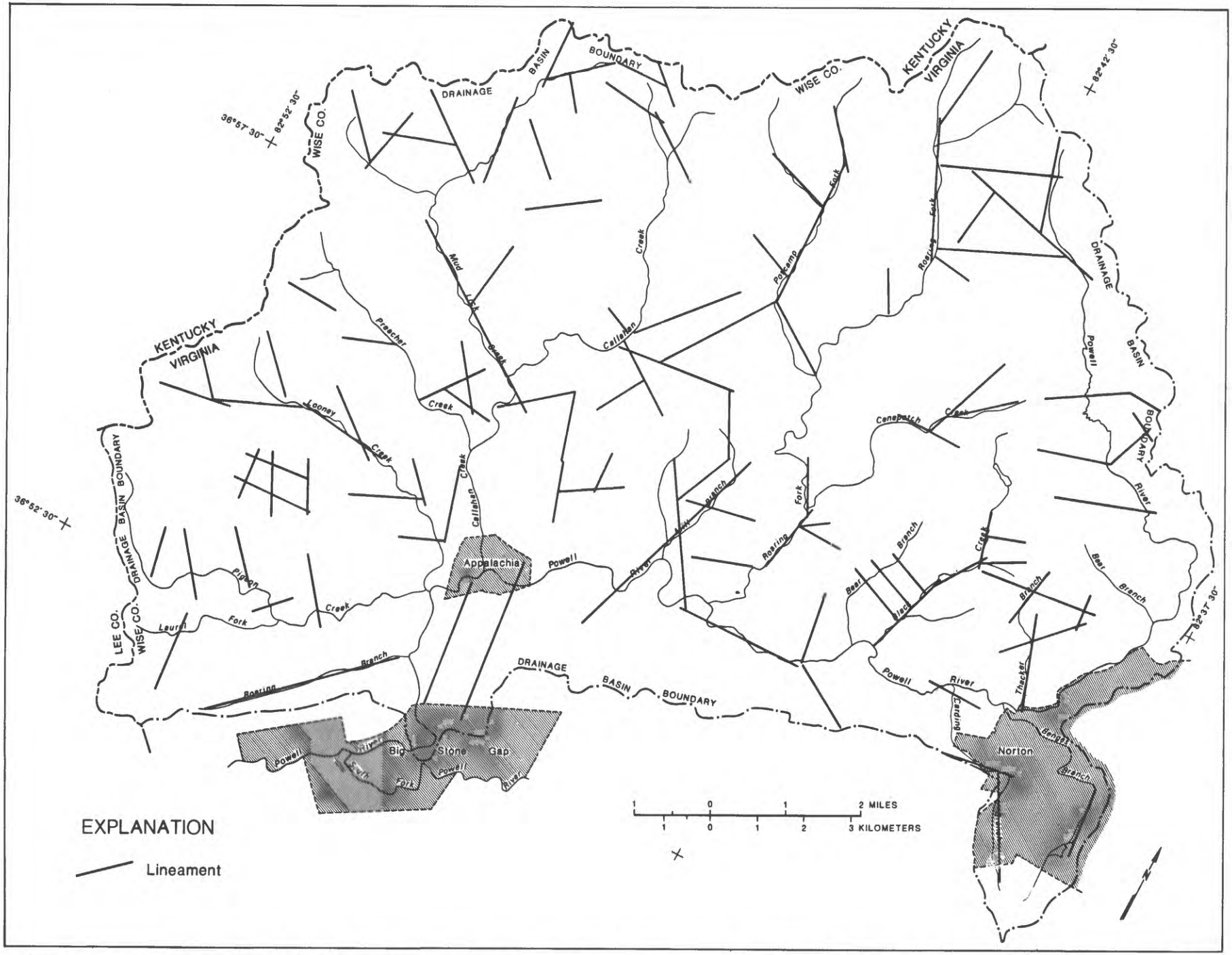

Figure 4.--Lineaments in the Powell River basin, (As mapped by the Virginia Division of Mineral Resources).

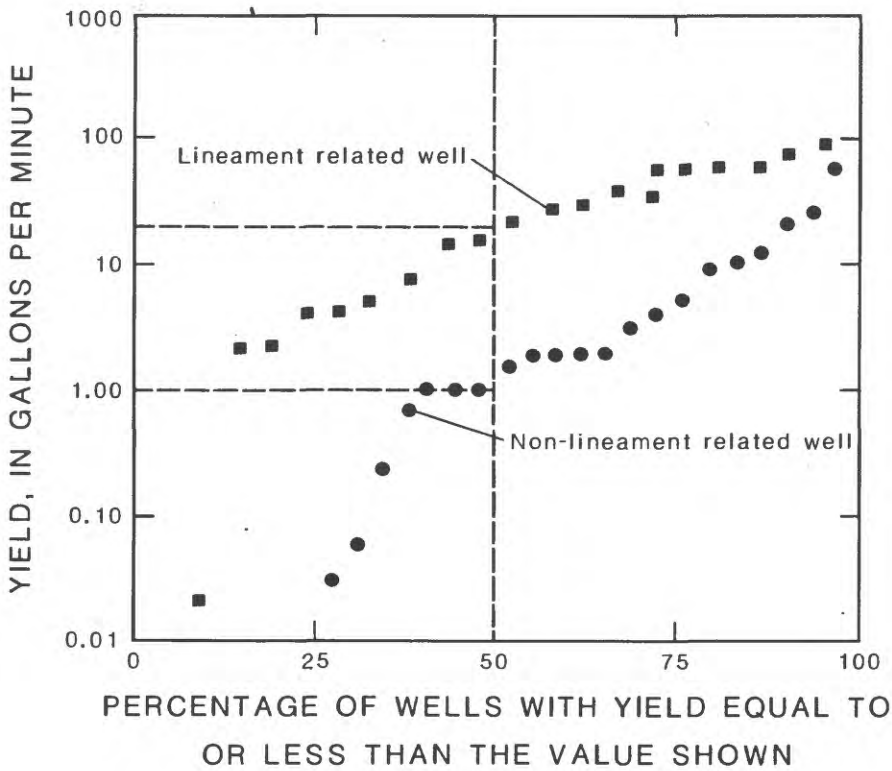

Figure 5.--Relation between well yields and the presence of wells near lineaments.

Water-quality analyses representing 209 samples were compiled from the inventoried wells. Water-quality characteristics that were determined are pH, specific conductance, dissolved solids, iron, manganese, and sulfate. Statistical results and the USEPA recommended ranges and limits are shown in the following table.

Variable	Maximum	Minimum	Mean	Median	Recommended limits (USEPA)
pH	10.8	4.5	6.98	7.00	5.0 - 9.0
Specific conductance	950.0	30.0	396.0	380	---
Dissolved solids (Mg/L)	1020.0	32.0	266.0	206	---
Iron (Mg/L)	75.0	0.05	4.6	1.6	0.3 (1.0 excessive)
Manganese (Mg/L)	17.5	0.02	1.05	0.4	0.05 (0.5 excessive)
Sulfate (Mg/L)	977.0	4.0	122	85	250

The percent of samples within each range of concentration for the selected constituents are shown by bar graphs (fig. 6).

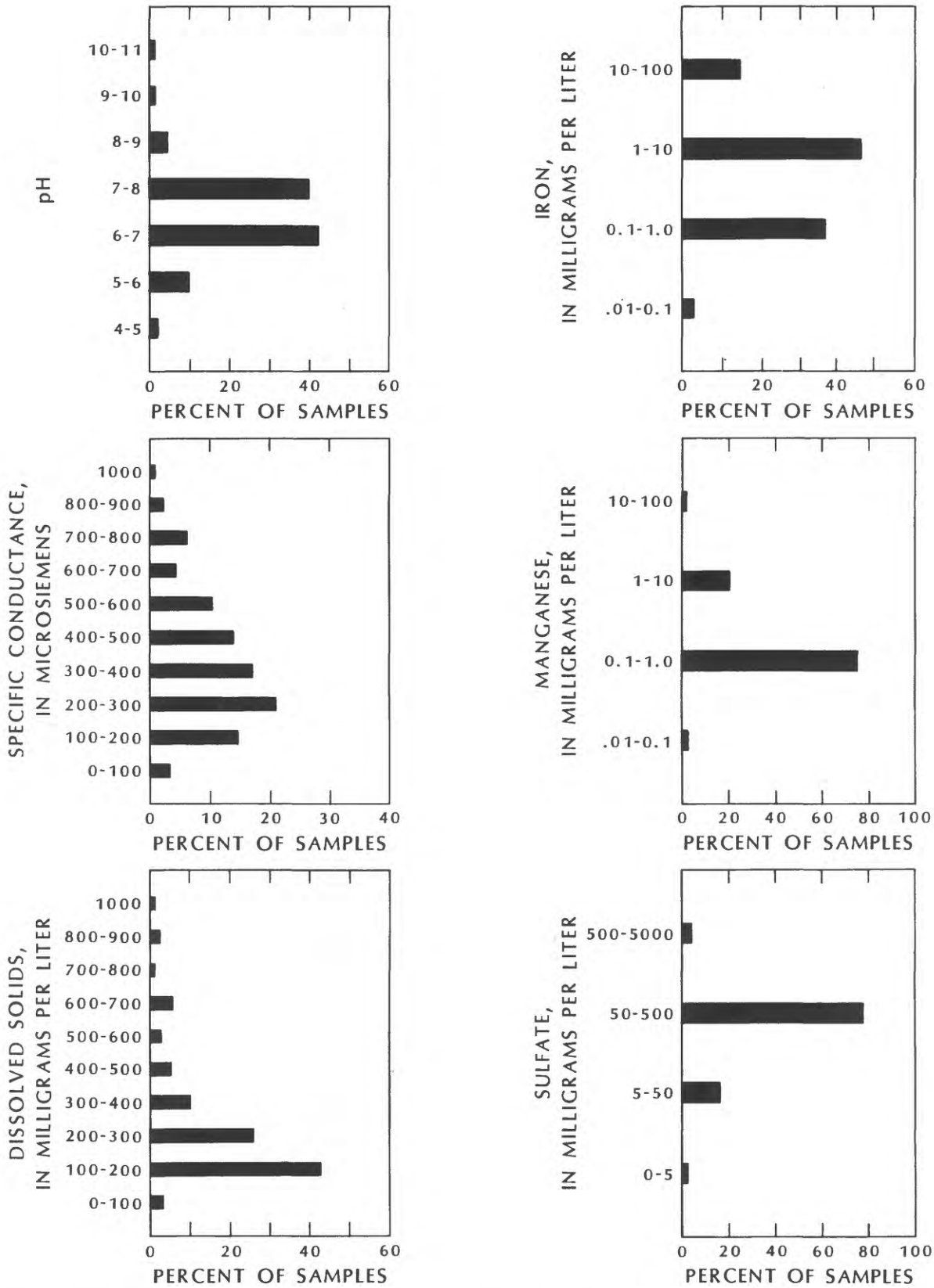

Figure 6.--Distribution of ground-water quality characteristics by range of values in the Powell River basin.

An overall assessment of the ground-water quality within the basin from the above table and figure 6 shows that more than 95 percent of the measurements have pH values from 5.0 to 9.0, which is the range established by USEPA for drinking water standards. Specific conductance values range from 30 to 950 µS (microsiemens, formerly micromhos), with a mean of 396 µS and a median of 380 µS. More than 70 percent of the analyses have a specific conductance less than 500 µS. Dissolved solids range from 32 to 1020 mg/L (milligrams per liter) with a mean of 266 mg/L and a median of 206 mg/L. More than 80 percent of the analyses have dissolved solids concentrations less than 500 mg/L. Iron concentrations range from 0.05 to 75 mg/L, with a mean of 4.6 mg/L and a median of 1.6 mg/L. Ninety-three percent of the reported iron concentrations exceed USEPA recommended limits. Manganese concentrations range from 0.02 to 17.5 mg/L, with a mean of 1.05 mg/L and a median of 0.4 mg/L. Ninety-eight percent of the manganese concentrations exceed the USEPA recommended limit of 0.05 mg/L. Fifty percent of the manganese concentrations exceed 0.5 mg/L. Sulfate concentrations range from 4 to 977 mg/L, with a mean of 122 mg/L and a median of 85 mg/L. Less than 10 percent of sulfate analyses have concentrations that exceed USEPA recommended limit of 250 mg/L.

Surface Water

A discharge measurement station (USGS Station No. 03529500) on the Powell River at Big Stone Gap, Virginia, has provided continuous streamflow records for the years 1945-59 and 1979-81. Infrequent water-quality sampling was conducted at this site during these periods. The discharge data are stored in WATSTORE and HISAR and water-quality data are stored in WATSTORE and STORET. A flow-duration graph for the Powell River at Big Stone Gap is shown in figure 7.

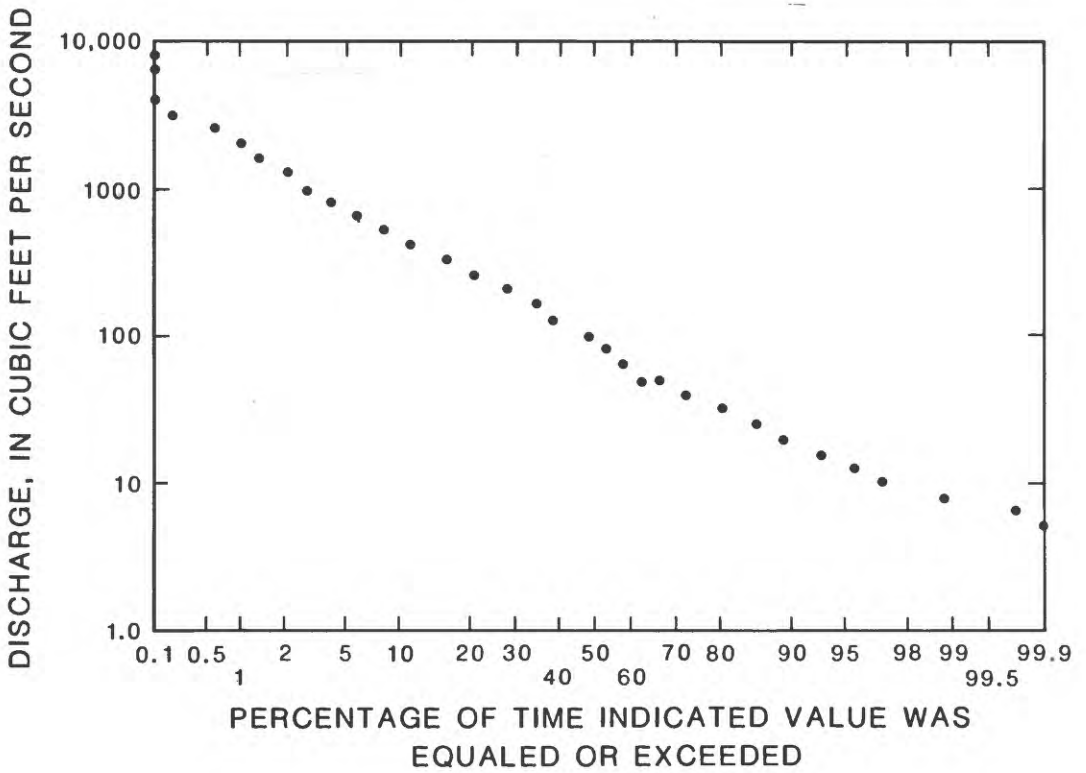

Figure 7.--Discharge-duration graph for Powell River at Big Stone Gap, Virginia, (1944-1981).

The graph shows that 50 percent of the time flows are equal to or greater than 96.2 ft^3/s (cubic feet per second) and 95 percent of the time flows are equal to or greater than 12.8 ft^3/s. All historic water-quality data for this station are discussed in the following paragraphs.

Eighty-six surface-water stations for which water-quality data are available were compiled from private and governmental sources (fig. 8). The following table shows the results of statistical analyses performed on selected constituents for 1,430 chemical analyses obtained from the surface-water stations. The percentage of analyses within each range of concentration or value for the constituents are shown in figure 9.

Variable	Maximum	Minimum	Mean	Median	Suggested limits (EPA) 1/
pH	9.3	3.0	7.1	7.2	5.0 - 9.0
Specific conductance	1,300	14.0	490.0	450.0	---
Total dissolved solids	9,600	1.0	384.0	303.0	---
Iron	205.0	.01	0.96	0.45	0.3 (1.0 excessive)
Manganese	99.0	0.01	1.34	0.70	0.05 (0.5 excessive)
Sulfate	750.0	0.8	142.0	120.0	250

1/ A dash indicates no established limit for the constituent.

Values of pH range from 3.0 to 9.3; 94 percent of the pH values range from 5.0 to 9.0, which is the recommended USEPA limit. Specific conductance ranges from 14 to 1300 µS, with mean and median values of 490 and 450 µS, respectively. More than 60 percent of the analyses have specific conductances that range from 200 to 600 µS. Dissolved solids in the surface waters range from 1.0 to 9,600 mg/L, with mean and median values of 384 and 303 mg/L, respectively. Sixty percent of the dissolved solids analyses have values that range from 100 to 400 mg/L. No USEPA limits have been established for specific conductance and dissolved solids. Dissolved iron concentrations in surface water ranged from 0.01 to 205 mg/L; mean and median concentrations are 0.96 and 0.45 mg/L, respectively. Sixty-four percent of the samples exceeded the USEPA recommended limit for iron concentration. Manganese concentrations ranged from 0.01 to 99 mg/L. The mean and median values are 1.34 and 0.70 mg/L, respectively. Ninety-one percent of the analyses had manganese concentrations exceeding the USEPA recommended limit of 0.05 mg/L. Sulfate concentrations ranged from 0.8 to 750 mg/L. Mean and median concentrations are 142 and 120 mg/L, respectively. Ten percent of the analyses have sulfate concentrations exceeding the recommended USEPA limit of 250 mg/L.

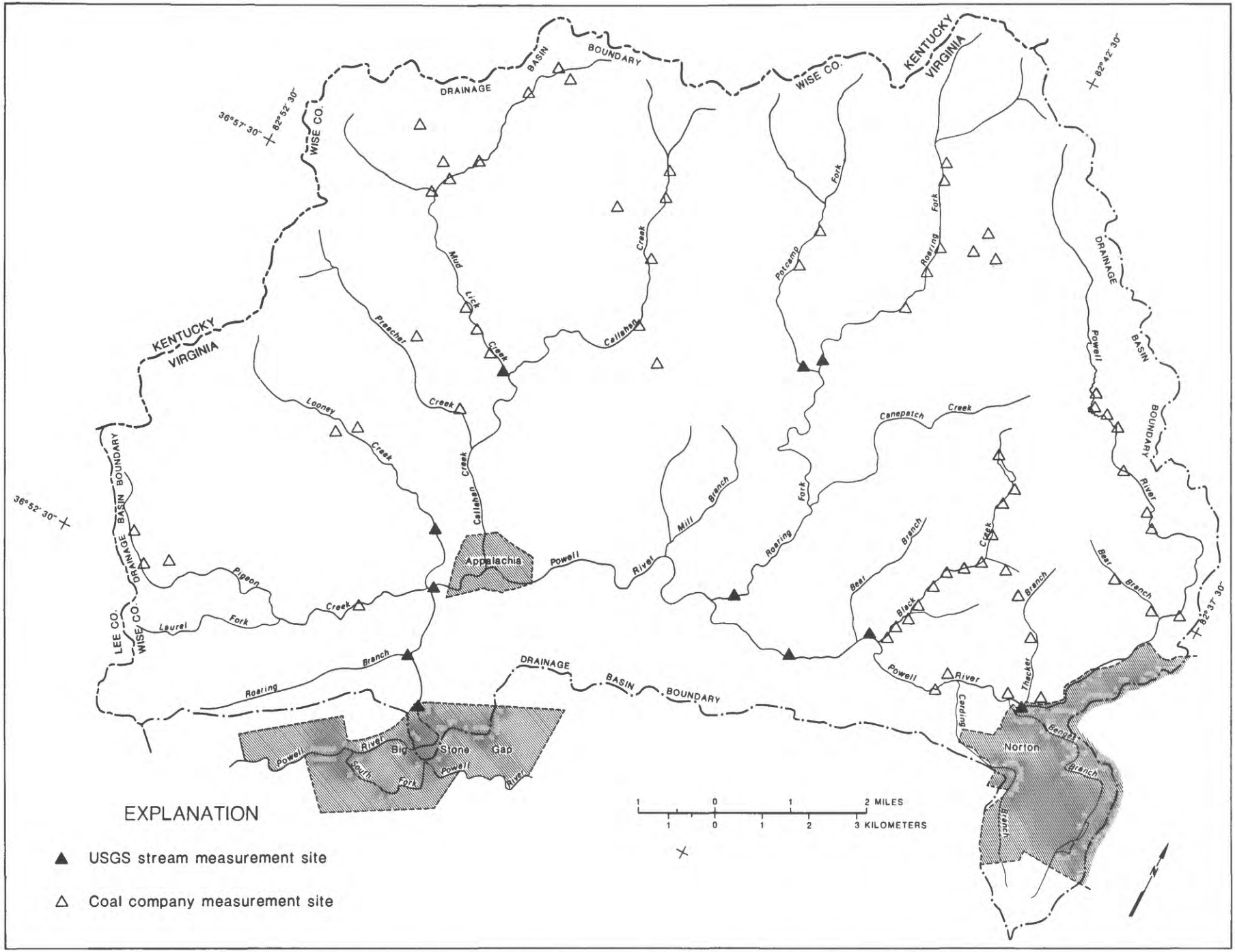

Figure 8.--Location of surface-water quality sites in the Powell River basin.

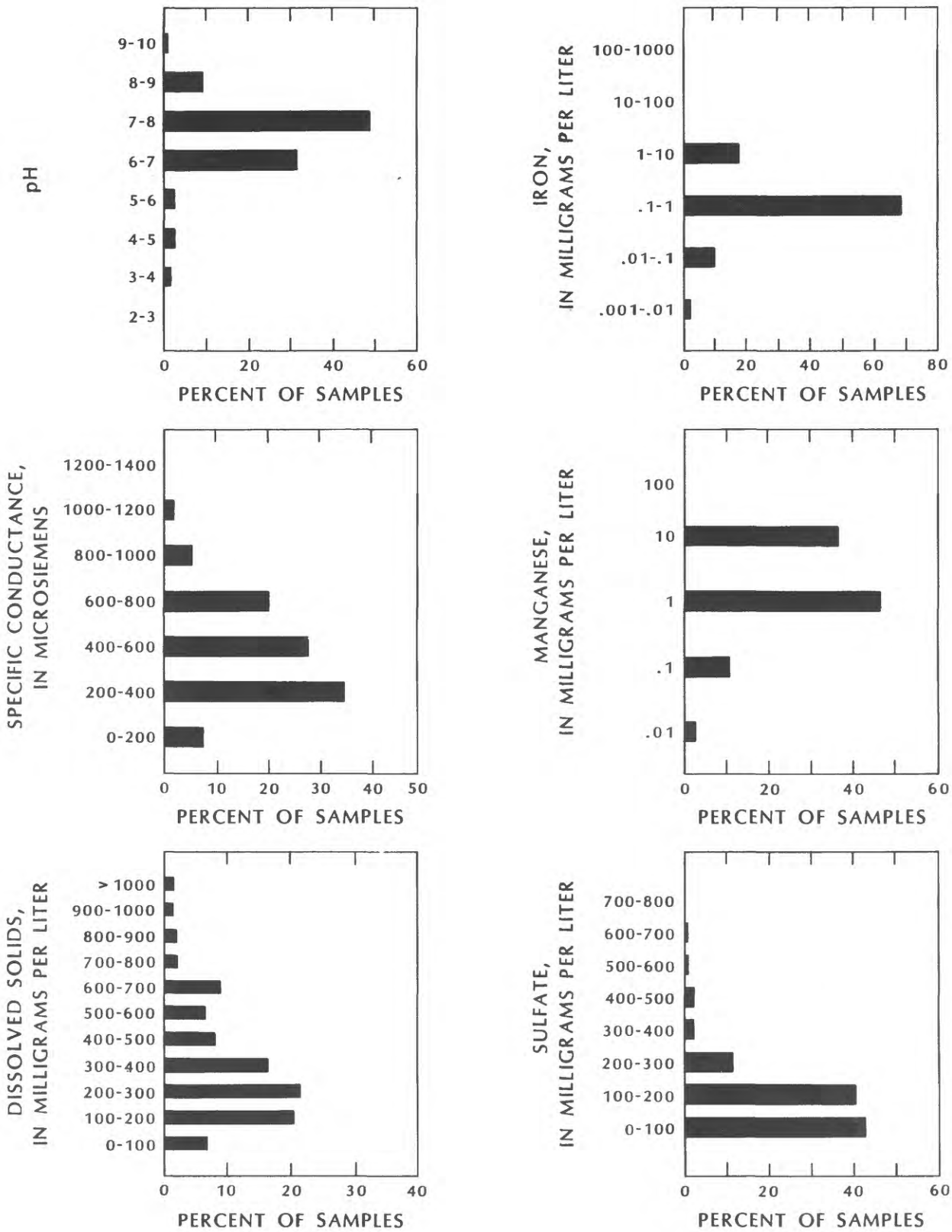

Figure 9.--Distribution of surface-water quality characteristics by range of values in the Powell River basin.

SUMMARY AND CONCLUSIONS

An inventory of selected hydrologic data from three coal companies and two governmental agencies indicates that a large volume of hydrologic data have been collected in the Powell River basin of Wise County, Virginia. The greatest volume of available data pertains to water quality. Ground-water and surface-water samples contained elevated concentrations of iron, manganese, and sulfate. Specific conductance, pH, and dissolved solids may present problems locally, but generally are within USEPA recommended limits throughout the study area.

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