Final Report

Water Resources Protection Act

Water Use Survey

December 29, 2006

west virginia department of environmental protection

Stephanie R. Timmermeyer, Cabinet Secretary

IMPLEMENTATION OF
THE WATER RESOURCES PROTECTION ACT
WEST VIRGINIA CODE, ARTICLE 22-26

FINAL REPORT

Submitted to the Joint Committee on Government and Finance
West Virginia Legislature
December 29, 2006

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Abbreviations and Acronyms

Act	Water Resources Protection Act
ASIWPCA	Association of State and Interstate Water Pollution Control Administrators
BBER	WVU's Bureau of Business and Economic Research
CBER	MU's Center for Business and Economic Research
CEGAS	MU's Center for Environmental, Geotechnical, and Applied Sciences
CFS	Cubic Feet per Second
CVI	Canaan Valley Institute
DOT	Department of Transportation
DNR	Division of Natural Resources
GED	Gallons per Employee per Day
GW	Ground Water
HUC	Hydrological Unit Code
ICPRB	Interstate Commission on the Potomac River Basin
IMS	Information Management System
MGD	Million Gallons per Day
MOU	Memorandum of Understanding
MU	Marshall University
NAICS	North American Industry Classification System
NCDC	National Climate Data Center
NFIP	National Flood Insurance Program
NHD	National Hydrography Dataset
NWS	National Weather Service
O&M	Operation and Maintenance
PDSI	Palmer Drought Severity Index
PSD	Public Service District
POTW	Publicly (or Privately) Owned Treatment Facility
RTI	Nick J. Rahall II Appalachian Transportation Institute
SB	Senate Bill
SDS	Spatial Data Standard
SIC	Standard Industrial Classification

SWAP	Source Water Assessment and Protection Program
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WRI	West Virginia Water Research Institute
WRPA	Water Resources Protection Act
WVBEP	West Virginia Bureau of Employment Programs
WVBPH	West Virginia Bureau for Public Health
WVDA	Department of Agriculture
WVDEP	West Virginia Department of Environmental Protection
WVGES	West Virginia Geologic and Economic Survey
WVDHSEM	West Virginia Division of Homeland Security and Emergency Management
WVU	West Virginia University
7Q10	Low Flow for a Stream for Seven Consecutive Days During a Ten Year Period

Acknowledgements

Without the assistance of numerous individuals within the Department of Environmental Protection (DEP), other state and federal agencies, academia, and the private sector, compilation of this report would not have been possible.

The DEP would like to thank the following groups for their assistance: West Virginia Legislature's Joint Legislative Oversight Commission on State Water Resources, the various offices within the Department of Environmental Protection, Bureau for Public Health, WV Geological and Economic Survey, Public Service Commission, Division of Natural Resources, Department of Agriculture, WV Division of Homeland Security and Emergency Management, U.S. Geological Survey, WV Chamber of Commerce, WV Rural Water Association, WV Conservation Agency, WV Development Office, WV Farm Bureau, WV Manufacturers Association, WV Coal Association, and the Independent Oil & Gas Association of West Virginia.

Special thanks to the Rahall Transportation Institute, the Center for Environmental, Geotechnical, and Applied Science at Marshall University, the Center for Business and Economic Research at Marshall University, and the Water Research Institute at West Virginia University, for contributing to the research necessary for this report. Special thanks also to the U.S. Geological Survey for providing data utilized in this report, and the West Virginia Geologic and Economic Survey for providing input into the survey design. In addition, the DEP extends special thanks to its Information Technology Office for developing the on-line survey and associated databases. The DEP would also like to recognize the West Virginia Coal Association for developing a survey preparation guideline document for the coal industry.

Finally, the DEP would like to thank all of the survey participants, including the draft survey (beta) testers: Arch Coal, WV-American Water Company, Appalachian Electric Power, Union Williams Public Service District, and Bright Industries.

Executive Summary

The final report is a compilation of findings, conclusions, and recommendations on the major tasks set out in the Water Resources Protection Act. Marshall University's Center for Environmental, Geotechnical, and Applied Sciences as well as its Center for Business and Economic Research and West Virginia University's Water Research Institute have co-authored this report.

As noted in the report, other states have had programs in place from three to 100 years. Others are still trying to implement a program. West Virginia has taken a major step forward in developing a comprehensive water management program. Ideas from programs in neighboring states were merged with the conclusions from the study to create recommendations for the program detailed in the final chapter of this report.

This report has identified that while strides have been made to quantify surface water availability (most recently with the 7Q10 study), there is a significant shortage of data to quantify the ground water resources. Creating a foundation to implement a water management program requires funding of a ground water monitoring network and the continuation of stream gauge monitoring. To prevent the survey data from becoming obsolete, continuation of a registration/certification program is recommended. The DEP recommends development of a statewide water management program over a multi-year period. The program should provide for regional watershed planning with state oversight. Additionally, the development of a standardized definition of drought is recommended.

West Virginia has taken the necessary first step to create a program so that it can begin gathering the data necessary to make decisions on water availability. The state now knows that at least 3.4 trillion gallons of water are withdrawn from its surface water and 30.7 billion gallons are withdrawn from its ground water annually. However without the continuation of data collection and analysis as recommended in this report, the state will not have the long-term data to responsibly manage its most abundant and vital natural resource: water.

Introduction

The Water Resources Protection Act ("Act" or "WRPA"), W.Va. Code §§22-26-1 *et seq*., enacted March 13, 2004, authorized the establishment of a Joint Legislative Oversight Commission on State Water Resources. The West Virginia Department of Environmental Protection (DEP), the implementing agency for the Act, was required to submit a yearly progress report to the Commission (§22-26-5(b)) and a final report to the Joint Committee on Government and Finance. Annual reports were prepared and submitted at the end of 2004 and 2005. This final report completes the DEP's reporting requirements under the Act. A copy of the Act may be found in Appendix A.

Major Tasks

The Act addresses water use in West Virginia, and focuses on three major tasks: 1) preparation and implementation of a survey of persons who withdrew and/or consumed more than 750,000 gallons of water in any month during calendar years 2003, 2004, or 2005; 2) preparation of a final report, due December 31, 2006, that addresses nine major topics related to water use, and provides recommendations for additional actions that should be taken to implement a water quantity management strategy, and 3) implementation of a registration/ certification program for large quantity water users beginning in 2006.

Data Collection

The questions posed in the WRPA may only be answered with accurate and complete data. A large number of personnel hours were expended to contact or otherwise determine which of the original 1,600 facilities were subject to the requirement to complete the survey. In addition, a significant amount of time was expended to convert data from the Department of Health and Human Resources Sanitary Surveys into an electronic format. Data was also collected from the United States Geological Survey, the Ohio Department of Natural Resources, and the West Virginia Department of Agriculture. In addition to the above, a survey of states was conducted through the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), and surrounding states were individually contacted in order to gather information about the status of water management programs outside West Virginia.

Marshall University and West Virginia University

Marshall University (MU) and West Virginia University (WVU) were specifically authorized to enter into interagency agreements with DEP to assist with implementation of the Act. During 2005, a memorandum of understanding (MOU) was executed between the DEP, MU, and WVU. The MOU specifically includes the MU Center for Environmental, Geotechnical and Applied Science (CEGAS), and WVU's Water Research Institute (WRI). Though not specifically mentioned in the MOU, additional assistance has been supplied by MU's Center for Business and Economic Research (CBER) and the Nick J. Rahall II Appalachian Transportation Institute (RTI).

West Virginia University assisted in the preparation of the following report sections: Chapter 4 – Drought, Flood, and Low Flow Conditions, Chapter 5 – Uses That Contribute to Detrimental Low Flow Conditions, and Chapter 9 – Water Conservation Practices.

Marshall University assisted in the preparation of the following report sections: Chapter 7 – Competition for Water Resources in Potential Growth Areas and Chapter 10 – Data Warehouse. Marshall also assisted with GIS mapping of the data.

Findings

This report will examine the nine major report elements of the WRPA in detail. Some activities that were not envisioned in the original act that are essential to the successful completion of the DEP's Legislative Mandate also will be discussed. These include establishment of the data warehouse and promulgation of the Procedural Rule "Administrative Procedures and Civil Administrative Penalty Assessment – Water Resources Protection Act," and the Interpretive Rule "Confidential Information Under Water Resources Protection Act."

During the research for this report, data deficiencies were discovered that will preclude a complete answer for the majority of the major report elements. However, the survey results provide a starting point for developing an understanding of how the state's water resources are utilized. In addition, the state now has an idea of how it should proceed in the future in order to effectively inventory and manage its precious water resources.

Chapter 1 - Location and Quantity of All Surface and Ground Water Resources

1.1 Surface Water

West Virginia is blessed with an abundance of rivers and streams. These rivers and streams have been designated by the state for a variety of uses, including fish and wildlife propagation, recreation, transportation, drinking, agriculture, and industry.

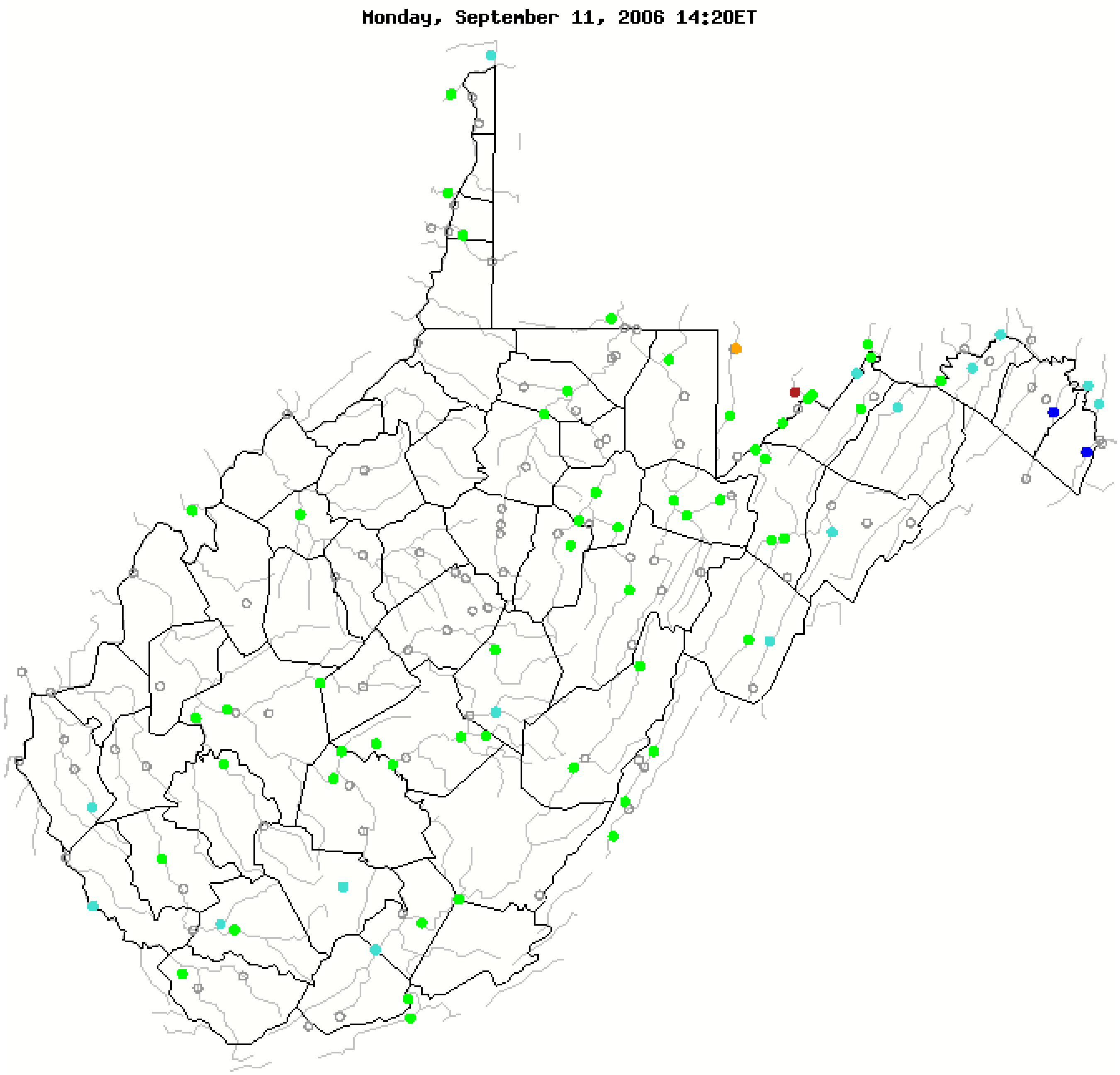
Table 1.1 is an atlas of West Virginia surface water resources. According to the National Hydrography Dataset (NHD), which is the most accurate coverage of West Virginia streams, the state contains approximately 52,500 unique streams that total approximately 55,400 miles. A breakdown of stream statistics by major watershed is provided in Appendix B.

Table 1.1 West Virginia Surface Water Resource Atlas

Number of major watersheds	32
Number of uniquely named streams (approx.)	8,700
Number of unnamed streams (approx.)	43,800
Miles of uniquely named streams (approx.)	28,200
Miles of unnamed streams (approx.)	27,200
Number of border stream miles	619
Number of lakes/reservoirs/ponds (publicly-owned)	115
Number of lakes/reservoirs/ponds (privately-owned)	396-
Acres of lakes/reservoirs/ponds (publicly-owned)	17,573
Acres of lakes/reservoirs/ponds (privately-owned)	10,252

According to the DEP's Dam Safety Office, the state contains 115 public lakes that total 17,573 acres. In addition, the state contains 396 private lakes that total 10,252 acres. The current inventory of lakes is provided in Appendix C.

Although estimating absolute stream volume is not feasible, data exist for flow rates at various gauging stations on many of the state's larger streams. The flow rate data will enable many of the questions posed by the Water Resources Protection Act to be answered. The locations of active USGS gauging stations are shown in Figure 1.1.



USGS

Explanation - Percentile classes							
Low	<10 Much below normal	10-24 Below normal	25-75 Normal	76-90 Above normal	>90 Much above normal	High	Not-ranked

Figure 1.1 Map of real-time streamflow compared to historical streamflow for 9/11/2006

There are 127 active streamflow-gauging stations in the state. A breakdown of the gauging stations by watershed is provided in Appendix D. These stations automatically record flow data at a given point on the stream. Instantaneous real-time flow data can be obtained by visiting the USGS Web site at http://wv.usgs.gov/wrt/. Various flow statistics are calculated for each station, and these can be obtained on the Web site. An example of the type of flow data available from the Web site is given in Table 1.2. Data are available for the entire period of record at each site, which, in some instances, spans more than 50 years.

Table 1.2 Average Annual Streamflow for Potomac River @ Hancock Maryland

1933-2003							
Year	**Annual mean Streamflow, in gal/s**	**Year**	**Annual mean Streamflow, in gal/s**	**Year**	**Annual mean Streamflow, in gal/s**	**Year**	**Annual mean Streamflow, in gal/s**
1933	34,991	**1951**	35,754	**1969**	13,898	**1987**	30,219
1934	17,787	**1952**	35,769	**1970**	33,488	**1988**	24,781
1935	32,022	**1953**	29,643	**1971**	38,978	**1989**	34,991
1936	44,611	**1954**	24,953	**1972**	56,654	**1990**	27,661
1937	45,291	**1955**	32,703	**1973**	40,242	**1991**	24,856
1938	18,117	**1956**	30,339	**1974**	29,972	**1992**	23,899
1939	29,583	**1957**	25,604	**1975**	42,651	**1993**	40,414
1940	32,396	**1958**	28,865	**1976**	30,907	**1994**	43,160
1941	18,880	**1959**	19,426	**1977**	25,148	**1995**	24,243
1942	36,667	**1960**	29,853	**1978**	38,896	**1996**	68,075
1943	27,586	**1961**	33,204	**1979**	50,550	**1997**	27,295
1944	28,701	**1962**	29,434	**1980**	31,790	**1998**	41,783
1945	32,149	**1963**	24,467	**1981**	22,934	**1999**	17,024
1946	23,106	**1964**	26,614	**1982**	30,930	**2000**	20,480
1947	16,531	**1965**	24,706	**1983**	35,231	**2001**	21,221
1948	34,827	**1966**	21,550	**1984**	40,699	**2002**	24,101
1949	34,909	**1967**	32,875	**1985**	38,821	**2003**	61,560
1950	35,044	**1968**	25,649	**1986**	25,469		

Flow data exists for many stream locations in West Virginia; however, most streams are unmonitored. USGS has developed a model to calculate flow on any stream. USGS, in cooperation with WVU and the DEP, is currently working to refine the streamflow model to allow for more accurate determinations of the flow rate at any point on any stream in West Virginia. This model will be able to predict both low flow (7Q10) and median flow statistics. One of the purposes of the model is to quantify water availability so that water resources can be more effectively managed. This valuable project is scheduled to be completed in 2007.

As previously noted, the absolute volume of water cannot be calculated for streams. However, it can be calculated with a fair degree of accuracy for lakes. According to the DEP's Dam Safety Office, West Virginia lakes (both public and private) contain 866,118 acre-feet (282.2 billion gallons) of water at normal pool levels.

Figure 3.10 (surface water withdrawal map) indicates three general areas in the state where surface water is heavily utilized: the Kanawha River Valley, the North-Central Border Region, and the Northern Panhandle. These three areas account for 85.35% of the total amount of surface water used by major facilities in the state.

Kanawha River Valley: The Kanawha River Valley accounts for 72.58% of the total amount of surface water withdrawn by major facilities in the state. This area spans the counties of Fayette, Kanawha, Putnam, and Mason. A large part of this region is fairly heavily populated and industrialized. It includes the capital city of Charleston, which is the state's largest metropolitan area. The largest public water provider in the state, West Virginia American Water, is located in Charleston.

The single largest water user in the state, Elkem metals, is located in the upper part of the region. This facility alone accounts for 53.54% of the total surface water withdrawn by major water users in the state. The water is used primarily for hydropower, and is diverted through a tunnel constructed on the lower New River near Hawks Nest Dam.

North-Central Border Region: The North-Central Border Region accounts for 3.55% of the total amount of surface water withdrawn by major facilities in the state. This area spans the counties of Harrison, Preston, Monongalia, and Marion. A portion of the area borders Pennsylvania and Maryland. The region is fairly well populated and includes the cities of Morgantown, Fairmont, and Clarksburg. Major uses of water in the area include power production and coal mining. Major rivers include the West Fork, Tygart, and Monongahela.

Northern Panhandle: The Northern Panhandle accounts for 9.22% of the total amount of surface water withdrawn by major facilities in the state. This area spans the counties of Hancock, Brooke, Ohio, and Marshall. Major cities include Wheeling and Weirton. This area is noted for its steel industry and power production. The Ohio River runs along the western border of these counties, and is the principal source of surface water for major facilities in the region.

The remainder of the state accounts for 14.65% of the total amount of surface water withdrawn by major facilities. Statewide, the top five major categories of surface water use are electrometalurgical products (Elkem Metals) (53.54%), power generation (37.88%), industrial organic chemicals (3.06%), chlor-alkali (1.55%), and public water supply (1.54%).

1.2 Springs

Springs are an important source of water for the state, especially in eastern counties. The definitive work on springs was compiled by the WVGES and published in 1986. The publication was a compilation of spring locations with quality and quantity information derived from a search of existing literature. No attempt was made to identify all of the springs in the state. The DEP converted the data into an electronic format from the 1986 report. Figure 1.2 is a map of the springs identified in the survey, coded to reflect whether a spring produces an average flow of over 750,000 gallons of water per month.

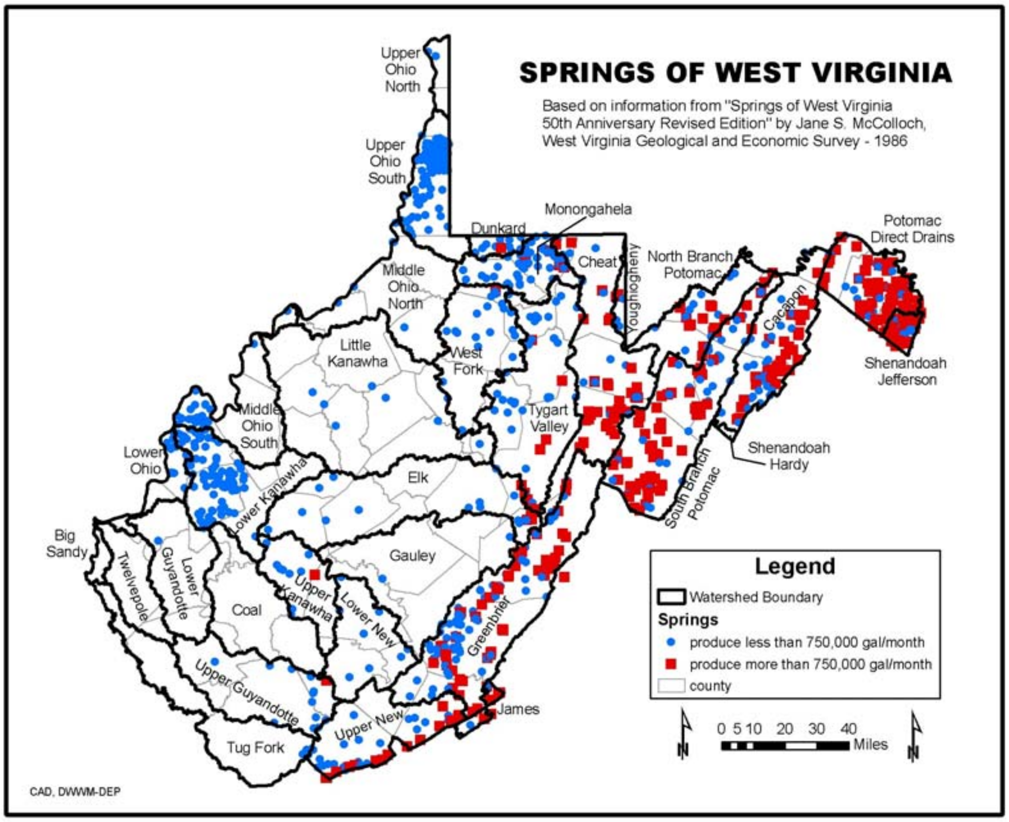


Figure 1.2 Spring Locations

1.3 Ground Water

West Virginia is heavily dependent on ground water. Large quantity ground water withdrawals averaged 33 billion gallons per year over the survey period. Approximately 41% (12.4 billion gallons) was withdrawn by public water suppliers. This figure does not include the tens of thousands of West Virginians that still rely on ground water for their daily domestic and business needs.

Data on the ground water resource has been collected for a number of years by the Department of Health and Human Resources in the form of yearly withdrawal data and sanitary surveys. County health departments require drilling information for water wells upon installation. This data is not addressed in this report because the records are maintained in each county, are not submitted to a central state agency, and are not stored electronically. Collecting the information and subjecting it to ground-truth inspections was beyond the ability of the DEP due to manpower and schedule constraints. The USGS published a ground water atlas, mapped by watershed, between 1980 and 1985.

The USGS has located and maintained as many as 11 ground water level monitoring wells. Although some have records dating from the mid 1970s, several only began operation after 2000. USGS has temporary funding to support eight monitoring wells (Figure 1.3) through the current federal fiscal year. A source of long term funding will be required to maintain all of these wells beyond 2007.

The Department of Health and Human Resources has years of water withdrawal data, but the aquifers have not been mapped, nor have the potential maximum withdrawal rates been studied. The sanitary surveys are predominately aimed at protecting human health. Therefore, they were never designed to supply the detailed aquifer data required for the Act.

The USGS water level monitoring wells are too sparsely distributed to be of use in developing a statewide understanding of the ground water resource (Figure 1.3). In addition, the only data recorded is the ground water level in the well. The wells have not been evaluated to determine where the water actually enters the well.

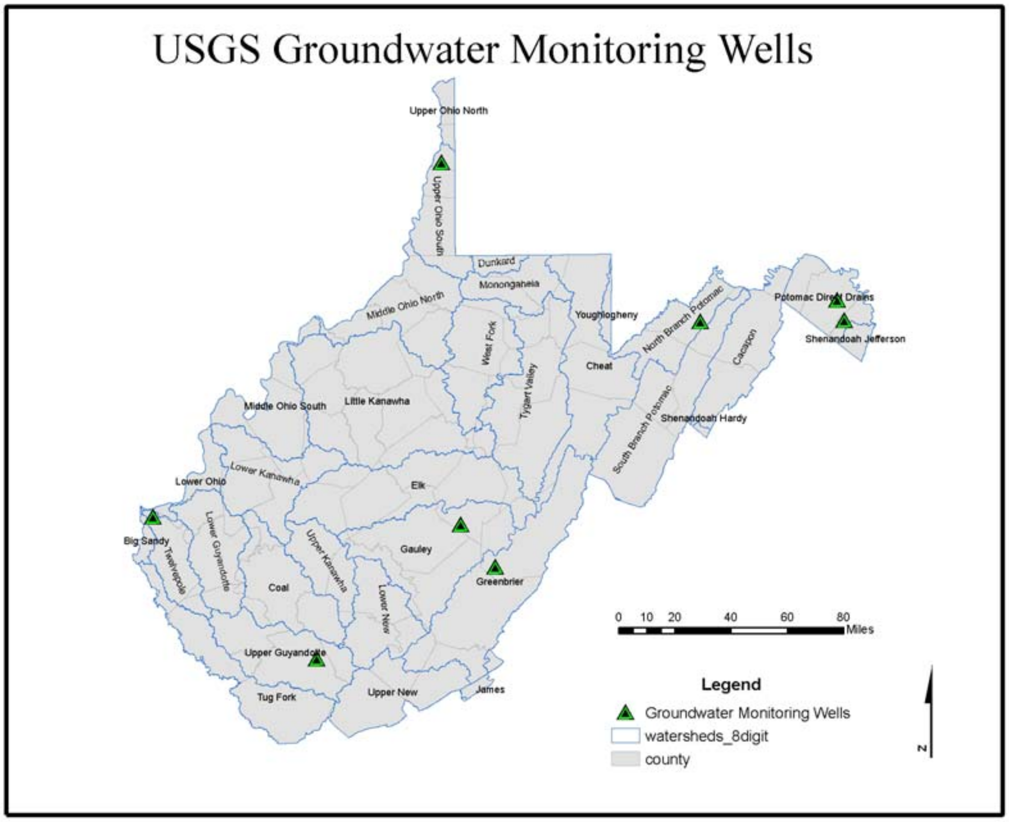


Figure 1.3 USGS Ground Water Monitoring Wells

The Interstate Commission on the Potomac River Basin (ICPRB) acquired federal funding to drill two ground water level monitoring wells in the Eastern Panhandle. However, the funding was not continued, and these wells have never been equipped with gauges or telemetry equipment.

The 2003-2005 Water Use Survey provided little information on aquifers. Only 11 respondents completed the boxes for formation name and lithology type. None of the 11 supplied an actual formation name, only the geologic system name. There are typically numerous formations within each geologic system. In most geographic areas, the geologic system will be too large a unit to be meaningfully mapped for ground water management.

To fully identify and quantify the ground water resources of the state, the aquifers must be identified, mapped, and tested. Data on the aerial distribution, thickness, fractures, yield rates, and lithology of the aquifers will be required. Only further work aimed at delineating the state's aquifers will permit successful management of the ground water resource.

Although the actual location of the ground water resource cannot be mapped, the information obtained from the water use surveys does indicate where ground water is abundant in significant quantities to support large withdrawals. Figure 3.9 maps the locations of the state's large quantity ground water users. Obviously, many factors other than water availability determine where a facility is located, and the absence of a large quantity user does not necessarily mean there is an absence of significant ground water reserves.

Figure 3.9 indicates three general areas where the ground water resource is both abundant and heavily exploited: along the Ohio River, the southern coalfields, and, to a lesser extent, the Eastern Panhandle.

Along the Ohio River: It is interesting to note that ground water use along the Ohio far exceeds surface water withdrawals. Yet, this observation is somewhat misleading. Water moves freely between the surface and the sub-surface along the river, depending on ever-fluctuating physical conditions. Thus, if a well extends below the river, or is adjacent to the river, and water is pumped out of the well at a sufficient rate, water from the surface will become ground water as it is drawn through the porous alluvial aquifer by the suction exerted upon it by the pumping of the well. The area along the Ohio River accounts for 64.5% (21 billion gallons annually) of the total surveyed ground water withdrawal in the state. The major use of ground water in this area is by various chemical manufacturers, which account for 60% of the total usage.

The Southern Coalfields: This area accounts for 9% (3 billion gallons) of the total ground water withdrawals from the state. The major use of ground water in this area is by coal mining, which accounts for 44% of the total.

The Eastern Panhandle: The Eastern Panhandle accounts for 19.5% (6.5 billion gallons) of the ground water usage in the state. The major use of ground water in this area is by one cement manufacturer (57%), closely followed by water supply companies (42%).

Other areas of the state account for the remaining 7% of the total ground water withdrawal.

1.3.1 Ground Water Conclusions

Data has been amassed from various sources by various agencies regarding the ground water resource. Past data was collected for a specific purpose, and usually does not provide the raw data necessary for an evaluation of the quantity of ground water in an aquifer. For the purpose of ground water management, the previously collected data is insufficient.

As previously noted, the state has few ground water monitoring wells. Except for Kentucky, states in EPA Region III and those states in Region V that border West Virginia all have a monitoring well network. Maryland has 141 wells, Delaware 96, Pennsylvania 65, Virginia 256, and Ohio 140. The majority of the state programs have conducted electronic logging of specific wells. Delaware has the ability to require logging of private wells through a permitting process.

Obtaining the necessary information will require a long-term commitment by the state. The cost for such a program will be modest, but must be sustained for a period of years. Gathering the data to evaluate the ground water resource could be accomplished by requiring public water supply wells to be electronically logged, and these logs be submitted to the appropriate regulatory agency. Cost to the individual facility installing the well for logging would range from $3,000 to $4,000, depending on the location, depth, and several other factors relating to the well. Over time, this would build a body of knowledge about ground water that would help in its evaluation and management.

Chapter 2 - Consumptive and Non-consumptive Withdrawals

As per the Act, consumptive use is defined as any withdrawal of water that returns less water to the water body than is withdrawn. With this in mind, the survey was designed to ask users from where they withdrew their water, including: latitude and longitude; stream, river, lake, or spring name; county; and well information. Details were also requested regarding discharge information, specifically whether the discharge was to a wastewater treatment facility, stream, underground injection well/septic system, private reservoir, lake, or other. In each of those categories, the respondent had to give the latitude and longitude, county, name or description of discharge point, and permit number (if applicable). Water providers were asked to provide the zip codes for the areas in which they distribute water.

2.1 Methodology

In theory, determination of consumptive use for any facility should be possible by subtracting the amount of water discharged from the amount of water withdrawn. In numerous instances, the practical application of this technique was not possible. The lack of metering for water discharged from some facilities before it entered the storm sewer resulted in stormwater being calculated as part of the discharge. This lack of metering made it nearly impossible to account for any stormwater that entered the system. A number of facilities also purchased water for use. According to the definition of consumptive use, purchased water is not counted in the amount of water withdrawn. As a result, some facilities gave the appearance of discharging more water than they withdrew. A few of the facilities also provided water to other facilities, and others discharged some of their water to wastewater treatment facilities. Since these exchanges of water are not accounted for in the consumptive use calculation, consumption amounts calculated for these facilities are higher than actual.

The table in Appendix E provides a listing of all survey participants and their consumptive and non-consumptive uses. It is sorted first by county and then by facility name. The values represented only illustrate the amount withdrawn from a water body and the amount discharged to a water body, not the other sources of water listed above.

Some assumptions have also been made regarding consumptive use. For example, water used on golf courses, for dust suppression on haul roads, and for public water is considered entirely consumptive. Regardless of where the water originates, either from the surface or from wells, it is not returned directly to that water source. Whereas the previous table lists each facility and the gallons of water consumed or added by the facility to a water body annually, the two tables in Appendix F break out the consumptive use by water body. Appendix F.1 breaks out the average gallons of ground water consumed from each county annually. The numbers in parentheses are for the counties where more water was injected back underground than was withdrawn. The largest consumption of ground water, with the exception of Berkeley County, is in the counties along the Ohio River. It should also be noted that not all West Virginia counties are represented on the table. As illustrated graphically on Figure 3.9, not all counties have facilities that pull enough ground water monthly to require them to report.

Appendix F.2 breaks out the average gallons of surface water consumed from each water body annually. Added to the data reported in the survey is the average design flow (ADF) for all public and privately owned wastewater treatment facilities (POTW). This data was needed to offset the consumptive use of the water providers and facilities with discharges to treatment facilities. This allowed a more accurate picture of water consumed from each water body, by accounting for the amount discharged back via POTWs.

The difficulty in calculating true consumptive use lies in the omission of facilities that withdrew less than 750,000 gallons in any given month (small water users). Without this data, the ability to determine if the water body will be able to withstand the consumptive use by all users is undermined. Any future legislation on a water management program should evaluate the impact of small water users on any stream in which the known consumptive use by large water users may jeopardize the 7Q10 flow of the stream.

2.2 Agricultural Water Consumption

The West Virginia Department of Agriculture provided the results of its 2002 livestock and poultry census, the most recent census available. Due to restrictions in the law, WVDA may not report data from individual farms. Data was aggregated by county for various types of livestock and poultry. If a county had two farms or fewer, the WVDA was prohibited from providing data specifically for a particular type of livestock for that county.

Very little water is used for irrigation by farmers in the state, so that statistic is not collected by WVDA. All of the water use reported is for livestock and poultry. As such, all of the use is consumptive. Table 2.1 Lists 2002 agricultural water consumption by county. Figure 2.1 displays the same information on a state county map.

Table 2.1 2002 Agricultural Water Consumption by County in Gallons

County	Livestock Water Consumption (gallons)	Poultry Water Consumption (gallons)	Total Agricultural Water Consumption (gallons)
Barbour	29,372,828	3,009	29,375,837
Berkeley	40,475,763	0	40,475,763
Boone	286,160	0	286,160
Braxton	19,487,168	0	19,487,168
Brooke	4,923,303	0	4,923,303
Cabell	11,991,528	36,518	12,028,046
Calhoun	11,116,623	0	11,116,623
Clay	4,499,355	0	4,499,355
Doddridge	15,925,680	2,062	15,927,742
Fayette	10,051,553	0	10,051,553
Gilmer	17,649,940	0	17,649,940
Grant	39,177,823	8,083,465,078	8,122,642,901
Greenbrier	110,838,090	0	110,838,090

County	Livestock Water Consumption (gallons)	Poultry Water Consumption (gallons)	Total Agricultural Water Consumption (gallons)
Hampshire	58,557,863	2,478,949,078	2,537,506,941
Hancock	2,777,833	0	2,777,833
Hardy	67,830,140	20,099,051,520	20,166,881,660
Harrison	38,022,598	24,025	38,046,623
Jackson	42,095,633	0	42,095,633
Jefferson	51,860,113	396,413	52,256,526
Kanawha	7,531,775	0	7,531,775
Lewis	24,642,975	0	24,642,975
Lincoln	5,954,610	0	5,954,610
Logan	389,820	0	389,820
Marion	15,987,000	0	15,987,000
Marshall	25,123,863	268,405	25,392,268
Mason	49,311,865	0	49,311,865
McDowell	160,600	0	160,600
Mercer	20,674,148	0	20,674,148
Mineral	20,592,023	2,935,707,744	2,956,299,767
Mingo	688,390	0	688,390
Monongalia	23,434,825	0	23,434,825
Monroe	76,881,410	1,375	76,882,785
Morgan	7,362,963	0	7,362,963
Nicholas	19,203,928	1,589	19,205,516
Ohio	9,279,395	0	9,279,395
Pendleton	69,026,610	9,103,688,776	9,172,715,386
Pleasants	6,523,098	0	6,523,098
Pocahontas	48,539,890	6,247	48,546,137
Preston	68,832,613	31,713	68,864,326
Putnam	18,055,273	0	18,055,273
Raleigh	11,847,353	0	11,847,353
Randolph	36,798,023	0	36,798,023
Ritchie	23,804,570	0	23,804,570
Roane	32,015,428	57,180	32,072,607
Summers	24,345,135	51,822	24,396,957
Taylor	19,710,000	285	19,710,285
Tucker	9,279,578	0	9,279,578
Tyler	15,182,175	43,998	15,226,173
Upshur	24,795,545	0	24,795,545
Wayne	9,156,938	0	9,156,938
Webster	3,093,740	0	3,093,740
Wetzel	8,830,445	0	8,830,445
Wirt	15,057,893	0	15,057,893
Wood	29,527,770	101,866	29,629,636
Wyoming	1,021,818	0	1,021,818

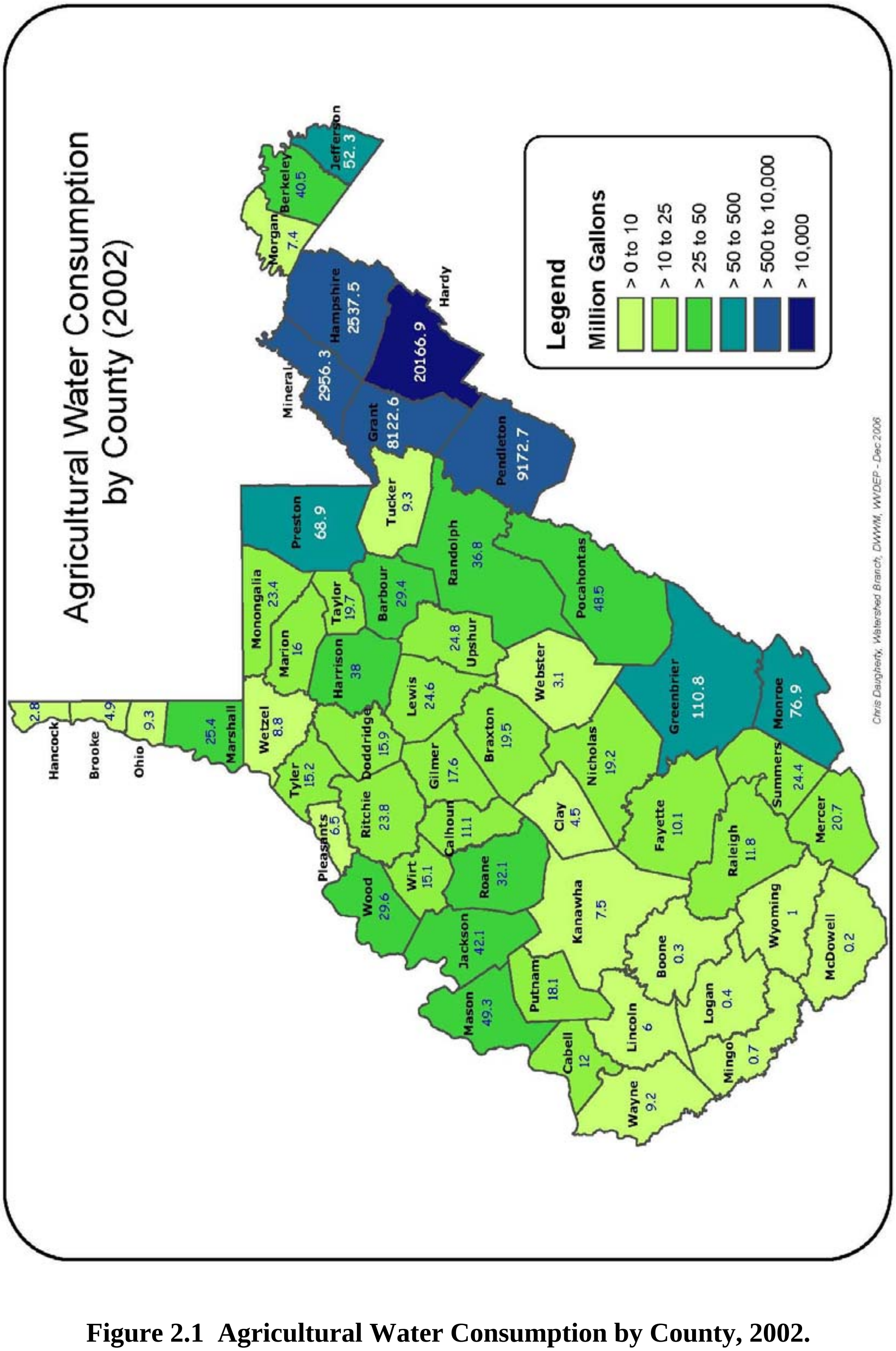


Figure 2.1 Agricultural Water Consumption by County, 2002.

As provided, the agricultural data cannot be used for detailed water use assessment and evaluation. For example, in four of the top five agricultural producing counties -- Mineral, Hardy, Pendleton and Hampshire – the agricultural water use accounts for over 95% of commercial water consumption (see Table 2.2). Yet, there is no location data for the withdrawals. They could be from one stream, several streams, or multiple wells at multiple depths. Without this information, it is impossible to evaluate the data for competing sources, conditions that exacerbate flooding and drought, or any other comparative statistic.

County	Industrial Water Withdrawal (gallons)	Agricultural Water Withdrawal (gallons)	Percentage of Total Water Use by Agriculture
Mineral	64,023,471	2,956,299,767	97.88
Grant	405,084,502,360	8,122,642,901	1.97
Hardy	8,188,418	20,166,881,660	99.96
Pendleton	482,160,000	9,172,715,386	95.01
Hampshire	0	2,537,506,941	100.00

Table 2.2 Comparison of Agricultural Water Withdrawals with Industrial Withdrawals for the Five Main Agricultural Producing Counties in West Virginia

If a water management program that reflects the range of competing uses is to be developed, everyone must work together to devise a program that will provide the water use data needed, while maintaining confidentiality of agricultural information. Otherwise, in those counties that have a large agricultural output, the water resource cannot be managed for the benefit of all.

Chapter 3 - Survey Results

The DEP began its initial design of a survey/registration form based on a review of forms and registration programs from other states, a review of the information required in the Act, and input from the USGS and WVGES. Both WVGES and USGS have previously published survey reports on water use for West Virginia. Cooperative agreements with both agencies regarding work needed for implementation of various aspects of the Act were executed.

The WVGES had considerable input into the reports authored by the USGS on water use in West Virginia. The DEP executed a contract with WVGES for $10,000 for assistance with developing the survey and interpreting the survey results.

3.1 Large Water User Determination

The USGS and DEP entered into a cooperative cost sharing agreement to provide estimates of water use by businesses in the state and assist with other aspects of preparation of the final report. The DEP contributed $93,000 and USGS provided $76,500 in matching funds for project funding. The first deliverable was for water use estimates for businesses in the state. The DEP used these estimates to identify persons who may have been required to complete the survey.

The water use estimates prepared by the USGS are calculated using Standard Industrial Classification (SIC) and North American Industry Classification System (NAICS) codes to determine the type of business, the number of employees at the facility, and a water use coefficient derived from prior research. The required data for each facility was obtained from the Harris Survey, a marketing research tool developed by Harris Interactive, Inc. The estimate is for average water use throughout the year, not the maximum water use during any particular month. Therefore, when determining which businesses should complete the survey, the DEP contacted businesses that may have exceeded 750,000 gallons during any month of the year.

The Harris Survey listed 6,875 businesses in West Virginia. Preliminary estimates indicated that 807 facilities might have water use above 750,000 gallons in any given month. Water use estimates for an additional 170 facilities could not be calculated because water use coefficients have not been determined for their particular SIC code. Use of alternate water use coefficients resulted in another 100 to 200 facilities being classified as large quantity users. Therefore, the total number of large quantity water users in the state, based on the Harris Survey, was as high as 1,200. The USGS information did not distinguish between which businesses withdrew from waters of the state and which purchased their water. The DEP had to contact all of the businesses to determine that information.

Although the Harris Survey does not list every business in West Virginia (estimated at 40,000), DEP believes that the USGS estimates have captured most of the large quantity users in the state. The DEP also contacted the WV Bureau for Public Health (BPH) to gather data on public water suppliers that exceeded the 750,000 gallon withdrawal threshold during any month of 2003, 2004 or 2005. The DEP was able to obtain records that showed 268 water supply facilities in West Virginia exceeded the 750,000 gallon reporting threshold.

3.2 Survey Testing and Notification

Shortly after reviewing other states' water use program requirements and meeting with various state agencies, the DEP began developing the Internet-based survey form. The form and its associated Oracle database, was alpha tested internally prior to release for beta testing. The survey was presented to Appalachian Electric Power (AEP), Arch Coal and West Virginia American Water for beta testing on December 10, 2004. Based on the results of two beta tests, the DEP made modifications to the survey and released it to the public on March 31, 2005, with a deadline of July 1, 2005, for submission.

In an effort to notify the large quantity users about the survey, the DEP issued 1600 postcards that provided the web address of the survey, contact information, and the survey deadline. These were mailed prior to the survey release and again in mid-May as a reminder to complete the survey. The DEP's Public Information Office issued several press releases via its email subscriber list and to media statewide. The following organizations also sent email messages to their contact lists reminding them of the necessity to complete the survey or contact the DEP if they were ineligible: WV Chamber of Commerce, WV Rural Water Association, and WV Coal Association. In a related effort to offer the public the opportunity to ask questions and receive training on completing the survey, the DEP held training in Charleston, Wheeling, Morgantown, Martinsburg, Beckley, and Parkersburg. Due to the complexities of water use by mining industries, the WV Coal Association requested additional training sessions for its members in Flatwoods and Logan.

In preparation for collecting data for 2005, the DEP made several modifications to the survey and made an effort to include a wider spectrum of beta testers. Two additional facilities that had some technical difficulty in completing the first survey were asked to participate. Beta testers for the 2005 survey were Arch Coal, AEP, WV American Water, Union Williams Public Service District, and Bright Industries. Beta testing began November 4, 2005. The 2005 survey was released January 2006 and was completed by the end of February 2006. A copy of the 2005 survey can be found in Appendix G.

3.3 Survey Results

Any interested party wishing to view the complete data set from the survey should submit a request to the DEP. Due to homeland security concerns, and in consultation with the Department of Military Affairs and Public Safety, location data for public water supply intakes will not be provided. One facility did not submit its survey until November 2006. It has not been included in the data analysis because of the late submission. However, it will be included in the data set.

Appendix H lists the facilities that responded to the survey and is sorted by county and then facility name. The three year average annual withdrawal listed is not consumptive use as referenced in the consumptive use table in Appendix F. It is the amount of water withdrawn by each facility and the name of the water body from which it was withdrawn. The following graphs (Figures 3.1 – 3.8) illustrate the fluctuations of ground water and surface water withdrawn from each county on an average monthly basis. These variations may be primarily attributed to seasonal use. For example, the ground water from Nicholas County fluctuates widely primarily for seasonal dust suppression at mining facilities

Ground Water

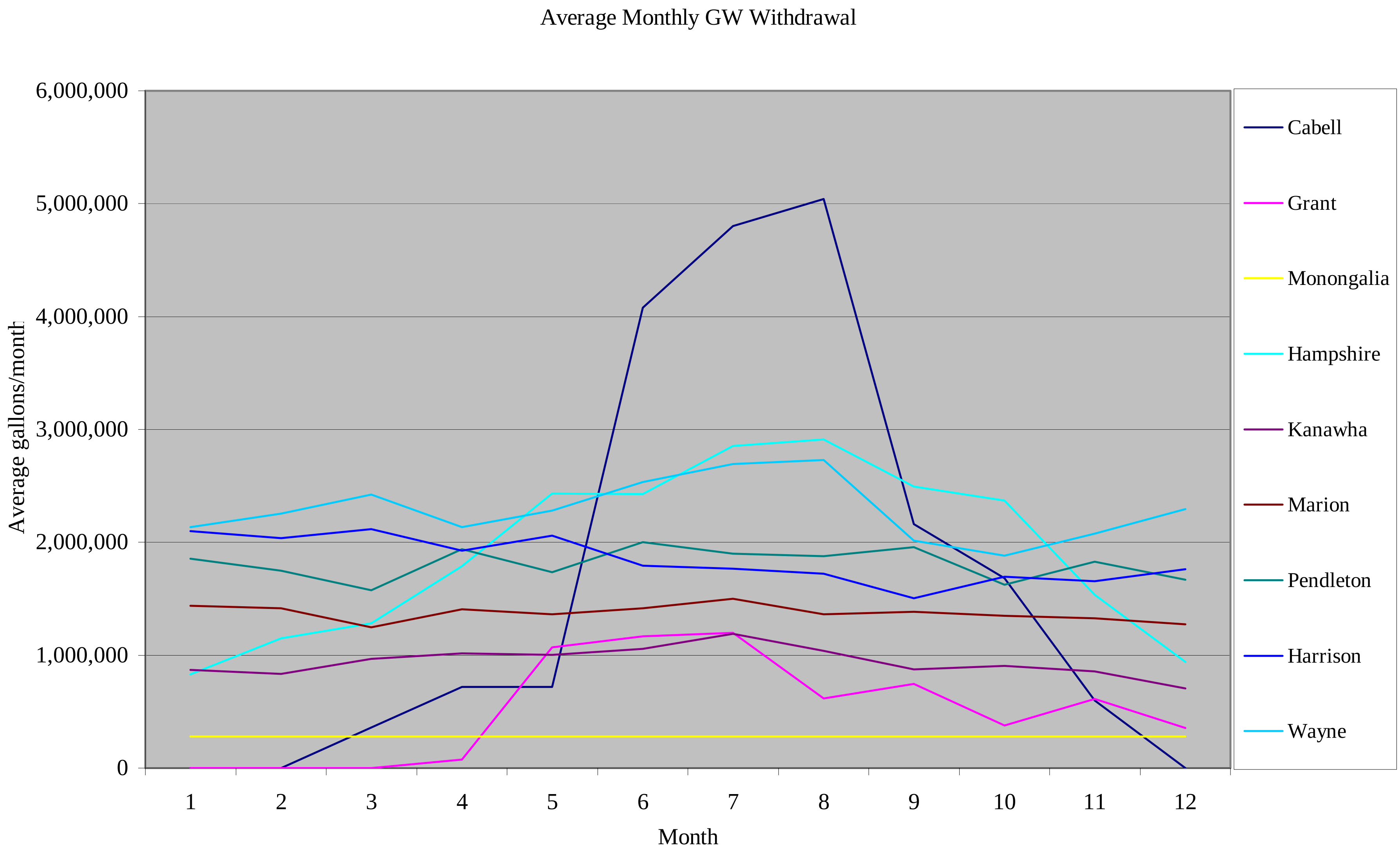


Figure 3.1 Average Monthly Ground Water Withdrawal by County

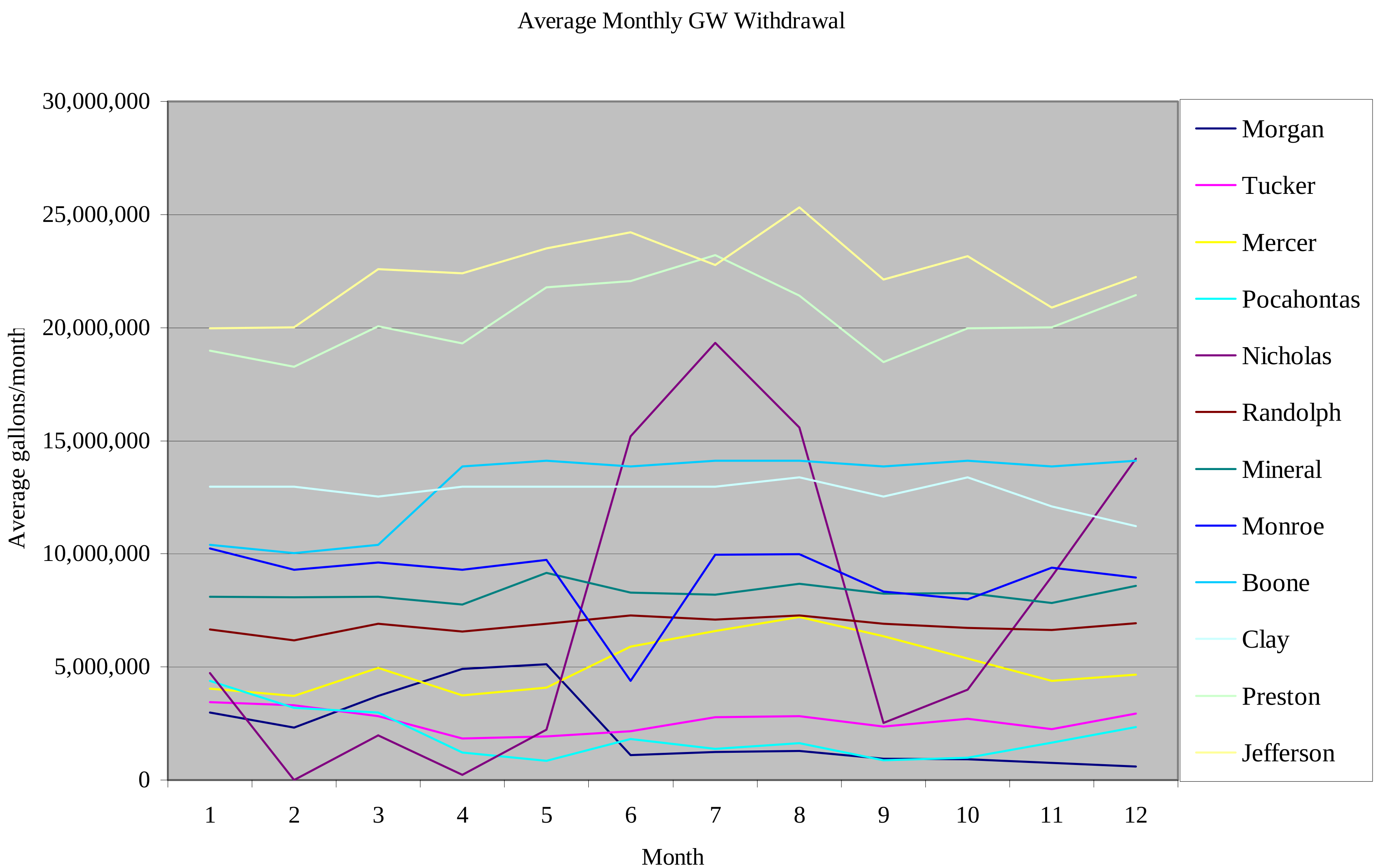


Figure 3.2 Average Monthly Ground Water Withdrawal by County

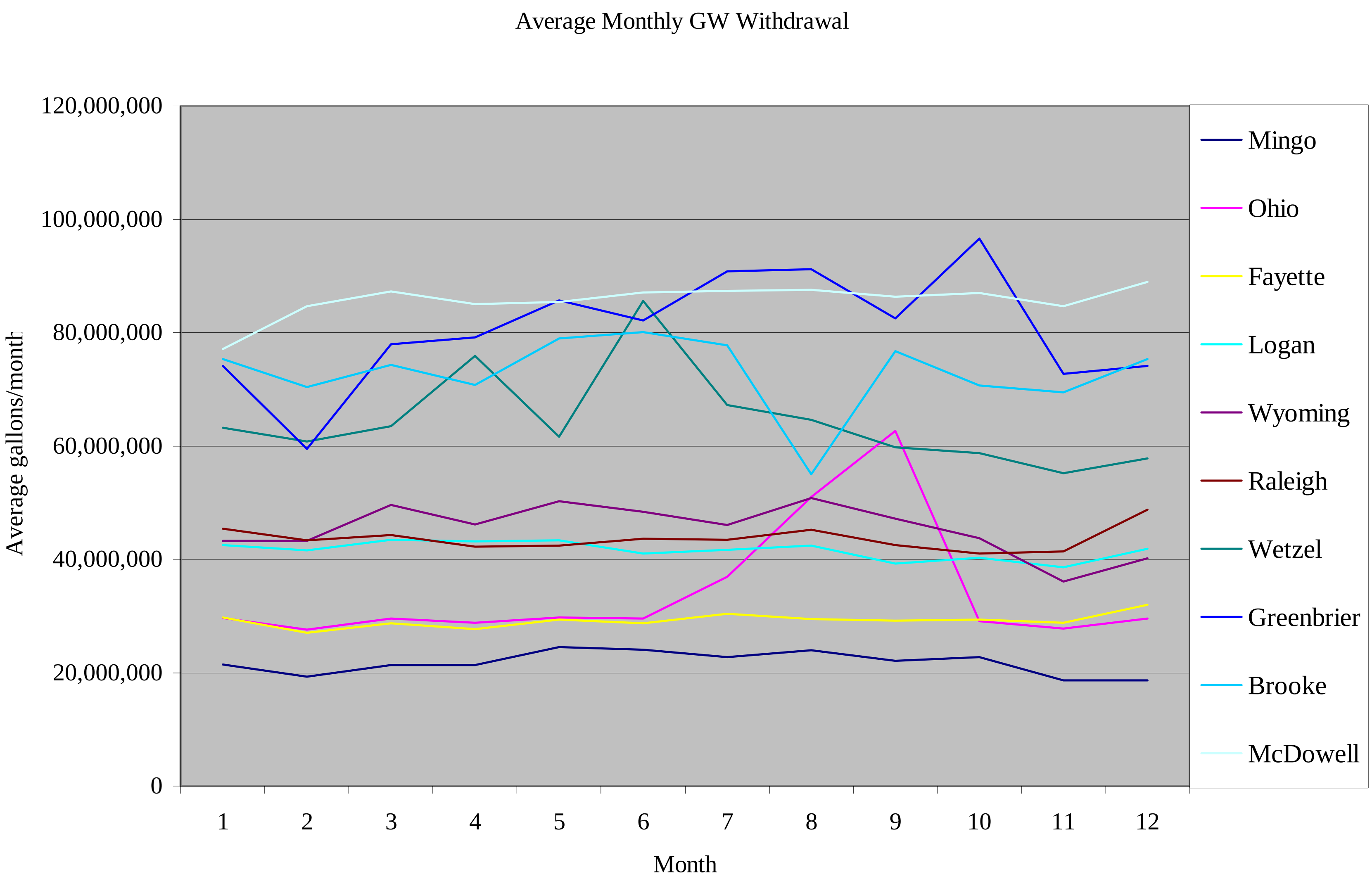


Figure 3.3 Average Monthly Ground Water Withdrawal by County

Surface Water

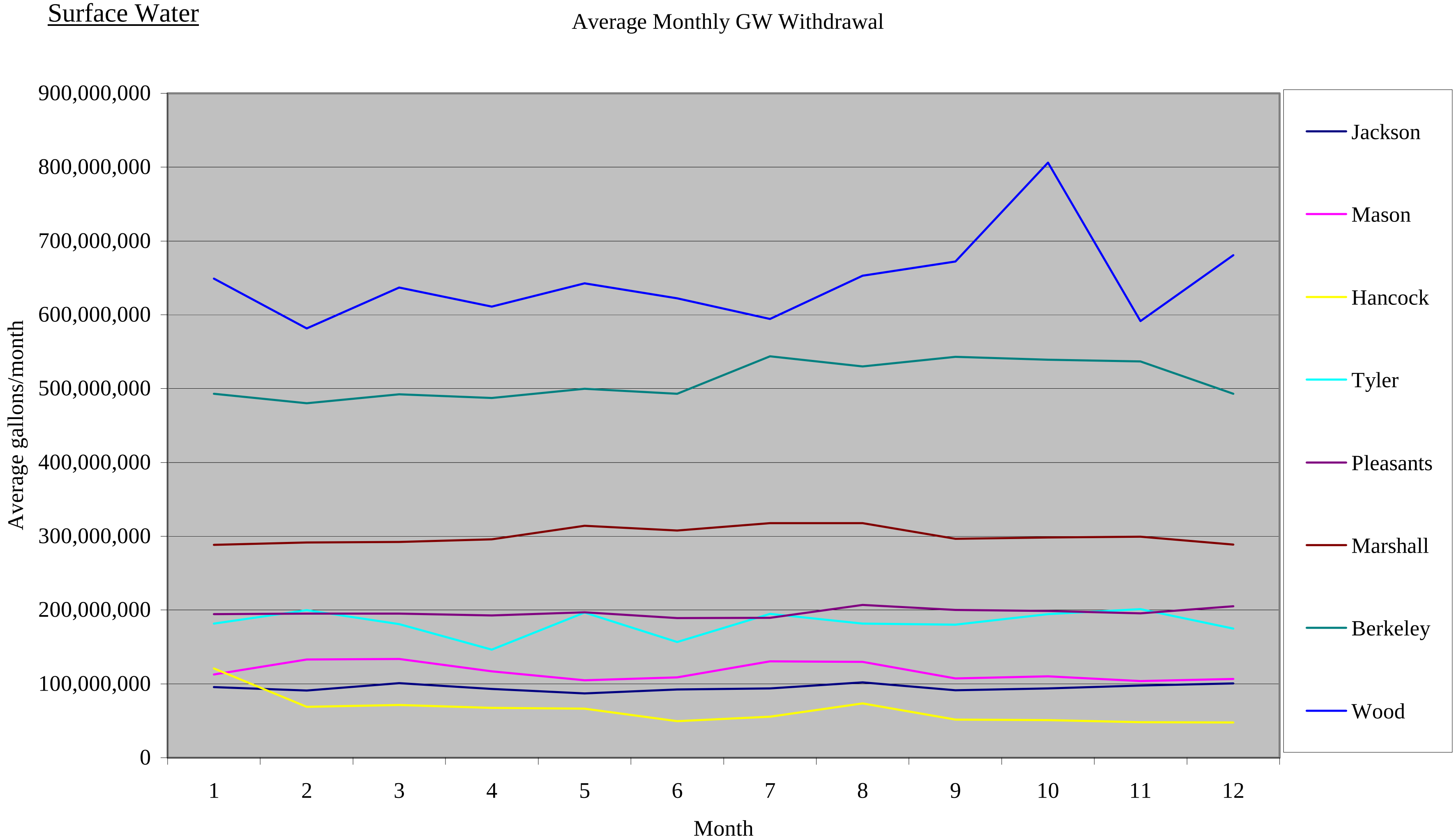


Figure 3.4 Average Monthly Ground Water Withdrawal by County

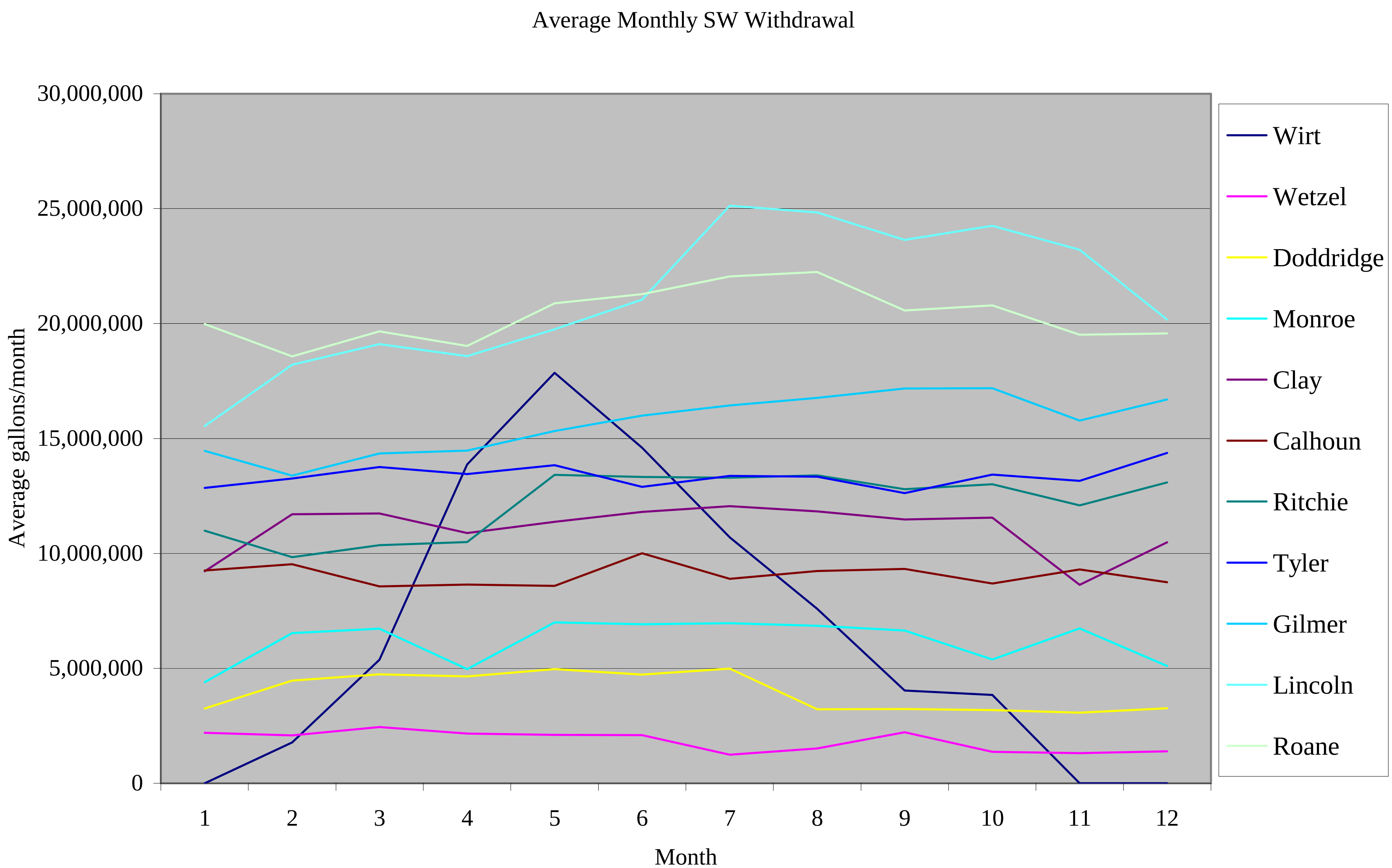


Figure 3.5 Average Monthly Surface Water Withdrawal by County

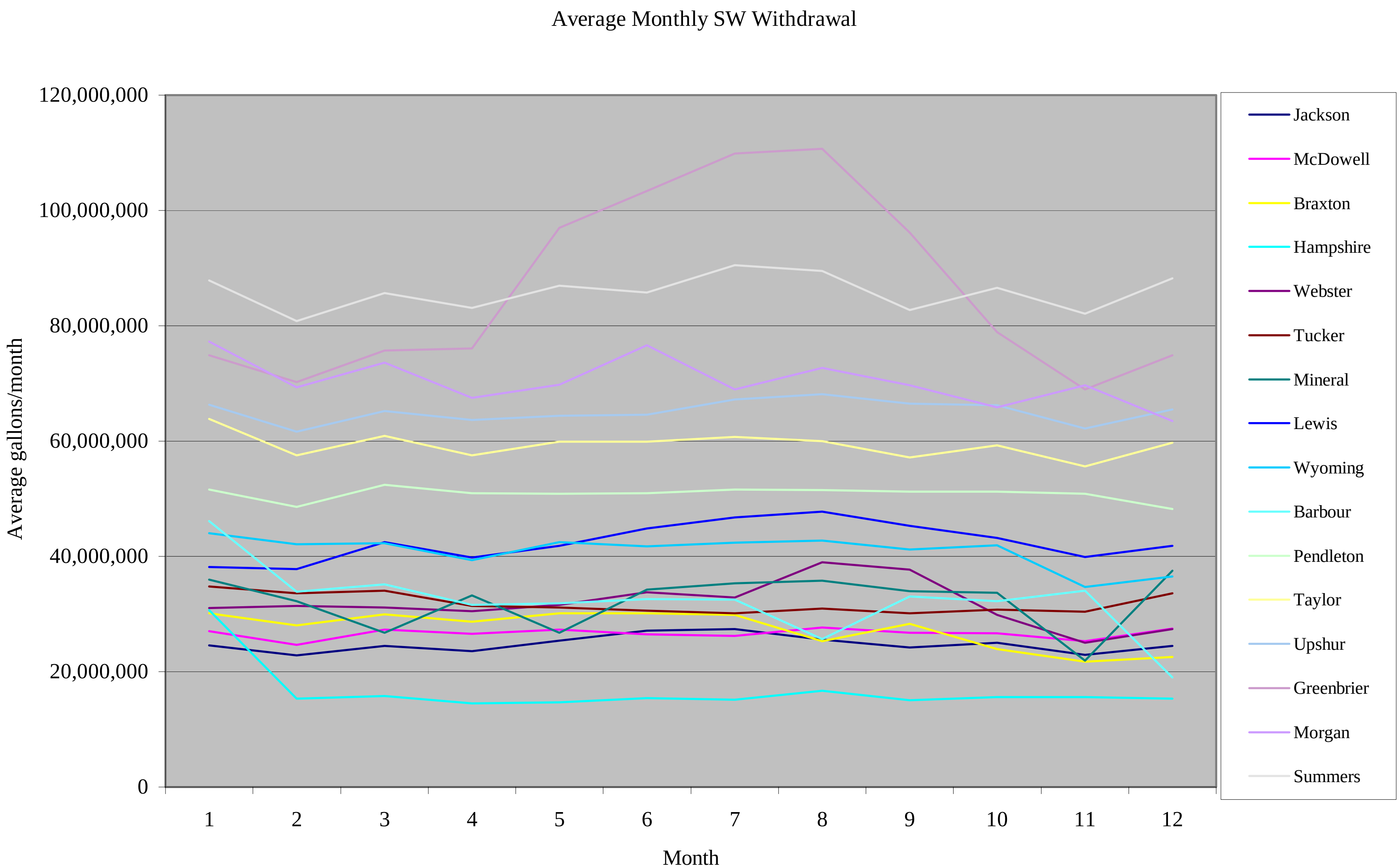


Figure 3.6 Average Monthly Surface Water Withdrawal by County

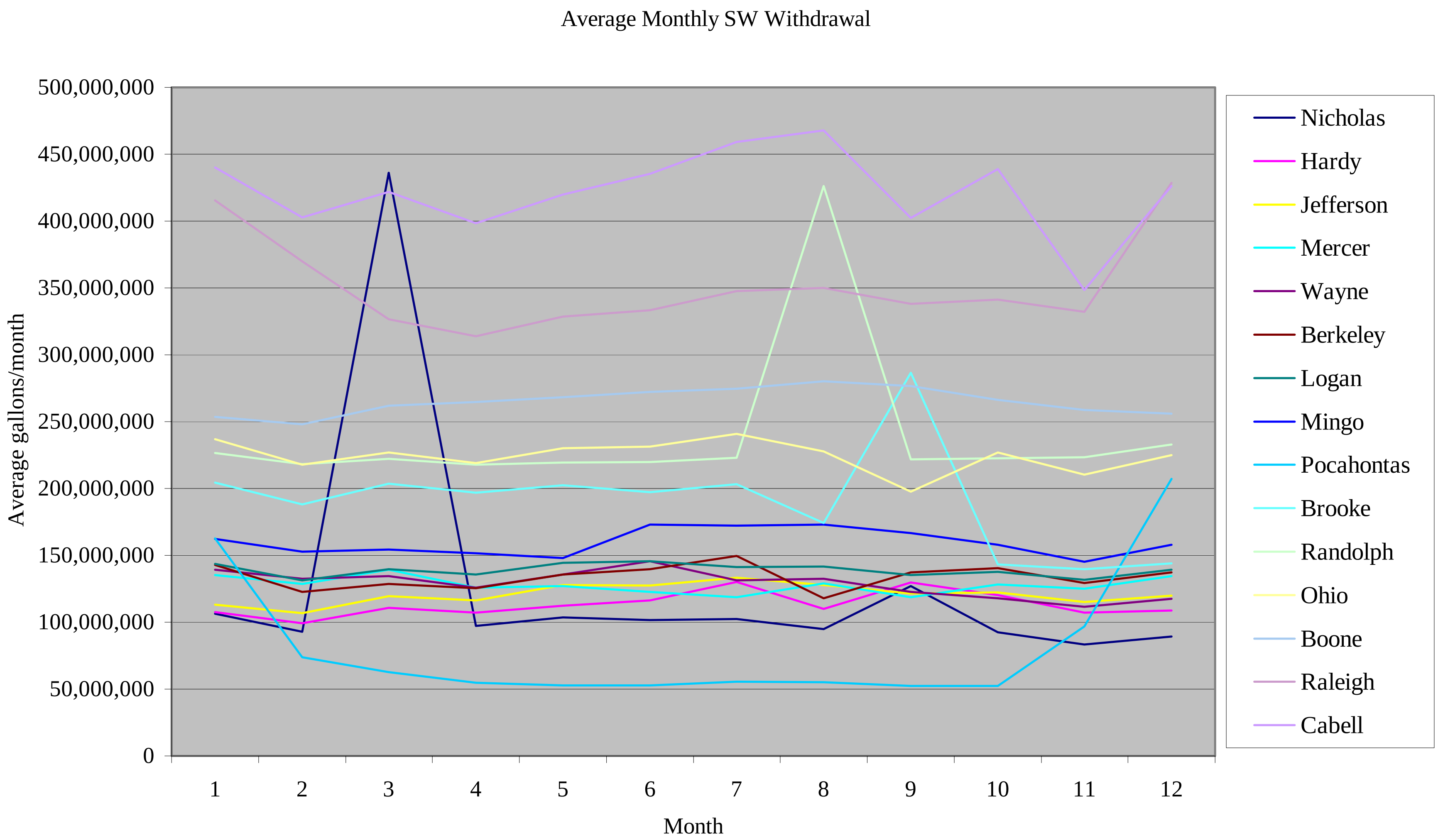


Figure 3.7 Average Monthly Surface Water Withdrawal by County

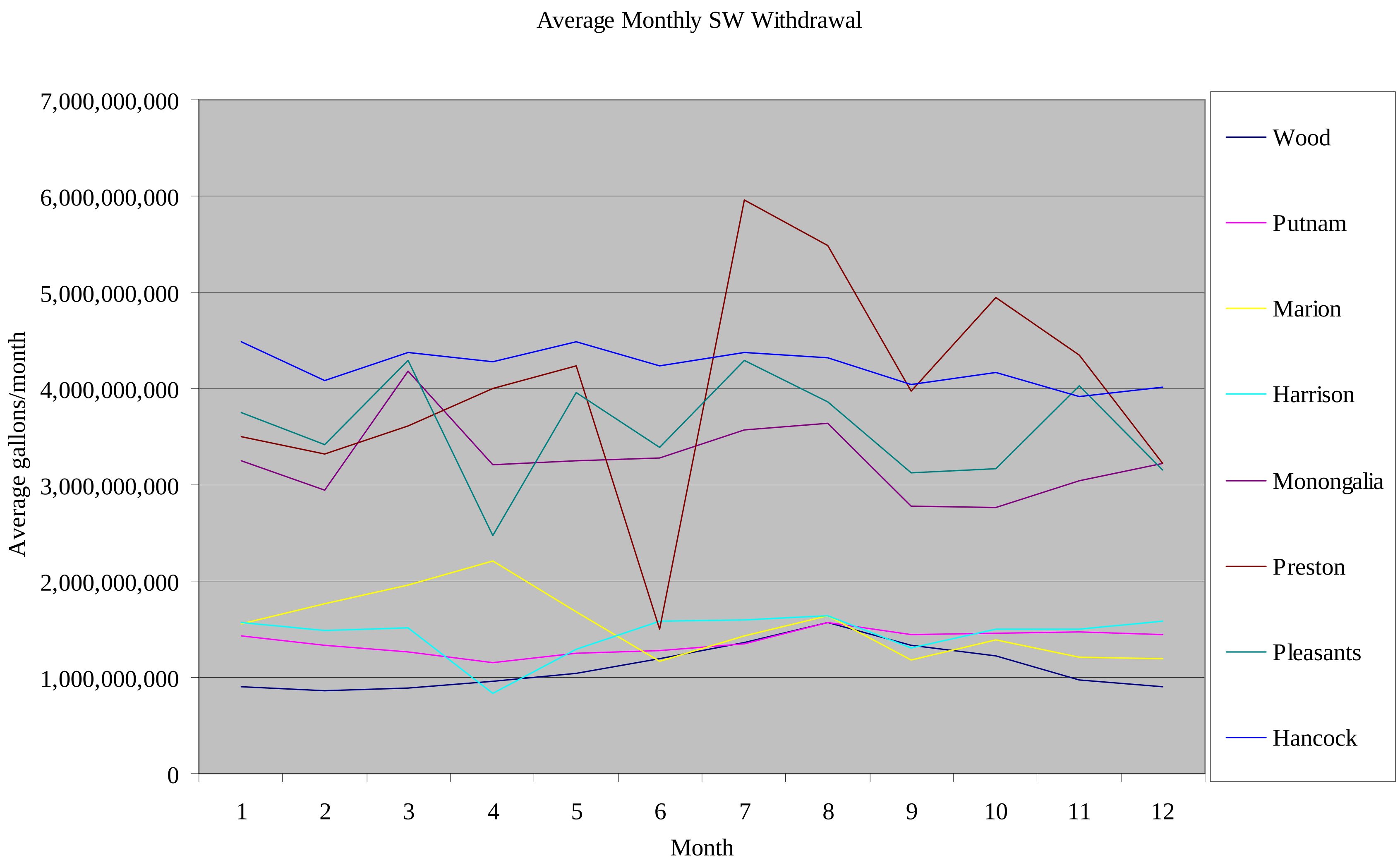


Figure 3.8 Average Monthly Surface Water Withdrawal by County

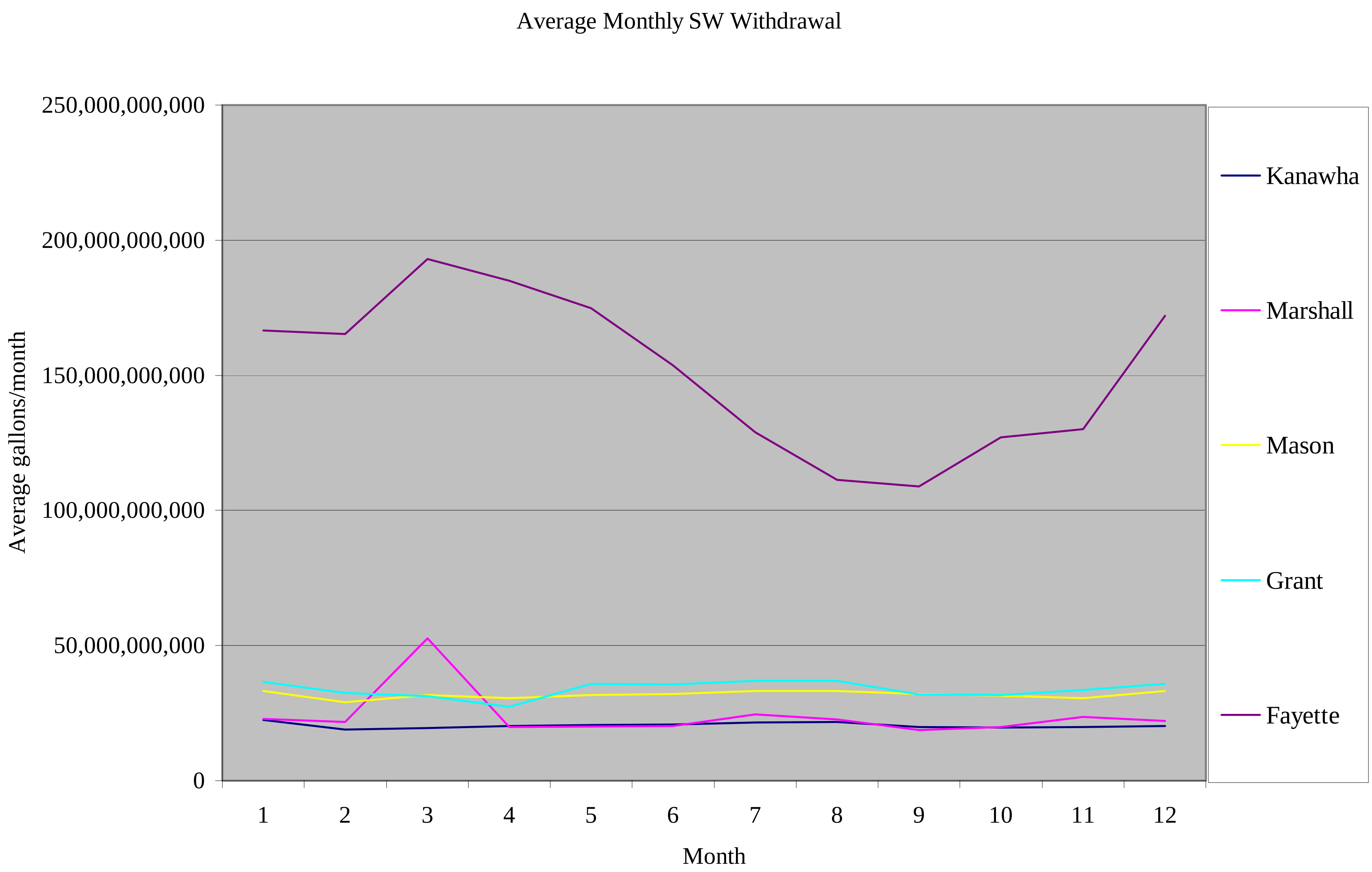


Figure 3.9 Average Monthly Surface Water Withdrawal by County

reporting. This also applies to the nursery reporting ground water use for irrigation in Cabell County. Surface water examples of this include a power station in Preston County and the fish hatchery in Wirt County. These two examples result in wide fluctuations of surface water needs in their counties on a monthly basis.

Figures 3.9 and Figure 3.10 illustrate the location of all water withdrawals from both ground and surface water. Figure 3.11 shows the coverage of all water providers reporting to the survey by the zip codes to which they provide water. The figure also shows the location of all wastewater treatment facilities (both public and private) with a NPDES permit issued by the DEP.

Figure 3.12 illustrates the 8-digit HUC watersheds for the state. A breakout map of each watershed showing lakes, ground water and surface water intakes is shown in Appendix I. Overall results from the three year survey (consumptive and non-consumptive uses) are:

1. Three year total water withdrawal: 10.2 trillion gallons

2. Percentage of water from ground water: 0.3%

3. Percentage of water from surface water: 99.7%

4. For public water suppliers:

    a. Three year total surface water withdrawal: 157 billion gallons
    b. Three year total ground water withdrawal: 13 billion gallons
    c. Public water supply percentage from ground water: 7.6%
    d. Public water supply percentage from surface water: 92.4%

5. For industrial users:

    a. Three year total surface water withdrawal: 10 trillion gallons
    b. Three year total ground water withdrawal: 20 billion gallons
    c. Industrial percentage from ground water: 0.2%
    d. Industrial percentage from surface water: 99.8%

6. There are 428 users registered with the state (Appendix J)

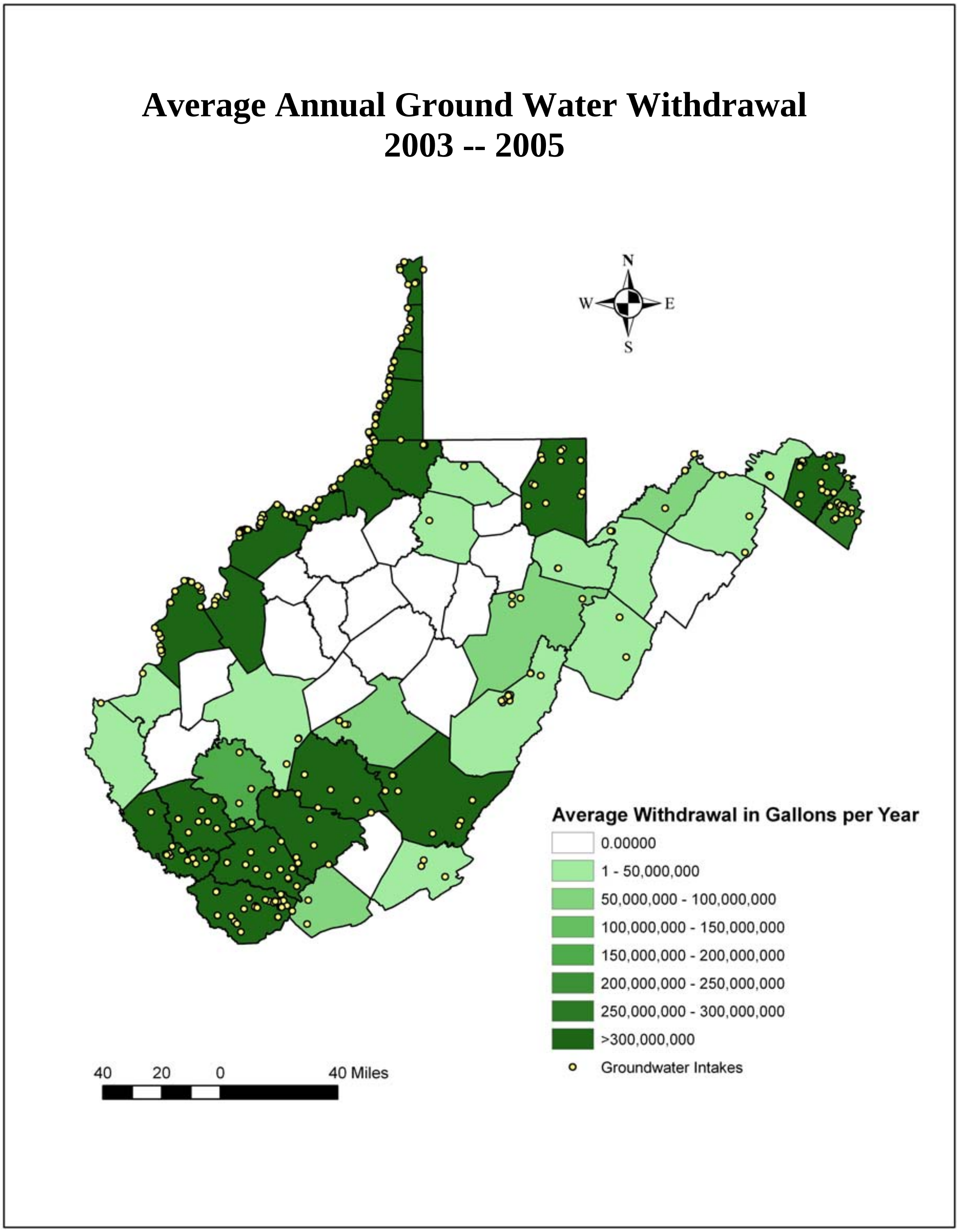


Figure 3.10 Average Annual Ground Water Withdrawal, 2003-2005

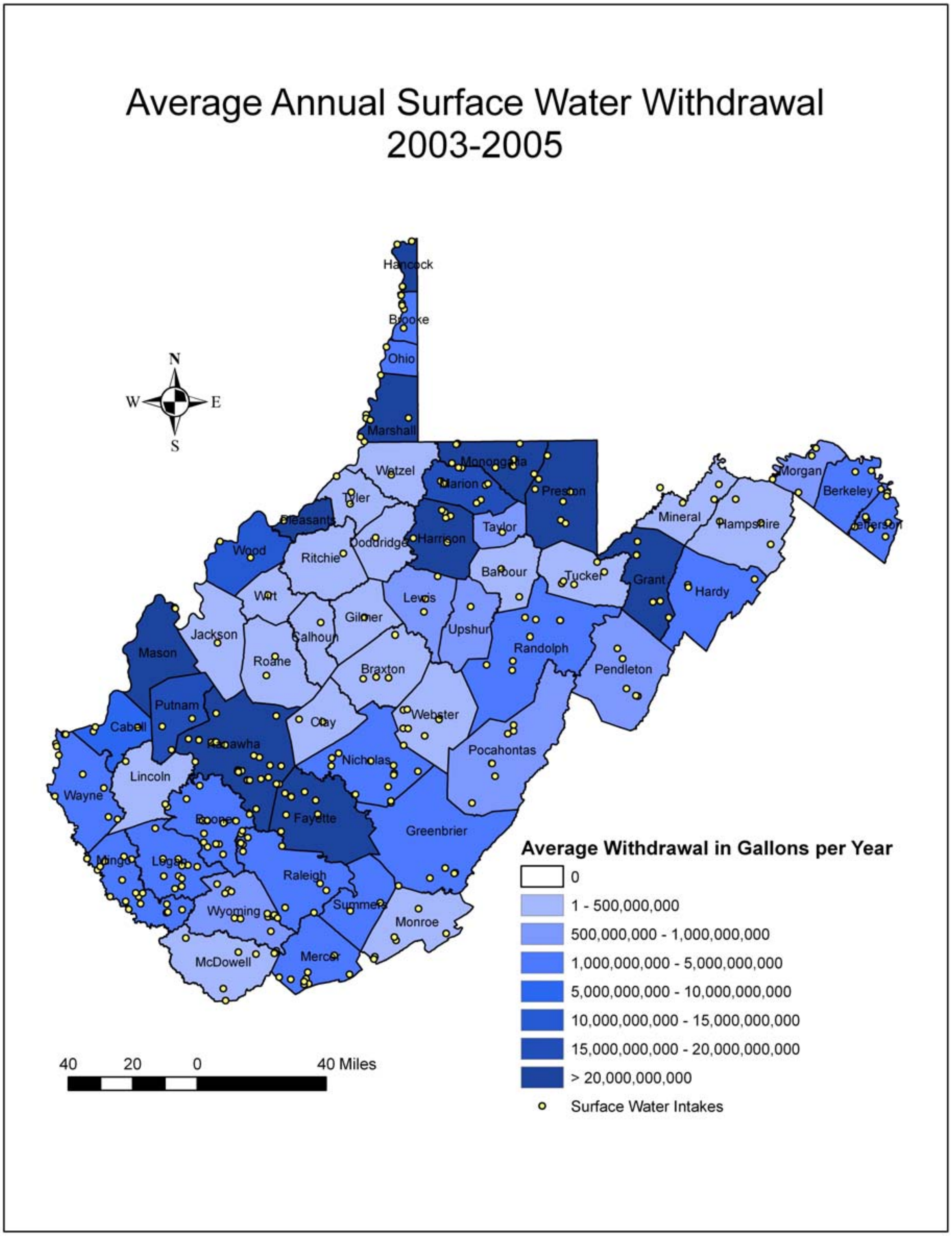


Figure 3.11 Average Annual Surface Water Withdrawal, 2003-2005

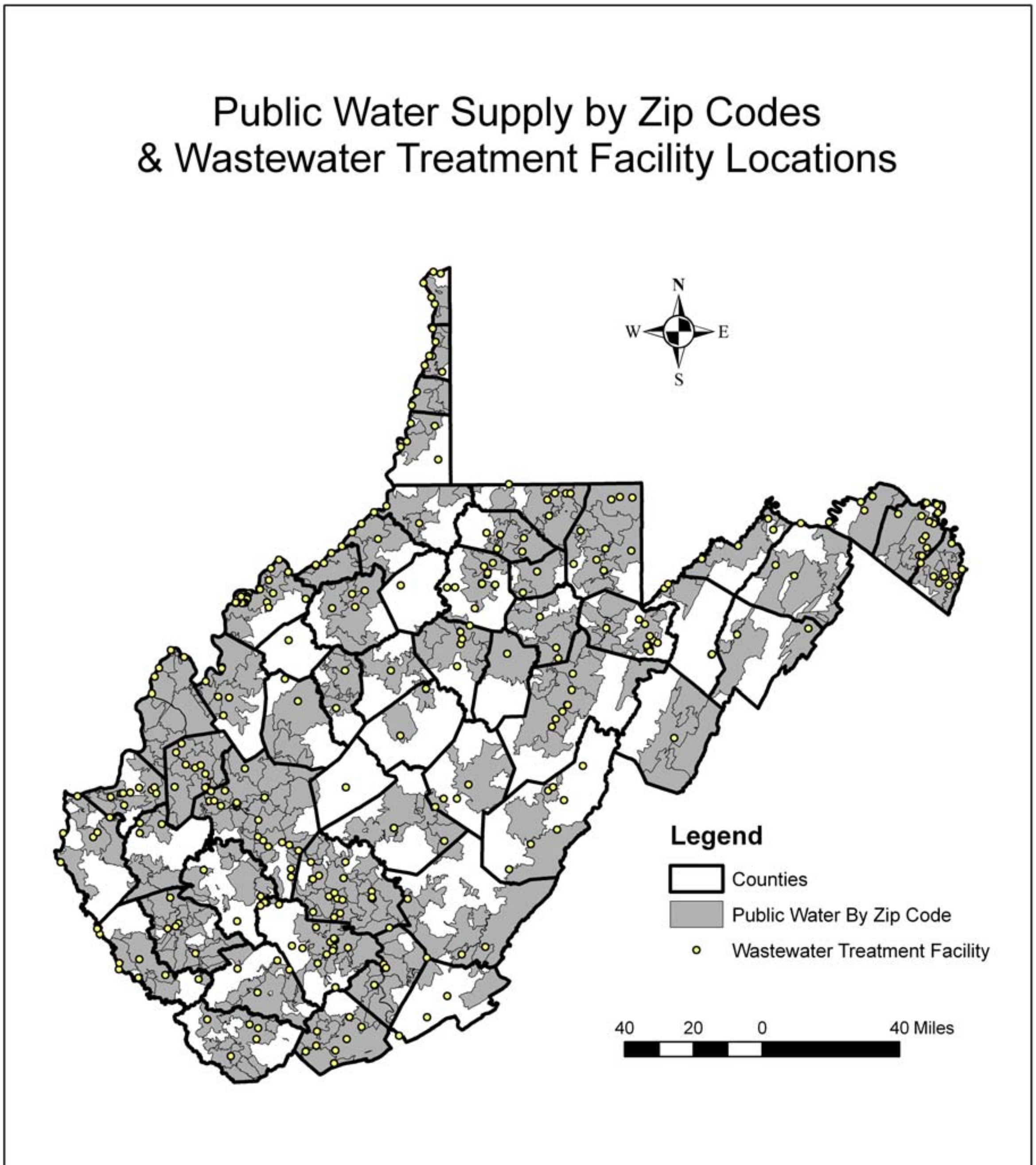


Figure 3.12 Public Water Supply by Zip Codes & Wastewater Treatment Facility Locations

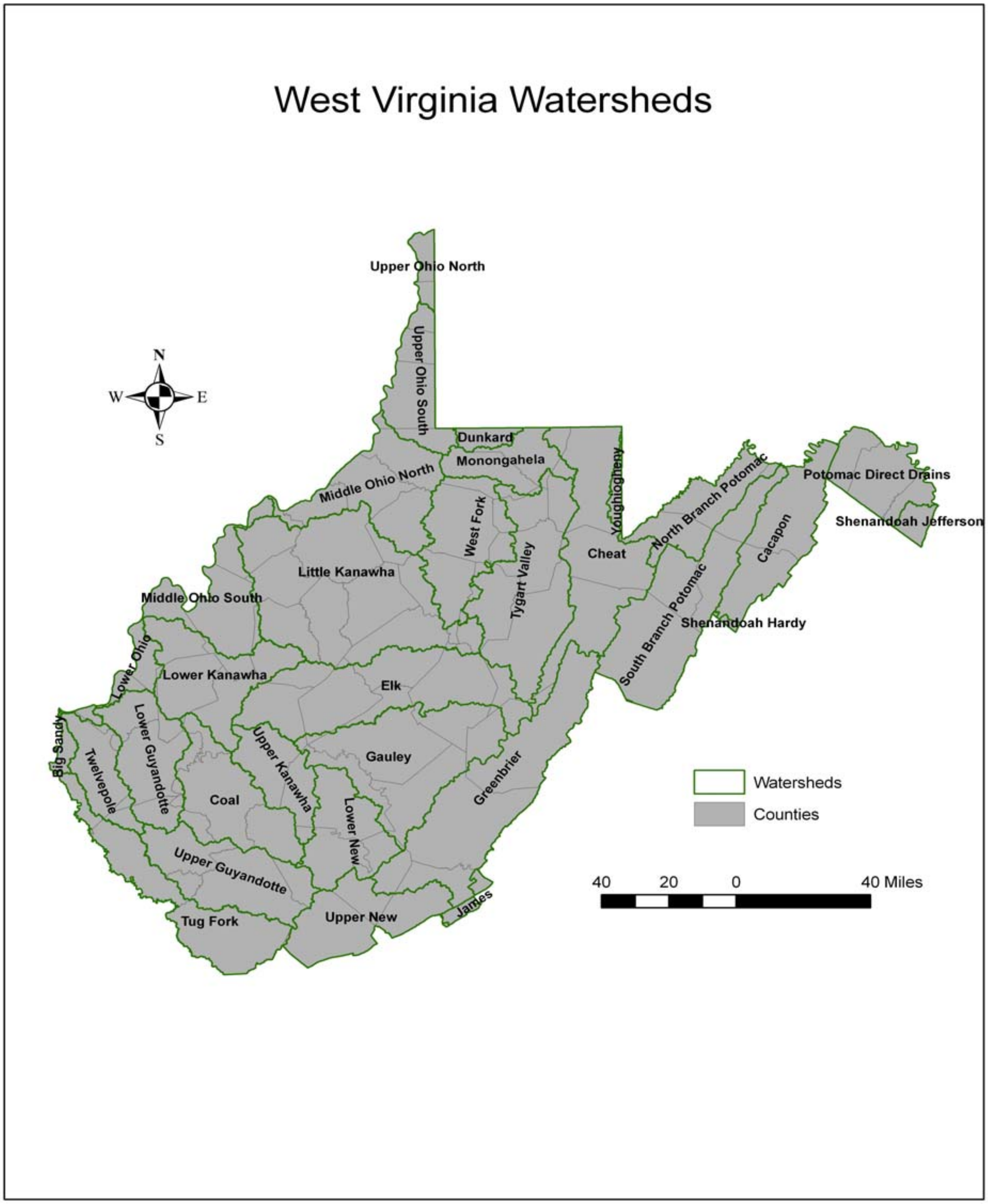


Figure 3.13 8 Digit HUC Watersheds

3.4 Deficiencies

Several of the facilities surveyed did not provide all requested information. For example, some of the survey respondents provided latitude and longitude that mapped outside of the state. Few facilities meter their water intake. Some of the facilities accidentally saved multiple screens of the same data. As a result, the DEP had to manually review the data to assure the validity of the information prior to drawing conclusions.

It is accepted that most of the data is an estimate based on the facility's best judgment of the amount of water used by its system. The DEP, with assistance from USGS, has done its best to identify all potential large water users. However, there is no way to verify 100 percent success in this effort.

3.5 Conclusions

Based upon the deficiencies listed above and the problems calculating consumptive use, as discussed in Chapter 2, the DEP recommends the establishment of an annual registration program. Without periodic updates, the survey information will become obsolete. These updates will also allow the DEP, over time, to generate data that are more accurate. The most difficult problem respondents reported in completing the survey was trying to calculate how much water they had used historically. With an annual reporting program, these facilities will have the opportunity to confirm and/or re-evaluate the data provided.

Chapter 4 - Drought, Flood, and Low Flow Conditions

Flooding

The Water Resources Protection Act research elements related to flooding entail the identification and mapping of historically flood-prone areas of the state, the anthropogenic factors exacerbating flood conditions, and areas in which high flows negatively affect beneficial uses.

Floods are seemingly easy events to define and identify. In West Virginia, however, no uniform and accepted definition exists to facilitate event tracking, thus complicating attempts to evaluate flooding events and trends in the state. Floods can be defined as when flow exceeds bankfull, when flows expand beyond 100-year floodplains, or when flows begin to threaten human safety and property. As well, flooding varies by frequency, severity, and economic impact. Additional complexities include the differences between natural flood patterns, flash flooding, and human-exacerbated flood flows (e.g. sedimentation, inappropriate land use practices), and human-exacerbated flood damages (e.g. inappropriate and uninsured development in floodplain).

West Virginia has funded significant research on flooding over the past few years. The Flood Advisory Technical Taskforce Report, the State Flood Plan, and the State All-Hazards Plan are key resources for analysis of flooding in West Virginia. These reports provide the foundation for flood analysis requested in the Act.

Three findings stand out among the others in this section. The first is that one-time-event driven research projects will continue to produce incomplete and potentially misleading findings until more resources are invested in expanding and maintaining our state's water monitoring infrastructure so that trends, anomalies, and problem areas can be evaluated within historical context. Streamflow data are monitored and recorded in 50 of the state's 159 watersheds (10 digit HUCs), and in only 31 of the state's 55 counties.

The second important finding is that the U.S. Army Corps of Engineers (USACE) Statewide Flood Report and the State All-Hazards Mitigation Plan both comprehensively address the flood-related research questions outlined in the Water Resources Protection Act (taking into consideration the stream flow data). This report references those findings and adds some new information, but the original reports should be referenced for more complete flood information, specifically relative to conditions that exacerbate flooding.

Finally, framing the question around impacts on beneficial use was important. However, this aspect of the question can only be addressed generally. To address these issues in a detailed manner, they must be evaluated on a watershed basis, which would require significant local participation and feedback at the information gathering stages.

4.1 Conditions That Indicate Where Flooding has or is Likely to Occur

This section presents four approaches to identifying and mapping areas where flooding has or is likely to occur. These are as follow: 1) identify existing flood monitoring data; 2) identify indirect indicators of flood events (insurance damages); 3) conduct statistical analysis on historical stream flow data; 4) model land and stream characteristics that are likely to contribute to flood events. The four approaches are used because of the paucity of direct flood monitoring data and lack of a consistent definition of flooding.

4.1.1 Direct Flood Monitoring Data

West Virginia monitors the threat of flooding in the state on a real-time basis based on precipitation (iFLOWS program) but invests little in maintaining flood records after the immediate threat at hand disappears. The state Division of Homeland Security and Emergency Management and the National Climate Data Center (NCDC) are two agencies that maintain a historical record of flooding in the state (Figures 4.1 and 4.2).

Unfortunately, each agency has different criteria and methodology for measuring flooding and, therefore, analysis of their data indicates contradictory flood-prone areas as well as dramatically different perspectives on flooding frequency. WVDHSEM data are based on official emergency declarations, while NCDC data reflects a variety of sources including staff observations, citizen phone calls, and newspaper clippings. WVDHSEM floods are limited to the most severe cases that warranted FEMA intervention. In determining areas that are “flood-prone,” however, based on the Figures 4.1 and 4.2, there appears to be a difference between areas that are prone to frequent floods (NCDC, Figure 4.2) and areas that are prone to severe floods (WVDHSEM, Figure 4.1).

NCDC also provides the state’s only historical record of flash flooding in the state (Figure 4.3). This is not necessarily an accurate representation of actual flash flooding events. A quick glance of the low estimated number of flash floods over the past 10 years, particularly in southern counties such as Mingo, Wyoming, and McDowell, warrant concern over the meaningfulness of these numbers. Flash flooding numbers are based in part on predictions of heavy rainfall that generate flash flood warnings. These warnings are then noted as actual events if newspapers or citizen/employee calls verify that flash flooding did occur in the county.

The rate of flash flood verifications to flash flood events is not uniform across all counties. As a result, the total numbers by county are erroneous, as are the indicators of relative flash flooding problems among different regions of the state. Finally, because these numbers have only been tracked for 10 years, it is not possible to identify trends such as increased or decreased flooding in watersheds or counties.

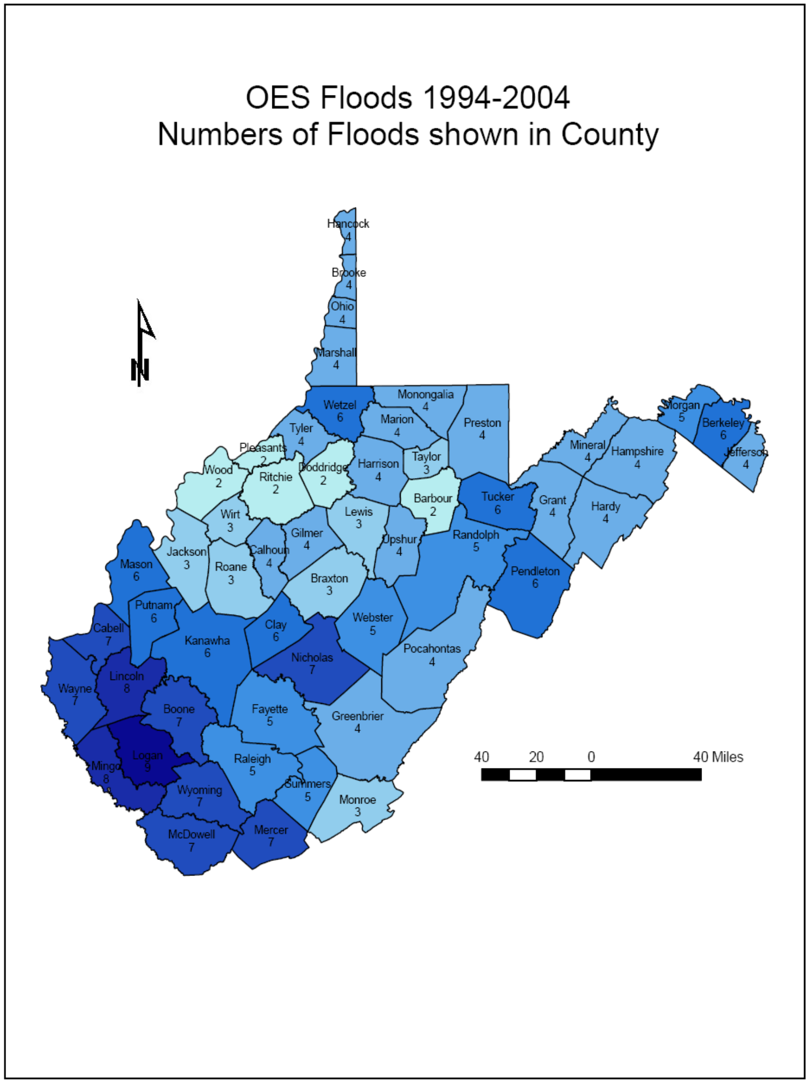


Figure 4.1 Floods 1994-2004, WVDHSEM

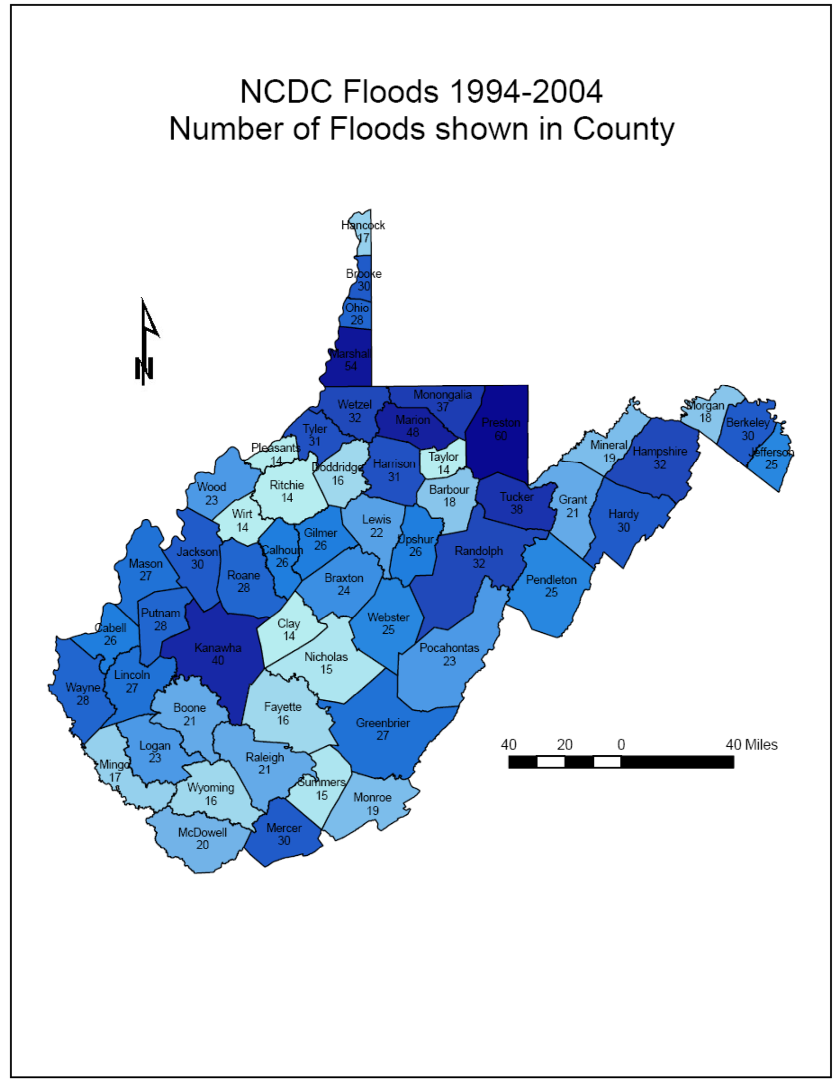


Figure 4.2 Floods 1994-2004, NCDC

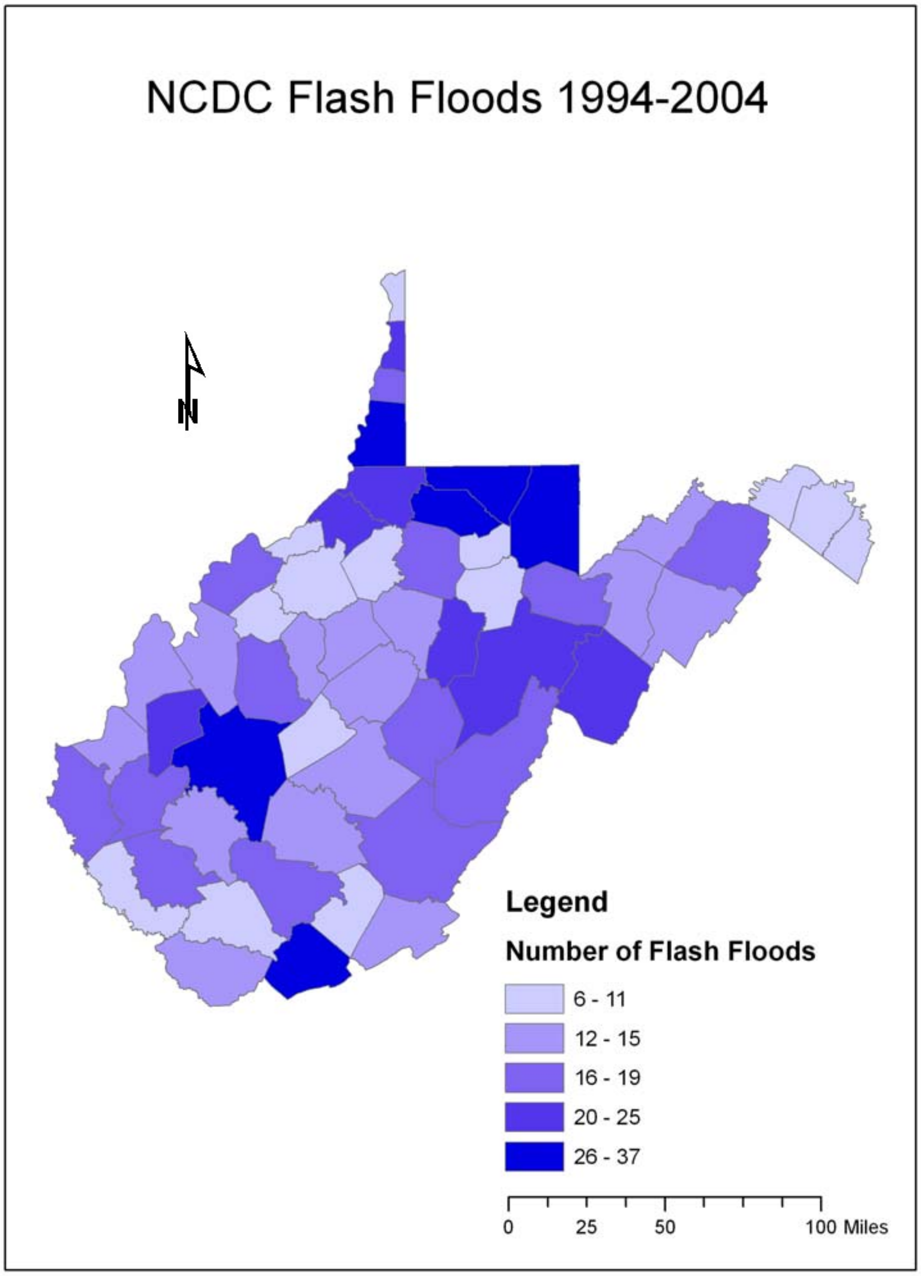
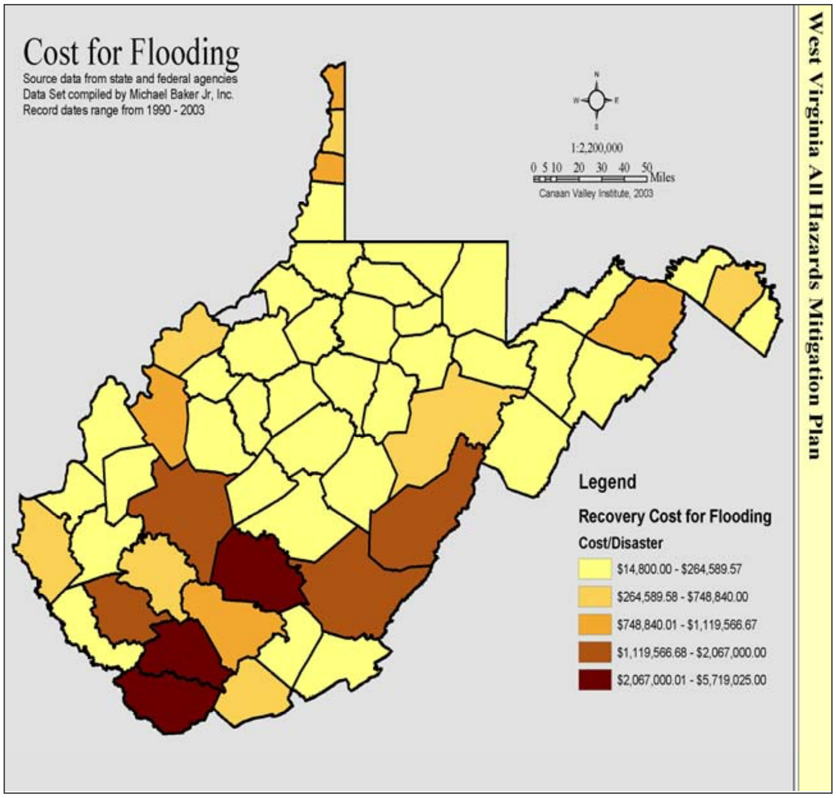


Figure 4.3 Flash Floods 1994-2004, NCDC

4.1.2 *Indirect Flood Monitoring Data*

One approach to measuring the incidence of flooding and, in particular, economic impacts of flood events, is to evaluate the costs of flood damages. The State All-Hazards Report used this approach by evaluating National Flood Insurance Program (NFIP) payment trends. The maps in Figure 4.4 illustrate relative scale of payments as well as recurrence rates of claims.

The cost estimates reflect only damage to properties insured by the NFIP. As a result, the distribution of claims and damages paid by this program reflect the distribution of flooding in the state skewed by the uneven distribution of NFIP coverage. According to the WVDHSEM, NFIP coverage rates of floodplain structures range from 10-90% across the state (mean coverage is only 34% per county).



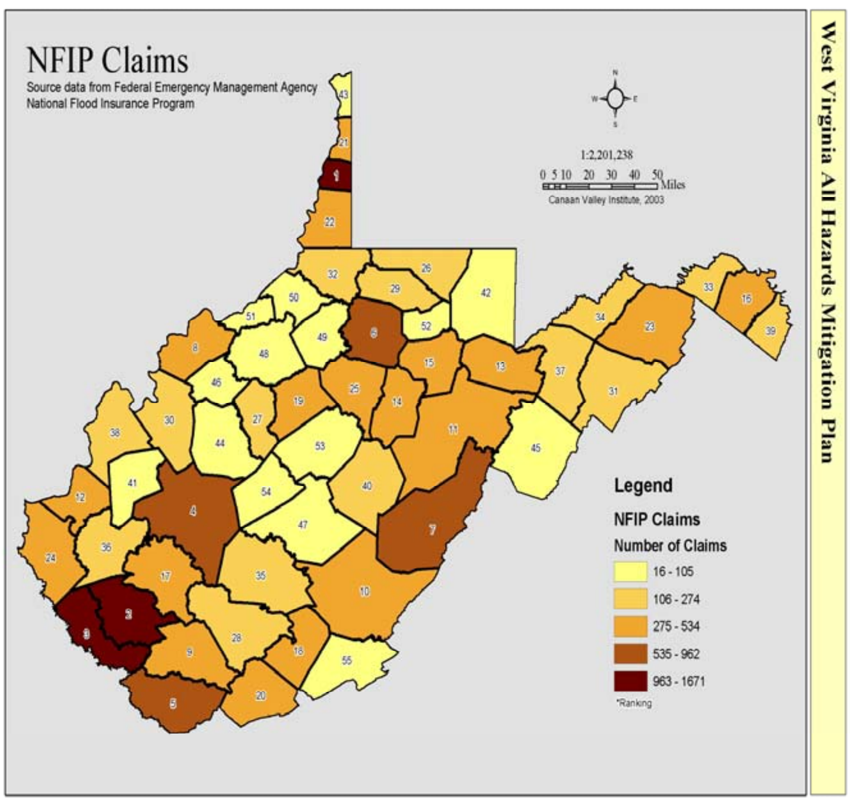


Figure 4.4 National Flood Insurance Program Payments, 1990-2003

4.1.3 Statistical Analysis of Stream Flows

It is reasonable to imagine that streamflow gauges would be good indicators of flood events. Flows on ungauged low order streams (smaller streams) cannot reliably be linked to gauged flows on higher order streams (larger rivers). While the USGS is working to develop a methodology to link small stream flows to monitored behavior on high order gauged streams, the model accuracy will be limited by lack of land use data in many areas. Furthermore, the model may be successful at detecting regular floods on low-order streams but will not likely be able to detect tributary flash flooding. Detecting unreported flash floods through data collection stations will be challenging well into the future, given the paucity of stream gauge stations and limited historical detailed meteorological data. For the short term, attention can be directed to improving the methodology of collecting and tracking flood and flash flood reports to the NCDC.

Aforementioned limitations considered, stream gauge analysis was conducted on all gauges with at least 30 years of data in the state. Where watersheds crossed state boundaries and there were no gauges in West Virginia, gauges were used from neighboring states. These data were compared with the period of record available for each gauge to determine the statistical five, 10, 50, and 100-year flood flows and the frequency of their occurrences over the past 30 years. The maps in Figure 4.5 indicate relative flooding frequencies among different gauges for two of the calculated levels of flood severity (percent time in a 10-50 year flood and percent time in greater than a 100-year flood).

Information in the maps of Figures 4.5 and 4.6 should be interpreted with caution. Gauge station flow analysis cannot be extrapolated to indicate flooding trends by watershed or county because of the problems with relating gauged and ungauged streamflow behavior within a watershed. Furthermore, the interpretive value of these maps is limited due to extensive gauge funding cuts in 1994. Many gauges were taken offline in 1995, so analysis was conducted on those gauges with a 30-year period from 1964-1994. As a result, no 100-year or greater floods appear to have occurred in Wyoming County over the past 30 years, according to the maps in Figure 4.5. Yet, the county suffered two greater than 100-year floods since 2000. Watersheds that currently have real time or online flow monitoring gauges are shown in Figure 4.7.

The final approach to gauge data collection as an indicator of flooding was to combine National Weather Service (NWS) flood stage (height) estimates with USGS flow data by using ratings tables (flow to height conversion equations). Flood heights have been established by NWS agents' trips to each gauge station in which they identified a local flood stage based on community input regarding the flow height at which floodwaters would begin to cause a threat to lives or property. Using USGS ratings curves, WRI determined what flow would raise the river to the NWS flood stage. Then, using historical USGS flow data, WRI produced a statistical analysis of historical flow data to determine the flood stage recurrence interval (how often flows would reach flood stage heights).

The results are mapped in Figure 4.6. There are clearly problems with the inputs to this analysis since some gauges appear to experience flood stage exceedence every year or two, while others have recurrence intervals that indicate thousands of years between floods.

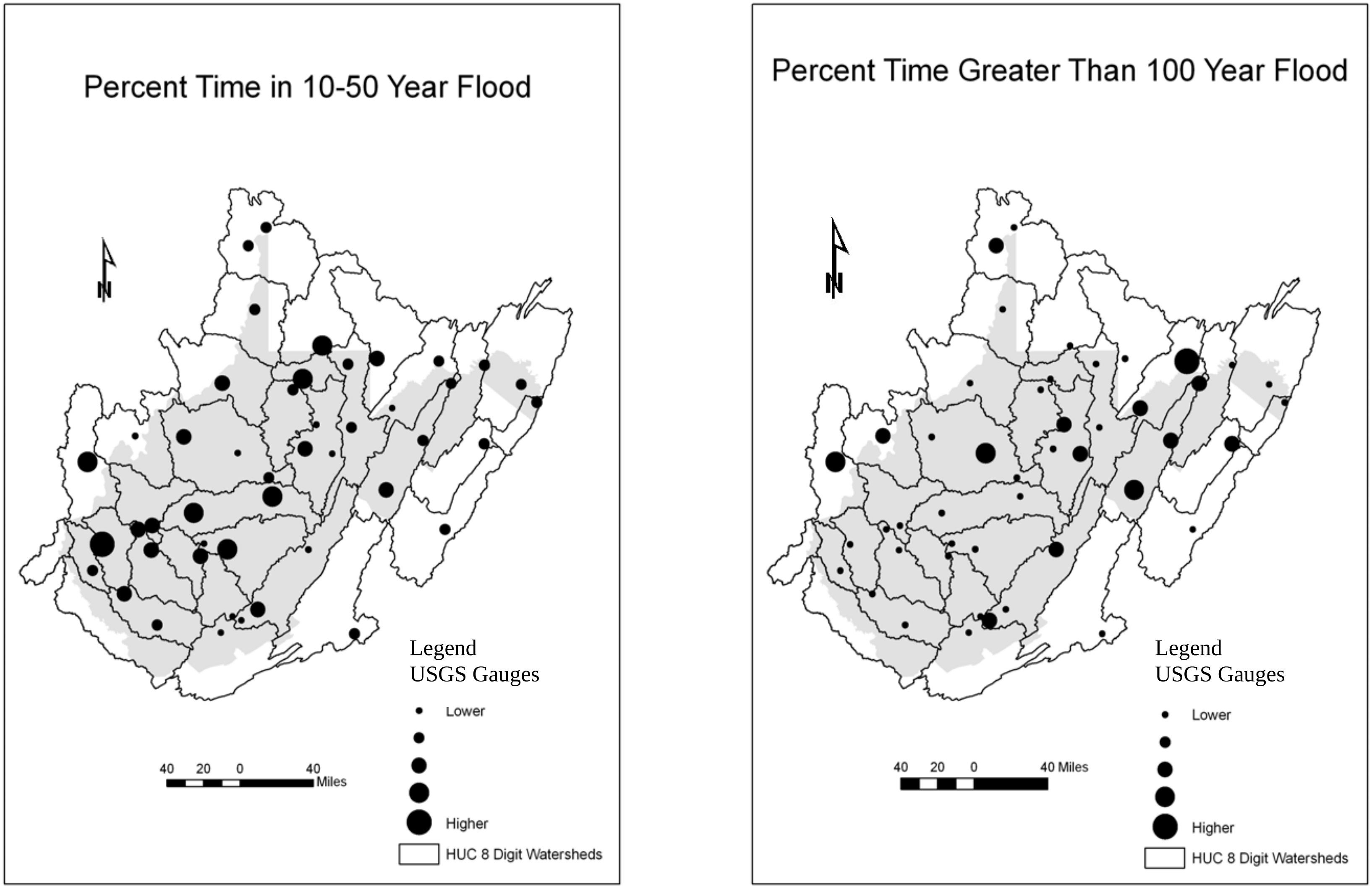


Figure 4.5 Relative Indicator of Flood Frequencies Among Relevant Gauge Stations, 1965-1994

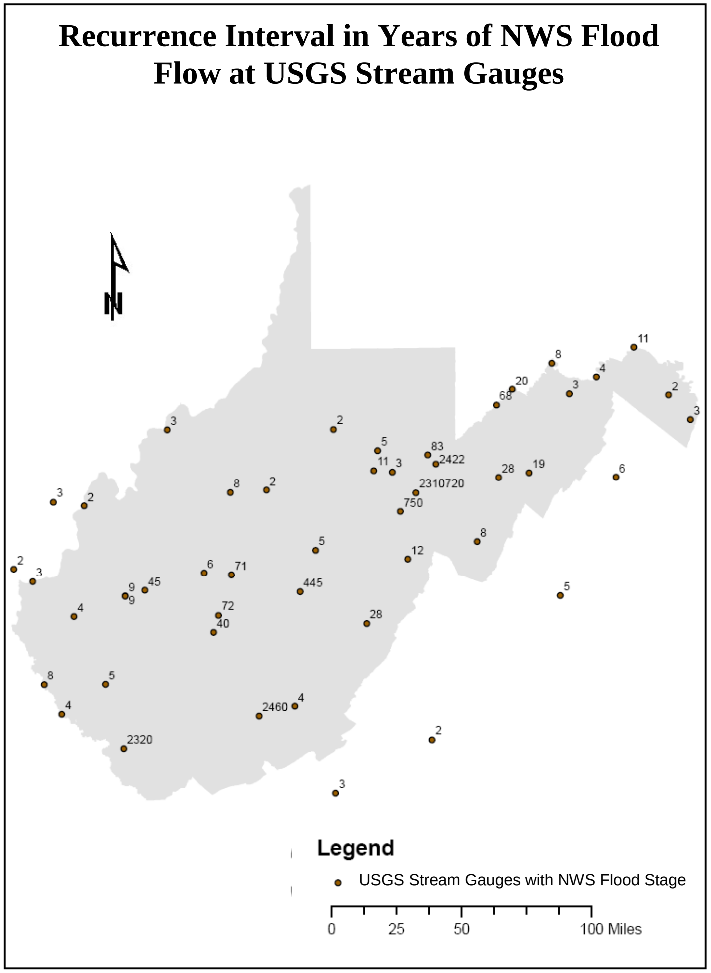


Figure 4.6 Recurrence Intervals for NWS-Defined Floods

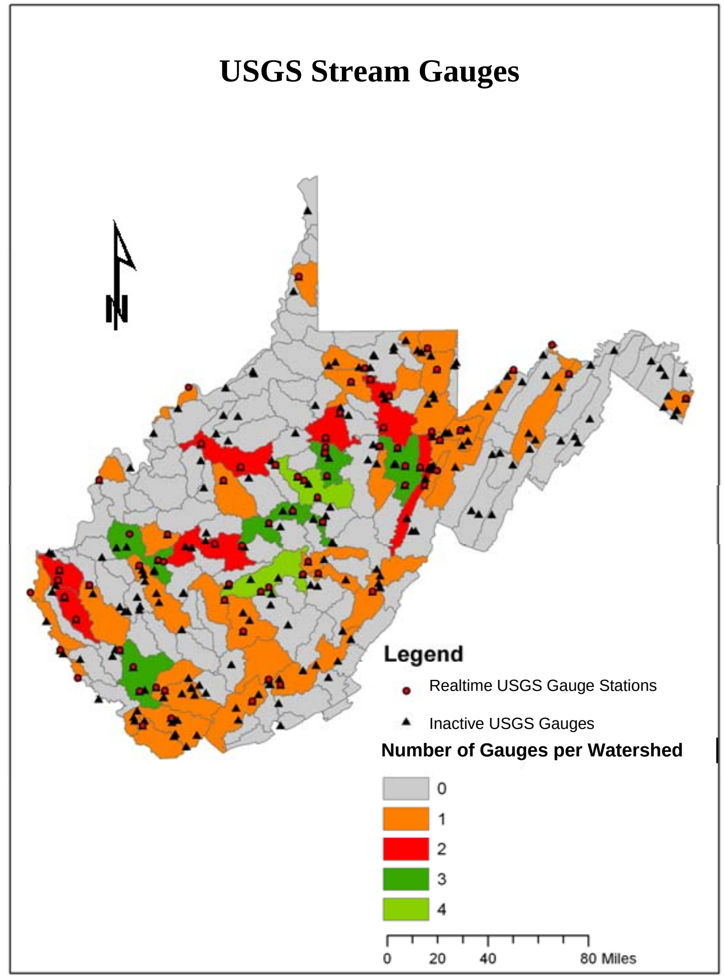


Figure 4.7 Watersheds With Active USGS Stream Gauges

Without making site visits and analyses of each gauge station, it is not possible to determine whether data inaccuracies lie with the stage heights recorded or with the rating curves provided by the USGS.

4.2 Factors that Exacerbate Flooding

As noted earlier, a great deal of state-funded work has recently been completed in West Virginia on flooding. The West Virginia Statewide Flood Report (2003) was written by a task force of experts from various state and federal agencies responding to the governor's call to address the increasing number of devastating floods in the state. The report notes that flooding has affected all 32 major watersheds and all 55 counties in West Virginia. USGS work on flood trends, valley fill impacts, and the Flood Advisory Task Force report are additional important and publicly funded reports that address flood issues in the state.

Drought

The purpose of drought analysis is to determine areas where historical drought and low-flow conditions have threatened beneficial uses of water and to map drought-prone areas of the state.

The same complexities that make flood events difficult to define and map also plague the issues of drought and low flow. Many of these complexities are discussed in Section 4.1. The variety of drought definitions introduces some of the factors at play in drought analysis.

Four drought definitions are often used to discern various sources and effects: meteorological, hydrological, agricultural, and socioeconomic (Table 4.1). With the exception of meteorological drought, differentiating between natural and anthropogenic causes of water scarcity is difficult to impossible. Consumptive resource use, interbasin transfers, and land use change are among many factors that can exacerbate dry meteorological conditions and cause supply-demand imbalance.

Droughts affect people, the economy, and the environment differently depending on the event's stage, severity, timing, and spatial

***Meteorological drought* -** a measured departure of precipitation from normal and the duration of a dry period for a given geographic area.

***Hydrological drought* -** amount of surface and ground water relative to normal levels as measured by streamflow, snow pack, and lake, reservoir and ground water levels. There is usually a delay between lack of precipitation and reduced water levels in streams, lakes and reservoirs. It can occur from a persistent meteorological drought *and/or* unsustainable withdrawal and consumptive use rates.

***Agricultural drought* -** inadequate soil moisture for a particular crop at a particular time. Factors include precipitation, ground water/reservoir levels, evapotranspiration, weather conditions, accessible irrigation technology, crop variety and stage of growth, soil type, and relative availability of water/moisture in prior growing stages.

***Socioeconomic drought* -** physical water shortages affect the health, well being, and quality of life of the people. Measurements integrate consumption patterns, production technologies, and resource management practices with natural climatological patterns.

Table 4.1 Types of Drought

impact. Agricultural productivity is affected when the soil moisture becomes too low for optimal plant development. This can result from a short-term precipitation deficit. Diminished flow in major navigable rivers is one of the last impacts of a long-term drought. These rivers have large watersheds that may extend beyond the meteorological drought; also, the base flow of rivers is sustained by ground water discharge, which is not strongly influenced by short-term precipitation deficits.

4.3 Conditions that Indicate Where Low Flow Conditions Have or are Likely to Occur

4.3.1 Existing Drought Indicators

The National Climate Data Center (NCDC), West Virginia Division of Homeland Security and Emergency Management (WVDHSEM) and the WV Department of Agriculture (WVDA) each use different systems for drought declaration. Mapping the history of these declarations serves primarily to illustrate inconsistency in the state's current capacity to evaluate and address water scarcity problems. WVDHSEM and NCDC droughts are mapped (Figures 4.8 and 4.9) for period of record. NCDC declarations are based on a variety of information sources including weather reports, local calls and newspaper stories. WVDHSEM drought declarations are based only on events that require FEMA payments. WVDA drought declaration history is based on payments made to farmers due to agricultural droughts declared by West Virginia, bordering states, or the federal Department of Agriculture. Data on these droughts are available in discontinuous intervals over the past two decades making a mapped analysis unreliable.

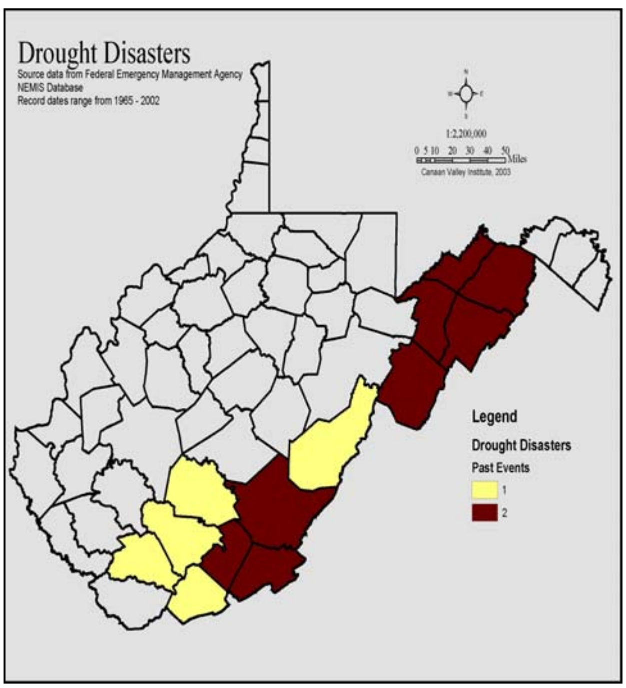


Figure 4.8 The All-Hazards Mitigation Report shows only two cases of drought in nearly 40 years.

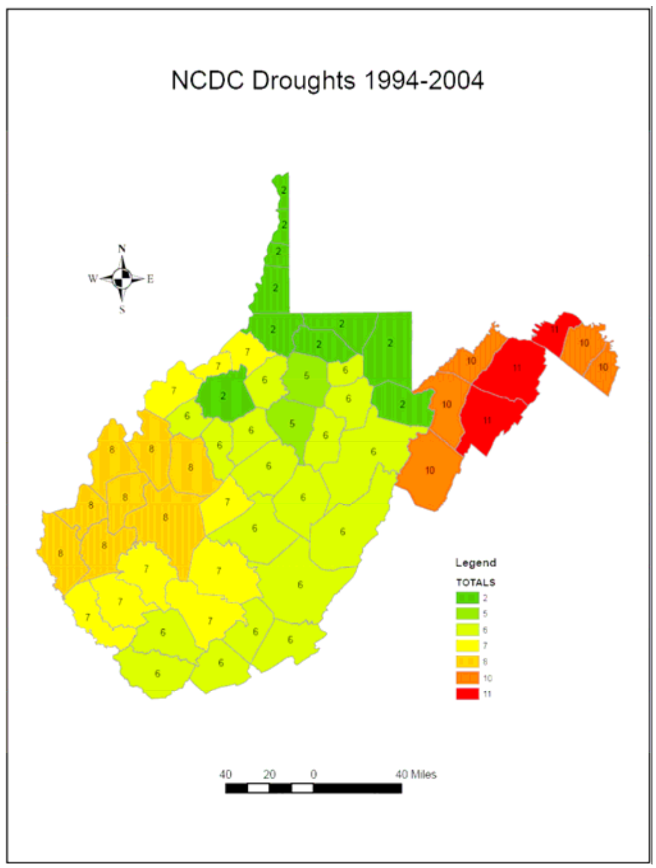


Figure 4.9 NCDC Reported Droughts 1994-2004

Upon review of the existing maps, it is evident that there are contradictions among data sources and indicators. An important finding is that more data collection and investment in reliable data analysis methodologies is necessary to produce reliable indicators of drought-prone areas. Furthermore, a standardized approach to local level data collection is likely to be the best source of information for indicating the impact of low flows and drought on beneficial uses as well as for identifying anthropogenic factors.

4.3.2 Alternative Approach: Drought Severity Index

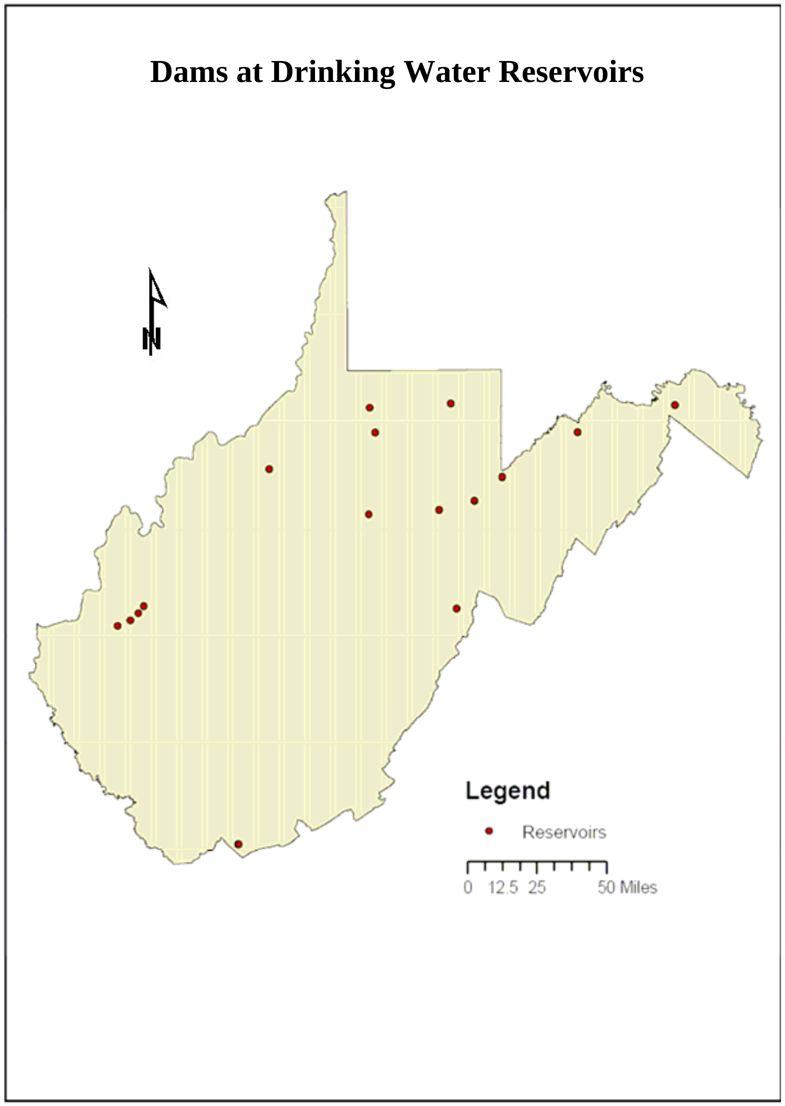
Drought monitoring trends in a region are generally based on an index of multiple drought indicators. An index of multiple drought indicators is useful because water resources are affected differently given the severity, timing, and duration of a drought and differences across topographies and geological contexts.

Looking to neighboring states' models, most rely on five indicators – precipitation, streamflow, soil moisture, ground water, and reservoir levels – to comprehensively determine drought conditions. For West Virginia, only three indicators are combined in an index to provide a snapshot of historically drought-prone areas including precipitation, streamflows, and the Palmer Drought Severity Index (PDSI – soil moisture). Ground water and public water supply reservoir levels should be included as additional index variables, but the number of gauges and period of record for existing gauges are insufficient to support a reliable analysis (Figures 4.10 and 4.11).

The three-factor index does not necessarily provide a reliable indicator of relative drought-prone areas in the state. The model does, however, demonstrate the objective standard for West Virginia. Pennsylvania and other neighboring states use drought indices both as a tool for historical recordkeeping as well as an on-going drought monitoring mechanism (http://www.dep.state.pa.us/dep/subject/hotopics/drought/). As a monitoring mechanism, the index allows state officials to declare drought watches, drought warnings, and drought emergencies in different regions of the state depending on the severity of drought in that area. A standardized set of voluntary and mandatory conservation practices are automatically announced and implemented under each category. With a standardized procedure for declaring drought at different levels of severity, agencies are better able to balance physical resource needs with political pressures when declaring droughts and suggesting conservation practices.

The following maps (Figures 4.10 and 4.11) illustrate why ground water and reservoir data cannot be used for West Virginia drought monitoring. These are followed by maps that illustrate the remaining three drought indicators (soil moisture – Figure 4.12; streamflow – Figure 4.13; and precipitation – Figure 4.14). Finally, the equation used to calculate state index values is presented with an explanation of methodology and resulting maps.

The results of the application of the multifactor index at the county and watershed level are illustrated in Figure s 4.13 and 4.14. It is evident from these figures that the areas affected by historical drought severity and frequency differ based on spatial-unit boundaries.



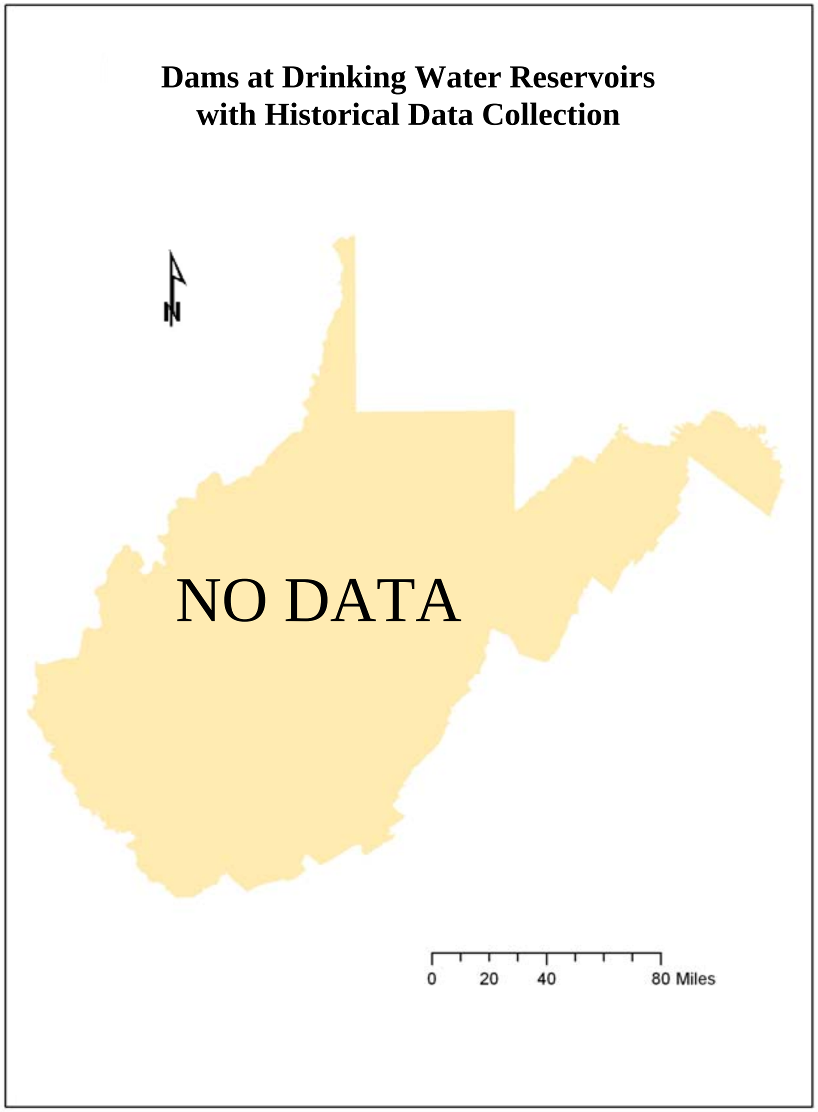


Figure 4.10 Public Water Supply Reservoirs with Monitoring Data Collection Capacity

This indicator is not used in the drought index.

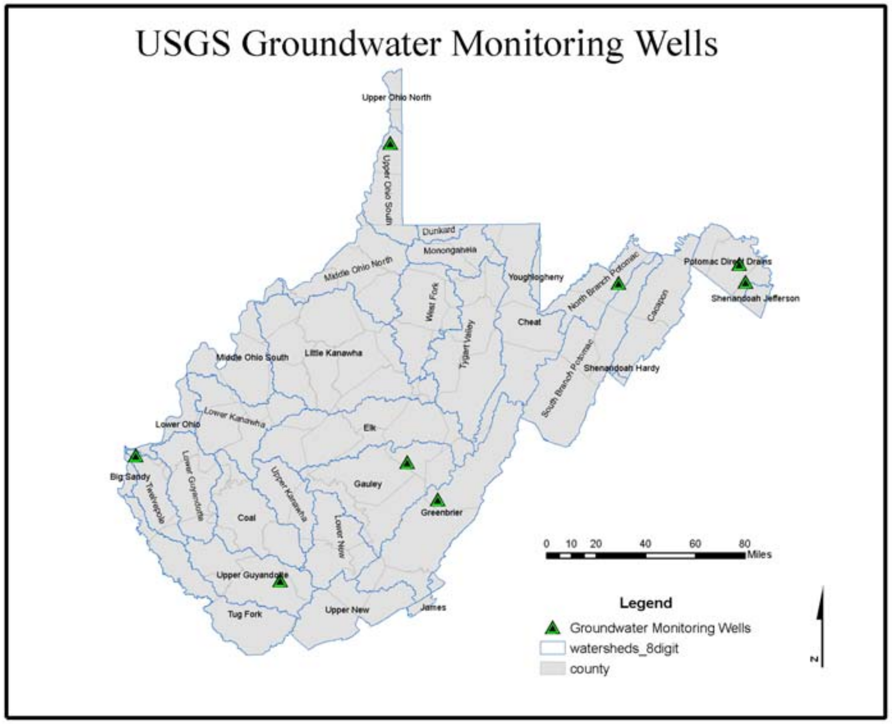


Figure 4.11 USGS Ground Water Monitoring Stations

This indicator is not used in the index.

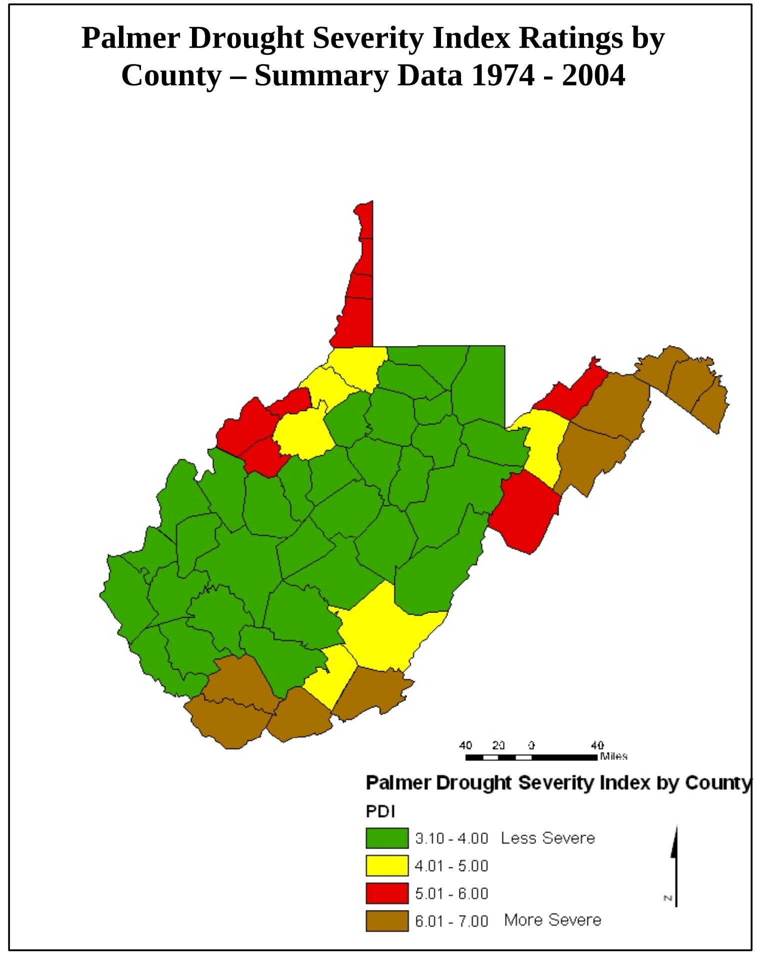


Figure 4.12 Soil Moisture Drought Indicator (PDSI)

This indicator is used in the index.

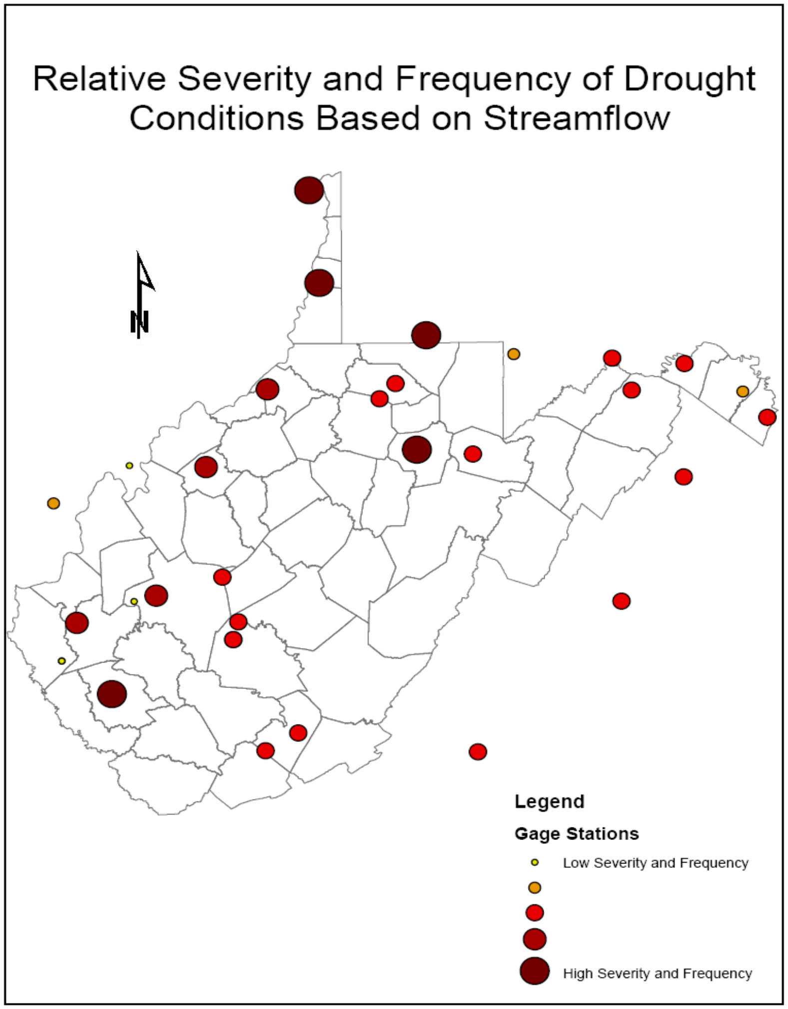


Figure 4.13 Streamflow Drought Indicator

State coverage by stream gauges, particularly gauges with 30 years of historical data, is not good. Data collected above were used in the index calculations, though it is not recommended that a stream gauge point be used as an indicator of flow patterns for its own watershed or neighboring watersheds.

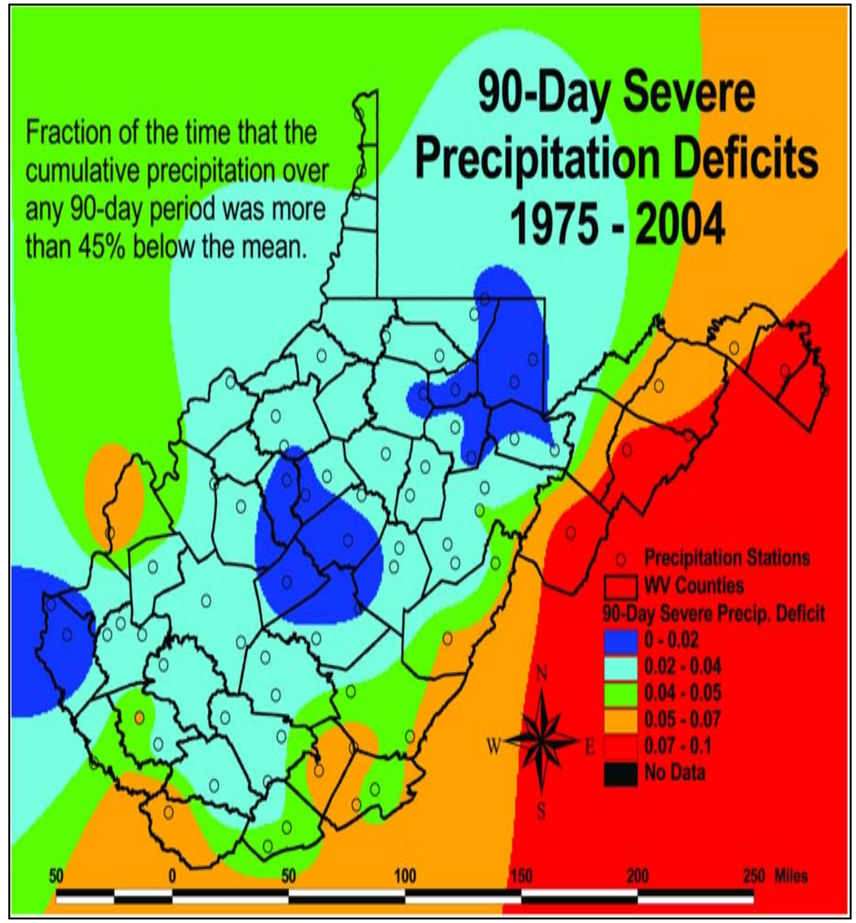


Figure 4.14 Precipitation Drought Indicator

This indicator is used in the index. The 90-day deficits indicate medium-term precipitation deficits, 30-day (short-term) and 360-day (long-term) deficits are also calculated and included in the index. Precipitation station coverage in the state is adequate.

The combined data for the drought index are spatially based on precipitation gauge location. Each precipitation gauge is assigned a corresponding PDSI value (climatological region) and a corresponding stream gauge based first on shared watershed and then, where there are multiple stream gauges in a watershed, by proximity. At each gauge site, all three indicators are evaluated separately on a daily basis over the past 30 years for drought severity ratings. Precipitation station points are assessed by the number of days spent in drought, with each day being weighted by the severity of the drought ranking of each indicator and by the number of the three factors indicating drought (one, two or three indicators in extreme or severe drought on any given day). Cumulative index values for each station are then gridded across the state, and spatially-weighted values assigned to each county and 8-digit watershed.

DROUGHT INDEX VARIABLES

- X Reservoir levels
- X Ground water
- Soil moisture (Palmer Drought Severity Index)
- Precipitation
- Stream gauges

The equation of the drought index is described below.

$$D_i = \frac{1}{9}\left[P_i^{30} + P_i^{90} + P_i^{365} + 3S_i + 3I_i\right]$$

D = Drought severity index for a particular precipitation gauge.

t = Time index, days.

= Duration of the total precipitation deficit code; 30, 60, or 365 days.

P_i^t = The *t*-day total precipitation deficit code.

S_i = 30-day mean stream discharge flow rate deficit code.

I_i = Palmer drought index code for precipitation gauge's climatological region.

Figure 4.15 WV Drought Index Equation

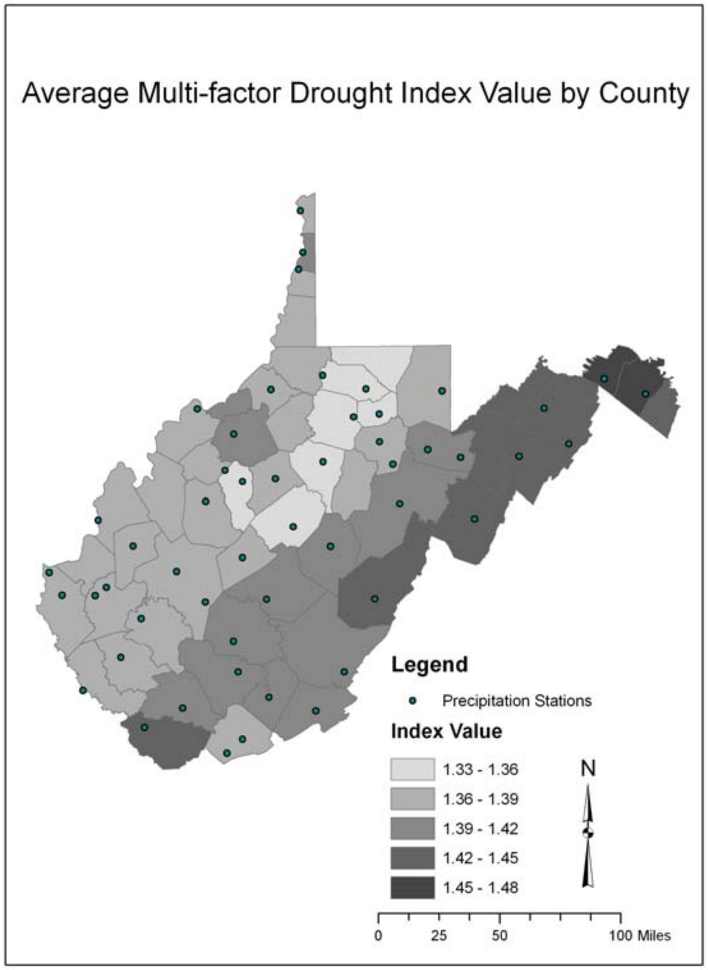


Figure 4.16 Drought Index by County

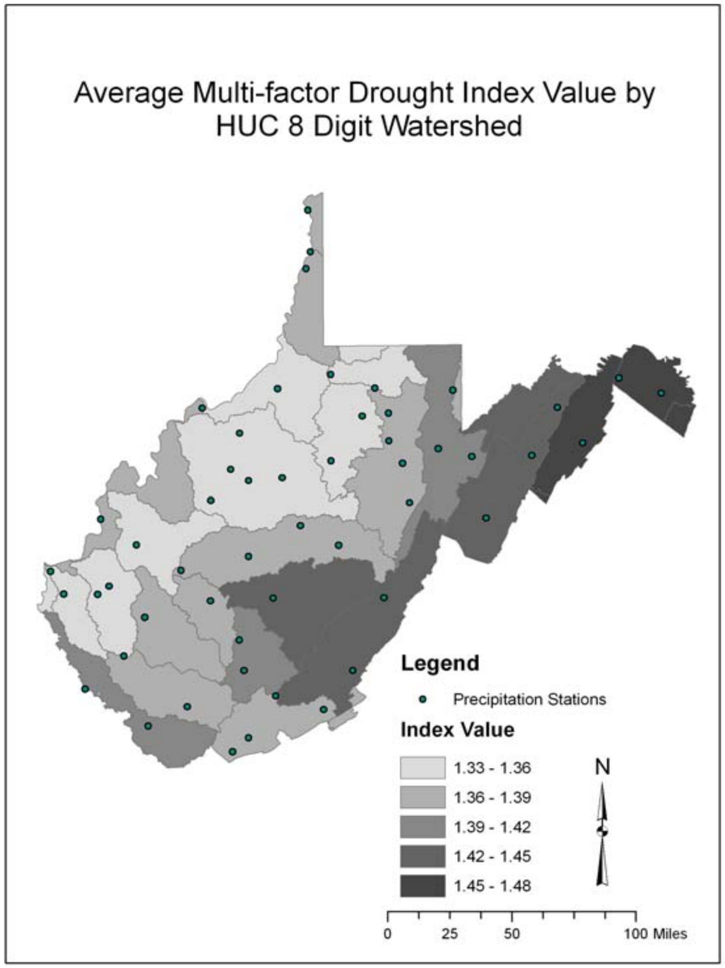


Figure 4.17 Drought Index Values by 8 Digit HUC Watershed

4.4 Impact of Drought and Low Flows on Beneficial Use

Data do not exist for most drought/low flow impacts on beneficial uses at the local or state level. Furthermore, because drought affects beneficial uses of water resources differently depending on the season, duration, and type of drought, as well as region-specific competing demands on water resources, it is difficult to extrapolate generalizations from case-specific data. Below are some important issues that should be considered in the evaluation of state water resources.

The section below identifies main categories of beneficial water use and describes how low flow conditions could impact those uses. Information was requested for drought impact estimates for at least one case in each category. This is followed by a review of the U.S. Army Corps of Engineers' drought-based integrated water resource management strategy in the Kanawha River Valley, which focuses on balancing the protection of different types of beneficial uses during resource scarcity.

Beneficial uses of water can be classified as consumptive or non-consumptive. Non-consumptive uses can be further divided into the following categories: ecological services, recreation and tourism, direct-market services, and transportation. The list in Table 4.2 is by no means complete. Each region and watershed will have a unique docket of water users and resource needs, which are often interrelated and interdependent.

NON-CONSUMPTIVE USES
Ecological Services
Habitat
Effluent dilution
Temperature/oxygen regulation
Ambient/soil moisture
Input to natural production functions (tree, plant, animal growth)
Recreation/Tourism
Swimming
Fishing
Boating/rafting
Aesthetic/existence values
Direct Market Services
Aquaculture
Public utility supply
Hydro-energy production
Transportation
CONSUMPTIVE USES
Industrial/commercial
Public utility supply
Energy production
Agriculture
Water bottling
Mining/natural resource extraction

Table 4.2 Beneficial Uses Affected by Low Flow Conditions

Ecological services of stream flows include natural habitat and effluent dilution, temperature and oxygen regulation, and it functions as an input in the production of natural goods and services. Naturally occurring low flow conditions reflect the expected fluctuations of dynamic ecosystems. These natural events should be understood and anticipated in land and water use planning and development.

An unnatural increase in the frequency or duration of low flow conditions may have a negative impact on the beneficial use of water through the destabilization of natural streambed morphology, degradation and reduction of wildlife habitat and other ecological services such as prevention of eutrophication. Low flows reduce stream velocity and result in the reduced capacity for the water to carry out natural stream-cleansing services, leading to embeddedness and loss of aquatic habitat.

Drought conditions can also have costly effects on state forest ecosystems. Drought increases tree susceptibility to disease, and it is identified by the State All Hazards Plan as a factor in the spread of wildfires. Drought-related losses were compounded in 1999 by extensive forest fires understood to have been an effect of the dry weather conditions. Between 1991 and 2000 on average 1,080 wildfires burned 65,435 acres *per year* in West Virginia costing the state $196,700,200 (almost exclusively in the southwestern region of the state). Wildfires can reduce post-fire landscapes' ability to retain soil moisture in the short run, exacerbating sedimentation and flash flooding factors.

Water-based recreation and tourism is widely recognized to be an engine of economic growth at local and state levels. Tourism and amusement-related sectors are leading the state in employment generation where other traditional sectors are declining. Fishing and boating are two important water-dependent recreation industries in the state.

Low flows can reduce fishing and rafting opportunities directly through insufficient flow and/or indirectly if reduced water quantities translate into quality problems that produce odor, public health threats, and reduced stream clarity. Whitewater rafting alone has consistently attracted over 200,000 visitors to the state annually for the past decade. As surrounding states invest in the development of competing recreation and tourism industries, protecting water quality and quantity will become increasingly important.

WV Department of Agriculture figures indicate that West Virginia aquaculture (primarily for trout stocking) is a $2 million-a-year sub sector activity that generates an additional $1 million in related income and taxes. Anglers' visits alone generate $2.5 million per 20,000 fishing trips. According to the DNR, trout stocked in 1999 were significantly smaller than previous years due to drought conditions that started in the summer of 1998 (1.9 trout per pound down from the average 1.5 – more than a 20% production loss). Ground water sources for commercial fishery production and adequate stream flows to attract anglers and protect fish habitat are important economic resources that are sensitive to natural flows.

Direct market services include aquaculture, public water utilities, and hydro-energy production. Drought threatens these uses when there is insufficient water to continue operations at full capacity. Reduced capacity for these users relates directly to reduced production and/or increased costs of production – resulting in lost revenue accordingly. In the cases of public utilities and hydro-energy production, drought-related production reductions often occur at the same time demand increases (watering lawns, swimming pools, running air conditioning etc.). Potential losses in each case are site and drought specific.

In Berkeley County in 2002, drought caused a 25% reduction in water supply as a result of a 50% reduction in the flow rate of two major springs. While the county is attempting to prepare for the next drought, population growth will inevitably result in future socio-economic droughts. Maryland granted temporary permission to increase daily maximum withdrawals from the Potomac River by over 30% (2.67 to 3.864 million gallons per day [MGD]) and emergency withdrawals of 5.52 MGD.

County officials are concerned about growing ground water scarcity due to the increased percent coverage of impervious surfaces in the county (limiting aquifer recharge) and degraded ground water quality (reducing the quantity of useable water supply/increasing treatment costs). Costly temporary building and development halts have already been implemented in the Eastern Panhandle and parts of Maryland due to water scarcity.

Consumptive uses of water include industrial manufacturing, public utilities with trans-basin service districts, energy production that requires water for cooling towers, agriculture that exports production, water bottling facilities, and mining/natural resource extraction operations that result in bulk transfers of ground water to surface water.

Drought and low flow conditions threaten energy production when discharge stream temperatures or flows limit facilities' discharge water or when intake water temperatures or flows reduce cooling capacity of the plant. Power companies do not keep records of drought-related production losses and estimates of such losses would have to be made on a facility-by-facility basis. Power generation is affected by drought because temperature and flow of cooling water supplies are determinants of the plant production capacity. The impact on each plant is unique and event-specific.

Agriculture production is threatened by drought when goods are smaller in size, misshapen, or diseased due to drought stress. The Department of Agriculture compiled historical data on financial compensation for drought-related agriculture losses, but the data was not continuous enough to generate a meaningful report. During the 1999 drought alone, USDA reported $200 million in agriculture-related drought losses.

There are 155 DHHR-licensed water-bottling facilities in the state (11 are West Virginia-owned). Water bottling facilities are not required to report the quantity of water they extract to any state agency (with the exception of the current DEP survey). There are no regulations that require facilities to measure the effects of pumping on neighboring wells or to determine baseline supplies/flows. Facilities are only regulated by DHHR for water quality and facility sanitation regulations. Low flows can threaten water bottling facilities if other users who rely on surface water are forced to switch to ground water sources, becoming competing users. Excessive surface water consumption can also reduce ground water recharge rates in some cases depending on the region's geology, hydrology and economic activities.

Monroe County, home to a number of bottlers and a growing population, is currently working to prevent conflict over surface and ground water supplies through countywide planning. Jefferson County's efforts to plan for future water supplies were limited to public utility planning. The county's Source Water Assessment and Protection Program (SWAP) specifically notes that a new water-intensive manufacturing facility or water bottling facility in the area would result in severe water scarcity for the public water utility.

Chapter 5 - Uses that Contribute to Detrimental Low Flow Conditions

As stated above, distinguishing natural from anthropogenic causes of water scarcity can be difficult to impossible. Understanding the relationship between surface and ground water movement, particularly in karst areas, can make it nearly impossible to predict where and to what degree one user's withdrawal or diversions may impact another's supply. This complication is compounded by the fact that there is little to no data on withdrawal quantities – making it impossible to understand how those withdrawals impact the hydrology around them.

Five general category practices have been identified to date as exacerbating low flow conditions. These problems are interrelated in many ways, as is illustrated in the discussion below. General categories include the following:

- Over-extraction (DNR v Tingler, 2005)
- Rapid growth/contamination (Eastern Panhandle)
- Competing uses (USACE Shared Vision balance of energy, boating, and ecology interests in Gauley basin during drought)
- Resource extraction (mining/quarries; Pennsylvania Act 54)
- Sedimentation (Hurricane, WV)

The WVU Hydrogeology Research Center attempted to identify natural and water resource extraction-based impacts on water levels in aquifers of the Eastern Panhandle, but has largely found the indicators to be confounding, even with significant project-based measurement and monitoring expenditure. DEP efforts to allocate liabilities in stream and well dewatering cases surrounding sub-surface mining operations are also hindered by problems distinguishing between natural and anthropogenic flow factors. Lack of flow and ground water monitoring data further limits our ability to provide a comprehensive analysis of this already complicated question.

Among the most important practices that exacerbate natural low flow conditions are over-extraction of water for consumptive uses and bulk water transfers (most often related to natural resource extraction). Countless anecdotes circulate of well owners who lose their water supply due to new water extraction practices on a neighboring parcel or due to underground mining activity. In these cases, lack of data and information about ground water extraction, supply, and underground water flows becomes a serious problem.

In West Virginia, stream and well dewatering problems that stem from nearby mining activity cannot be tracked or monitored without extensive manual research. Available information for valley fills and permanent stream loss due to mining are show in Figures 5.1 and 5.2. Pennsylvania mandates regular collection and reporting of mine-related dewatering data (Act 54).

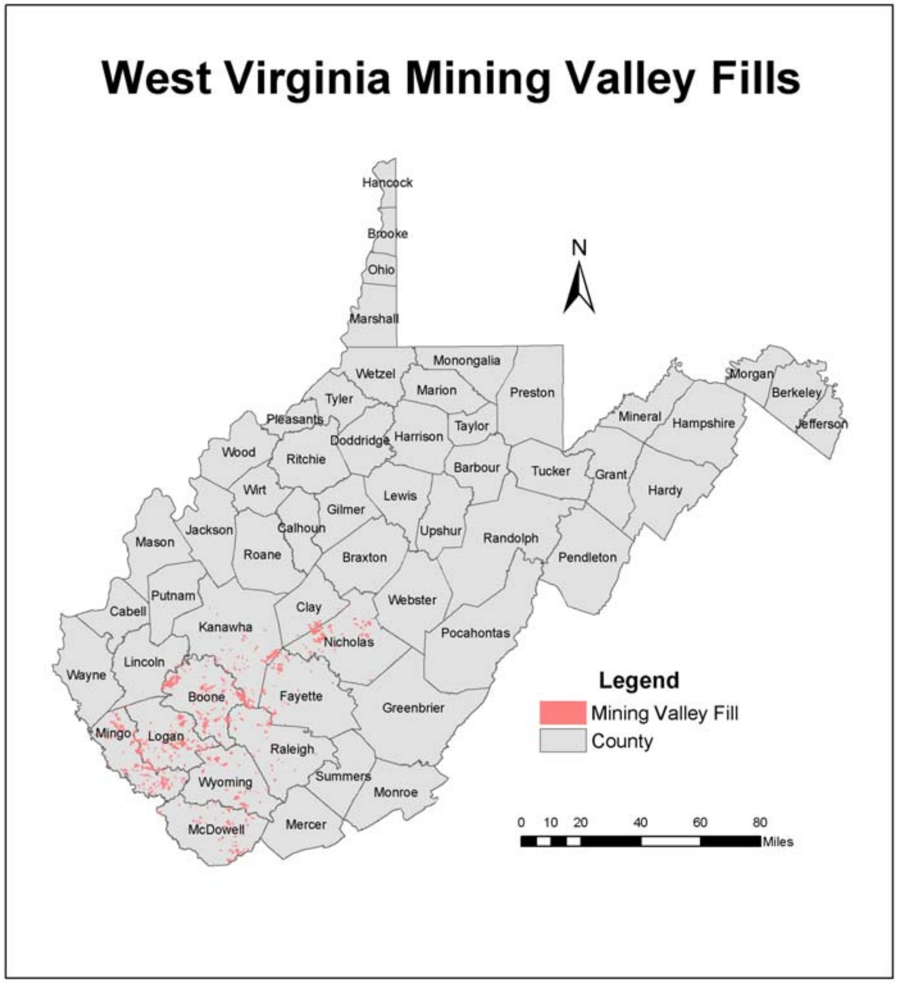


Figure 5.1 Mining Valley Fill Locations

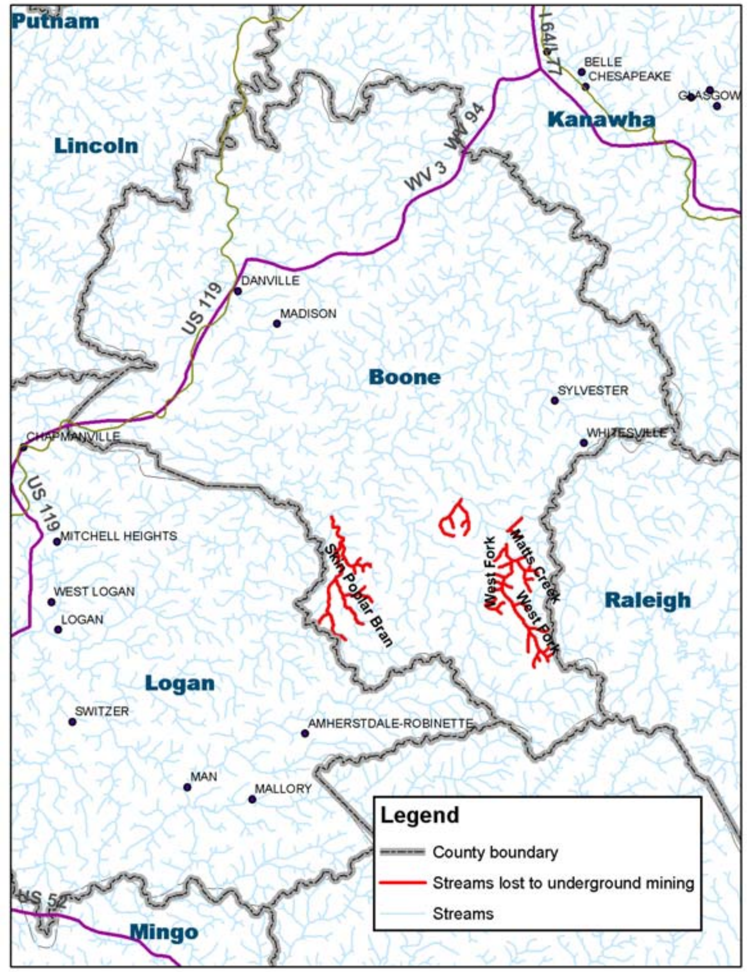


Figure 5.2 Permanent Stream Loss Due to Underground Mining

The DNR faced water scarcity problems in Randolph County (WVDNR v Tingler) when a neighbor began pumping ground water next to a DNR fish hatchery. The resulting reduced spring flows on DNR property caused the hatchery to close (the case was recently ruled in favor of DNR).

Interestingly, many anthropogenic factors that cause and/or exacerbate low flow conditions can also exacerbate flood conditions. Increased coverage of impervious surfaces and increased erosion are two such factors in West Virginia. Increased sedimentation is the state's leading water quality impairment. Other than drought, it was the most frequently mentioned problem relating to surface water intake on the water use surveys. Land use practices often lead to erosion, which causes sediment to accumulate in streambeds (aggradation). Raised streambeds exacerbate flooding and erosion problems, but result in streams that are increasingly shallow, wider, and warmer, losing more water to evaporation and having lower dissolved oxygen levels than they would in their natural condition.

In Figure 5.3, the Hurricane Public Water Supply Reservoir illustrates how land use, flooding, and low flows or water scarcity are related issues. Inappropriate land use practices at construction sites (sub-photo) upstream from the reservoir caused almost $500,000 in damages to this reservoir. Dredging was necessary to increase the water supply. Reduced water storage capacity also brought the floor of the reservoir dangerously close to developed structures and roads. Finally, sediment transport brings with it the transport of pathogens that can contaminate streams and reservoirs. A special enforcement sweep upstream and throughout Putnam County resulted in 119 notices of violation at 33 of the 41 inspected sites.

Figure 5.3 Sedimentation of the Hurricane Reservoir - A Factor that Exacerbates Low Flows and Flood

Land use changes that significantly increase the degree of imperviousness in a watershed is another contributor to both drought and flood events – this includes mine land reclamation practices as well as urbanization practices. Water that would otherwise percolate into soil and underground aquifer systems instead flows directly into surface water streams, often transporting contaminants such as pesticides, oils, sediments, and other watershed-specific contaminants – a problem particularly in sensitive karst areas. Increased surface flow volume and velocity can exacerbate flooding in the short run and destabilize streambeds in the long run.

Canaan Valley Institute is working to develop geospatial models of sediment-based relationships between land use and changing stream morphology in a subwatershed of the Little Kanawha as part of its work to update FEMA maps in the watershed. Once completed, such information will provide important lessons for other areas of the state. Land use-based reduced flows cannot be summarized quantitatively for the state with existing data. Land use-related factors are also absent in USGS low flow modeling efforts.

Drought management Drought's impact on various beneficial uses can also vary depending on how the drought is managed by local and state officials and by each water user. A drought warning and response system can help users plan for water scarcity by employing water conservation measures, by understanding their own use in the context of other users and the watershed system, and by preparing users to contribute to watershed or county-based contingency plans that are acceptable to all stakeholders. The case below illustrates how integrated water resource management reduced and distributed the impact of drought on beneficial uses in a way that was politically accepted due to stakeholder participation in the planning process. It further illustrates how flows can be managed, at least on some streams, by planning for natural low flow conditions.

The Kanawha River The Kanawha River and its tributaries drain 12,300 square miles of land starting in North Carolina and crossing into Virginia and West Virginia before joining the Ohio River. Major tributaries in the state include the Gauley, the New, the Elk and the Greenbrier rivers. Minimum in-stream requirements maintain fish and wildlife habitat, transportation, and ecological services (primarily dilution of downstream effluent discharges) but rely on reservoir releases from Summersville and Sutton dams. The whitewater industry provides the region with millions of dollars in revenue every summer and Appalachian Power Company has hydropower plants on three USACE multipurpose reservoirs and owns a fourth reservoir at Claytor Lake.

A drought that began with low rainfall in 1987 and continued through the fall of 1988 restricted important whitewater releases during weekdays, costing millions of dollars in lost local revenues. USACE reservoir releases eventually fell below what was necessary to maintain minimum in-stream flow requirements (for ecological services, wildlife, and transportation) at a perceptible cost to water quality and habitat.

USACE convened a study team of experts to evaluate the situation and develop a series of policy alternatives to the status quo management plan. For each alternative, impacts on lake recreation, water quality, rafting, navigation, and hydropower were evaluated. A group of stakeholders was convened to debate the various management scenarios and the corresponding implications. Debate and discussion eventually led to the endorsement and implementation of a situation-tailored plan to manage water resources that both protected the ecological and economic services of the watershed.

In 1993, when drought again required exceptional water resource allocation decisions be made, informed and experienced stakeholders reconvened with the USACE using the Shared Vision model and decided on a new strategy given the specific drought conditions they faced.

The regional drought watch was lifted after heavy rains eliminated the resource scarcity problem; however, the Kanawha case study illustrates the usefulness of and need for regional drought readiness and management planning. Each drought event poses different types of scarcity depending on when it occurs, duration and other events going on at the time. Each region faces different water resource demands and may prioritize needs for each drought event differently given the temporally and regionally unique context. This is particularly useful when water resource uses can be coordinated to facilitate multiple-use management of scarce resources. Combining the participatory and information-driven approaches of the Shared Vision model helped to develop a team of local experts interested in and capable of finding the best management solution for the region. Such participation is likely to provide additional benefits of stakeholder cooperation during the implementation phase of any drought mitigation plan.

5.1 Survey Results

The survey indicates there are 223 separate surface water intakes located in streams (Appendix K). The maximum daily potential to withdraw water from the stream, as reported on the survey, was subtracted from the 7Q10 (low flow) value for the stream. If the result was zero or a negative number, the facility possesses the capability to completely dewater the stream during low flow events.

There are 68 facilities that could potentially dewater a stream during low flow conditions. Fifteen of the 68 facilities are suspected of supplying incorrect location data for their intakes, based on an analysis of other information supplied in the survey and on their mapped withdrawal points. The 53 remaining facilities were evaluated by subtracting their reported average daily withdrawals from the survey from the 7Q10 value. Thirty-two of those facilities had average daily withdrawal rates that exceeded the stream's 7Q10 value.

If a facility does not use the water consumptively there should be no major negative effect on the stream – the facility will put as much water back into the stream as it withdraws. However, of the 53 facilities that could potentially have a detrimental effect during low flow conditions, 32 (60%) use water consumptively.

Clearly, a number of facilities have the capability of contributing to the detrimental effects of low stream flow. This is particularly true because harm to the aquatic habitat of a stream generally occurs at flow rates that are higher than the 7Q10 value. If a higher flow rate than the 7Q10 value were used, for example 50% of the average stream flow, the number of facilities that could exacerbate the harm resulting from low flow conditions would greatly increase.

These statistics alone should only be used as an indication that a facility could contribute to low flow conditions. Having the capacity to do something does not mean that the action would ever be taken. It may simply indicate the equipment was over-designed, or the facility has access to other water supplies that are relied upon in times of low flow. For example, 16 of the 29 facilities are coal mines or related mining operations. Mines typically have large capacity equipment, which is moved as needed, and other water sources that are not required to be reported by the act. Thus, they could simply switch from one source to another when required.

Other considerations in evaluation of this information are that the reported withdrawal points did not always plot on a stream. This occurred for numerous reasons. Generally, the closest point on the stream to the withdrawal point was selected to calculate the value for 7Q10. If the withdrawal point is near the confluence with a larger stream, the calculated 7Q10 value may be misleadingly low, since water from the larger stream will maintain higher water levels at the mouth of the smaller tributary. Since most of the low flow values were calculated, the actual 7Q10 value might be much different. This is particularly true now because only two regression models are used to calculate all 7Q10 values in the state. DEP has contracted with the USGS to develop an improved model for determination of 7Q10 values utilizing the closest stream gauge data. This work is scheduled for completion by the end of 2006.

Although there are difficulties in this type of analysis, the identified companies should examine their operational procedures to ensure they do not cause harm to the aquatic habitat of the stream by withdrawing too much water. In addition, further analysis and data collection should be performed to permit an evaluation of the minimum flow necessary to maintain the aquatic habitat in a stream – a number which is almost certainly higher than the 7Q10 value.

Chapter 6 - Potential Ground Water Well Network

Ground water is extremely important to West Virginia. Because surface water re-charge is dependent mostly on ground water, an understanding of the ground water resource is imperative. In some areas of the state, utilization of the ground water resource assures year-round domestic and commercial supplies.

Management of the ground water resource requires an understanding of both an aquifer's characteristics and its water level history. The water level history can only be obtained in one way – establishment and regular monitoring of dedicated water wells over a number of years. Aquifer characteristics, however, may be obtained from any well as long as they are acquired when the well is drilled. The best method to rapidly acquire such data would be to require all new non-residential water wells be tested and electronically logged when drilled. Determination of the recharge rate, when combined with gamma ray, spontaneous potential, resistivity, electronic flow meter, acoustic televiewer and caliper logs would accurately determine an aquifer's characteristics. Over time, maps of the most actively used aquifers would emerge, making management of the ground water resource possible.

A ground water monitoring well network cannot be immediately established due to cost and technical considerations. Therefore, a methodology for prioritizing well installation was developed based on the areas of greatest current ground water usage, areas of projected water use growth, areas of projected residential water use growth, and the probability for the occurrence of drought as measured by the multi-factor drought index described in Chapter 4.

For each factor, a county was assigned a value. The values for each factor were totaled and the counties ranked in order based on the sum. Berkeley was the highest ranked county, with a combined score of 8. Table 6.1 displays the values assigned for each factor and the total ranking.

Areas of greatest current ground water usage were determined by examination of Figure 3.9. The majority of the state's water wells cluster in the far Eastern Panhandle, along the Ohio River, and in the southern coalfields. The Eastern Panhandle counties were given a value of 2 because their water use is primarily domestic and commercial, which are commonly more consumptive in nature. The southern coalfields were given a value of 1 because the primary water use is associated with mining. Mining activities are usually concerned with removing water from their operations and supplying water for dust suppression. The Ohio River wells are almost completely found in the alluvial aquifer of the river. The river is regulated, i.e. dammed, so a minimum flow is guaranteed throughout the year. Because the alluvial aquifer can be recharged from the river, there is never a problem with water supply from these wells. Therefore, the Ohio River counties received a score of 0.

Projected overall water use growth was based on the data illustrated in Figure 7.2. Counties expected to have an increase in water demand over the next five years between 5% and 10% were given a value of 1. Those counties with expected growth over 10% were given a value of 2.

Projected residential water use growth (Figure 7.6) by county of 5% to 10% was assigned a value of 1; between 10% and 15% a value of 2; and between 15% and 20% a value of 3.

The Multi-factor Drought Index map (Figure 4.16) was used to assign a value of 1 to those counties with an index of 1.42 to 1.45. Counties with values between 1.45 and 1.48 were assigned a value of 2.

Totaling the values for each county gives a ranking score, which is used to prioritize counties based on their reliance on the ground water resource. The highest ranked counties should then be the first to have ground water monitoring wells installed. However, seven counties currently have USGS monitoring wells (indicated by gray shading on Table 6.1). Wells in these counties should be maintained, and new wells should be placed in those high ranking counties without existing wells.

Thus, to establish the fledgling ground water monitoring well network, wells should be located in Morgan, Grant, Hampshire, McDowell, and Putnam counties. After data from those wells are evaluated, along with any other available information, a plan may be developed for the location of future wells.

Table 6.1 Factors Utilized in Determining Potential Ground Water Monitoring Well Locations

County	Greatest Ground Water Usage[1]	Projected Water Use Growth[2]	Projected Residential Water Use Growth[3]	Multi-factor Drought Index[4]	Contains Current USGS Monitoring Well	Score
Berkeley	2	1	3	2	X	8
Jefferson	2	1	3	1	X	7
Morgan			2	2		4
Grant		1	1	1		3
Hampshire			2	1		3
McDowell	1			2		3
Putnam		1	2			3
Boone	1		1			2
Hardy			1	1		2
Mineral		1		1	X	2
Monongalia		1	1			2
Preston		1	1			2
Tucker		2				2

Table 6.1 Factors Utilized in Determining Potential Ground Water Monitoring Well Locations (Continued)						
County	Greatest Ground Water Usage[1]	Projected Water Use Growth[2]	Projected Residential Water Use Growth[3]	Multi-factor Drought Index[4]	Contains Current USGS Monitoring Well	Score
Braxton			1			1
Clay			1			1
Fayette	1					1
Harrison		1				1
Jackson	0		1			1
Lewis			1			1
Lincoln			1			1
Logan	1					1
Marion		1				1
Mason	0	1				1
Mingo	1					1
Pendleton				1		1
Pleasants		1				1
Pocahontas				1	X	1
Raleigh	1					1
Randolph			1			1
Ritchie			1			1
Taylor			1			1
Upshur			1			1
Webster			1		X	1
Wyoming	1				X	1
Brooke	0					0
Hancock	0					0
Marshall	0					0
Ohio	0					0
Wayne					X	0
Wetzel	0					0
Wood	0					0

[1] Eastern Panhandle = 2; Southern coalfields = 1; Ohio River counties = 0.

[2] Increase between 5% -10% = 1; Increase greater than 10% = 2 (From Figure 7.2).

[3] From Figure 7.5: 5% - 10% = 1; 10% - 15% = 2; 15% - 20% = 3.

[4] From Figure 4.16: 1.42 -- 1.45 = 1; 1.45 -- 1.48 = 2.

Chapter 7 – Competition for Water Resources in Potential Growth Areas

7.1 Potential Growth Areas

The goal of this task is to identify potential economic growth areas that would impact water consumption and apply that expectation to forecasts of near-term regional economic development.

7.1.1 Commercial and Industrial

Economic activity for the years 2005 through 2010 is forecast based on the North American Industry Classification System (NAICS). Future water use is based on economic activity and recent county-level trends combined with aggregate statewide forecasts of industry-specific employment change.

Economic forecasts published by West Virginia University's Bureau of Business and Economic Research (BBER) in its 2005 Economic Outlook are used to calculate industry forecasts for the state as a whole. [1] The following industry categories were evaluated as listed below, along with BBER's forecasted rate of change for employment by industry at the two-digit NAICS level. The industries with the highest rate of growth are the service industries. These industries generally have lower rates of water consumption than non-services industries. Other industries projected to experience growth are recreation and accommodation and food services. The mining industry is also projected to see employment growth, although that growth is not projected to translate into increased water use from current levels, as 2006 coal production is expected to be at a level that is the high for the decade.

For most industries it is assumed that negative employment growth corresponds with a decline in water use for that industry, and that an increase in employment represents an increase in water use. However, this relationship is not necessarily true for some industries, including power generation and mining, and was not assumed in this analysis for those two industries. A direct correlation may also not be true for many manufacturing facilities, but due to the lack of data defining an actual relationship, a direct employment to water use coefficient was utilized.

[1] West Virginia University, Bureau of Business and Economic Research, 2005. "West Virginia Economic Outlook."

Table 7.1 WVU BBER Forecasted Employment by Industry

NAICS/Industry	WVU BBER Employment Annual Change 2004-2009
11 Forestry, fishing, hunting, and agriculture support	-2.7%
21 Mining	0.3%
22 Utilities	-1.8%
23 Construction	0.2%
31-33 Manufacturing	-0.6%
42 Wholesale trade	0.2%
44-45 Retail trade	0.3%
48-49 Transportation & warehousing	1.0%
51 Information	0.4%
52 Finance & insurance	0.6%
53 Real estate & rental & leasing	0.6%
54 Professional, scientific & technical services	2.3%
55 Management of companies & enterprises	2.3%
56 Admin, support, waste mgt, remediation services	2.3%
61 Educational services	0.3%
62 Health care and social assistance	1.5%
71 Arts, entertainment & recreation	1.2%
72 Accommodation & food services	1.2%
81 Other services (except public administration)	0.9%
92 Public Administration	-0.1%

CBER compiled individual county-level economic activity data provided by the Bureau of Employment Programs for 1998 and 2003. To translate this economic activity into water consumption levels, trends in number of establishments, number of employees and payroll were examined at the two-digit NAICS code and for some sectors at the six-digit code. For industries with economic activity that generates little variation in water use, the higher two-digit level of activity was evaluated. These industries comprise the majority of NAICS sectors but a relatively small portion of water use.

The following two-digit industries were evaluated at the six-digit industry code for water consumption, due to economic activity that creates more variation in water use per employee. These industries were analyzed at a lower level of activity to account for as much detail as possible. Major use activities are described below.

- Forestry, fishing, hunting and agriculture support – Sub-industry activities include agriculture and logging, with livestock accounting for the largest quantity of water use.
- Arts and recreation – This group includes fitness centers, theaters, casinos and sports. Golf courses are the largest sub-group in terms of water use.
- Manufacturing – This sector includes activities ranging from chemical manufacturing to food production. Sub-industry water use estimates were

obtained from a combination of USGS and DEP survey data for gross consumption. The highest use sub-industries are in chemical manufacturing.

- Utilities -Thermoelectric power generation (NAICS 221112 -Fossil Fuel Electric Power Generation) was calculated separately.
- Mining – Coal mining, quarries and oil production were evaluated separately.

The results of the DEP major user survey, which provides consumption data at the facility level and thus corresponds with the six-digit NAICS level of economic activity, were applied to these sectors whenever possible. The remaining industry categories all consume water at consistent levels, at lower levels as represented by commercial office users, or higher levels as represented by hospitals or other types of accommodation, that can be applied at the two-digit level of economic activity. Few facilities within these sectors were required to participate in the DEP survey due to water consumption not meeting the required quantity. Data provided within the USGS survey of water users was applied to estimate water withdrawals for these industries.[2]

7.1.2 Residential

Household consumption is directly related to population growth, which in aggregate is projected to be flat through 2010. Average annual consumption estimates were calculated using publicly available annual reports for public service districts from the West Virginia Public Service Commission website (www.state.psc.wv.us). These consumption levels are then applied to individual counties. The assumptions to this analysis are provided in the residential part of the Water Use Calculation Section.

7.2 <u>Impacts of Out-of-State Industries</u>

The Water Resources Protection Act (§22-25-3(d)) requires the DEP Cabinet Secretary to obtain survey information from persons who are withdrawing water from an in-state water resource, but who are located outside the state borders. Only along the Ohio River is there potential for out-of-state facilities to withdraw directly from the state's waters. The other boundary rivers are either entirely owned by another state, such as the Potomac, or the boundary divides the stream, such as in the Tug Fork and Big Sandy rivers.

The state's western boundary is defined as the historic low water mark on the western bank of the Ohio River. Numerous locks and their associated dams have ensured that the Ohio River is never as low as the historic low water level that formed the original boundary. Thus actual ownership of the water over the land west of the historic low water level may be legally problematic.

Regardless, 19 registered Ohio companies (facilities that have the capability to withdraw over 100,000 gallons per day) are utilizing water from the Ohio River.

[2] USGS, Dunn & Bradstreet and Harris Interactive, Inc., 2004.

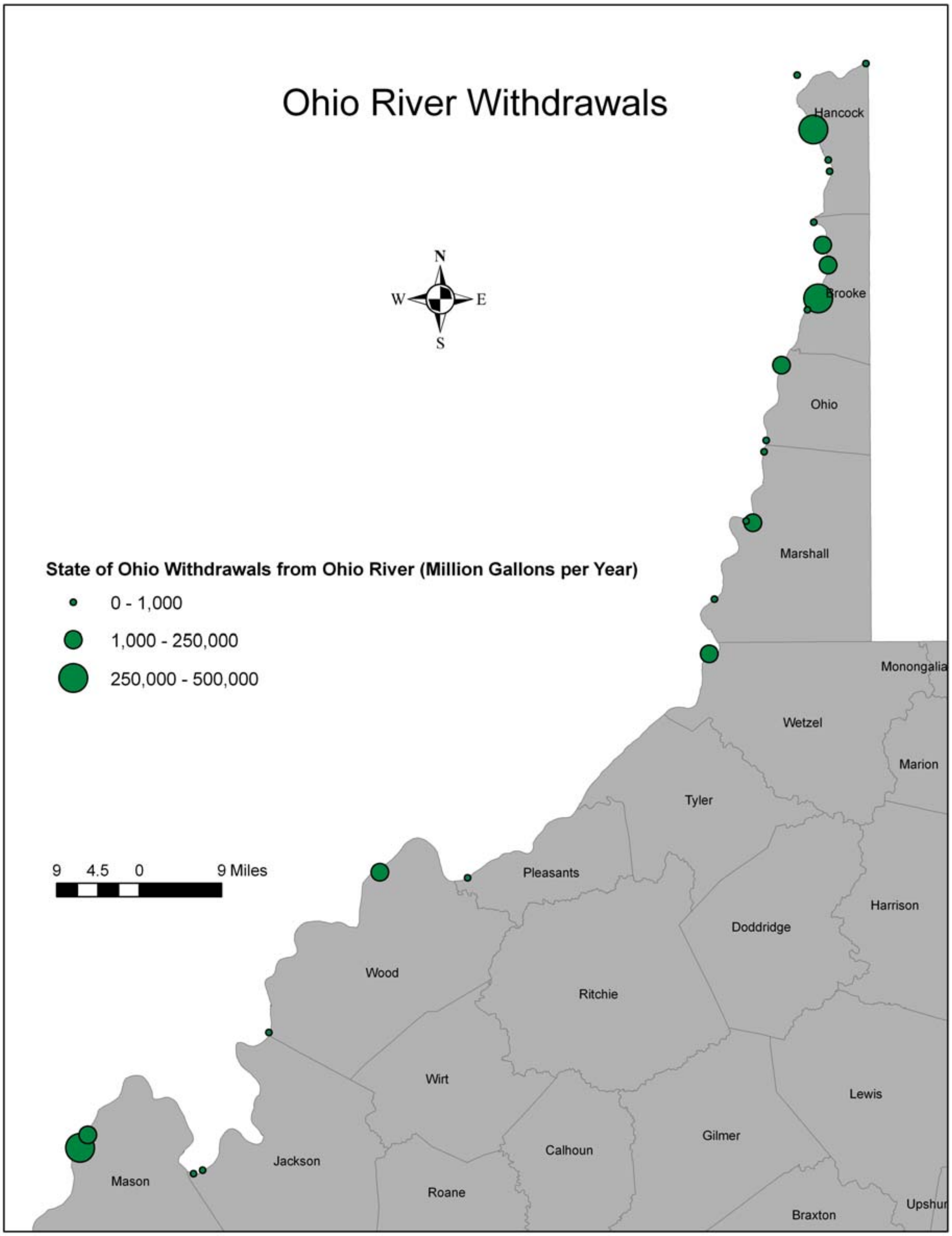


Figure 7.1 Withdrawals from the Ohio River by Ohio Industries

Based on 2002 and 2003 data obtained from the Ohio Department of Natural Resources, the average yearly withdrawal by these facilities is 1.4 trillion gallons. According to records maintained by the USACE, the average flow of the Ohio River at Huntington, West Virginia during the 2003-2005 investigative period was 7.75 million gallons per second. Enough water flows past Huntington in two days to account for the entire year's water withdrawals by Ohio's large quantity users. The location of these facilities is shown on figure 7.1.

Only one other instance of West Virginia waters used by out of state consumers was reported in the survey. In this situation, a water supply company in Bluefield is supplying customers in Virginia.

Of interest is one West Virginia company that receives its water from Steubenville, Ohio, where the water is obtained from the Ohio River. Another West Virginia municipality receives its water from the Savage River in Maryland, and its wastewater treatment facility is also located in Maryland.

A power generation facility near Rockport, Maryland is in the planning stage. To receive a Maryland permit to use water from the Potomac for the plant, the owners must be able to replace the water it withdraws under certain low flow conditions. To provide the necessary replacement flow, the owners propose pumping water from the Shenandoah River near Millville (Jefferson County) into an abandoned quarry during times of high flow. During times of low flow, they will pump water back into the Shenandoah to meet their replacement requirement at their Maryland facility. Thus, they are not taking water out of the state, but are using the state's waters to their advantage, even though their facility is located in Maryland.

7.3 Potential Future Water Needs

The goal of this task is to estimate water demand by industry and households in the near term. This projection was completed for 2005 through 2010. These estimates cover the state at the county level, although results are often presented at the state level. The numbers presented here are rudimentary calculations and for many sectors are based on sparse data regarding actual gross and net consumption.

7.3.1 Net Use Versus Withdrawals

It is important to note the distinguishing of net versus gross water consumption. While estimates of total withdrawals, or gross consumption, are available for most industry groups, estimates of net consumption (withdrawals minus discharges) are less readily available. This report focuses on net consumption, due to emphasis by the WRPA on estimating consumptive use. The DEP survey results include figures that can be used to calculate net consumption, although some calculations often resulted in negative net consumption.

7.3.2 Water Use Calculations

The number of employees is used to calculate water consumption for most industries due to the availability of estimates that are a function of number of employees. No assumptions were made regarding the underlying productivity of labor in any water-consuming industry in West Virginia. This implies that industrial efficiency is constant with the addition or subtraction of employees and that water use is directly proportional to employment. This method has been criticized for not accounting for operational efficiencies achieved by many facilities that have been able to maintain output with reductions in employment or that have reduced water consumption while maintaining output. This criticism is legitimate, but due to the lack of alternative methods, an estimation of gallons per employee per day (GED) was used for most industries evaluated in this report.

Water consumption for the power industry was calculated based on production and at rates determined by consultation with industry. Mining consumption is also based on production, but due to the range of estimates, a more thorough analysis at the county or watershed level is needed. Recent trends in employment by industry and by county were analyzed to provide a basis for near-term consumption trends. For industries where water consumption was calculated based on number of employees, the forecast for state-level employment was matched to the WVU BBER forecast shown above. Individual county growth within that forecast was estimated from data on employment changes between 1998 and 2003. A logic formula was applied to project a percentage growth in a specific two-digit industry for a specific county based on the recent historical growth. Historical county-level growth was grouped into tiers and used to project future county growth, also in tiers, that is representative of past growth, while also matching the overall projected state growth.

In other words, the projected 2005 to 2010 employment growth rate for County_y in Industry_x is a function of 1998 to 2003 employment growth rate for County_y in Industry_x, plus WVU BBER's forecasted employment growth for West Virginia in Industry_x. The logic formula applied to each county to determine the projected growth rate is based on four conditions:

1. If historical employment growth was positive and greater than a, then projected growth is a_1;
2. If historical growth was positive and less than or equal to a, but greater than 0, then projected growth is a_2;
3. If historical growth was less than or equal to 0, but greater than b, then projected growth is b_1; and,
4. If historical growth was less than or equal to b, then projected growth is b_2.

The four growth rates, a_1, a_2, b_1 and b_2, were calculated using an iterative process that forces the combined employment for all counties in each sector to equal the growth rate forecasted by WVU BBER. For example, counties that experienced greater than four percent annual growth in employment in the accommodation and food service industries are projected to continue that growth, although at a slower pace of three percent. Counties that saw positive growth of less than four percent are projected to see one percent growth and counties that lost employment in this industry are projected to continue to do so at a rate of negative one percent. Total aggregate county employment growth in accommodation equals 1.2%. The following chart shows projected changes in net water use by sector for 2005 to 2010 based on these employment calculations.

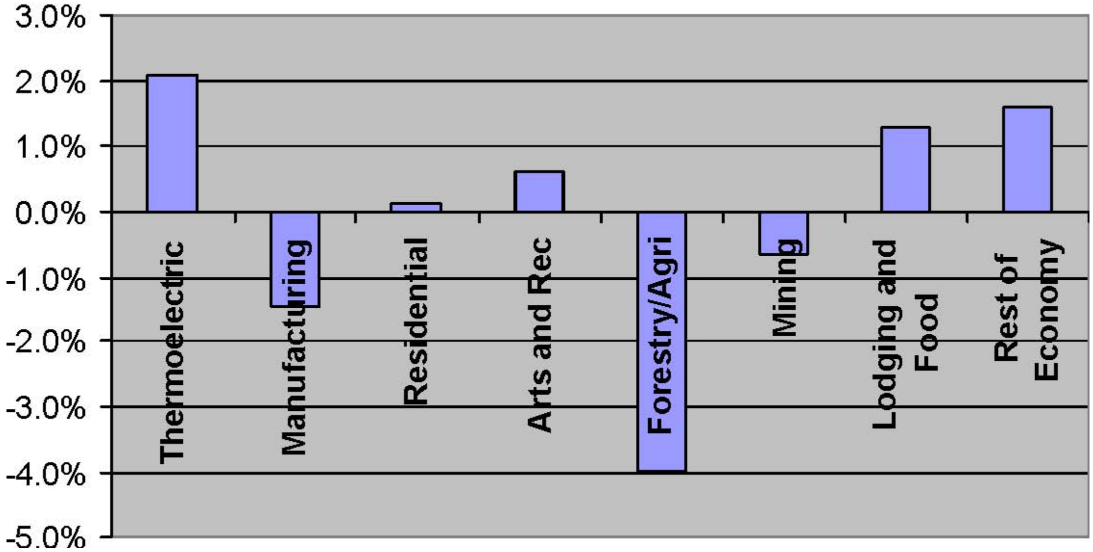


Figure 7.2 Projected Annual Percentage Growth in Net Water Use, by Sector

Figure 7.3 describes the overall results for the change in projected water consumption by county between 2005 and 2010.

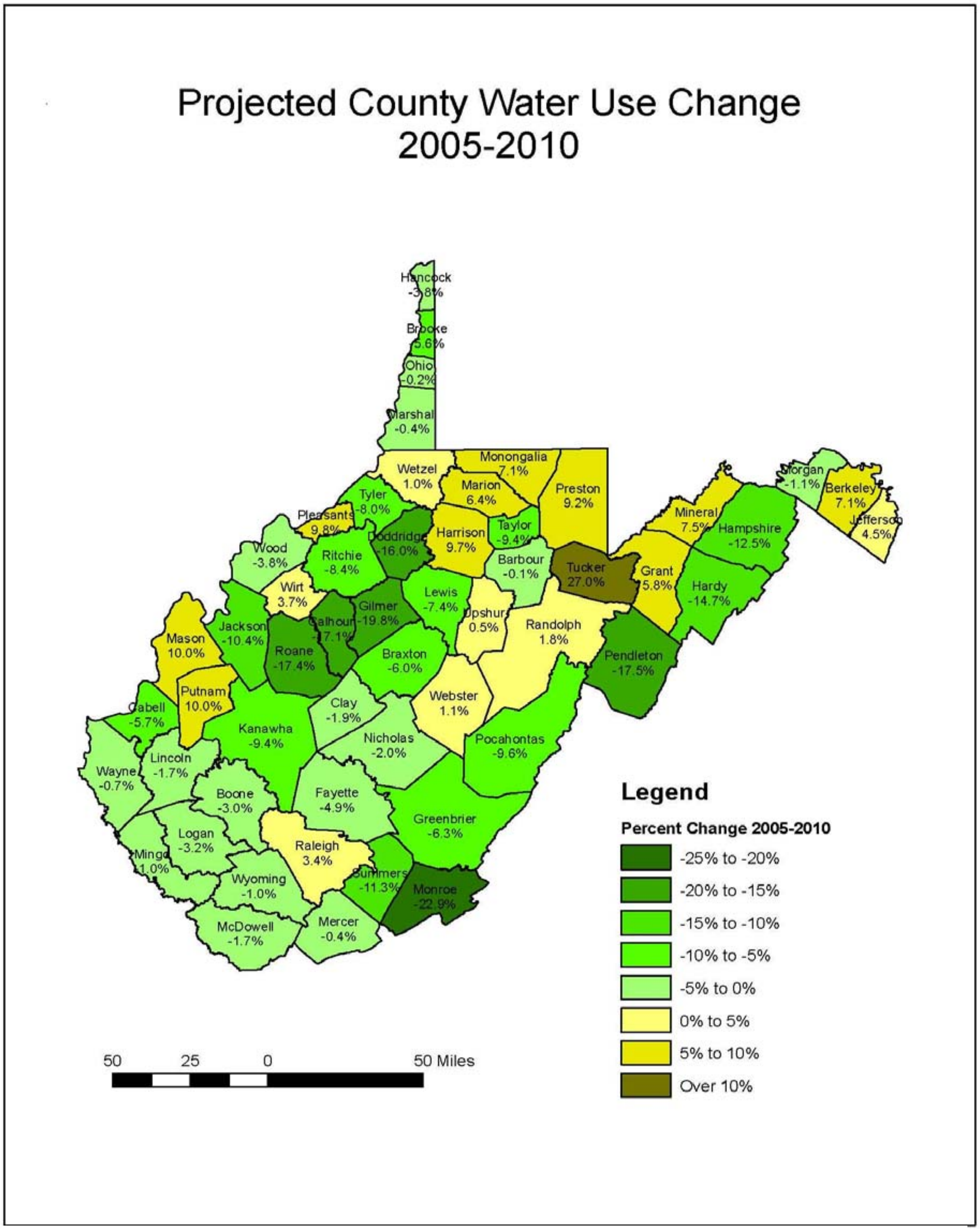


Figure 7.3 Preliminary Estimates of County Water Use Change, 2005 - 2010

Figure 7.4 describes relative net water use projected by sector for 2005. The category "Rest of Economy" represents all other water consumption that is not covered in the other sectors and is primarily lodging and food services, schools, commercial office buildings and healthcare facilities. Most of the businesses within these sectors will use water from public sources. The relative levels of consumption are not significantly changed over the forecast period and, with the exception of the assumed increase in thermoelectric power generation, are for the most part not observable on a chart of this scale.

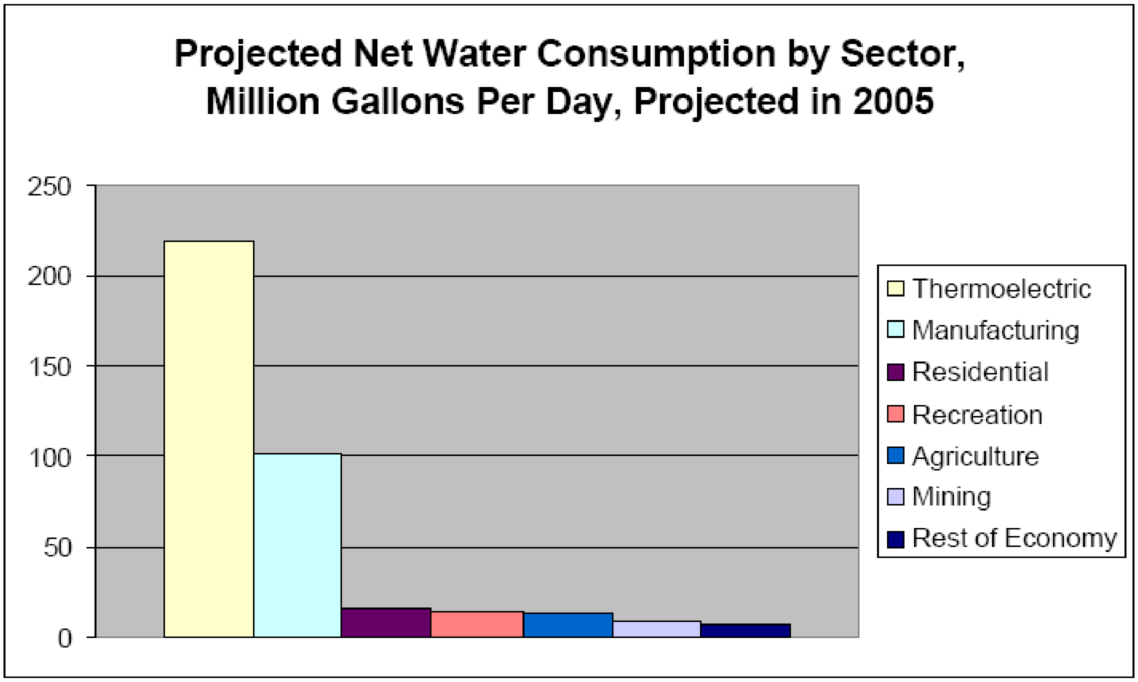


Figure 7.4 Projected Net Water Consumption by Sector, Million Gallons Per Day, Projected in 2005

This report will next describe water use estimation for individual sectors of the economy. Because thermoelectric power generation for dispatch to the electricity grid accounts for the single largest category of water use, both gross and net consumption, this industry is reported first.

7.3.3 Thermoelectric Power Generation

Utility thermoelectric power generation occurs in 10 counties in West Virginia. With the exception of one plant, all the facilities rely on a major river or water body for cooling water. Total water withdrawals for this category of activity were 3,785 million gallons per day (mgpd) in 2004. For comparison, the USGS estimated this category of withdrawals at 3,950 mgpd in 2000 for West Virginia. The range of both gross and net withdrawals by plant is fairly large and depends on the type of cooling system utilized. Once-through cooling systems withdraw at much higher rates than do recirculating systems, although recirculating systems return a much lower portion to the water system due to evaporation. By county, net water use (withdrawals minus discharges) ranges from 1% to 81% for power generation.

Rates of return also vary for plants utilizing the same type of system. Due to NPDES standards regarding thermal discharges, plants that utilize once-through cooling tend to overestimate water discharges. This practice led to the reporting of negative water consumption for several of these plants. For this analysis, a one percent net water consumption was assumed based on discussion with industry regarding typical plant operation.[3]

One small power plant in the state, located in Grant County, utilizes an air-cooled condenser and thus relies much less on water for cooling. This plant's water consumption was not reported in the DEP's water survey. Thus, an intake rate of 1% of a similar vintage once-through system was assumed.[4] Net use of eight percent was assumed.[5]

Forecasted net water consumption from utility power generation is shown in Table 7.2. A two percent annual increase is assumed, matching expected increases in power generation for the country. Increases also reflect the addition of scrubbers to several of the plants between 2007 and 2009, in compliance with the Clean Air Act.[6] These plants are all located along major rivers and most take 100% of their water from those rivers. One exception is the Mountaineer Plant in Mason County. That plant reported two percent of its withdrawals from ground water.[7]

These quantities do not include water consumed by utility employees in operation of utility offices. This consumption is calculated separately and included in the category referred to as "Rest of Economy." While some overlap may exist, as power plants also report water used in plant offices, the majority of utility employees are not located onsite of a power plant. Utility employment is dispersed throughout the state and is represented in 54 counties. This employment also includes those employed by water and gas utilities. However, while power generation is expected to increase by two percent annually over the next five to six years, total employment in the utility industry is projected to decline by 1.6% per year. A spatial representation of the counties expected to see growth in water use resulting from increased thermoelectric power generation is shown in Figure 7.5.

[3] Bill Cannon of Allegheny Energy provided fundamental guidance on calculation of net consumption.
[4] The plant of similar vintage is the Morgantown Energy Facility. This percentage is from the EPA's overview report on dry cooling facilities, http://www.epa.gov/waterscience/316b/technical/ch4.pdf.
[5] Afonso, Rui (2001). Energy and Environmental Strategies for the Clean Air Task Force. "Dry vs. Wet-Cooling Technologies."
[6] Bill Cannon of Allegheny Energy and Tim Mallen of Appalachian Electric Power provided guidance on calculation of water use related to scrubber installation.
[7] DEP Water User Survey, 2005.

Table 7.2 Projected Net Water Consumption from Utility Power Generation, by County, Million Gallons per Day (2005-2010)

County	2005	2006	2007	2008	2009	2010
Grant	11.79	12.03	12.27	12.51	12.76	13.02
Harrison	32.26	32.90	33.56	34.23	34.92	35.62
Kanawha	3.51	3.58	3.65	3.72	3.80	3.87
Marion	3.60	3.67	3.75	3.82	3.90	3.98
Marshall	10.11	10.31	10.52	10.73	10.94	11.16
Mason	108.14	110.30	112.51	114.76	117.05	119.39
Monongalia	8.49	8.66	8.83	9.01	9.19	9.37
Pleasants	10.98	11.20	11.43	11.66	11.89	12.13
Preston	3.11	3.17	3.23	3.30	3.36	3.43
Putnam	26.90	27.44	27.99	28.55	29.12	29.70

7.3.4 Manufacturing

Manufacturing water use was evaluated by county at the six-digit industry code and aggregated at the county level. Water use is a function of the number of employees in an establishment. Because manufacturing employment is projected to decline over the next five years, water consumption from manufacturing is also projected to decline in most counties. The 14 counties that have been experiencing growth in manufacturing employment are projected to continue that trend, at rates of either two or three percent a year. These counties are: Boone, Greenbrier, Hardy, Mineral, Mingo, Monongalia, Nicholas, Ohio, Preston, Putnam, Raleigh, Randolph, Ritchie and Wirt. Again, these counties are projected to have increases due to the recent trends of increasing employment and the expectation that these trends will continue. The remaining counties are projected to experience declines in water use, also in continuation of recent trends.

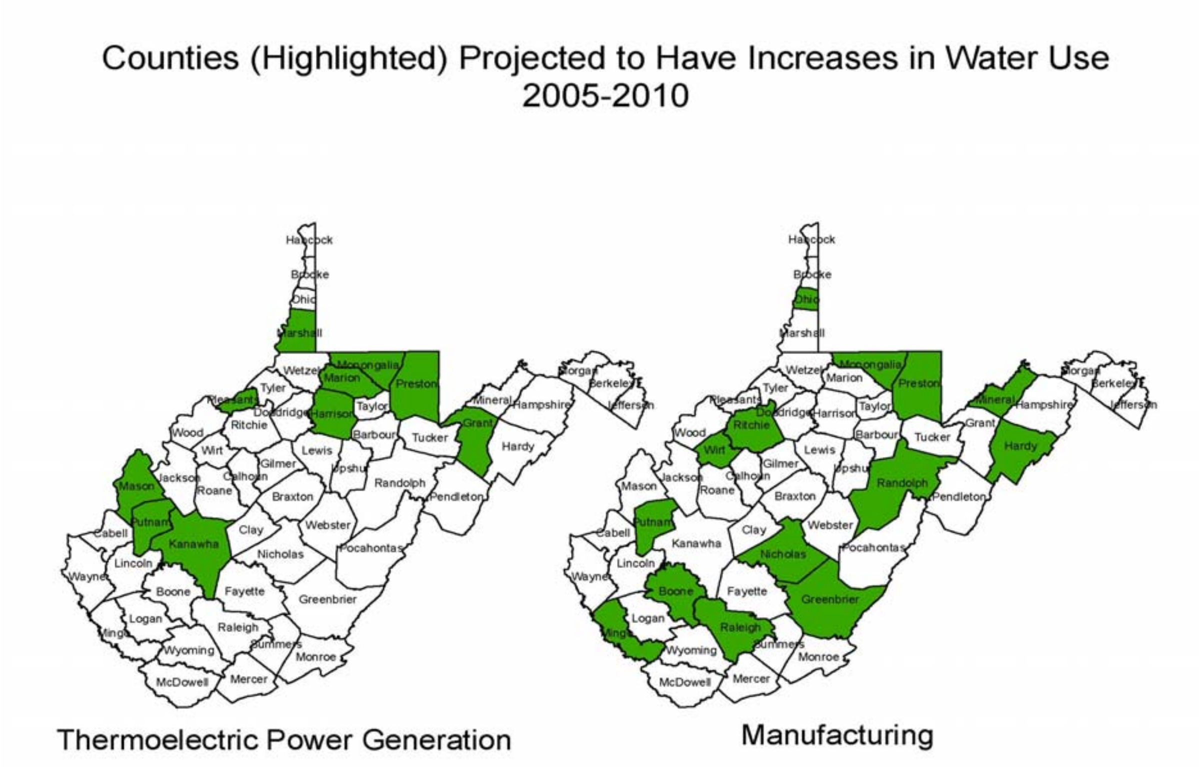


Figure 7.5 Counties Projected to Have Increases in Water Use: Thermoelectric Power Generation and Manufacturing 2005 - 2010

The distinction between withdrawals and net consumptive use is very important, yet difficult to estimate for this category of economic activity. While reported and estimated withdrawals are considered to be good approximations of actual water used in the manufacturing processes, net consumption is much less accurate. This is the result of several factors:

- Varying reporting methods on water discharges
- Lack of reporting on some sub-industries
- Lack of estimates on many sub-industries. Most published estimates of consumption tend to provide ranges of consumptive use in manufacturing and those ranges are not specific to individual manufacturing sub-industries.

CBER's calculation of consumptive use based on total withdrawals and discharges reported to the DEP varied considerably, in some cases even within the same six-digit industry. Several manufacturers also reported negative water use numbers, where total water withdrawn minus total water discharged is less than zero. This is presumed to be a function of the NPDES standards and tendency to overestimate the quantity of discharges in compliance with temperature release standards, combined with the reporting of stormwater runoff from facilities. For example, in the chemical manufacturing industry, reported net use ranged from -475% to 92%. This type of reporting is standard practice for many industries, but to avoid reporting negative consumption for this analysis, assumptions were made regarding internal water use rates.

Where positive net consumption was reported, these ratios were applied to other establishments in the same or similar manufacturing NAICS code. If a facility reported negative net use and no information was available regarding actual net internal water use for a similar manufacturer, it was assumed that the facility used 25% of its withdrawals for consumptive use. Due to the large number of manufacturers that reported negative net use and the large number of industries that were not represented in the DEP survey, the 25% rate was assumed for about two-thirds of the 1,017 county-specific manufacturing industries evaluated. By contrast, a net use rate of 15% was applied to non-manufacturing industries that typically operate out of commercial office space. It is expected that the 25% net rate overestimates some industries and underestimates others. However, due to the lack of available data this is a fair approximation, although due to the range of use estimates these calculations are considered preliminary.[8]

Total manufacturing net water consumption projected for the state is in line with overall forecasted employment decline in this sector. The counties that are projected to increase water use due to increased employment in manufacturing as shown in Figure 7.4.

7.3.5 Residential

Residential consumption is estimated at the county level. Input data and assumptions to the analysis are as follows:

- Metered sales in gallons to residential customers and the annual average of the monthly number of customers were used to derive average household consumption.
- Data was compiled for 2003, 2002, and 2001, as it was available for each of the public service districts.
- The ZIP code of the primary city for each of the service districts was used to determine the representative county for further calculation. (Many public service districts transcend ZIP code and/or county lines and accurate determination of the exact portions of counties served by any individual service district was, at this point, impossible to establish).
- Average annual consumption data was weighted by the number of residential customers observed as purchasing metered service (households) to derive a county-level consumption figure.
- All but six of West Virginia's 55 counties provided a reliable estimate of annual water consumption per household using this method without modification.
- Data for Randolph and Ritchie counties were obtained from the public service district annual reports. However, careful examination indicated that the resulting figures for these two counties were outliers as compared with the remaining observed averages, as they were in excess of five standard deviations of the mean consumption level for all observed averages within the state.
- Averages for Cabell, Doddridge, Gilmer and Wirt counties were not available from the public service district annual reports.

[8] The USGS estimates that self-supplied industrial water users' net consumption is between 10 and 40 percent of withdrawals.

- To develop workable averages for these six counties, a spatial average was calculated based upon the counties bordering the counties with the absent consumption value. These were also weighted by the number of observed residential customers in each tabulated county. The number of counties used to calculate each new figure was necessarily limited by the geography and established boundary lines.

Population estimates from the U.S. Census Bureau were used to gather an average annual rate of population change for each of West Virginia's 55 counties.

- Estimated population changes from the Population Estimates Program at the U.S. Census Bureau for each year, beginning in July, were used to determine the average rate of change at the county level.[9]
- Straight-line projections for each year, 2005 to 2010, were maintained for counties. The straight-line method employed in these calculations appears to follow inline with state level population projections through the year 2010 also produced by the Census Bureau. However, the state level projections indicate a marked decline in population for estimates in 2015, 2020, 2025 and 2030. This indicates that using the straight-line projection for population change beyond the 2005-2010 time period would be unreliable.
- Using the annual rate of population change for each county, population estimates for each year in the projection period 2005 to 2010 were calculated.
- The approximate number of households for each year was calculated via an estimate of average household size from the 2000 U.S. Census Summary Tape File 3 Long Form (1 in 6 sample).
- Average annual consumption patterns from the public service districts aggregated to the county level were then applied to the population projections to estimate annual water consumption in gallons per county.
- A range for each county using a +/- one standard deviation from the mean of all observed consumption patterns was also developed as a check figure to ensure the likelihood that the estimates were reliable.
- No significant outliers were observed upon comparison of the estimates and their expected ranges.

Figure 7.6 shows the expected change in residential water use by county. As expected, the largest increases are concentrated in the Eastern Panhandle and Putnam County.

[9] http://www.census.gov/popest/counties/

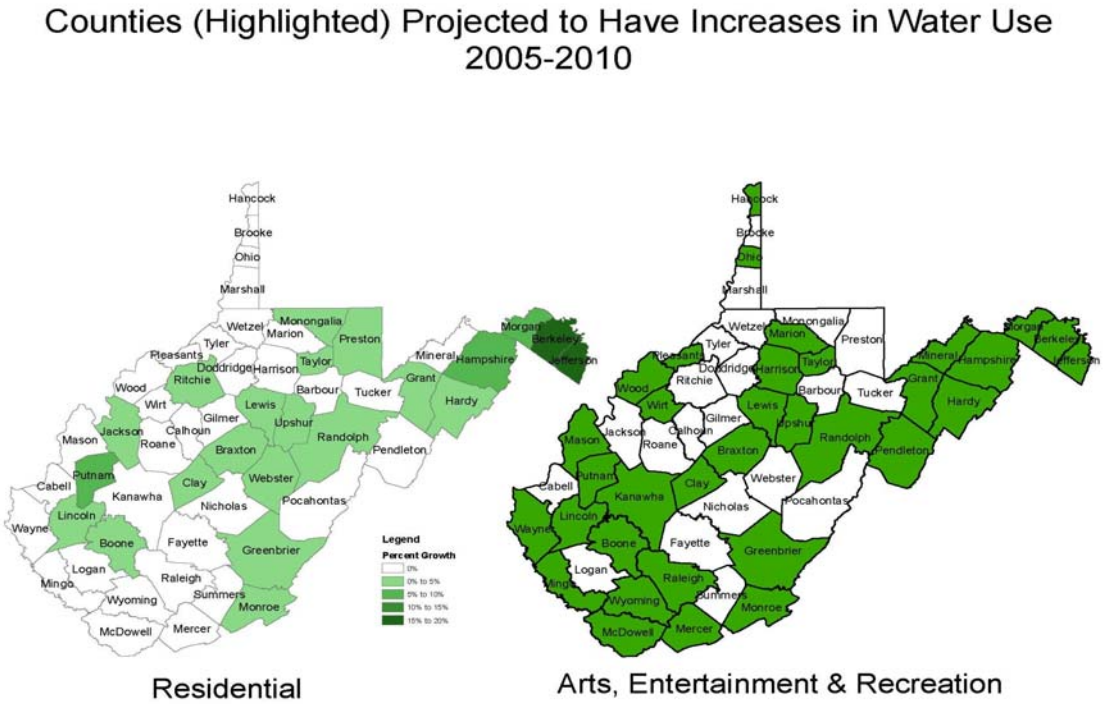


Figure 7.6 Counties Projected to Have Increases in Water Use: Residential and Arts, Entertainment and Recreation

7.3.6 Arts, Entertainment, and Recreation

Golf courses are the major consumer of water in this sector, and consumption for this category of activity varies considerably. Golf courses in the DEP survey reported gross consumption equal to net consumption of between 1,800 GED for a small course and 15,000 GED for a larger course. For the purposes of this analysis, if a golf course employed 20 people or less it was considered a small course, and the 1,800 GED net consumption rate was applied. For larger golf courses the larger rate was applied. According to the West Virginia Bureau of Employment Programs, 40 counties in West Virginia have golf courses.

Most other categories of activity were assumed to consume 175 GED. This rate was taken from the USGS and was applied to include health and fitness centers, racetracks, performing arts centers, bowling centers, and other types of recreational facilities. A 15% net rate of consumption was applied. Due to projected overall industry growth, within this category more counties are projected to have increasing water consumption than decreasing. Overall net consumption rises from about 14.2 mgpd to about 14.7 mgpd. Figure 7.6 provides a spatial representation of counties expected to see increased water use from increased economic activity in this sector.

7.3.7 Forestry, Fishing, Hunting, and Agriculture

Farm animals comprise the bulk of water use in this category. County level data on the number of animals was combined with estimates of water use per animal to calculate total withdrawals for this sub-group. All 55 counties have livestock. The number one livestock producing county and thus water consuming county for this activity is Hardy County, followed by Pendleton and Grant counties. Water use per animal per day was calculated as follows, based on data estimated by The Pennsylvania State University[10]:

- Milk cows (50% of cattle) – 35 gallons
- Dry cows (beef cattle or steers, 25% of cattle) – 12 gallons
- Calves (10% of cattle) – 3 gallons
- Heifers (15% of cattle) – 8 gallons
- Swine – 1.5 gallons
- Horses – 12 gallons
- Sheep or goats – 2 gallons
- Chickens (per 100 head) – 9 gallons
- Turkeys (per 100 head) – 15 gallons

A net use coefficient of 80% was applied for livestock. This rate represents that estimated by a number of eastern and midwestern states including Illinois, Indiana, Michigan, Minnesota, Ohio and Pennsylvania.[11] Other categories of water use in this industry are fruit and vegetable crops and logging. Little data or estimation was available regarding water use for crops or for logging. The USGS estimates provide gross use coefficients of 25 GED for some crops and 1,600 GED for logging, but do not estimate net consumption. These rates were applied based on the number of employees in each of these categories, with a net use rate of 90% assumed for crop production.[12] A net use rate of 2% was assumed for logging. No timbering operations were included in the DEP survey and no alternative source could be found that provided an estimate of consumption for that industry.

As described in Table 7.1, the state is projected to experience declines in employment in this economic sector. Water use is projected to decline at about four percent per year, although the counties that saw recent growth in this sector are projected to experience a one percent annual increase in water use. These counties are shown in Figure 7.7. This industry is worthy of additional analysis, as it is possible that efficiencies of production could overcome employment changes and the direct water use to employment relationship assumed.

[10] The Pennsylvania State University, College of Agricultural Sciences (2003). " Estimating Water Use For the Farm and Home."
[11] Great Lakes Commission and the Water Withdrawal and Use Technical Subcommittee of the Water Resources Management Decision Support System Project, 2003. "Measuring and Estimating Consumptive Use of the Great Lakes Water"
[12] Ibid.

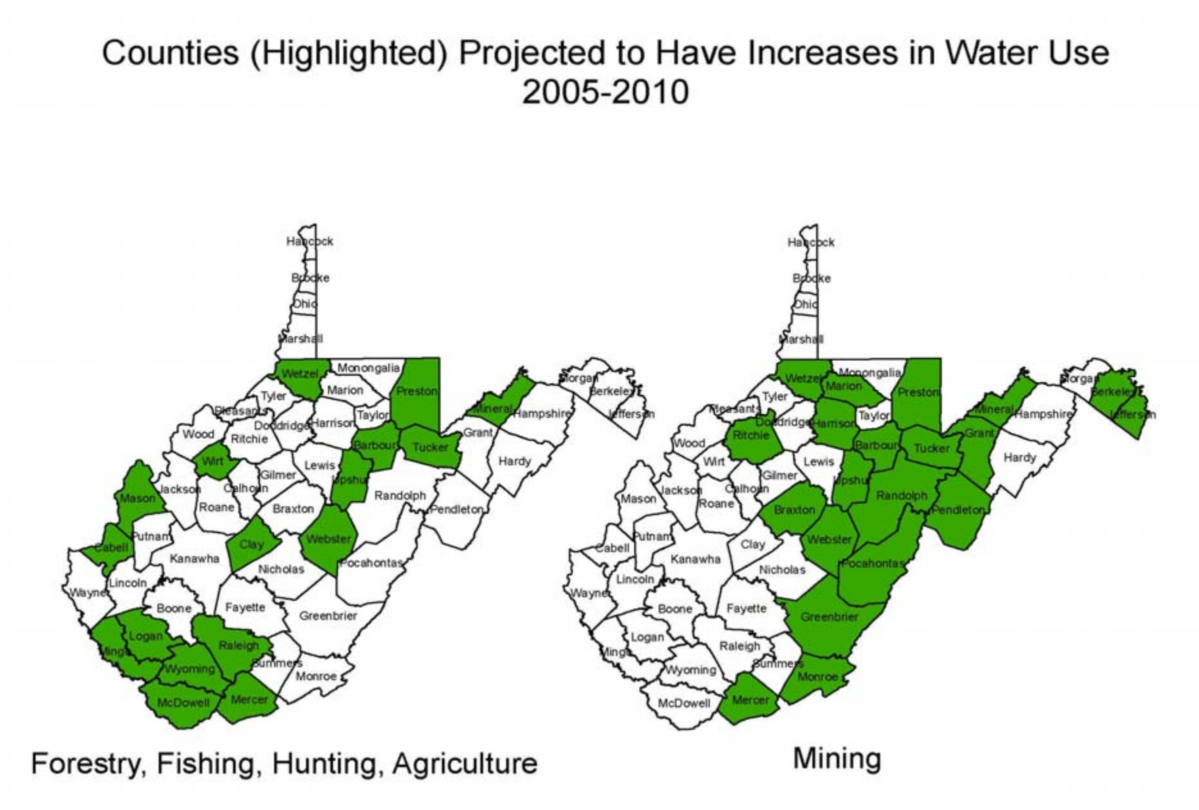


Figure 7.7 Counties Projected to Have Increases in Water Use: Forestry, Fishing, Hunting, Agriculture, and Mining

7.3.8 Mining

The category *Mining* includes not only those industries commonly thought of as mines, but also stone quarries and petroleum production.

7.3.8.1 Coal Mining

Estimation of both withdrawals and net consumption for the coal industry is difficult. Reported withdrawals per ton of coal mined varied considerably when calculated using a per ton or per employee rate. This is most likely the cause of the varying amount of water required for different grades of coal and different mining techniques. While most coal requires processing, some low sulfur, surface-mined coal often requires little processing and can be shipped run-of-mine.

Tonnage was chosen as the unit of consumption to evaluate due to the availability of county-level production numbers and the ability to forecast those levels. The DEP's water use survey provided a range of water use per ton. For operations where the combined mining and processing tonnage was known, the middle range was about 30 to 40 gallons per ton for mining and about 60 gallons per ton for processing. Based on these numbers, a rate of 95 gallons per ton was applied to total coal production to arrive at an estimate of water withdrawals for the 27 counties that produce coal.

The source of water used for mining is also worthy of further analysis. Ground water that is transferred to the surface as part of the dewatering process prior to underground mining is not considered consumptive use. This practice applies most often to underground mines as ground water is commonly re-injected into the geological formation. Surface mines do not re-inject ground water and any resulting displacement of ground water is thus consumptive. Based on the DEP survey results, it is not possible to get a complete picture of the quantity of ground water transferred. The encountering of ground water during the mining process is a function of the water table, and the need to use ground water for processing or dust control depends on the availability of other sources. Both of these variables are not uniform in mining regions and may vary considerably by surface and underground operations.

About one-third of mining operations reported use of ground water, with portions that ranged from 2% to 100%, with an average of 20%. For this analysis it was thus assumed that 20% of water used for mining is displaced ground water, and that that rate represents net consumption for mining. This rate was applied to forecasted county-level coal production to arrive at net water use for this industry of nine mgpd in 2005. However, because the survey sample is not a statistically significant representation of either surface or underground operations for either mining or preparation, this rate is considered preliminary and needs additional analysis.

County-level coal production was calculated based on historical trends and accounts for differences in surface and underground mining. Each county's portion of total coal production was projected to remain constant through 2010, as was their portion of surface and underground coal production. Total production in West Virginia was based in part on the "Consensus Coal Production Forecast for West Virginia."[13] That forecast was pushed out by two years to account for the recent and sustained increase in coal prices and production experienced in 2004 and 2005. Projected county-level increases and decreases are shown in Figure 7.6.

It is likely that other variations in mining operations could also impact the quantity of water used. For example, some surface-mined coal in the southern part of the state may require less processing water per ton than surface-mined coal in the north. However, due to the difficulties of estimating what portion of production this might be, all coal was assumed to require the same quantity of water per ton, and no distinction was made between location and mode of production. Again, due to regional variations in mining and processing techniques and the resulting variations in water consumption, further analysis for this industry group is recommended.

7.3.8.2 Stone Quarries

One limestone quarry reported water consumption to the DEP. That rate was applied to all limestone quarries in the state based on the GED reported by that single producer. That reported GED was 12,078. Net use was reported as 10%. These rates were applied to

[13] Hammond, George W, 2004. West Virginia University, Bureau of Business and Economic Research

operations in all 19 counties for which the DEP reported this type of mining. Use is projected to increase slightly, in line with overall mining employment.

7.3.8.3 *Oil Production*

West Virginia produced 1,339 barrels of oil in 2004. Of this quantity, about half is produced using secondary oil recovery methods, including water injection.[14] Wells that generate production water re-inject that water back into the geological formation and the use is non-consumptive. Water injection wells that use non-production water and where water is not returned to the originating body are considered consumptive use. Thus, for this analysis only production of that nature is included. In West Virginia, this type of use is confined to Wetzel County, where production is expected to increase. As secondary recovery methods progress, more oil is extracted from the reservoir until it is unprofitable to continue the water-flood. By 2010, water use will return to 2003 levels for this activity.

7.3.9 Other Industries

The following industries' gross water use is based on the withdrawal estimates calculated by the USGS. The growth projected for most of these industries is representative of overall growth in the service sector, with much of the impact on demand for water to be seen in increasing demand from commercial buildings. The large majority of these industries will demand water from public supply.

With the exception of public administration, these industries are projected to experience overall annual employment growth through 2010, at rates of between 0.2% and 2.3%. Net water is assumed to be 15%. The combined total water consumption for these industries is less than the each of the other industries profiled thus far.

Accommodation and Food Services A gross water use coefficient of 187 gallons per employee per day was assumed for this category of activity. Positive growth is expected for all but 12 counties.

Construction A gross water use coefficient of 20 gallons per employee per day was assumed. Growth is expected for 23 counties and overall growth leads declines.

Utilities A water use coefficient of seven gallons per employee per day was assumed for utility services. With the exception of Doddridge County, all counties have employment in utility services. This level of activity excludes the power generation process. That water use is accounted for separately under thermoelectric power generation. Growth is expected in 23 counties. Overall, declines lead increases.

Wholesale Trade This category is broken down into durable and non-durable goods. A water use coefficient of 21 GED was assumed for durable goods, and a coefficient of 77 GED was assumed for non-durable goods. Employment in the two categories varies by county, with most counties having more activity in durable goods. Statewide, about 60% of the

[14] Energy Information Administration, 2005. www.eia.doe.gov/oil_gas/petroleum/info_glance/crudeoil.html.

employment occurs in non-durable goods. However, as expected, the more agricultural counties have larger portions of employment in non-durable goods. The range for the population of counties is 21 GED, for four counties with no wholesale activity in non-durable goods, and 77 GED for two counties with no wholesale activity in durable goods. Growth is expected in 18 counties.

Educational Services A gross water use coefficient of 56 GED per day was assumed for this category of activity. Growth is expected in 23 counties.

Healthcare and Social Assistance A gross water use coefficient of 70 GED was assumed for this category of activity. Growth is expected in all but nine counties.

Retail Trade A gross water use coefficient of 31 GED was assumed for this category of activity. Growth is expected in 20 counties.

Other Categories Industries with businesses that operate out of commercial office space are assumed to have gross water use of 47 GED. These include: administration, support, waste management and remediation, information, finance and insurance, real estate professional, scientific and technical services, management of companies and enterprises, public administration, other services, unclassified establishments and transportation and warehousing.

With the exception of public administration, growth is expected in all these industries statewide. That growth is spread throughout West Virginia's 55 counties, with more counties seeing growth than declines for these activities.

7.3.10 Conclusions

This analysis projects net water consumption for West Virginia based on forecasts of economic activity. Consumption is calculated at both the county and industry level (Appendix L). The largest increase in water consumption is expected to occur in thermoelectric power generation. Other increases are expected in the food and lodging industry, the recreation industry and in what is termed for this analysis, the rest of the economy that represents the service industries, education, healthcare and construction. Over the 2005 to 2010 time period, small declines are projected in the mining industry and larger declines in the agriculture and manufacturing industries.

By county, changes in water use are a function of expected levels of economic activity. For this report, this is an expectation of the continuation of recent trends. Thus, growth in water consumption is located in most of the Eastern Panhandle, the northern counties with the exception of the Northern Panhandle, and the counties in which power generation facilities are located. Declines in consumption are expected in most of the mid-Ohio valley counties, many of the central counties, the southern counties and in the eastern counties due to declines in agricultural employment. Overall, 19 counties are expected to have growth in water consumption and growth leads declines as West Virginia as a whole is projected to see growth of 3.7% over the forecast time period.

The estimates reported here should be considered imperfect, but reasonable approximations of actual consumptive water use. Projections for most sectors could be improved with more thorough evaluation and more data. A primary issue is the calculation of net versus gross consumption. Little data exists on which to base net consumption equations. A more in-depth review of the DEP user survey combined with acquisition of other state data could prove informative and help to refine these preliminary estimates.

7.3 Areas Where Competition for Water Resources May Occur

The goal of this task is to evaluate potential competing use scenarios regarding existing water resources for both surface water and ground water. It should be noted that conclusions drawn from the survey only address large quantity users. Small quantity users, and agricultural users, which may experience competition for the water resource, are not addressed by the survey. Identification of areas where competition for the water resource is, or will, occur is difficult. For ground water, this is because the aquifers have not been mapped, and therefore reserve estimates have not been possible. Without knowing the aerial extent of an aquifer and certain physical traits, such as recharge rates, an evaluation of possible competing uses is impossible. To a lesser extent, it is equally difficult to predict where competition will occur for surface water. This would require an accurate knowledge of flow rates based on stream gauges. Most of the streams in West Virginia are not gauged, and actual flow rates are not available.

However, some conclusions may be drawn based on the results of the three year water use survey recently completed by the DEP.

- First, none of the commercial/ industrial or public water supply respondents reported competition for a water resource. This probably implies these facilities, realizing a need for a large quantity of water for their processes, located where abundant water was available.

- Second, the only difficulties with water supply reported were in association with drought and/or floods. Discounting flooding, as an overabundance of water does not lead to a competitive situation, the only time there is competition for the water resource is in times of drought. However, drought impacts everyone in the affected area, and is not truly indicative of competition during average water supply conditions.

- Third, competition for an available water resource is probably more noticeable in areas where the resource is limited even before it is exploited. Major water users generally do not locate in these areas, and thus information on competing usage was not collected in the survey.

It is expected that additional insight on how to compare water demand data with data on water availability will develop as any future program matures. Currently a detailed analysis of the available data will not result in a better understanding of the situation.

Chapter 8 - Interfering Water Withdrawals

Of the 383 surveys received in 2005, none of the respondents indicated that their ability to withdraw water was negatively affected by withdrawals from other individuals or businesses using the same water source. However, since only major water users were required to complete the survey, it is unknown whether any minor users were adversely affected by competition for the same water source. It would be difficult to predict with current data whether conflicts for water supplies might arise in the future. However, it is logical to assume that conflicts would be more likely to occur on smaller streams where water quantity is more limited.

Research has revealed two historical cases of water use conflict between adjacent riparian landowners: *Halltown Paperboard Company v. The C.L. Robinson Corporation*, 150 W.Va. 624, 48 S.E.2d 721 (1986) and *Roberts v. Martin*, 77 W.Va. 535 (1913). In both of these cases, the court ruled in favor of the lower riparian landowner. The basis of the rulings was that natural flow is a property right that may be enforced by a lower riparian landowner.

A third case involving interfering withdrawals was WVDNR v. Tingler (2005). The DNR faced water scarcity problems in Randolph County when a neighbor began pumping ground water next to a DNR fish hatchery. The resulting reduced spring flows on DNR property caused the hatchery to close (the case was recently ruled in favor of DNR).

Chapter 9 - Water Conservation Practices

9.1 Identify Practices to Reduce Water Withdrawals

Given the state's abundance of water resources, water conservation has not been a previous priority for many lawmakers or regulatory officials. Water conservation practices in water rich regions reduce costs associated with water diversion, filtering, transportation, and wastewater treatment. The cost factor, more than any other, appears to be the driving force behind water conservation activities in West Virginia.

9.1.1 Industrial/Commercial

Only slightly over 35% of the industrial/commercial facilities surveyed reported any type of water conservation activity. This is not a surprising statistic given the abundance of water in the state. Most water conservation practices were implemented for cost savings rather than in response to water shortages. With the driving force being economic, most of the practices implemented are simple physical controls, which do not require the use of high cost, hi-tech equipment or advanced water management techniques.

The most advanced conservation techniques have been implemented at some of the state's golf courses. Computer controlled irrigation systems utilizing water efficient sprinklers, combined with wetting agents added to the water, all help reduce the overall amount of water needed for proper greens maintenance. These systems permit selective watering of the course, based on actual staff observations of course vegetation, and decrease water loss due to evaporation by permitting nighttime watering.

Some aquaculture facilities are working to develop filtering systems that will permit re-cycling of their pond water. This process could expand areas where fish farming is economically viable within the state.

Facilities involved in general manufacturing or chemical production, including petroleum refining, reported water savings due to general maintenance and upkeep of their systems. They also changed their processes to utilize the same water for more than one purpose, such as using cooling water in boilers, rather than simply discharging it. Water-cooled equipment has been replaced with air-cooled equipment, eliminating the need for cooling water in some instances.

Mines and their associated preparation plants usually have the problem of eliminating excess water, not conserving it during times of shortage. In spite of this, most coal mines and preparation plants that responded to the survey have some type of water conservation procedure in place. The most common is to reuse water by recycling it through their associated sediment ponds. In some instances, the intake pipe for the facility is located below their discharge point, effectively recycling the water. Several facilities reported using chemicals for dust control, thus reducing or eliminating the amount of water required. Like the manufacturing and chemical production facilities mentioned above, some mining related operations have replaced water-cooled equipment with air-cooled equipment. However, due to the abundance of water at these facilities, this practice is not widespread.

9.1.1.a. Specific Examples

DuPont Washington Works (plastics), in Wood County, stands out among the respondents as having implemented one of the biggest water-saving systems in terms of gallons of water conserved. The plant's survey indicates, "*Site procedures are in place that include the review of projects impacting water consumption. This review includes consideration of water conservation in the approval process*." The estimated water savings at the plant, which uses ground and surface water for "*Cooling Water, Chemical Reactions, & Steam generation,*" is 50 million gallons per month. The facility has the capacity to withdraw 3.3 billion gallons per month.

The facility is considering plans for "*a project involving the recovery and recycling of steam condensate used in steam production at the site.... This project would conserve the use of ground water.*" Washington Works' planned projects in Wood County would save 13 million gallons per month at an estimated cost of $2 million.

Likewise, the Follansbee Coke Plant (129.6 million gallons monthly withdrawal) in Brooke County is saving 31 million gallons per month by using cooling water that was previously discharged as boiler feed water.

Huntington Alloys Corporation (28 million gallons monthly withdrawal) installed a leak detection system that reportedly saves the facility 10 million gallons monthly.

While not the largest water user in the area, the Toyota Plant in Buffalo, WV is one of the more innovative and progressive facilities in the state in terms of implementing voluntary conservation measures. The plant is implementing conservation plans that will save them millions of gallons of water per year. While there is no water shortage in the Buffalo area, Toyota understands that capturing, filtering, transporting water, and treating excess wastewater are all costly activities. Reducing use reduces operating costs. Toyota's goal is to match the plant's zero solid waste discharge standard with a zero wastewater discharge standard.

According to Toyota's environmental specialist, stormwater from about 100 acres of impervious surface (building and parking lot) is already captured and used for landscape irrigation (20-25 acres), saving the plant half a million gallons/year.

Currently, the plant is losing 14 million gallons/year to evaporation while operating its cooling compressors and tower. In an effort to reduce this loss, the plant is in the final research and development stages of an onsite water treatment facility that will help save 10 to 11 million evaporated gallons/yr. This move will also reduce the plant's demand on the local public water utility to three million gal/yr. Just 20 miles outside of Charleston, this demand reduction will provide the city of Buffalo with important opportunities to extend public service to growing residential and commercial demand without incurring additional capital costs for water system expansions.

In summary, the primary water conservation techniques utilized by industrial/ commercial facilities are:

- Recycle water rather than discharge it
- Maintain and monitor equipment to minimize water loss
- Use the same water for more than one process
- Use wetting agents or other chemicals to reduce the amount of water needed
- Replace equipment with more effective water saving devices, including air-cooled machinery
- Apply computer controls to irrigation systems

9.1.2. Public Water Suppliers

Since water is the commodity they provide, public water suppliers are limited in their ability to conserve water. Except in times of drought, these facilities generally do not have the ability to restrict how much water their customers use, or how they use it. Only in times of sustained drought are they able to reduce water consumption by their customers by banning watering of lawns or washing cars. Thus, these are not true conservation measures aimed at permanently reducing water use, but only temporary actions utilized to limit the non-essential use of water during times of emergency.

The majority of suppliers did not report any type of water conservation practice. Of those that did, the primary method of conserving water was to monitor for leaks and maintain lines. Leak identification and line repair and maintenance will result in significant water savings for many suppliers. Several survey respondents reported water loss of up to 50%, with one reporting a water loss of 65%. Though infrastructure maintenance is the best method to conserve water for these facilities, aging pipes and limited funding may make this a difficult practice to employ in many locales.

The only other water conservation technique reported on the survey involved changing the types of chemicals used in the water to decrease the amount of water needed during a backwash. Since backwash water is typically returned to the water source, this technique would have minimal impact on actual water usage.

Chapter 10 – Water Resources Information Management System

10.1 WV Water Resources Information Management System

Throughout the process of collecting, evaluating and storing water quantity data, the latest digital technologies were used and evaluated. This was done with the understanding that this process is critical to long-term success of the program. Such tools include databases, geographic information systems (GIS) and web-based applications.

This philosophy is evident with work between DEP and the Center for Economic, Geologic and Applied Sciences (CEGAS). During this project, CEGAS studied the implementation of a WV Water Resources Information Management System. The long term goals for this system are: integration of data from different sources in a standard database format; insuring appropriate quality control of the data; making the data available via the internet that will support queries using standard query language; development of standard queries to fulfill typical data requirements; and provide support for data editing functions.

Below is a summary of work done in this area. If the legislature finds it appropriate to expand this project into a permanent program, the steps are in place to develop a full-scale system.

10.2 UPDATE – 2006

10.2.1 *Further mapping to Spatial Data Standard (SDS)*

The initial concept was to use a Spatial Data Standard developed by the USACE to store data from the survey. The intent was to utilize a standardized database format with defined labels for each field, making data transfer and analysis between agencies relatively simple.

Implementation of the SDS proved to be difficult. To accommodate all of the data, the SDS would have to be modified. Because this is a standard format, addition of new fields involves an administrative process to insure the new fields are defined and made available to all users. The SDS would need extensive design changes to define the relationship between Public Service Districts and their facilities, a facility's intake and discharge points, and accommodate appropriate aquifer attributes.

SDS offered almost no support for time series data, such as monthly water volumes. Because SDS was designed for other purposes, it contains a number of fields for information that do not pertain to water resource management. Therefore, most of the fields in the database would never be used.

The advantages gained by storing the WRPA survey data in a SDS standard-based database are outweighed by the complexity involved in adapting the SDS structure to accommodate the required data.

10.2.2 *Investigation of other emerging standards*

Subsequent to the determination that the SDS was inappropriate for the task, other systems were investigated. Compatibility with surface and subsurface flow modeling software packages such as GEO-HMS, GEO-RAS, WMS, SMS, GMS, and the ArcHydro toolkit are important considerations. The following standards were investigated for possible future use:

- ArcHydro: A geodatabase standard designed expressly for surface water with existing interfaces to USACE Geo-HMS and Geo-RAS modelling packages. It has support for time-series data.

- National Hydrologic Datasets: This is a national standard, but the level of compatibility with ArcHydro is not clear.

- ESRI Water Utility Geodatabase.

- Arc Hydro Ground Water Data Model (a database developed by the University of Texas, Center for Research in Water Resources).

10.2.3 *Issues encountered when combining well data from the WRPA survey, Public Service Sanitary Survey, and USGS wells*

In an effort to evaluate existing ground water information, the USGS ground water dataset was compared to the Bureau for Public Health's sanitary surveys and data from the WRPA survey. It was determined these databases only marginally compliment each other. Given the lack of descriptions and the difference in location data, these tables should be regarded as primarily distinct datasets with between 10-25% overlap.

10.2.4 *Water resources geographic database*

GIS technology has been used to develop maps and to provide limited analysis. This has been helpful in finding errors in the data. Geographic database structures specifically designed for water resources data may be preferable to the Spatial Data Standard. Future efforts, with appropriate commitment of resources, would focus on tying the mapping directly to the information system. This would allow for real-time mapping, as data is added and/or edited.

10.3 Final Status (December 2006)

The final WRPA survey data has been loaded into a CEGAS database. Latitude and longitude data has been removed from input and discharge points**.** The WRPA survey data is available on a publicly accessible website on a CEGAS server. The system will have built-in queries to retrieve and integrate data from the database, and the data may be sorted. Currently the edit functions are not enabled since data will be static.

Chapter 11 – Other State Programs

Many states have implemented water registration and/or permitting programs. To better formulate its final recommendations to the legislature, the DEP sent a questionnaire to the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA). This survey asked respondents to provide information about programs to control or monitor their state's water resources. Specific data concerning the type of program, program length, withdrawal amounts, statewide annual water use, program budget, and obstacles/challenges were requested. Of the 20 states that responded, most had some type of permitting or withdrawal registration program, ranging in age from newly developed to 100 years. The mean water withdrawal amount that required registration was 100,000 gallons per day and the annual budgets ranged from $60,000 to $6 million.

A common response among all that provided feedback about their programs was the challenge of implementation. Most cited lack of funds or inadequate staff, difficulty with public/permittee cooperation, or challenges to data collection. Complete results are listed in Appendix M-1.

DEP personnel also directly contacted all states in EPA Region III and bordering states not in Region III. All of the states have had some type of water management program since the 1980s, with one as early as 1930. Generally, additional laws supplemented the first programs as new needs were identified. Four of the adjacent states fund their programs entirely through general revenue. Virginia derives approximately 30% of its funding from permit fees, with the remainder from general revenue. Delaware's program is primarily funded by permit fees, with some additional funding from other programs. A summary of each state's program may be found in Appendix M–2.

- Ohio: Ohio is divided into five water use planning regions. Each of these regions has been mapped by county, and those maps may be retrieved, along with their associated data, from the Internet (http://www.ohiodnr.com/water/). Ohio DNR identifies areas where the ground water resource is stressed, and sets threshold values for registration.

- Delaware: Delaware has 250 permitted facilities, with permit fees ranging from $250 to $375. Permitting fees are the primary funding source for the state's water management program. When contacted in 2005, Delaware did not have 2004 or 2005 data available due to a change in their information management system.

- Kentucky: Kentucky has a water development strategic plan. The plan is comprised of 15 separate plans developed by water development planning districts.

- Pennsylvania: Pennsylvania has a state water plan that is currently under revision. Funding was provided to the River Basin Commission for development of six regional plans. The state has also worked with the USGS to develop a watershed budgeting tool, and a base flow separation analysis program to determine ground water yield. Pennsylvania is also working on a critical water needs allocation program.

- Virginia: All cities, counties and towns must develop a water plan, which must be approved by the Department of Environmental Quality before integration into the statewide plan. Virginia is dedicating $400,000 annually to support development of these plans. The first plans are due in 2008, with the final plans due in 2011.

- Maryland: Maryland has experienced a 35% increase in population, which has resulted in a 250 MGD increase in drinking water demand. After the 2002 drought, a task force was formed to examine water use issues. The resultant program will cost $64 million dollars over an eight-year period.

In summary, although the states surrounding West Virginia have had water use registration and/or permitting programs for much longer, these programs have generally not been designed to provide the information necessary for a comprehensive water management program. In the past few years, each of these states has realized its program's shortfalls, and has taken actions to address those problems. With the completion of the three-year water use survey and this report, West Virginia is almost on par with surrounding states' water management programs. The DEP utilized the information gained from these states in development of its recommendation for a continued water management program detailed in Chapter 14.

Chapter 12 – Legislative Rules

After consultation with numerous interest groups, it was determined there was a need for rules to address concerns regarding penalties and confidential information requests. The first rule, Administrative Procedures and Civil Administrative Penalty Assessment – Water Resources Protection Act, 60CSR6 (Appendix N) became effective May 16, 2005.

The second rule, 60CSR7 Confidential Information Under Water Resources Protection Act (Appendix O), had an effective date of October 11, 2005. Only two requests for confidentiality were received. One accompanied an explanation for why the company should not be required to complete the survey. The DEP agreed with the company's position, and since there was no need to retain the information, it was returned. The second request involved public water supply intake locations. Since DEP determined, in consultation with the Department of Military Affairs, Division of Homeland Security, that such information was considered secure critical infrastructure data, and thus confidential, the request did not require further action.

The DEP has executed security agreements with MU, WVU, and the USGS. A request from the ICPRB is pending.

Chapter 13 – Registration

The Water Resources Protection Act, §22-26-3(b), mandates the Secretary of the DEP establish a statewide registration program to monitor large quantity users of water resources of this state beginning in 2006. Those facilities that have completed the survey are registered with the DEP. Unregistered users must provide three years of water use data to register with the DEP.

Registered users are not required to register further withdrawals unless the amount withdrawn annually varies by more than 10 percent from the three year average [§22-26-3(h)]. The three-year average water withdrawal has been calculated and may be found in Appendix J. If a facility alters the location of an intake or discharge point that results in a 10 percent change in the impact on a water resource of more than the three year average, it must also re-register with the DEP.

Chapter 14 - Conclusions and Recommendations

14.1 Conclusions

West Virginia has taken the first step in understanding the scope of one of its most important natural resources: water. The three-year study of water usage detailed in this report gives policymakers and the public a foundation upon which to build a comprehensive water management program. Gaps in our knowledge of the resource have been identified, and existing programs and information that are essential to the management of the waters of the state have been detailed. Examination of other states' programs has shown that West Virginia is not far behind in terms of implementation of a water management strategy. West Virginia now has the capability to design its program based on the most successful program elements from other states, as well as the survey data collected.

West Virginia is blessed with an abundance of water. Competition for water is usually not significant, and is mostly associated with prolonged drought conditions. However, changing socioeconomic conditions, especially population growth, have the potential to aggravate water use disputes. This is especially true in the Eastern Panhandle, where urbanization resulting from overflow from large population centers to the east combines with the region's karst geology to set the stage for future water shortages. Because agricultural water use is poorly understood in the Eastern Panhandle, there is potential for urbanization to cause competition for water sources with the region's farmers.

The nature of the science behind water resource evaluation requires a number of years of data to permit valid interpretation. Long term data allows a trend analysis that will indicate if a year's low water levels are the continued worsening of a drought that began earlier, or is simply due to a lack of rainfall during the current year. Although the state is not currently in a crisis situation, the time to collect the necessary data is now, not when the crisis is imminent. If action is not taken, long term data upon which to base decisions will not be available. The DEP's proposal is for a continuing program that will provide the essential data for water use management.

14.2 Program Recommendations

The DEP has examined other states' water management programs, identified available data collected by other West Virginia government agencies, and surveyed the large quantity water users in the state. Based on this knowledge, the DEP recommends the following:

1) The DEP recommends a program to begin to address the data deficiencies identified in this report. Based on evaluation of current data, the DEP believes an additional five monitoring wells for higher growth areas and three stream gauges for western West Virginia are needed to enhance the existing infrastructure.

    a) Capital cost for five monitoring wells and three stream gauges is estimated to be $117,500.

b) Annual operation and maintenance cost for the wells and gauges is approximately $33,500.

2) The DEP recommends development of a statewide water management program over a multi-year period.

a) At a minimum, the DEP recommends continuation of a registration program. The water use survey required the expenditure of substantial resources and resulted in a wealth of valuable information. However, the information from the survey will soon become obsolete if there are not periodic updates. Each registered user should be required to report any changes in facility information (such as ownership, contact information, or relocation of an intake/discharge) and certify that its water usage has not varied by more than 10% of its baseline average. This re-registration should be performed annually. In addition, the DEP recommends a complete survey be conducted every five years beginning in 2010.

i) The cost of this requirement to a facility should be minimal. The agency cost to maintain an annual registration program is $25,000.

b) The DEP recommends the development of a statewide water management plan with the involvement of multiple state agencies with appropriate authorities and responsibilities, including, but not limited to, the Development Office, the Conservation Agency, the state Geological and Economic Survey, the Division of Natural Resources, the Public Service Commission, the DHHR Bureau for Public Health, the Department of Agriculture, the Division of Homeland Security and Emergency Management, Marshall University and West Virginia University.

The Conservation Agency is currently conducting county water resource assessments. The completion of these assessments needs to continue, and will complement a statewide plan. In addition, the DEP should be authorized to enter into agreements with watershed associations and local government entities to provide funding and assistance for development of regional water management plans that are consistent with the statewide effort. Annual funding should be sufficient to support staff and research needs, and to fund development of regional water management plans.

i) Personnel costs for two full time employees and part time clerical assistance are $168,000/year;

ii) Registration, certification, and reporting costs are $40,000/year;

iii) Support of Marshall University's Center for Environmental and Geotechnical Applied Sciences for data management, mapping and web hosting is $30,000/year.

iv) The cost for funding the Conservation Agency's county water resource assessments is $350,000/county.

3) The development of a standardized definition of drought, as proposed in Chapter 4, Section 3.2, requires stage monitors on public water supply reservoirs in addition to the ground water monitoring wells detailed in Recommendation 1.

   a) The total cost of these stage monitors is difficult to determine because the number of necessary reservoirs has not been identified. The coordination and development of infrastructure to permit consistent statewide determination and announcement of drought conditions is recommended. The cost of an individual reservoir gauge and associated equipment is approximately $8,000.

4) The state's ground water resources are neither defined nor well understood. The state should consider electronic logging and production testing of all non-residential water wells. The scientific data from these wells could permit, over time, a better understanding of the resources, especially when combined with a ground water monitoring well network. The state should require a facility to notify the state of its intent to install ground water supply wells to provide the state the opportunity to log the well to obtain more data.

An understanding of the surface and ground waters of the state, and how they are interrelated, is essential for the wise management of that resource. Continued support from the legislature, and the citizens of the state for whom the waters have been claimed, will ensure this valuable resource is wisely managed.