Final

HARDY COUNTY WATER RESOURCES ASSESSMENT

Prepared for the Hardy County Commission

Prepared by
USDA Natural Resources Conservation Service
WV Conservation Agency

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Cover photo by Tim Ridley

Executive Summary

This Water Resources Assessment was commissioned by the West Virginia Conservation Agency for the Hardy County Commission. The Natural Resources Conservation Service provided technical support and contractual services. The report provides information that will aid in planning and development of water resources in Hardy County as the county grows and expands. Of particular interest are the groundwater resources, springs, and the ability of municipal systems to meet current and future water demands.

Chapters 1 through 3 contain descriptive information about Hardy County. This information is based on the latest census reports and other appropriate references, supplemented by information from local planners.

There is detailed, analytical information in Chapter 4 regarding the springs, wells, and groundwater resources in the county. Because so many of the county residents are dependent on groundwater, and the poultry industry is completely dependent on wells, this portion of the report may be the most valuable to local planners. Future development of groundwater resources in the county should consider the limitations posed by the hydro-geologic character of the groundwater aquifiers, which have low productive rates, although recharge to these aquifiers is adequate across the county.

Wastewater and sewage collection systems are described in Chapter 5. Hardy County leaders have stressed the importance of developing information on community wastewater treatment systems than what was formerly available.

Public water supply systems are described in Chapters 6 and 7. Systems were located, described, and evaluated as to their current condition. The public water systems are also included in the GIS database. The Moorefield and Wardensville public water supply systems were evaluated for their ability to meet demand through the Year 2020 with a 25 percent growth factor. The potential for using the Lost River Sites 4 and 10 for future water supply was evaluated and deemed feasible

Costs for a water treatment plant in the Lost River Valley were evaluated in Chapter 8. This information will enable the Hardy County Commission to seek funding for such a facility.

A computerized geographic information system (GIS) file accompanies the report. The GIS shows the location and configuration of public water service, sewer service, and twenty five prominent natural springs developed specifically for the study, as well as a host of existing data on Hardy County.

Summary recommendations are included in the final chapter.

TABLE OF CONTENTS

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Figures …

Additional Resource Reports…

***Groundwater Assessment for Hardy County, West Virginia**, conducted by Dr. Phil Hays, NRCS Water Management Center, Little Rock, Arkansas, February 2004*

***Moorefield Water Treatment Plant Raw Water Supply Assessment**, conducted by Gannett Fleming, Inc., January 2004*

***Lost River Water Supply Assessment**, conducted by Gannett Fleming, Inc., January 2004*

CHAPTER 1 STUDY DESCRIPTION

The purpose of this study is to evaluate the present and projected water resource needs of Hardy County and to identify alternatives to meet those needs. Hardy County is a developing area with potential for future growth, but such growth requires modern infrastructure and utility services. This assessment evaluates the current infrastructure and recommends future actions to meet the needs of residents, farmers, businesses, and industry in a growing county.

Goals of this study include:

- describe and evaluate the existing infrastructure in the county
- determine the adequacy of existing systems to meet current needs
- project water resource needs through the Year 2020
- determine the most cost effective alternatives to meet future needs
- describe and evaluate springs located in Hardy County
- describe and evaluate the extent of groundwater use in the county, including an estimate of the number of wells in the county, the geographic location of wells, and the quantity of water being withdrawn from those wells
- develop data within a geographic information system (GIS) that can be delivered to the Hardy County Commission that will aide in future planning

This plan resulted from the combined efforts of the Hardy County Commission, Potomac Valley Conservation District, the West Virginia Conservation Agency, and the USDA Natural Resources Conservation Service. Portions of this report were produced by a number of entities. The Natural Resources Conservation Service Water Management Center in Little Rock, Arkansas provided expertise and guidance with regard to ground water. Gannett Fleming, Inc. evaluated surface water supply sources within the county and developed the wastewater information for the GIS database. MSES, Inc. provided general descriptive information for the study. The West Virginia Conservation Agency provided GIS expertise and quality management. The Natural Resources Conservation Service (NRCS) served as the contracting entity and was responsible for quality control and project oversight.

CHAPTER 2 COUNTY DESCRIPTION

Hardy County, located in the eastern panhandle of West Virginia, encompasses approximately 584 square miles and 373,760 acres. The town of Moorefield, located in the western portion of the county at the confluence of the South Branch of the Potomac River and the South Fork of the South Branch of the Potomac River, is the county seat and the largest town in the county. Hardy County is a rural county, with only two (2) municipalities, Moorefield and Wardensville. Wardensville is located in the northeastern portion of the county. In 2002, there were an estimated 12,795 residents in Hardy County. The rural nature of Hardy County is evidenced by its few number of schools (five) and the absence of a hospital.

Hardy County has relatively few businesses, many of which are service businesses for area residents. Major industries include Pilgrims's Pride and American Woodmark Corporation. The region is primarily manufacturing and agricultural in nature. According to the latest Census of Agriculture, there are 467 farms in the county. These farms include cattle, hogs, sheep, poultry, and cropland. Hardy County ranks first in West Virginia with regard to poultry production.

2.1 - LAND

Land Features and Use

According to the United States Geological Survey, Hardy County is classified as forest, with clearings on the floodplains and in the valley floors. The latest Census of Agriculture indicates the county is 73% forest land, 19% pastureland, 6% cropland, 1% urban area, and 1% recreational land. The recreational category includes Lost River State Park, South Branch Wildlife Management Area, and several county and city recreational parks. George Washington National Forest is considered forest land.

Public and Private Land Use

Approximately 39% of the total acreage of the county is private, non-farmland. Public lands such as Lost River State Park (3,712 acres), the South Branch Wildlife Management area (1,030 non-contiguous acres), and the George Washington National Forest (72,000 acres) cover approximately 21%, or 76,742 acres of the county's total area. Farmland comprises another thirty-nine percent (39%), or 142,940 acres of the county's total area. Less than one percent (1%) of the total acreage is urban.

Farmland

The latest Census of Agriculture shows farmland occupies over a third of land in the county. Almost half the acreage (49%) was pastureland. Woodland comprised the next largest land use with 31% and cropland comprised 15%. Other farmland, including houses and other buildings held 5% of the total acreage.

Recreation

Recreation in Hardy County is an important resource in terms of tourism and an appealing quality of life. Recreation activities abound in the county. Within the borders, there are the George Washington National Forest, Lost River State Park, South Branch Wildlife Management Area, five (5) community parks, Hardy County 4-H Camp, Valley View Golf Course, and numerous roadside park areas and public fishing areas.

Two of the more popular activities in Hardy County include fishing and canoeing. There are three (3) primary canoe routes in the county on the South Branch River and numerous public fishing accesses on the South Branch, the South Fork of the South Branch, and Lost River. In addition, public access to Kimsey Run Dam, Lost River Dam #27, Rock Cliff Lake, Trout Pond Recreation Area, and Warden Lake provide fishing opportunities.

Other Resources of Interest

Hardy County has many unique resources. Two (2) of these are the historic area of Moorefield and the Lost River. The Moorefield area contains numerous National Historic Register eligible properties and one National Historic Register Civil War battlefield. These National Historic Register eligible properties create a rural historic district. The importance of this area is emphasized by the rerouting of Corridor H around this area, thus preserving it.

Another unique area in the county is located in the northeastern portion. Near Wardensville, the Lost River (aptly named), disappears under Sandy Ridge and reappears over four (4) miles away where it is called the Cacapon River. This feature draws tourists to the area; the Lost River State Park was developed in the vicinity to provide recreation and other accommodations for tourists and visitors to the area.

2.2 – INFRASTRUCTURE

Highways

Hardy County contains a main east-west transportation corridor, as well as three (3) north-south corridors. The east-west route, West Virginia Route 55, connects Moorefield, Needmore, Baker, and Wardensville to the Virginia State line. Route 55 is approximately the same route of the nearly completed Corridor H highway. In the western portion of the county, West Virginia Route 220 traverses the county from the Hampshire County line through Old Fields and Moorefield, roughly following the South Branch River to the Grant County line. West Virginia County Route 7 links Moorefield south to the Pendleton County line. In the eastern portion of the county, West Virginia Route 259 connects Hampshire County to Lost River, Mathias, and south to Harrisonburg, Virginia.

Corridor H highway will significantly impact transportation and development in the county as segments of the highway are constructed. Corridor H will connect Interstate 79 at Weston, West Virginia to Interstate 81 in Virginia, providing the transportation infrastructure necessary for economic growth. This four lane, divided highway and associated exits (proposed at Baker, Moorefield, and Wardensville) will lead to growth of residential, commercial, and industrial sites in Hardy County. Encasements for water and sewer lines are being constructed under the highway at exits where growth is expected. These areas include the Moorefield exit area (north of Moorefield at County Road 15 and WV 55), west of Moorefield where WV 55 intersects with Corridor H, south of Bean Settlement, and the Baker exit area. It is predicted that residential growth will occur near Bean Settlement and Baker while commercial and industrial growth will occur at Moorefield, Bean Settlement, Baker, and Wardensville.

The poultry industry in Hardy County is expected to grow as transportation efficiency is improved. Industrial growth is also predicted to increase at the three existing industrial parks in Hardy County. Commercial development at highway exits is expected to be light tourist service development such as gasoline stations, hotels, and restaurants. It is predicted that there will be growth in employment due to interchange commercial development. Computer modeling indicates that Hardy County will increase in

industrial jobs, commercial, and service-oriented jobs. Service-oriented jobs include such categories as banks, doctors' offices, and real estate offices.

Commercial and industrial growth are interrelated with residential growth. It is predicted that housing units will increase in the South Branch of the Potomac Watershed in the areas of Moorefield, Fisher, Kessel, Cunningham, and Fort Run. The Cacapon River Watershed will have housing growth in the areas of Baker, McCauley, Arkansas, Needmore, Bean Settlement, and Wardensville.

2.3 - TOPOGRAPHY, PHYSIOGRAPHY, GEOLOGY, SOILS

Topography

The topography of the county is rugged, being comprised of a series of mountain ranges. The only comparatively level land in the county is the bottom lands along the major rivers, notably the South Branch of the Potomac, and the South Fork of the South Branch, and the Lost River. Elevations range from approximately 725 feet above mean sea level (amsl) on the South Branch at "the Trough" (Hampshire-Hardy County line) to approximately 3,320 feet amsl on South Branch Mountain, approximately 4-1/2 miles northeast of Helmick Rock, near the center of the county.

Physiography

The county is in an area enclosed by the approximate latitudes of 38° 46' N to N 39° 08' N and approximate longitudes of 79° 05' W to 78° 31' W. The county is situated entirely within the Folded Appalachian/Valley and Ridge physiographic province. The area is characterized by tightly folded sedimentary rocks, with a common northeast/southwesterly trend, with principal drainage lines paralleling this orientation. The province is characterized by long, narrow ridge lines with steep valley sides and relatively narrow valley bottoms.

The mountains of the Valley and Ridge province were formed during the Allegheny Orogeny, which occurred with the collision of the ancestral continents of Europe, Africa, and North America during the late part of the Paleozoic Era (286 to 300 million years ago). Compressional forces formed the mountains, with the folding and faulting of rocks above a more competent underlying rock sheet. The immense parental mountains were subsequently eroded, with the currently-observed landforms resulting from subsequent uplift and erosion that began 30 to 50 million years ago.

Drainage patterns are primarily trellis in form, in response to the influences imparted by the geologic structures and/or lithologic units present. The principal drainage lines parallel the prevailing northeast/southwesterly trend of the folded rocks of the area, with many tributary streams having cut deep gorges at near right angles across the mountains.

Geology

Surface rocks exposed in the county are limited to Paleozoic sedimentary strata, ranging in age from middle and upper Ordovician through early Mississippian. Prominent geologic formations include the middle and upper Ordovician Martinsburg, which is composed predominantly of shales, and the Oswego (Gray Medina) and Juniata (Red Medina) Formations, consisting primarily of sandstones; the Silurian Tuscarora (White Medina) sandstone, Clinton (shale) Group, McKenzie Formation (limestone/limey shale), Williamsport sandstone, Wills Creek (shale) Formation, and Tonoloway Formation, including the Bloomsburg red sandstone; thick Devonian sequences, including the Helderberg Group (limestones), the

Oriskany Sandstone, the Needmore and Harrell and Marcellus, Mahantango, and Brailler Formation shales; and the thick sandstones, siltstones, and shales of the Devonian Chemung and Hampshire Formations and the Mississippian Pocono Group. These are blanketed by Quaternary alluvium, which occurs as terrace and valley bottom deposits of unconsolidated gravel, sand, silt, and clay, located along major floodplains.

The regional geologic structure of the area is characterized by tightly folded sedimentary strata, with major structural features in the county differentiated as the Town Hill and Sideling Hill Synclines, the Broad Top Anticline, and numerous less prominent features. These exhibit the northeast/southwesterly trend that is common to this physiographic province. No major systemic faulting is reported for the county, although the surface projection of a thrust fault at depth coincides with the location of the Lost River, in the east-central portion of the county.

Soils

Hardy County contains six (6) soil associations. The western and eastern borders and much of the area of the George Washington National Forest are comprised of the Dekalb-Hazleton-Laidig-Opequon association. This association is characterized by gently sloping to very steep, well drained, deep to shallow soil on uplands. The soils along the South Branch, South Fork and Lost Rivers are from the Potomac-Tioga-Melvin association. These are deep floodplain soils, found in areas that are nearly level, with highly variable drainage characteristics. The Monongahela-Clarksburg-Ernest association, consisting of nearly level to moderately steep, moderately well drained, deep soils on terraces and foot slopes, is found in transitional topographic settings along the South Branch, South Fork, and Lost Rivers. Additional transitional soils, found within bands in interior portions of the county, include the Berks-Weikert association. This association is indicative of gently sloping to very steep, well drained, moderately deep and shallow units on uplands. The soils of the central portion of the county are of the Berks-Lehew-Dekalb association, correlated with gently sloping to very steep, well drained, moderately deep soils on uplands. The Schaffenaker-Drall association is found in the George Washington National Forest. These areas are characterized by gently sloping to very steep, well drained and excessively drained, deep soils on uplands.

Earthquakes, Subsidence, Permafrost Hazard

Earthquakes do not represent a significant geologic hazard in the county. There is no widespread subsidence hazard for the county. Based on Hardy County's location and review of pertinent geological references, permafrost is not present in the area.

Landslides and Slumps

Landslides could be considered a significant problem associated with construction and subsequent land use. Landslides could be expected to occur in valley bottoms as a result of undercutting by rain-swollen streams; along highways as a result of slope cuts during construction; and in pastureland as a result of removal of the vegetation that was stabilizing an over-steep condition. Characteristically, once a plane of weakness has developed in the soil and/or rock slopes, the slide or slope failure condition is difficult to remedy. NRCS data indicate that low strengths in conjunction with steep slopes (hence, potential for landslide hazards) are associated with the Monongahela-Clarksburg-Ernest soil association. These soils typically occupy transitional settings in the county, between the floodplains of major streams and the surrounding steeper topography.

Erosion

Erosion could be a significant geological hazard in portions of the county. Erosion, as a natural phenomenon, can greatly influence the development of topography, drainage patterns, soil cover, flora and fauna, and land uses. Erosion effected by man's activities can also significantly influence these characteristics of the environment. A review of the soil types and characteristics indicates that erosion can be considered a severe hazard in areas in which the Opequon soils occur, i.e., in the mountainous terrain in the eastern portions of the county. Slight to moderate erosion hazards, dependent on steepness and slope aspect, are associated with the remainder of the soil associations of Hardy County.

2.4 - POPULATION AND HOUSING

Population

The number of residents in West Virginia and Hardy County has fluctuated from 1960 to 2000. The trends exhibited by Hardy County have deviated somewhat relative to those of the State as a whole, especially in more recent years.

For example, moderate (approximately 6% to 7%) decreases in the statewide number of residents were experienced from 1950 through 1970, with Hardy County experiencing a similar to slightly lower decline in population, by 7.2% to 4.9% during the same two decades, respectively.

A recovery period occurred during the decade from 1970 to 1980, in which the state's population rose by 11.8%. The statewide recovery may be reflective of a brief resurgence in the coal mining industry at that time, which served to revitalize the more mining-dependent areas of the state. Out-migration, decreases in manufacturing, the declining coal industry, and other negative influences in the 1980s are expressed by the deflated statewide population count of the 1990 census, where the number of inhabitants of West Virginia fell by nearly 8 percent. It remained stable, with a slight increase (approximately 0.8%) from 1990 to the 2000 Census. The most recent population estimate indicates 12,795 residents in Hardy County as of July 1, 2002.

In contrast, however, the population of Hardy County increased by over 13% from 1970 to 1980. It rose again from 1980 to 1990, by a margin of 9.4%, and again from 1990 to 2000, by over 15%. The county's location within the growing Eastern Panhandle region of the state, near the heavily populated eastern seaboard and D.C. Metro area, most certainly plays a critical role in the continued growth. Hardy County exhibits a positive net migration, attracting residents from other West Virginia counties and from other states. Virginia, Maryland, New Jersey, Florida, and New York represent the top five (5) states of origin for new residents.

Hardy County has two (2) incorporated towns: Moorefield and Wardensville. According to the 2000 census, Moorefield, located in the western portion of the county, had a population of 2,375, or 18.7% of the county's population. It is the site of the major industries in the county and is the county seat.
Wardensville, located in the northeastern portion of the county, had a 2000 population of 246 persons, or 1.9% of the county's population. In 2000, there were 12,669 residents in Hardy County. As of July 1, 2002, the county population was estimated at 12,795

Population Projections

Population projections by West Virginia University and other sources indicate growth will continue in the county. The following table lists the predicted population growth by different sources.

Table 2-1
POPULATION PROJECTIONS FOR HARDY COUNTY

Source	Percent Increase over Year 2000 Population Census	Number of Persons by Year 2020
West Virginia University (Series A Method)	12% increase	14,129
West Virginia University (Series M Method)	3.5% increase	13,115
Hardy County Officials' Estimate	25% increase	15,836

Based on the variation in growth predictions for Hardy County, local officials requested that water resource infrastructure plans be based on a growth factor of 25 percent by year 2020.

Housing

The number of housing units experienced a continual, although erratic, rise on a statewide basis from 1960 through 2000. A significant increase occurred between 1970 and 1980, both on a state and countywide basis, in which the number of housing units soared by a factor of 25% (West Virginia) to over 35% (Hardy County). This positive trend continued somewhat for the state through the 1990 and 2000 censuses (+4.5% and +8.1%, respectively), but Hardy County continued its dramatic increase in the number of housing units, with 1,000 units (+24.6%) added between 1980 and 1990, and another 1,542 units (+27.7%) added between 1990 and 2000. There are a considerable number of seasonal homes or vacation homes in Hardy County, with the count at 1,314 as of the latest census.

Schools

There are five schools in Hardy County – East Hardy Early/Middle, East Hardy High, Moorefield Elementary, Moorefield Middle, and Moorefield High School – with an enrollment of about 1,950 students. Enrollment has been steady to slightly increasing since 1985. The Eastern West Virginia Community and Technical College (EWVCTC) was recently constructed on West Virginia Route 55, east of Moorefield. This facility offers college level courses in business, computers, trades and industrial health sciences, and engineering.

2.5 - LOCAL ECONOMY

Industry

Employment in Hardy County has historically been dependent on agriculture and manufacturing, setting it apart from the remainder of the state. Construction is another prominent industry group, in which the numbers of persons employed in Hardy County have continually exceeded those statewide for this sector. Wholesale/retail trade and service-related industries also play a significant role in the employment climate of the county, but much less so than in other areas of West Virginia. Other industry groups which employ

fewer Hardy County residents relative to other counties statewide include services, public administration, transportation/communication/utilities, finance/insurance/real estate, and, most notably, mining. The manufacturing sector in Hardy County is growing with American Woodmark adding another 250,000 square foot manufacturing plant to the area. Summit Financial Group, headquartered in Moorefield, is another significant employer in the local economy.

Agriculture

Agriculture dominates the economy of Hardy County which continues to be one of the leading counties in the state in terms of total agricultural production. The 2003 West Virginia agricultural statistics show Hardy ranked 4th for cattle, 2nd for hogs, 6th for sheep, 6th for wool, and 1st in poultry production.

Table 2-2
NUMBER AND SIZE OF FARMS IN HARDY COUNTY

Farm Type	Unit
Poultry	
- Broilers	46,592,000 birds/year
- Breeders	782,000 birds/year
- Pullets	1,225,000 birds/year
- Turkeys	1,008,000 birds/year
All Cattle	22,000 head
Hogs	800 head
Sheep	2,200 head
All Hay	17,200 acres/year
All Corn	4,900 acres/year
Soybeans	800 acres/year

The impact of the agricultural industry on the Hardy County economy is significant. According to the 1997 Census of Agriculture, the total market value of agricultural products sold was $109,461,000, with an average of $234,392 per farm. Crops accounted for $1,604,000 and livestock and poultry accounted for $107,857,000, with poultry sales comprising 93.2% of the market value of agricultural products in Hardy County.

Personal Income

The median family incomes for both Hardy County and the state have shown a continual rise, but still lag behind the national average. The following table shows the relative standing of Hardy County with regard to income measures according to the latest United States Census:

Table 2-3
INCOME LEVELS FOR HARDY COUNTY

Place	Per Capita Income	Median Family Income
Hardy County	$21,007	$31,846
West Virginia	$22,862	$36,484
United States	$30,413	$50,046

Tourism

Recreation opportunities create a healthy tourism industry in Hardy County. According to the West Virginia Division of Natural Resources Parks and Recreation, in fiscal year 1999-2000 $1,554,233 was spent at Lost River State Park. The direct impact of tourism on Hardy County (as provided by the West Virginia Department of Tourism) is $17,859,400 and 550 jobs, an indirect impact of $5,784,200, and 72 jobs, and an induced impact of $4,285,500 and 64 jobs.

Unemployment

The unemployment figures for Hardy County have remained consistently lower than those for the state. Countywide unemployment rates have remained fairly stable, having risen slowly from 1960 to 1980 but decreasing more sharply from 1980 through 2000, for a total drop of 3.2% over the course of this forty-year period. This is relative to an overall statewide decrease in unemployment by 2.8% during the same time interval, with the period between 1990 and 2000 exhibiting a significant decline in unemployment for both Hardy County and the state. Hardy County has consistently maintained its favorable ranking among the top five counties with the lowest unemployment rates. The most recent unemployment rate for Hardy County was 3.9 percent in December 2003, which is below the statewide average of 5.1 percent and the national average of 5.4 percent.

CHAPTER 3 SURFACE WATER RESOURCES

This chapter provides an overview of pertinent characteristics of the water resources of Hardy County including climate, drought history, hydrology/hydrography, surface water aspects and groundwater characteristics.

3.1 - CLIMATE

The climate of Hardy County is characterized by the temperate four-season cycle common to the east-central United States. The area experiences dominant west to east weather movements with widespread excellent air quality.

The climate of Hardy County is seasonal in nature, with warm summers, cold winters, stormy springs and mild fall seasons. The average annual temperature for the area is approximately 51.3 degrees Fahrenheit ($^{\circ}$F) with monthly extremes ranging from approximately 28.6 $^{\circ}$F in January to approximately 72.4 $^{\circ}$F in July. The average annual precipitation for the area is 34.12 inches with the maximum of 3.44 inches in the month of July and the minimum of 2.01 inches in the month of February.

Data from the Roanoke, Virginia National Weather Service Office indicate the area experiences approximately 23.0 inches of snowfall per year, usually during the December to March winter season, and relative humidity ranges between 53% and 78%, daily. Additional data indicate that, on the average, there are 27 days with maximum temperatures above 90°F and 89 days with minimum temperatures below freezing.

Table 3-1
CLIMATE DATA FOR HARDY COUNTY

Month	Hardy County		Wardensville		Moorefield	
	Average Temperature (degrees F)	Normal Precipitation (inches)	Average Temperature (degrees F)	Total Precipitation (inches)	Average Temperature (degrees F)	Total Precipitation (inches)
January	28.6	2.05	33.2	4.07	32.6	3.54
February	31.1	2.01	34.8	0.80	35.8	0.72
March	40.7	2.71	36.8	3.24	36.4	2.75
April	50.2	2.83	50.7	2.19	52.1	1.82
May	60.0	3.42	59.5	1.79	61.5	1.34
June	68.3	3.27	68.7	1.01	71.0	0.74
July	72.4	3.44	76.2	2.42	77.5	0.76
August	71.0	3.29	71.4	2.16	73.0	2.47
September	64.1	3.12	63.1	7.30	64.1	5.56
October	52.5	3.06	50.5	2.48	52.4	2.43
November	43.4	2.81	48.3	1.74	48.1	1.30
December	33.5	2.11	34.8	2.00	35.1	1.72
Annual	51.3	34.12	52.3	31.20	53.3	25.15

Prevailing winds are from the west to southwest with higher speeds in colder months. The winds in the valleys are subject to a channeling effect and generally are not as strong as on the ridge tops or in flat open areas.

Hurricanes do not move as far inland as Hardy County, however the remnants of hurricanes and tropical storms can produce significant rainfall in West Virginia. In 1985, Hurricane Juan produced flooding of catastrophic proportions in many areas of West Virginia, including Hardy County. Hurricanes Fran (1996) and Dennis (1999) resulted in heavy rainfall and flooding again during the 1990's. No tornadoes were reported in Hardy County between 1950 and 1995. The most common destructive storms are severe thundershowers which cause flash flooding due to the watershed characteristics.

3.2 - DROUGHT HISTORY

West Virginia has experienced several drought periods from 1895 through 2000 as indicated by the Palmer Drought Severity Index (Palmer Index). The Palmer Index is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions.

Over the 105 years of data collection, West Virginia's most severe drought was in the 1930s (the Dust Bowl Era). The most severe drought occurred in 1931 and the recovery did not occur until 1933. From 1933 to the present, there have been several more droughts. Drought periods have occurred approximately 19 times since the 1930s. There was an extreme drought in 1991, several moderate droughts from 1992 to 1998, and another extreme drought in 1999. However, during the 1990's, there were also periods of extremely wet weather, which provided abundant recharge to Hardy County's aquifers.

To alleviate isolated problems with water supplies in Hardy County and surrounding counties during the 1999 drought, the USDA Farm Service Agency, NRCS, and WVSCA implemented the Emergency Conservation Program. This program allowed for water wells to be drilled, with the cost of these wells subsidized by state and federal programs.

3.3 – SURFACE WATERS

Streamflow Gaging Stations

The USGS maintains two (2) active streamflow gaging stations in Hardy County. These are both located near Moorefield, on the South Fork of the South Branch (drainage area of 277 square miles) and the South Branch (drainage area of 1,241 square miles). The South Branch station has been utilized since October 1993 to present; the South Fork South Branch station has a longer period of record, which spans from June 1928 to present, less a period of non-reporting from September 1935 to August 1938. The monthly mean data for each station are summarized in the following tables:

Table 3-2
SOUTH FORK SOUTH BRANCH POTOMAC RIVER NEAR MOOREFIELD (01608000)
Monthly Mean Discharge Data (cubic feet per second)
(June 1928 -September 1935; August 1938-present)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	127	177	206	272	339	497	404	328	166	83.9	106	94.1
MAX, YEAR	776 (1977)	2951 (1986)	879 (1974)	1267 (1996)	1591 (1998)	1327 (1993)	1787 (1987)	946 (1988)	1071 (1949)	510 (1949)	801 (1955)	1340 (1996)
MIN, YEAR	12.8 (1992)	14.0 (1999)	17.4 (1966)	21.3 (1981)	25.2 (1934)	72.2 (1981)	91.7 (1981)	51.2 (1930)	28.1 (1977)	9.48 (1999)	10.4 (1965)	10.2 (1968)

Table 3-3
SOUTH BRANCH POTOMAC RIVER NEAR MOOREFIELD (01608070)
Monthly Mean Discharge Data (cubic feet per second)
(October 1993 - present)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	279	907	1087	2669	2799	3592	1495	2212	860	565	792	1113
MAX, YEAR	846 (1997)	2446 (1997)	2933 (1997)	5168 (1996)	5672 (1998)	5844 (1994)	2895 (1998)	5072 (1996)	1554 (1996)	1248 (1996)	2464 (1996)	5444 (1996)
MIN, YEAR	127 (1999)	143 (1999)	154 (1999)	1237 (1997)	596 (1999)	1082 (1995)	771 (1995)	502 (1999)	188 (1999)	85.2 (1999)	92.7 (1999)	117 (1995)

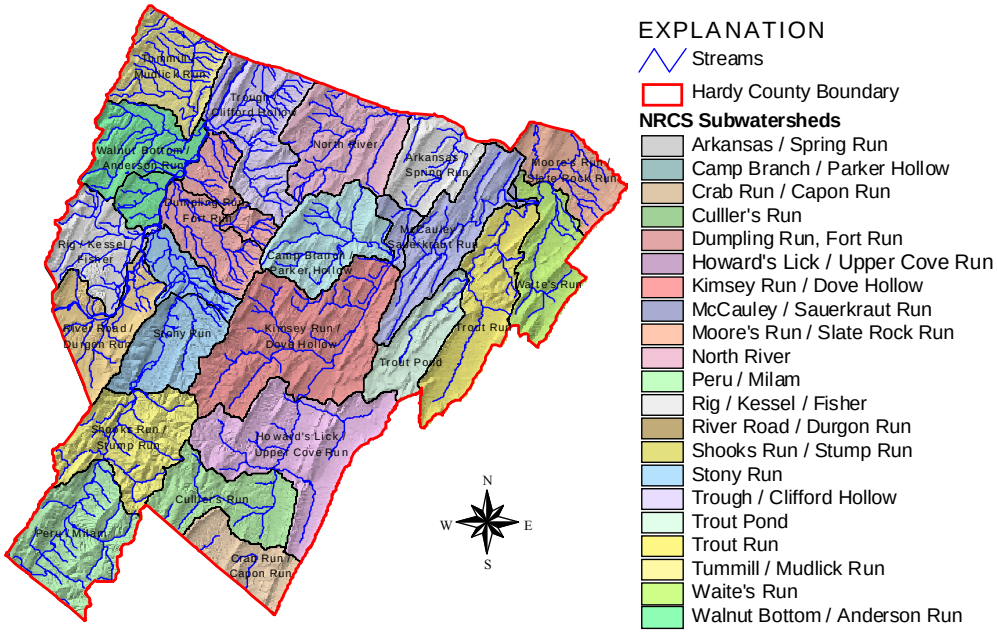
Watershed Descriptions

Hardy County is divided into five major river basins – the North Fork of the South Branch of the Potomac River, the South Fork of the South Branch of the Potomac, the North River, the Cacapon River, and Lost River. For the purposes of this study, the NRCS identified twenty-one (21) subwatersheds, as follows:

Table 3-4
SUBWATERSHEDS IN HARDY COUNTY

Map Reference Number	Subwatershed by Stream or Community Name	Major Watershed
1	Turnmill/Mudlick Run	South Branch
2	Trough/Clifford Hollow	South Branch
3	North River	North River
4	Arkansas/Sperry Run	North River
5	McCauley/Sauerkraut Run	Lost River
6	Moore's Run/Slate Rock Run	Cacapon
7	Walnut Bottom/Anderson Run	South Branch
8	Dumpling Run/Fort Run	South Branch
9	Camp Branch/Parker Hollow	Lost River
10	Trout Run	Cacapon
11	Waite's Run	Cacapon
12	Rig/Kessel/Fisher	South Branch
13	Stony Run	South Fork
14	Kimsey Run/Dove Hollow	Lost River
15	Trout Pond	Cacapon
16	River Road/Durgon Run	South Branch
17	Shooks Run/Stump Run	South Fork
18	Howard's Lick/Upper Cove Run	Lost River
19	Peru/Milam	South Fork
20	Culler's Run	Lost River
21	Crab Run/Capon Run	Lost River

Figure 3-1
SUBWATERSHEDS AND STREAM BOUNDARIES IN HARDY COUNTY



Stream Water Quality

Water quality is a high priority issue in Hardy County. Several studies have been conducted to describe and evaluate water quality throughout the county, especially as it relates to fecal coliform and nutrients. Each study is unique with regard to its scope and methodology. For the purposes of this assessment, water quality was evaluated at potential municipal water sources once those sources were identified. The following studies are recommended for more information on specific water quality findings:

Streamwater Quality in the Headwaters of the South Branch Potomac River Basin, West Virginia, 1994-1995, and the Lost River Basin, West Virginia, 1995. United States Geological Survey.

Interim Report on Water Quality Studies in the Lost River, North River, and South Branch of the Potomac River Watersheds of West Virginia. Cacapon Institute. 1999.

South Branch and Lost River Watershed Preliminary Water Quality Report (1999), South Branch and Lost River Watershed Fecal Coliform Water Quality Report (2000) and South Branch and Lost River Watershed Nutrient Water Quality Report (2000). West Virginia Department of Agriculture.

An Ecological Assessment of the South Branch of the Potomac River Watershed. 1996. Office of Water Resources. West Virginia Division of Environmental Protection.

Bureau of Public Health Raw Water Bacteriological Testing

Total Maximum Daily Loads. West Virginia Division of Environmental Protection and the United States Environmental Protection Agency.

3.4 - RESERVOIRS

There are nine (9) significant impoundments in Hardy County. Ownership, purpose and other information about each dam is summarized in Table 3-5. Five (5) dams (Lost River No. 27, Lost River No. 10, Lost River No. 4, South Fork No. 4, and Warden Lake) are classified as high hazard dams, meaning the structures have the potential to cause significant property damage or loss of life downstream if they were to fail. Dams of this classification are built with the most stringent engineering and safety criteria available. Two impoundments, South Fork No. 1 and South Fork No. 2, are classified as significant hazards. The hazard code is defined and assigned to each dam by the WVDEP Office of Dam Safety and indicates the potential hazard to the downstream area resulting from failure or misuse of the dam facilities.

- A high hazard is defined to have the capacity to cause loss of life.
- A significant hazard is defined to cause property damage but probably no loss of life.
- A low hazard is defined to pose no threat to life or property.

Table 3-5
DAMS IN HARDY COUNTY

	Lost River No. 27	Rockcliff	South Fork No. 2	Lost River No. 4	South Fork No. 4	South Fork No. 1	Warden Lake	South Fork No. 5	Lost River No. 10
National Inventory of Dams Number	WV03110	WV03107	WV03104	WV03108	WV03105	WV03103	WV03101	WV03106	WV03112
Stream on which structure is built	Upper Cove	Trout Run	Stump Run	Kimsey Run	Rohrbaugh Run	Shook's Run	Moore's Run	Radabaugh	Camp Branch
Downstream Town	Mathias	n/a	Moorefield	Lost River	Moorefield	Moorefield	Wardensville	Milam	Needmore
Miles to nearest town	2	5	11	1	18	10	4	1	.5
Owner Name	PVSCD	USFS	PVSCD	PVSCD	PVSCD	PVSCD	WVDNR	PVSCD	PVSCD
Planned Purpose (s)	Flood Control	Recreation, Fish and Wildlife	Flood Control	Flood Control	Flood Control	Flood Control	Recreational	Flood Control	Flood Control, Water Supply
Dam Length (Feet)	922	280	790	1,800	860	830	620	625	768
Dam Height (Feet)	75	60	98	90.9	116.7	122	30	107	82
Maximum Storage (acre feet)	1,009	275	1,530	10,256	2,941	187	460	690	1,685
Permanent Storage (acre feet)	67	190	83	605	181	96	382	53	618
Surface Area (acres)	7.2	17	9	66	9.9	11	44	4	53
Drainage Area (square miles)	3.75	3	4.16	32.41	9.05	6.42	10.14	2.34	6.69
Hazard Classification	High	Low	Significant	High	High	Significant	High	High	High
Emergency Action Plan	Yes	No	No	No	Yes	Yes	No	Yes	Yes
Regulatory Agency	DEP -Office Water Resources Dam Safety	DEP -Office Water Resources Dam Safety	DEP -Office Water Resources Dam Safety	DEP -Office Water Resources Dam Safety	DEP -Office Water Resources Dam Safety	DEP -Office Water Resources Dam Safety	DEP -Office Water Resources Dam Safety	DEP -Office Water Resources Dam Safety	DEP -Office Water Resources Dam Safety

Proposed Impoundments

Two (2) proposed dams of interest for potential water supply are Lost River No. 16 and Lost River No. 23. Stony Run was evaluated by NRCS as a water supply dam, but it was not cost-effective under NRCS programs. The Hardy County Commission requested that water supply be incorporated into Lost River No. 16 when it is built. If requested by the Local Sponsors, the feasibility of adding water supply to Lost River No. 23 may also be evaluated.

Table 3-6
PROPOSED DAMS IN HARDY COUNTY

Dam ID (Common Name)	Stream	Subwatershed	Spillway Location		Permanent Pool Storage Capacity (acre feet)	Water Supply Storage (acre feet)	Proposed Primary Use
			Latitude (decimal degrees)	Longitude (decimal degrees)			
Lost River No. 16	Lower Cove Run	Lost River	38.93	78.83	198	To be determined	Flood Control, Recreation, water supply
Lost River No. 23	Cullers Run	Lost River	38.85	78.92	312	To be determined	Flood Control

CHAPTER 4 GROUND WATER RESOURCES

4.1 – GROUND WATER CHARACTERISTICS

As part of the overall assessment of the water resources in Hardy County, an evaluation of the ground water characteristics was conducted by the NRCS Water Management Center. The study, in its entirety, is included as an accompanying document. The findings and recommendations are briefly described in this section.

Information on water availability is a primary concern for water resource planners, water managers, and water users. Hardy County is projected to have significant growth in population, business, and industry and commensurate growth in the demand for water. In Hardy County, ground water is an important part of the water resource base - constituting 25% of total water used and approximately 100% for water users located away from public water supply lines, and planners must have information on the amount of water that county aquifers can yield on a sustainable basis. The amount of water that can be withdrawn from an aquifer on a long-term basis without causing overdraft and depletion of storage is limited by the amount of water that recharges the aquifer. Under optimum aquifer and hydrologic conditions, the longterm yield of an aquifer approaches or equals aquifer recharge. Defining recharge sets an upper limit on the amount of water available in an area. The limit on the rate of water that can be pumped from a single well or nest of wells within a localized area also affects the economic viability.

Approximately 1.1 million gallons of ground water are used per day in Hardy County. Recharge estimation shows that as much as 211 million gallons per day are available across the entire county. Current water use within Hardy County is a tiny fraction of what is available on a countywide basis. Water use is currently less than 0.5% of estimated recharge. These data show that there is considerable remaining development potential for ground water within Hardy County. Maximum development potential may only be realized if effective planning and management addresses local hydraulic properties and well spacing limitations. Other concerns such as minimum stream baseflows, stream ecosystem, and spring/cave ecosystem viability also must be considered.

From a user-specific standpoint, the ability of aquifers in Hardy County to yield water at rates needed for various uses will be the greatest limitation on development for the near term. Because of low porosity and low hydraulic conductivities typical of much of the aquifer material in the county, typical single well yields are low, and may make ground water unviable for some uses. Pumping at rates needed, but which are in excess of what can move into a well bore, will result in localized depletion and water level declines. Although a large quantity of water is available across a large area, a single well removes water quickly only from a smaller area. An aquifer may be thought of as a tank, and the hydraulic parameter of hydraulic conductivity as the pipe tapping the tank. Although a lot of water may be available, the rate at which that water can be yielded is limited by the size of the pipe, and if the pipe is small, the rate at which water is yielded is small. In Hardy County, the pipe is of small diameter; aquifers have relatively low hydraulic conductivity and low yields.

Figure 4-1
USGS GAGE STATIONS AND DRAINAGE AREAS IN HARDY COUNTY

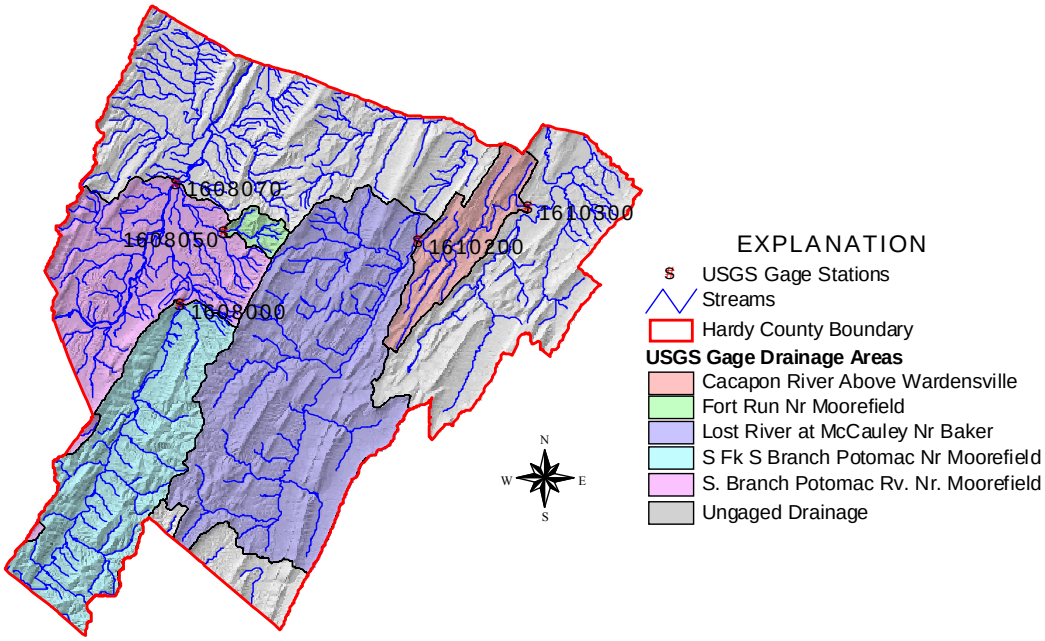
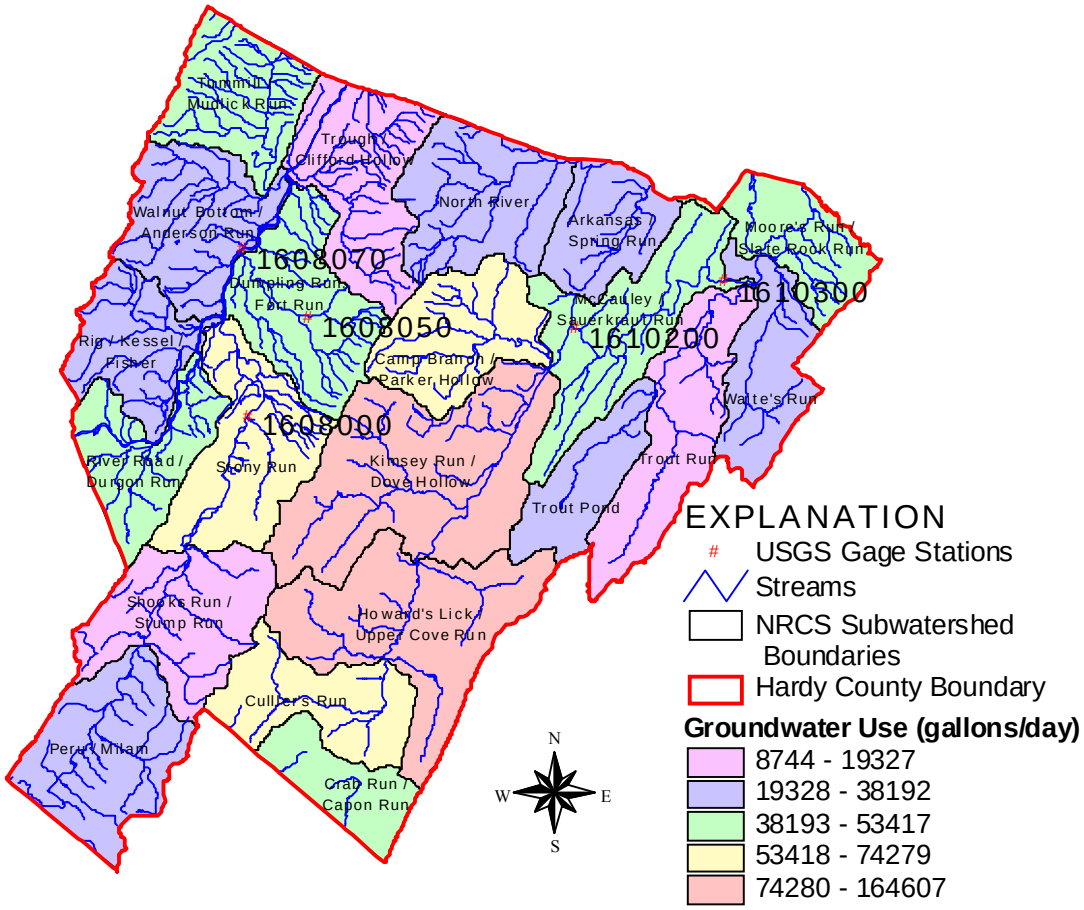


Figure 4-2
RANGE OF GROUNDWATER USES BY SUBWATERSHEDS IN HARDY COUNTY



Intensity of ground water use varies between subwatersheds in Hardy County. Figure 4-2 shows the range in ground water use for five different categories of withdrawal, beginning with the least intensive rate of 8,744 gallons per day to the most intensive rate of 164,607 gallons per day. The ranges of withdrawal are based on ground water use in the twenty-one subwatersheds. This information is displayed on Table 4-3. As illustrated in the graphic, the most intensive ground water use is occurring in the south central portion of the county in the areas of Howards Lick, Upper Cove Run, Dove Hollow, and Kimsey Run. This area also coincides with the most intensive poultry production in the county.

Summary

- Hardy County is projected to have significant growth in population, business, and industry and commensurate growth in the demand for water. In Hardy County, ground water is an important part of the water resource base - constituting 25% of total water used and approximately 100% for water users located away from public water supply lines, and planners must have information on the amount of water that county aquifers can yield on a sustainable basis.

- Geologic units present in the county represent primarily highly fractured clastic (sandstone, siltstone, and shale) sequences with relatively low intergranular porosity and low hydraulic conductivity. Fracture porosity is important in these rocks. Also important is porosity in the regolith (weathered rock and soil) that develops during exposure and weathering.

- Hydraulic properties for aquifers in the county typically are at the lower end of the spectrum in terms of the capacity to transmit water, and observed production rates for wells in the county are low - typically much less than 50 gallons per minute.

- Recharge estimates were derived for four watersheds covering approximately 60% of the county and results were extrapolated to adjacent watersheds for which no stream gage data were available based on proximity, topography, precipitation distribution, and geology. Hydrologic computer modeling was utilized to develop these extrapolations. Results of the modeling show that for the four watersheds for which suitable data were available, recharge rates were fairly consistent, ranging from 7.2 inches per year to 8.0 inches per year.

- Recharge estimation shows that as much as 211 million gallons per day are available across the entire county. Water use is a small fraction of what is available on a county-wide basis - approximately 1.1 million gallons of ground water are used per day in Hardy County, thus water use currently is less than 0.5% of estimated recharge.

- Data show that there is considerable remaining development potential for ground water within Hardy County; however, well yields are limited by low hydraulic conductivity values. Single wells pumped at high rates will rapidly drop ground water levels in an area close to the well, while outside of the well's small radius of influence, ground water is not tapped and ground water levels are unaffected. Installation of multiple well pumping "galleries" may be one answer to improving viability of the ground water resource in the county. Maximum development potential may only be realized if effective planning and management addresses local hydraulic properties and well spacing limitations. Other concerns such as minimum stream baseflows, stream ecosystem, and spring/cave ecosystem viability also must be considered.

Recommendation

It is highly recommended that Hardy County initiate a ground water monitoring program. Cooperating parties in the county have done an excellent job of identifying and assimilating much of the data needed for resource planning. A critical element still missing is data on aquifer response, specifically ground water levels. The basic data needed for ground water analysis begins with water level monitoring data. Ground water levels in wells change annually and seasonally due to changes in pumping and precipitation. Monitoring the ground water level should occur every year at the approximately same time. This data is critical to the effective evaluation of recharge, water withdrawal rates, and aquifer response with respect to sustainable use of the resource. In the eastern United States, spring time water level measuring in agricultural areas is the most common. This is because recharge has been maximized during the rainy season of winter and spring and water use is minimal. Ground water level monitoring is easy to do accurately and is inexpensive, and the resulting data base is invaluable for assessment of aquifer conditions, trends in water levels, and of impacts of changing water use patterns.

4.2 - WELLS

Although municipal water service is available in parts of Hardy County, individual water wells are an extremely important part of the county's water resources. Hundreds of residents and virtually 100% of the poultry houses depend on ground water wells. Without reliable, high quality, abundant ground water resources, the economic and social base of the county would not be sustained. One of the goals of this report is to estimate the total number of wells in the county and determine the geographic distribution of those wells throughout the county. An additional goal is to estimate the amount of water being withdrawn by ground water users. Comprehensive water resources planning cannot occur without knowing the extent to which the county relies on ground water.

Although the county is highly dependent on wells, there is only limited data available on the location and number of wells throughout the county. Since 1985, a county issued permit has been required for water well drilling, construction, alteration, or abandonment, but this system provides only a limited amount of data. Consequently, for this study several sources of data were used to provide a comprehensive overview of ground water.

The poultry industry is the cornerstone of Hardy County's agricultural and manufacturing base. Poultry producers are also the most significant ground water users, with production houses dependent soley on ground water. In most areas of the county where production houses are located, municipal water is simply not available. Even if it were available, the cost of municipal water would increase the overall cost of poultry production, causing producers to be noncompetitive. Given the importance of this industry and the extent of its ground water dependency, additional emphasis was placed on locating and defining the consumption levels of poultry farms. While it is recognized that cattle and other livestock utilize ground water resources in some instances, most of their water consumption is from streams, surface impoundments, and captured spring discharge. For the purpose of this assessment, they were not considered to have significant impact on ground water resources.

Location Methodology

An estimation of the number of ground water well users in the county was performed spatially, through the utilization of Arcview Geographic Information System (GIS) software. Data was combined from many different sources in an attempt to locate and count wells throughout the county. During the time frame of 2000-2002, Hardy County Emergency Services developed detailed digital mapping for the county-wide 911 system. This mapping was combined with digitial orthophotography to determine the location of all structures in the county.

GIS data on the physical location of residential, commercial, governmental, public and school structures, was provided by the Hardy County Office of Emergency Services' Emergency 911 Addressing System. GIS data on the location and types of poultry operations was provided by the NRCS, with assistance from Pilgrims Pride Poultry, Inc. Furthermore, GIS data was developed by the West Virginia Conservation Agency delineating the location of public water service distribution lines, facilities, and components utilizing drawings provided by Thrasher Engineering, Inc.

Consumption Methodology

The number of ground water users was broken down into five categories: fulltime residential dwellings, commercial businesses, government facilities, schools, and poultry operations. Poultry operations were broken down further into four types of operations due to the significant variances in daily water use among those types. Other types of users, such as government facilities, were analyzed to ensure an accurate water use assessment at each of those locations. Categories such as seasonal homes/cabins and other types of agricultural operations were evaluated, but deemed to have an insignificant effect on the average daily demand for ground water.

A seven hundred foot buffer was delineated around the public water distribution system, and those addresses that fell within that buffer were queried and removed from the total data set of ground water users. It was assumed that it would be cost-prohibitive to construct water lines to users beyond seven hundred feet of the main line. The seven hundred foot limit was provided by the Hardy County PSD.

All the users served by public water were queried from the total data set of physical addresses. The remaining addresses were assumed to be served by ground water sources, such as a well or spring.

The four major river basins in Hardy County – Lost River, South Fork, South Branch, and North River – were delineated into 21 subwatersheds by NRCS for the purposes of this study. These subwatersheds were then developed into a GIS data set to aid in the spatial analysis of ground water users.

The final estimate of ground water users was developed by querying each subwatershed for type of user. Consumptive rates of daily water usage were then applied to each user and totaled by subwatershed. Determination of daily consumption rates for residences, commercial businesses, government facilities and schools are based on the Water Distribution Handbook, Mays, 2000 and the State of West Virginia Design Standards, 2000. Table 4-1 shows the applied consumptive rates.

Table 4-1
CONSUMPTIVE RATES FOR GROUND WATER USER CATEGORIES

User Category	Rate (gallons per day)	Factor
Residential Households	150 gpd	per household
Commercial Businesses	11 gpd per person	average of 4 persons
Government Facilities	11 gpd per person	average of 4 persons
School	11 gpd per student	834 students for 180 days
Broilers	696 gpd	per house
Layers	631 gpd	per house
Pullets	504 gpd	per house
Turkeys	2003 gpd	per house
Lost River State Park	150 gpd	for each of 2 fulltime residences
Lost River State Park	135 gpd	for each of 11 year-round cabins, 90% occupancy rate
Lost River State Park	63 gpd	for each of 15 seasonal cabins, 5 month occupancy
Lost River State Park Office	150 gpd	for 1 office

Table 4-2
ESTIMATED GROUND WATER USERS BY CATEGORY AND SUBWATERSHED IN HARDY COUNTY

Subwatershed	Number							
	Residences	Commercial Businesses	Governmental Facilities	Schools	Poultry - Broilers	Poultry - Breeders	Poultry - Pullets	Poultry - Turkeys
Turnmill/Mudlick	163	1	0	0	16	24	3	0
Trough / Clifford Hollow	82	2	1	0	9	1	0	0
North River	161	6	0	0	16	0	0	0
Arkansas / Sperry Run	184	3	0	0	0	0	0	0
McCauley / Sauerkraut Run	185	18	1	0	6	2	0	0
Moore's Run / Slate Rock Run	254	2	1	0	1	1	0	5
Walnut Bottom / Anderson Run	124	1	0	0	5	7	16	0
Dumpling Run/ Fort Run	259	8	0	0	13	1	9	0
Camp Branch / Parker Hollow	207	10	1	2	25	6	0	0
Trout Run	79	1	0	0	2	0	0	0
Waite's Run	180	4	0	0	0	2	0	3
Rig/Kessel/Fisher	95	1	0	0	26	6	4	0
Stony Run	358	15	1	0	8	0	0	0
Kimsey Run/Dove Hollow	542	23	0	0	28	17	0	26
Trout Pond	220	2	0	0	0	0	0	0
River Road/Durgon Run	196	1	0	0	13	7	2	0
Shook's Run/Stump Run	58	1	0	0	0	0	0	0
Howard's Lick/Upper Cove Run	578	14	* 31	0	11	12	0	20
Peru/Milam	71	1	0	0	15	0	0	3
Culler's Run	266	4	0	0	36	1	1	4
Crab Run/Capon Run	107	0	0	0	26	5	0	2
TOTALS	**4,369**	**118**	**35**	**2**	**256**	**92**	**35**	**63**

Number and location of residences, commercial businesses, government facilities, and schools provided by the Hardy County E911 Addressing System. Number, location, and type of poultry operation provided by the USDA-NRCS. * Government facilities in Howard's Lick subwatershed are the Lost River State Park facilities.

Table 4-3
ESTIMATED WATER CONSUMPTION BY USE AND SUBWATERSHED IN HARDY COUNTY

Subwatershed	Groundwater Use (Gallons Per Day)								
	Residences	Comercial Businesses	Governmental Facilities	Schools	Poultry - Broilers	Poultry – Breeders	Poultry - Pullets	Poultry - Turkeys	TOTALS
Turnmill/Mudlick	24,450	44	0	0	11,136	15,134	1,512	0	**52,276**
Trough/Clifford Hollow	12,300	88	44	0	6,264	631	0	0	**19,327**
North River	24,150	264	0	0	11,136	0	0	0	**35,550**
Arkansas/Sperry Run	27,600	132	0	0	0	0	0	0	**27,732**
McCauley/Sauerkraut Run	27,750	10,748	44	0	4,176	1,262	0	0	**43,980**
Moore's Run/Slate Rock Run	38,100	88	44	0	696	631	0	10,015	**49,574**
Walnut Bottom/Anderson Run	18,600	44	0	0	3,480	4,417	8,064	0	**34,605**
Dumpling Run/Fort Run	38,850	352	0	0	9,048	631	4,536	0	**53,417**
Camp Branch/Parker Hollow	31,050	440	44	4,525	17,400	3,786	0	0	**57,245**
Trout Run	11,850	44	0	0	1,392	0	0	0	**13,286**
Waite's Run	27,000	176	0	0	0	1,262	0	6,009	**34,447**
Rig/Kessel/Fisher	14,250	44	0	0	18,096	3,786	2,016	0	**38,192**
Stony Run	53,700	660	44	0	5,568	0	0	0	**59,972**
Kimsey Run/Dove Hollow	81,300	1,012	0	0	19,488	10,729	0	52,078	**164,607**
Trout Pond	33,000	88	0	0	0	0	0	0	**33,088**
River Road/Durgon Run	29,400	44	0	0	9,048	4,417	1,008	0	**43,917**
Shook's Run/Stump Run	8,700	44	0	0	0	0	0	0	**8,744**
Howard's Lick/Upper Cove Run	86,700	616	1,540	0	7,656	7,572	0	40,060	**144,144**
Peru/Milam	10,650	44	0	0	10,440	0	0	6,009	**27,143**
Culler's Run	39,900	176	0	0	25,056	631	504	8,012	**74,279**
Crab Run/Capon Run	16,050	0	0	0	18,096	3,155	0	4,006	**41,307**
TOTALS	***655,350***	***15,148***	***1,760***	***4,525***	***178,176***	***58,044***	***17,640***	***126,189***	***1,056,832***

4.3 - SPRINGS

Selection and Location of Springs

County officials requested that twenty-five (25) natural springs be studied for the purpose of potential water supply sources. The initial request included five (5) springs that access and/or information could not be obtained on. These springs were locally known as Green Spring, Powder Spring, Large Spring, PeeWee Spring and Huffman/Thrasher Spring. Additional springs were substituted so the evaluation would include a total of twenty-five (25). Approximate geographic locations for each spring were determined. Table 4-4 summaries the available information on the springs of interest, including some information from USGS sources, where available.

Spring Characteristics

Spring discharges are from a variety of sources. Most discharges are from the 1975 USGS publication Records of Wells, Springs, and Streams in the Potomac River Basin, West Virginia or from the 1986 Springs of West Virginia book. In a few instances, measurements were conducted in the field or estimated by the landowner. None of the twenty-five (25) springs is reported to have gone dry. Eighteen (18) of the springs have discharges in excess of 100 gallons per minute (gpm); two (2) of these have flows of 1,000 gpm or better. These springs would be the most likely candidates for water supply source development, based on the quantity of water that each could supply.

Five (5) springs were reported with flows of less than 100 gpm. These springs were eliminated from consideration for water source development due to their limited discharge potential. Two springs have no flow information. No water quality testing was conducted at any of the springs, but limited water quality data is available from the cited publications.

Hydrogeologic Characteristics

The springs are all greatly influenced by their structural geologic setting. They occur along the flanks and/or near the hingelines of several major and minor fold axes, including the Patterson Creek Mountain Anticline, Broad Top Anticline, the Hanging Rock Anticline and surrounding structural system, the Great North Mountain Anticline, the structural system surrounding the Baker Mountain Anticline, the Anderson Ridge Anticline and other unnamed, closely-spaced folds.

The high discharges from several of the springs (Big Spring and Lower State Farm Spring) can also be attributed to their structural setting. The flow of these springs is reported to be augmented by their situation near plunging anticlines, especially when located at the noses (Big Spring) of these structures. Additional increased flow may be attributed to the fracturing or faulting that often occurs in zones normal to the predominant structural trend (Lower State Farm Spring).

Another factor that promotes the occurrence of the springs is their hydrogeologic/stratigraphic setting. The majority of the springs are associated with the Oriskany Sandstone, a major water-bearing unit in the area. Fewer of the springs are situated within the prominent carbonate aquifers of the Tonoloway Limestone, Helderberg Group, and Wills Creek Formation.

Minor occurrences of the reported springs are also associated with the shales of the Martinsburg Formation, the Tuscarora Sandstone, and the Needmore and Harrell shales. One (1) spring, Tannery Spring, occurs near the sandstone/shale interface. An additional spring, Frye Spring, is located near the contact between two distinct geological settings. These springs most likely represent perched conditions that mark the contact between the rocks/geologic materials of such contrasting permeabilities.

Other Pertinent Factors

Springs are widely occurring in Hardy County and are currently utilized as a water supply source for several localities within the county. There are a few limitations, however, relevant to the practicality and feasibility of exploiting this resource for additional sources of potable water. Concerns regarding dependable yield and quality of springs should be considered prior to adopting their widespread use.

There is potential for the introduction of contaminants into the ground water. The springs themselves may act as direct conduits between the surface and subsurface water bearing zones. This is especially true in areas where recharge or direct hydraulic contact is occurring via fractures, solutional openings, or other potential conduits that may facilitate the migration of surface-derived contaminants into the ground water. Care must be taken in the evaluation and selection processes to ensure that springs designated as water supply sources are not affected by these processes prior to their development.

Recommendation

Highland Spring, Big Spring and Dumpling Run Spring have significant flows and could serve as potential water supply sources. As demonstrated by the Wardensville System, which relies on the Hawkins Farm Spring, springs can serve as viable water supply sources. In the event that additional water supply is needed in the vicinity of these spring locations, they should be considered as potential sources. Additional flow and water quality evaluations would be necessary for each spring.

TABLE 4-4
DESIGNATED SPRINGS IN HARDY COUNTY

Spring Number	Local Name	Other Identification Number	Lat/Long from "Springs of WV"	Discharge (gpm)
1-S	Highland Spring	No USGS Information (1)		1000+
2-S	Canada Spring	No USGS Information		No USGS Information
3-S	Sulfur Spring	25-1-27 (USGS) #3 (Springs of WV)	39°09'27"N 73°56'23.1"E	1.3
4-S	Waterfall Spring East	No USGS Information		100
5-S	Pancake Spring	No USGS Information		250
6-S	Warner Spring	#25 (Springs of WV)	39°04'37"N 79°03'22.1"E	250
7-S	Tannery Spring	No USGS Information		20
8-S	Dumpling Run Spring	25-3-5 (USGS) #58 (Springs of WV)	38°53'30"N 79°03'10.1"E	934
9-S	White Cloud Green Spring	25-3-4 (USGS) #59 (Springs of WV)	38°53'27"N 79°02'57.1"E	100
10-S	Upper Cove Spring	25-4-1 (USGS) #62 (Springs of WV)	38°52'03"N 78°49'28.1"E	87
11-S	T.W. Strawderman Spring	#49 (Springs of WV)	38°57'06"N 78°47'39.1"E	170
12-S	Baker Mine Spring	25-3-3 (USGS) #30 (Springs of WV)	39°03'18"N 78°43'19.1"E	250
13-S	Lost River/Route 55 Spring	#27 (Springs of WV)	39°03'54"N 78°39'20.1"E	0.7
14-S	Camp Pinnacle Spring	25-2-2 (USGS) #20 (Springs of WV)	39°04'47"N 78°39'07.0"E	450
15-S	J. Ginn Spring	No USGS Information		No USGS Information
16-S	Big Spring	25-2-3 (USGS) #29 (Springs of WV)	39°03'45"N 78°37'45.1"E	5,220
17-S	Lower State Farm Spring	25-2-9 (USGS) #14 (Springs of WV)	39°06'10"N 79°35'16.1"E	740
18-S	Upper State Farm Spring	25-2-4 (USGS) #16 (Springs of WV)	39°05'47"N 78°35'59.1"E	156
19-S	Frye Spring	No USGS Information		10
20-S	Boiling Spring	25-2-7 (USGS) #38 (Springs of WV)	39°01'16"N 78°36'20.1"E	103
21-S	Waterfall Spring West	25-1-10 (USGS) #7 (Springs of WV)	39°08'18"N 79°01'02.1"E	280
22-S	J.M. McNeil Spring	25-1-9 (USGS) #8 (Springs of WV)	39°08'18"N 78°58'03.1"E	100
23-S	Cold Spring	#23 (Springs of WV)	39°04'40"N 78°37'15.1"E	100
24-S	Unnamed Spring	#24 (Springs of WV)	39°04'38"N 79°03'17.1"E	300
25-S	Lower Cove Spring	25-4-2 (USGS) #63 (Springs of WV)	38°61'47"N 78°50'15.1"E	100

(1) These springs were not included in any scientific reference, thus information is limited to the name, approximate flow, and approximate location.

CHAPTER 5 WASTEWATER

Information regarding wastewater in Hardy County was obtained from the West Virginia Division of Environmental Protection (WVDEP) and the West Virginia Public Service Commission. The WVDEP provided a listing of all permit numbers/types/permittees/locations, etc. for all types of permits in Hardy County that are WVDEP-regulated. For the three (3) wastewater treatment systems that report to the West Virginia Public Service Commission (Town of Moorefield, Town of Wardensville, and Hardy County Rural Development Authority), the annual reports for the years 1997, 1998, and 1999 were obtained and reviewed. Individual wastewater treatment facility inventories and plant operator interviews were conducted for the two (2) municipal systems identified (Town of Moorefield, Town of Wardensville), to gather further information on system type and management, administration, system demand, collection system, and overall system condition.

5.1 - WVDEP Permitted Systems

There are thirteen (13) WVDEP-regulated sewage dischargers permitted in Hardy County. The sewage permit entities are reported as follows:

Table 5-1
WV/NPDES SEWAGE DISCHARGE PERMITS IN HARDY COUNTY

	Entity
1.	Caledonia Heights
2.	R.C. Byrd Industrial Park
3.	East Hardy Middle School
4.	East Hardy High School
5.	E.A. Hawse
6.	Town of Moorefield
7.	Town of Wardensville
8.	Pilgrim's Pride
9.	Con-Agra
10.	Walmart
11.	WV Parks & Recreation - Lost River State Park
12.	WV Parks & Recreation – Trout Pond Rec Area
13.	N&S Family Restaurant

More detailed information for each system is summarized by the system overviews. The existing sanitary sewage collection systems, which include manholes, lift stations, and outfalls, were located by Global Positioning Systems (GPS) survey techniques to an accuracy of 5.0' horizontal and 0.1' vertical. This information is provided in shapefile format, concurrent with Environmental Science and Research Institute's (ESRI) ARC GIS Software Package, in UTM 17, NAD 83 projection. This data is provided in a GIS database for local planners to use and maintain.

5.2 - Impact of Wastewater on Water Resources

The Moorefield and Wardensville public wastewater systems serve an area less than the area served by their drinking water supply systems. Therefore, a large percentage of the population is not served by wastewater treatment systems. Major industrial and commercial sources maintain their own wastewater treatment systems. When comparing the populations served by these various systems, it is evident that wastewater of the major population centers of Hardy County is being treated, with the treated water discharging to the surface waters of the county. However, a large percentage of rural areas of Hardy County treat wastewater by on-site treatment systems, such as septic tanks and leach fields.

Recommendation

As noted above, much of Hardy County is unserved by an organized wastewater collection and treatment system. A number of existing systems/private homes provide collection with no treatment before discharging directly into surface waters. Countywide, the lack of proper wastewater handling capability can have a negative impact on water resources. This may be evidenced, at least in part, by the presence of fecal bacteria detected by several sampling programs in surface and ground waters at various locations. As the population grows, the impacts of wastewater on water resources will continue to increase. It is recommended that a more comprehensive approach to wastewater and sewage collection be adopted by Hardy County.

It is also recommended that a plan for maintaining and updating the GIS database that accompanies this report be formulated by the Hardy County Commission. A central point of contact should be established so that the database is maintained by one entity and shared with all other planning organizations in the county. Maintenance is critical so that the database reflects the most current water and sewer distribution lines, system upgrades, changes in roads, additions of key facilities, and other information that allows the system to be used for planning.

Town of Moorefield
Wastewater System

System Location	The Town of Moorefield wastewater treatment system is located between U.S. Route 220/State Route 28 (North Main Street) and the South Branch of the Potomac River, in the Town of Moorefield.
Service Area	The wastewater treatment system serves the Town of Moorefield and some unincorporated areas outside of Town
Organization	The system is owned and operated by the Town of Moorefield. It is staffed by one (1) chief certified operator, two (2) additional certified operators, a clerk, and the town recorder.
System Capabilities	The system serves approximately 770 households. It has a design flow of 0.6 million gallons per day (mgd). Based on a review of monthly Discharge Monitoring Reports for 1999/early 2000, the system reported an average flow of 0.298 mgd, with a maximum reported flow of 0.320 mgd, and a minimum flow of 0.270 mgd.
System Facilities	The system consists of a comminutor/bar screen; 590,000 gallon aeration pond; 21,357,000 gallon stabilization pond; ultraviolet disinfection unit; and chlorine disinfection system. The outfall discharges into the South Branch of the Potomac River.
System Condition	The wastewater treatment system and much of the collection system were built over 20 years ago. The system was upgraded in 1987, and 3 miles of collection lines were added in 1987. Their general condition is fair to good. All older (Orangeberg) line is being replaced when encountered. Planned system improvements include the installation of two (2) dividers in aeration pond, their division into four (4) cells, the addition of 100 horsepower pump for aeration, the construction of a chlorine contact chamber, and upgrades to the pump stations.
Future Plans	The Town of Moorefield is seeking funding for design of a regional waste- water treatment facility. The facility would serve the western portion of the county.

Town of Wardensville
Wastewater System

System Location	The Town of Wardensville sewer plant is located along the Cacapon River, to the west of Route 55, approximately one (1) mile north of Wardensville.
Service Area	The system serves the Town of Wardensville and some unincorporated areas outside of Town.
Organization	The system is owned and operated by the Town of Wardensville. It is staffed by a full time certified operator and a billing and collection clerk. A second operator is in training.
System Capabilities	The system serves approximately 283 households. It has a design flow of 0.120 million gallons per day (mgd). Based on a review of monthly Discharge Monitoring Reports for 1999, the system reported an average flow of 0.026 mgd, with a maximum reported flow of 0.055 mgd, and a minimum flow of 0.006 mgd.
System Facilities	The system consists of a grit chamber, a comminutor, a bar screen, two (2) 3-acre stabilization ponds, and 6,500 gallon chlorine contact tank. The outfall discharges into the Cacapon River of the Potomac River.
System Condition	The wastewater treatment system and collection system were built in 1985. Their general condition is good. A dechlorination unit is planned to be installed.

Caledonia Heights Subdivision
Wastewater System

System Location	About 1.5 miles northeast of Moorefield
Owner	Hardy County Rural Development Authority 204 Washington Street Moorefield, WV 26836
Permit #	WVG550723
Type of System	Non-aerated lagoon
Treatment Capacity	21,500 gal/day.
System Problems	Pond is full of sludge; stormwater inflow and infiltration.
Planned Improvements	Connection to Town of Moorefield by mid-June, 2004.

E.A. Hawse Continuous Care Facility
Wastewater System

Location	Community of Baker, WV
Owner	AM/FM of Hardy County Inc. P.O. Box 70 Baker, WV 26801
Permit#	WVG550120
Type of System	Non-aerated lagoon
Treatment Capacity	20,500 gal/day
System Problems	Algae, prevents ultraviolet exposure
Planned Improvements	Chlorination/de-chlorination to be added.

East Hardy High School
Wastewater System

Location	Community of Baker, WV
Owner	Hardy County Board of Education 510 Ashby St. Moorefield, WV 26836
Permit #	WV0100969
Type of System	Package Plant
Treatment Capacity	5,000 gal/day
System Problems	Operation and maintenance
Planned Improvements	New operator as of March, 2004.

East Hardy Early-Middle School
Wastewater System

Type of System	Package Plant
Treatment Capacity	6,000 gal/day
System Problems	Operation and maintenance
Planned Improvements	New operator as of March, 2004

Robert C. Byrd Industrial Park
Wastewater System

Location	About 1.8 miles northeast of Moorefield
Owner	Hardy County Rural Development Authority 204 Washington Street Moorefield, WV 26836
Permit #	WVG551085
Type of System	Package Plant
Treatment Capacity	20,000 gal/day
System Problems	Plant leaked untreated wastewater into groundwater; malfunctioning lift stations; operation and maintenance.
Planned Improvements	Remediation of leaks and lift stations.

Pilgrim's Pride Live Production Plant
Wastewater System

Location	Moorefield, WV
Owner	Pilgrim's Pride of WV P.O. Box 359 Moorefield, WV 26836
Permit #	WV00548
Type of System	Bio-oxidation Ditch, Activated sludge
Treatment Capacity	2.16 million gal/day
System Problems	Land application of sludge under review by WV Division of Environmental Protection
Planned Improvements	None

Pilgrim's Pride Processing Plant
Wastewater System

Location	Moorefield, WV
Owner	Pilgrim's Pride of WV P.O. Box 359 Moorefield, WV 26836
Permit #	WV0047236
Type of System	Bio-oxidation Ditch, Activated sludge
Treatment Capacity	1 million gal/day
System Problems	Land application of sludge under review by WV Division of Environmental Protection
Planned Improvements	None

Lost River State Park
Wastewater System

Location	About 5 miles east of Community of Mathias
Owner	WV Division of Natural Resources Charleston, WV
Permit #	WVG550937
Type of System	Package Plant
Treatment Capacity	9,000 gal/day
System Problems	None
Planned Improvements	A service line extension is planned in 2004-05

N&S Family Restaurant
Wastewater System

Location	Community of Mathias, WV
Owner	Carol Miller 5935 Dove Hollow Road Mathias, WV 26812
Permit #	WVG5500949
Type of System	Package Plant
Treatment Capacity	2000 gal/day
System Problems	Operation and maintenance
Planned Improvements	New operator as of March, 2004

Trout Pond Recreation Area
Wastewater System

Location	About 10 miles west of Community of Lost River, WV
Owner	U.S. Forest Service 5162 Valley Point Parkway Roanoke, VA 22801
Permit #	WVG550214
Type of System	Pond system, with aerator
Treatment Capacity	13,200 gal/day
System Problems	None
Planned Improvements	None

Moorefield Walmart
Wastewater System

Location	About 1 mile north of Moorefield, WV
Owner	Walmart Stores, Inc. 2001 South East 10th Street Bentonville, ARK. 72716-0550
Permit #	WVG550944
Type of System	Package Plant
Treatment Capacity	10,000 gal/day
System Problems	None
Planned Improvements	Connection to Town of Moorefield System

CHAPTER 6 PUBLIC WATER SUPPLY

The community water supplies addressed in this assessment are based on West Virginia Division of Health's (WDOH) definition of a public water supply

> **Public Water System** - Any water system or supply which regularly supplies or offers to supply, piped water to the public for human consumption, if serving at least an average of twenty-five (25) individuals per day for at least sixty (60) days per year, or which has at least fifteen (15) service connections and includes:
>
> (1) Any collection, treatment, storage, and distribution facilities under the control of the owner or operator of the system and used primarily in connection with the system, and
>
> (2) Any collection or pretreatment storage facilities not under such control which are used primarily in connection with the system.

There are twenty-six (26) public water supply systems within Hardy County. Eight (8) of these systems supply water to the general public for a per month charge to the user. The remaining eighteen (18) systems supply water to a closed community with the user not billed for the water consumed.

6.1 - EXISTING WATER SYSTEMS

The twenty-six (26) public water systems are comprised of a combination of public service districts (PSDs), municipal systems, community associations, and private systems. Overviews for each water system were assembled from data collected from the Division of Health Sanitary Surveys, water system inventories, and other information from federal and state agencies. They are identified on Table 6-1.

Water System Sources

The majority of the water systems in the county utilize ground water wells as their primary raw water source. One (1) system (Wardensville Water) uses a spring as its source while twenty (20) use wells. Moorefield Municipal Water system is the only system to utilize surface water as its source. There are intakes on both the South Branch and the South Fork Rivers. Four (4) systems (Caledonia Heights, Hardy County PSD 220 South, Hardy County PSD 220 North, and Hardy County PSD-Trout Run) purchase water in bulk from Wardensville and Moorefield Municipal Water. The water systems that served Critestown and Rig were taken over by the Hardy County PSD in 2003.

Water Treatment

All of the twenty-six (26) public water systems provide some form of water treatment. Treatment facilities are in fair to good condition. The majority of the systems are reported to be in compliance with State and Federal drinking water quality requirements. Finished water quality is generally good.

Transmission, Distribution, and Storage

Transmission, distribution, and storage of each system are presented in the system overviews. Facilities range from 6 to 50 years in age, with generally good conditions. Only six (6) systems (Moorefield

Municipal Water, Wardensville Water, Caledonia Heights, Hardy County PSD 220 South, Hardy County PSD 220 North, and Hardy County PSD-Trout Run) maintain an active leak detection program; the same six (6) systems totally meter system sales and have a meter replacement program. The difference between water supplied to the system and the metered consumption is termed "unaccounted-for-water". Unaccounted-for-water may result from leaking distribution systems, public uses such as hydrant flushing and fire-fighting, losses during repairs, unmetered customers, or other uses, such as unmetered service within the system. Different accounting practices and, in particular, the extent of metering within a system can greatly affect the amount of unaccounted-for-water that a system recognizes. Irregular meter arrangement within the treatment plant can result in misinterpretation of the plant production and the amount of process water used during water treatment. In addition, certain data necessary for water demand evaluations were not reported, and portions of the reported data were considered suspect. In these cases, the unaccounted-for-water was estimated to be 20%. Estimated unaccounted-for-water ranges from 2.0 % to 19.0 %, and the countywide average is approximately 12.4%. In unmetered systems, it is impossible to trace system losses. The water industry standard for unaccounted-for-water is regarded to be 15 % for well-maintained and normally operated water systems.

Administration

Moorefield Municipal Water, Wardensville Water, Caledonia Heights, Hardy County PSD 220 South, Hardy County PSD 220 North, and Hardy County PSD-Trout Run are the only systems that have complied with the WVPSC requirement of submitting an Annual Report. The Hardy County PSD files a joint report for 220 South, 220 North, and Trout Run. The remaining systems file separate reports.

Table 6-1
PUBLIC WATER SYSTEMS IN HARDY COUNTY

System Name	Water Producer	Bulk Purchaser	Ownership
Moorefield Municipal Water	✓		Municipal
Wardensville Water	✓		Municipal
Caledonia Heights		✓	Rural Development Authority
E.A. Hawse Continuous Care Center	✓		Private
Hardy County PSD - 220 South		✓	Public Service District
Hardy County PSD - 220 North		✓	Public Service District
Hardy County PSD - Trout Run		✓	Public Service District
East Hardy Schools	✓		County
E.A. Hawse Health Center	✓		Private
Big Ridge Campground	✓		Private
Camp Hemlock	✓		Private
Camp Pinnacle	✓		Private
Lost River Retreat Center	✓		State
Lost River State Park	✓		State
Lost River State Park	✓		State
Trout Pond – USFS	✓		Federal
M&S Grocery	✓		Private
Wolf Gap Picnic – USFS	✓		Federal
Lost River Grill	✓		Private
Mathias Community Center	✓		Private
Warden Ridge Service Center	✓		Private
Lost River Retreat Center	✓		State
Corner Mart	✓		Private
Misty Valley Hardware Center	✓		Private
N&S Family Restaurant	✓		Private
Baker Run General Store	✓		Private

Moorefield Water System
Municipal

System Location - On the South Fork of the South Branch of the Potomac River at Moorefield.

Service Areas - The system serves the Town of Moorefield, Southfork Estates, Misty Terrace, and the Industrial Park. In addition, it sells water to the Hardy County Public Service District.

Administration and Organization - The Moorefield Municipal Water System is owned and operated by the Town of Moorefield. The Town Council oversees the operation of the system. A certified operator performs day to day operations, testing, repairs, and reports. Four to five certified operators repair breaks, test, read meters, and install hook ups. Four other workers perform administrative duties.

Source and Intake – Surface water, South Fork River as primary source, South Branch River as secondary source. The pumping station on the South Branch is owned by the Hardy County Public Service District. The intakes are located in the center of the rivers on the channel bottom. A low level dam is in use on the South Fork River only.

Treatment - Design capacity: 4,800,00 gallons per day (Total Both Plants) Typical Operation: 16 hours/day, 3,000,000 gallons per day Processes: Flocculation, coagulation, sedimentation, filtration, and disinfection. Average chemical feed rates: Chlorination 2ppm

Distribution - The Moorefield Municipal Water System consists of two plants, the "old plant" and the "new plant". The distribution/transmission system consists of 2-inch to 12-inch PVC, AC, ductile iron, and cast iron piping, approximately twenty years old. Average system pressure is 40-100 psig.

Interconnects - Bulk water supplier to the Hardy County PSD and Hardy County Rural Development.

Storage - Three steel storage ground level tanks (1,000,000 gal; 1,250,000 gal; 1,500,000 gal) were constructed in 1975, 1993, and 1988, respectively. They are in good physical condition.

System Conditions and Problems - The "old plant", approximately 50 years old, was upgraded in 1984 and is in good physical condition. The "new plant" was constructed in 1994 and is also in good physical condition.

Planned Improvements – Moorefield has contracted with engineers to design an additional 1.5 million gallon storage tank and improvements that will increase the plant's pumping capacity.

Wardensville Water
Municipal

System Location - Approximately 3/4 miles east of Wardensville

Service Areas -The system serves the Town of Wardensville and Warden Acres. In addition, it sells water to the Hardy County Public Service District.

Administration and Organization - Wardensville Water is organized as a municipal water system. A certified operator reads meters, collects samples, and performs routine maintenance. A part-time clerk performs administrative duties.

Source and Intake - Wardensville Water System utilizes Hawkins Farm Spring as a supply. The spring is located 3/4 miles east of Wardensville and has an estimated sustained yield of 65 gallons per minute. Water from the spring collection system enters a 2,200 gallon clear well through two six inch perforated pipes. In 1997, a WVBPH Sanitary Survey reported the spring was being directly influenced by surface water. A drainage ditch below the pump house has been closed and 500 LF of 24 inch CMP pipe has been installed to divert storm water away from the spring box. Wardensville has an approved wellhead protection plan.

Treatment - Design capacity: 72,000 gallons per day. Typical Operation: 50,000 gallons per day Processes: Disinfection by gas chlorination system. Average chemical feed rates: Chlorine 0.5lbs/day

Distribution - The distribution/transmission system consists of 2-inch to 8-inch PVC piping, approximately 32 years old. Average system pressure is 20 - 85 psig. A valve exercise and maintenance program is performed every 6 months.

Interconnects - Bulk water supplier to Hardy County PSD System with an average of 260,000 gallons per month sold through 4-inch lines and 2-inch meters.

Storage - Two steel storage tanks (100,000 gal; 300,000 gal) were constructed in 1968 and 1985, respectively, and are in good condition.

System Conditions and Problems - The system was constructed in 1968 and is in adequate condition.

Planned Improvements - A new water well as a second source has been constructed, but is not on line yet. Additional funds are needed to complete work on the well. The size of the clear well is to be increased. Storage tanks are to be upgraded and low pressure areas are to be corrected but, to date, no plans or funds have been secured.

Caledonia Heights Water System
Hardy County Rural Development

System Location - Purchaser only; no plant facilities

Service Areas and Demands - The system serves Caledonia Heights subdivision.

Administration and Organization - The system is owned and operated by the Hardy County Rural Development Authority. A part-time certified operator samples and prepares reports. Other part-time employees perform administrative duties. A contract operator provides maintenance, repairs, hook-ups, and meter reading and replacing.

Source and Intake - Purchases domestic water from the Town of Moorefield. Water for a fire line is purchased from the Hardy County PSD through a 6-inch main.

Treatment - None

Distribution - Distribution/transmission system consists of 80LF of 2 inch PVC pipe, 5,740 LF 6 inch PVC pipe, and 7,904 LF of 8 inch PVC pipe, with a minimum pressure of 23psig, provided by the Town of Moorefield.

Interconnects - Town of Moorefield is primary interconnect, supplying 150,000 gallons per month drinking water. The Hardy County PSD provides a separate system of 6 inch fire water line.

Storage - Provided by the Town of Moorefield.

System Conditions and Problems - The WVBPH 1999 Sanitary Survey states that the system needs to begin a cross-connection control and backflow prevention program.

Planned Improvements - None

E.A. Hawse Continuous Care Center
Private

System Location - Along Lost River, east of Route 55, 3/4 miles northeast of Baker.

Service Areas and Demands - Only the E.A. Hawse Continuous Care Center nursing home and assisted living apartments are served by this system.

Administration and Organization - The E.A. Hawse System is privately owned by AM/FM of Hardy County. A certified operator performs maintenance and is responsible for testing and sampling. Two other staff members perform administrative duties. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - Well No. 1 went dry and is no longer in use. Well No. 2 (500 ft) had a decrease in yield to 3 gallons per minute and is no longer in service. Well No. 3 (750 ft) is in good condition with a safe yield of 25 gallons per minute.

Treatment - Design Capacity: 25,000 gallons per day. Typical Operation: 9.5 hours per day resulting in 7,500 gallons per day. Processes: Disinfection. Chlorination by metered pump

Distribution - The distribution/transmission system consists of 60 LF of 2-inch PVC pipe, 3,500 of 6-inch PVC pipe and 100 LF of 12-inch ductile iron pipe. The distribution/transmission systems were built in 1984 and are in good condition.

Interconnects - None

Storage - One steel tank (60,000 gallon), in good condition, was constructed in 1984. It was cleaned in 1995.

System Conditions and Problems - The system was constructed in 1989 and is in good physical condition. The 1996 WVBPH Sanitary Survey concluded that chlorine residual was not continuously maintained, and a bacteriological sampling plan needs developed. It further states that the wells not in use need to be properly closed and a wellhead protection program should be developed.

Planned Improvements - None

Hardy County Public Service District Areas
Public Service District

System Location - Purchaser only; no plant facilities

Service Areas and Demands - The Public Service District serves three service areas: 220 South Service Area (Fisher); the 220 North Service Area (Old Fields); and the Trout Run Area.

Administration and Organization - The three areas are owned and operated by the Hardy Public Service District. An executive director and two staff members perform administrative duties. A certified water operator samples and oversees operations. Maintenance and meter reader services are contracted.

Source and Intake - The 220 South and 220 North Public Service Areas purchase water from the Town of Moorefield; the Trout Run Public Service Area purchases water from the Town of Wardensville.

Treatment - Design Capacity: 70,000 gallon per day total (220 South/North); 42,000 gallon per day (Trout Run). Typical Operation: 65,000 gallon per day total (220 South/North); 14,000 gallon per day (Trout Run). Processes: Chlorination

Distribution - Distribution/transmission for the 220 South and North Areas are provided by the Town of Moorefield through 2-inch meters to 6-inch PVC pipe. The distribution/transmission system is approximately 6 years old and is in good condition. Distribution/transmission for the Trout Run Area is provided by the Community of Wardensville through 2-inch meters to 6-inch PVC pipe.

Interconnects - Hardy County PSD receives bulk finished water supplies from Moorefield for the 220 South and 220 North service area. It receives bulk finished water supplies from Wardensville for the Trout Run service area. Hardy County PSDs resell to industrial and residential customers with no bulk sales interconnects.

Storage - Six steel tanks, all in good condition, have a combined capacity of 439,000 gallons (100,000 gal, 158,000, 142,000 gal, 53,000 gal, 54,000 gal, and 22,000 gal).

System Conditions and Problems - The 1999 WVBPH Sanitary Survey indicates that 220 South is in good physical condition, with approved coliform sampling and lead and copper monitoring plans. It indicated the system needs to develop a cross-connection control and backflow prevention program. Deficiencies noted were a need for a bacteriological sampling and chlorine monitoring plan and performing the required monitoring for lead and copper. The 1997 WVBPH Sanitary Survey for Trout Run Public Service Area stated that the water system is complying with all requirements of WV public water supply regulations. It was recommended that a lead and copper monitoring program be initiated.

Planned Improvements - Exploration of future water sources in Baker, Mathias, Lost River, and South Fork Road.

E.A. Hawse Health Center
Private

System Location - Rt. 55 Baker

Service Areas and Demands - This system serves the E.A. Hawse Health Center employees and patients.

Administration and Organization - This a private system. The operator employed by E.A. Hawse Continuous Care Center is also responsible for the system maintenance, sampling, testing, and records. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well that is approximately 103 feet deep.

Treatment - Design capacity: 15,000 gallons per day. Typical Operation: 2,500 gallons per day. Processes: Disinfection by chlorination. Average chemical feed rates: Chlorine 15 ml/L

System Conditions and Problems - The system is in good condition and has a wellhead protection program in place.

Planned Improvements - None

Lost River State Park
State-Owned
Two Systems

System Location - Lost River State Park

Service Areas and Demands - These systems serve Lost River State Park guest cabins, pool, restaurant, one (1) residence, and staff facilities.

Administration and Organization - These are state-run systems. The operation and maintenance of these systems are by the Lost River State Park. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The sources are 2 water wells.

Treatment - Design capacity: 20 gallon per minute. 47 gallon per minute. Typical Operation: No data. Available Processes: Disinfection by chlorination

Planned Improvements - None

Baker Run General Store
Private

System Location - State Route 55 at Needmore

Service Areas and Demands - The water system is for store use only.

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by the Baker Run General Store. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements - None

Mathias Community Center
Private

System Location - Mathias

Service Areas and Demand - Mathias Community Center

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by the Mathias Community Center. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Treatment - Disinfection by chlorination

Planned Improvements - None

Misty Valley Hardware
Private

System Location - Mathias

Service Areas and Demand - This system serves the Misty Valley Hardware and Grocery.

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by the Misty Valley Hardware Store. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements - None

Corner Mart
Private

System Location - Baker

Service Areas and Demands - This system serves the Corner Mart

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by the Corner Mart. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements - None

Lost River Retreat Center
State-Owned

System Location - Lost River

Service Areas and Demands - This system serves the Lost River Retreat Center

Administration and Organization - This is a state-run system. Operation and maintenance of this system are by the Lost River Retreat Center. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements - None

Warden Ridge Service Center
Private

System Location – Baker

Service Areas and Demands - This system serves the Warden Ridge Service Center

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by the Warden Ridge Service Center. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Treatment - Disinfection by chlorination, iron removal by green sand filter

Planned Improvements - None

Camp Hemlock
Private

System Location - Wardensville

Service Areas and Demands - This system serves Camp Hemlock.

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by Camp Hemlock. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements - None

Camp Pinnacle
Private

System Location – Moorefield

Service Areas and Demands - This system serves the 4-H Camp.

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by Camp Pinnacle. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Treatment - Chlorination

Planned Improvements - None

United State Forest Service Trout Pond
Federal

System Location - Lost River

Service Areas and Demands - This system serves the Trout Pond Area.

Administration and Organization - This is a federal-run system. Operation and maintenance of this system are by the USFS. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements – None

M&S Grocery
Private

System Location - Mathias

Service Areas and Demands - This system serves the M&S Grocery

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by M&S Grocery. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Treatment - Chlorination

Planned Improvements - None

United State Forest Service Wolf Gap
Federal

System Location- Wardensville

Service Areas and Demands - This system serves the Wolf Gap Area.

Administration and Organization - This is a federal-run system. Operation and maintenance of this system are by the USFS. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements - None

Lost River Grill
Private

System Location - Lost River

Service Areas and Demands - This system serves the Lost River Grill restaurant, nine (9) motel rooms, and employees.

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by the Lost River Grill. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Treatment - Chlorination

Planned Improvements – None

N&S Family Restaurant
Private

System Location – Mathias

Service Areas and Demands - This system serves N& S Family Restaurant

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by N&S Family Restaurant. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements – None

Big Ridge Campground
Private

System Location - Mathias

Service Areas and Demands - This system serves the Big Ridge Campground.

Administration and Organization - This is a private-run system. Operation and maintenance of this system are by the Big Ridge Campground. Since this is a private water provider with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake - The source is a well.

Planned Improvements – None

East Hardy Schools Complex
County

System Location – Baker

Service Area and Demands – This system serves East Hardy Early Middle School, East Hardy High School, and East Hardy Vocational Technical School, with approximately 750 students and staff.

Administration and Organization – This is a county-run system. Operation and maintenance is provided by the Hardy County Board of Education. Since this system is operated solely to serve the students and staff at the three schools, with no sales of its water, no financial reports are required by the WVPSC or WVBPH.

Source and Intake – The source are two wells

Treatment – Chlorination

Planned Improvements – None

Compliance – Raw water testing performed by the WVBPH for the period of March to May, 2000, on well #1 and well #2 revealed high total and fecal bacteria levels from well #1. A Sanitary Survey was conducted by the WVBPH in August, 2000, which determined well #1 to be under the influence of surface water (**GUIDI**). A new well was permitted and constructed to replace well #1 in November, 2001. Subsequently, both wells were determined to be free of the direct influence of surface water in August, 2003 by the WVBPH.

Water Quality Data – The owner-operator of this system has complied with WVBPH requirements for raw and finished water testing and reporting.

CHAPTER 7 Adequacy of Existing Water Systems

Data regarding water demands for the various public and private water supplies in Hardy County were evaluated from four (4) primary sources: WV PSC Annual Reports; Sanitary Surveys; water system inventories, and operator interviews. Water system adequacy and projected increases in water demand were determined for the two municipal systems. Projections were not made for systems that served only a single source, such as N&S Family Restaurant, or for transient systems, such as campgrounds. Because the Hardy County PSD purchases bulk water from the two municipal systems, increased demand for PSD water is already accounted for in the calculations for Moorefield and Wardensville systems.

The public water systems that will be evaluated are identified below:

Table 7-1
WATER SYSTEM INFORMATION FOR HARDY COUNTY

Water System	Ownership	System
Town of Moorefield	Municipal	Treatment, Transmission, Storage, Distribution, and Bulk Sales
Town of Wardensville	Municipal	Treatment, Transmission, Storage, Distribution, and Bulk Sales

An estimate of current demands was made utilizing all available data. Projected water demands were based on projected growth and water industry standards.

The following description of terms is provided to aid the reader in understanding the data presented and associated calculations. Average daily demand (ADD), which is the average amount of water supplied to the systems on each day of the year, is the sum total of metered consumption and unaccounted-for water. Total metered consumption, or total sales, is the sum total of the water used by all of the customers in the system and measured by each customer's meter. Unaccounted-for water is the difference between the amount of water delivered to the water system (average daily demand) and total metered consumption. Unaccounted-for water does not produce revenue. It includes such water uses as line flushing, fire fighting, leakage, and inaccurate supply metering. Although unaccounted-for water can never be eliminated, it should be minimized. Certain uses, however, are necessary and a normal part of providing public water. Unaccounted-for water in most small and medium size public water systems should be maintained at or below 15% of the ADD. Maximum daily demand (MDD) is the greatest quantity of water supplied to the system in one full day of a particular year. It is often evaluated and projected as a multiple of ADD; for example, 1.5 times the ADD. This value is necessary for evaluating and designing source and treatment systems.

Service Areas

Generally, the systems tend to either follow linear paths along steep mountain valleys that are typical of West Virginia, or they are limited to closely-knit communities and do not extend much into the rural areas beyond these towns' boundaries. The existing water systems serve approximately 39% of the county population, with the Hardy County PSD, Moorefield and Wardensville having the largest service areas.

7.1 - Estimated Population Served and Water Demands

Current water demands are presented in Table 7-2. For Moorefield, the ADD is approximately 3.1 million gallons per day and MDD is approximately 5.1 million gallons per day. Wardensville has an ADD of approximately 64,400 gallons per day and a MDD of record of approximately 77,000 gallons per day

Projected Population Served

Approximately 39% of the current households in the county are served by public water. Population in Hardy County is expected to increase by 25% by the year 2020. This expectation is based on historical census data, population predictions, housing trends, Corridor H construction, and input from local planners. It is also anticipated that the Hardy County PSD, Moorefield, and Wardensville will continue to expand their water systems to serve the increasing rural population. Once a treatment plant and distribution lines are completed, public water will be available from the Lost River Site 10 impoundment. The largest potential customer base for expanded public water is in the Baker area. A significant number of households will be candidates for public water once it becomes available at Lost River Site 10 and/or Lost River Site 4.

Adequacy of Existing Water Systems

Criteria were developed to evaluate the systems' abilities to meet current and future water supply needs. The general categories for evaluation of each system were the source, treatment, transmission, distribution, and storage components of each system. System capacity and source capacity were evaluated for Year 2020 demands for the Moorefield and Wardensville systems.

Table 7-2
REPORTED WATER SYSTEM DATA IN HARDY COUNTY[1]

Water System	Average Daily Demand (gpd)	Maximum Daily Demand of record (gpd)	Maximum Daily Demand Industry Standard (1.5 *ADD)	Total Metered Consump-tion (gpd)	Total Bulk Sales (gpd)	Retail Metered Consump-tion (gpd)	Unaccounted for Water		Residential taps	Commercial taps	Industrial taps
							(gpd)	%			
Moorefield [2]	3,060,627	5,059,800	4,590,941	2,720,920	216,945	2,512,194	290,616	9.5	840	252	24
Wardensville[3]	64,380	76,966	96,570	52,126	10,397	41,729	12,254	19	257	40	2

1. The Hardy County PSD bulk purchases are included in the average daily demand and maximum daily demand for Moorefield and Wardensville system
2. The information provided is from the 2003 West Virginia Public Service Commission Report
3. The information provided is from the 1999 West Virginia Public Service Commission Report

Table 7-3
PROJECTED WATER SYSTEM DEMANDS THROUGH YEAR 2020 IN HARDY COUNTY

Water System	Year 2000 Average Daily Demand (gpd)	Maximum Daily Demand of record (gpd)	Year 2000 Maximum Daily Demand Industry Standard (1.5 *ADD)	Year 2020 Projected Average Daily Demand (gpd) (ADD*25 %)	Year 2020 Projected Maximum Daily Demand (1.5 *ADD)
Moorefield	3,060,627	5,059,800	4,590,941	3,825,784	5,738,676
Wardensville	64,380	76,966	96,570	80,475	120,713

TABLE 7-4
ADEQUACY OF WATER SOURCE IN HARDY COUNTY

Water System	Source Capacity (gpd)	Source Adequacy				Source Affected by Drought	Contingency Source Available
		Year 2000		Year 2020			
		Adequate	Surplus (gpd)	Adequate	Surplus (gpd)		
Moorefield	4,650,000 [1.]	Yes	1,857,877	Yes	1,159,846	No	No
Wardensville	129,600	Yes	65,220	Yes	49,125	No	No

[1.] South Branch intake only. South Fork will provide another .59 million gallons per day. $Q_{7\text{-}10}$ low-flow worst case conditions.

TABLE 7-5
ADEQUACY OF TREATMENT FACILITIES IN HARDY COUNTY

Water System	Plant Limit (gpd)	Processes [1]	Year 2020 System Capacity			
			Storage Capacity	Combined Storage and Plant Capacity	Projected 2020 MDD (gpd)	Adequate
Moorefield	4,800,000	D,FL, C, S, F, TO	3,750,000	8,550,000	5,738,676	Yes
Wardensville	72,000	D	400,000	472,000	120,713	Yes

[1.] D – disinfection, FL – flocculation, C – coagulation, S – sedimentation, F- filtration, TO – taste/odor control

7.2 Sources of Supply

All systems were evaluated using their Year 2020 estimated MDDs. Water source adequacy is presented in Table 7-4. Moorefield draws its water from a surface

water source. Wardensville uses the Hawkins Farm Spring for its water source. The Town of Moorefield water treatment plant was originally constructed in the 1950s. In 1984, the original plant underwent a major upgrade. With the demand for more finished water, the Town of Moorefield constructed a second plant in 1994 to supplement the water being produced from the original upgraded plant. As part of the Town of Moorefield's water system upgrades, a supplementary raw water intake was constructed, with both plants being capable of withdrawing water simultaneously or separately from the South Fork of the South Branch of the Potomac River or the South Branch of the Potomac River.

When siting a public water supply withdrawal a normal industrial standard is that the maximum designed water withdrawal should be no larger than 10 % of the surface water body's low flow, averaged over 7 days." Approximately 75 years of historical stream flow data for the period from 928 to 2003 were analyzed at two USGS gaging stations located upstream of the river intakes. The $Q_{7\text{-}10}$ low flow statistic for each gaging station was computed according to methods prescribed by the USGS and was linearly transposed according to contributing drainage area to estimate $Q_{7\text{-}10}$ low flow values at each respective river intake. The maximum allowable withdrawal rate at each river intake was selected to correspond to 10 percent of the $Q_{7\text{-}10}$ low-flow discharge. The results of these analyses are summarized in Table 7-6.

Table 7-6
SUMMARY OF MAXIMUM WITHDRAWAL RATE ANALYSES FOR MOOREFIELD WATER TREATMENT PLANT RIVER INTAKE SITES

River Intake	USGS Gage Number	$Q_{7\text{-}10}$ at Gage	$Q_{7\text{-}10}$ at Intake	Maximum Withdrawal Rate 10% $Q_{7\text{-}10}$
South Branch Potomac River	01606500	52.0 cfs	72.4 cfs	7.24 cfs (4.65 million gallons per day)
South Fork South Branch Potomac River	01608000	9.0 cfs	9.1 cfs	0.91 cfs (0.59 million gallons per day)

For both gaging periods for the two (2) river gaging stations, the combined minimum seven day low flow period was more than the Town of Moorefield's intake capacity (both plants) of 4.8 million gallons per day. The recorded dry period experienced in 1999 had an impact on both of the town's raw water sources, but, even with this impact from the unusually dry period, sufficient raw water was available with a withdrawal of less than ten percent (10%) of the seven (7) day low flow.

The Town of Wardensville receives its raw water supply from a spring. The reported normal flow of the spring is 90 gallons per minute. Interviews with the water system operator indicated that the spring has never gone dry. During periods of dry weather, with the most notable being 1999, this raw water source continued to provide water for the Town of Wardensville.

The Town of Wardensville has recognized the vulnerability of this single raw water source, plus its potential susceptibility to prolonged periods of dry weather. In addition, the projected average daily demand, as well as the maximum daily demand, are shown to increase over the next twenty (20) years. For these two factors, the Town of Wardensville has recognized a need for an additional water source.

USGS is conducting an analysis on the Wardensville Spring that will provide more information on the spring's yield. This study is scheduled for completion in Summer 2004 and is being funded by the WVCA.

7.3 - Treatment Facilities

Treatment facility evaluations were based on facility age, general observed conditions of facilities, and information provided by the system operators. Treatment capacities, processes, and evaluations for each system are presented in Tables 7-4 and 7-5.

Both the Moorefield and Wardensville municipal water systems have adequate water sources and plant/storage capacity to meet the 2020 maximum daily demand. Wardensville is adding a second water source and additional treatment system capacity to supplement the supply from the Wardensville Spring. Continued system improvements and enhancements at Moorefield and Wardensville will enable both systems to provide long-term, safe, reliable drinking water into the future.

7.4 - Transmission, Distribution and Storage Facilities

Normal water industry practice recommends the presence of 8-inch mains, which are generally regarded as the minimum size to provide domestic and fire service. Existing service areas were inventoried for their storage capacities and sizes of their primary transmission lines. Secondary transmission mains are recommended to be a minimum of 6-inch piping.

General information regarding the location of water system transmission lines is provided in the GIS component accompanying this study. However, the length and extent of transmission lines were not identified for each system. System operators may want to supplement the GIS information with pipe sizes and configurations. Such information may reveal that the piping network will need some changes to provide suitably sized mains within reasonable reach of all service areas, in the event of a fire.

The summary of system storage is shown on Table 7-7. This storage provides the system with an ability to absorb normal daily peaks in demand without causing an excessive load on the treatment plant. The treatment plant can "catch up" by filling the storage during low demand periods, such as overnight, and the tank supplements the system during the day, when demands are high. This effect is referred to as "equalization". In addition to equalization, one day's ADD provides storage for emergency conditions, such as when the treatment plant must be taken off-line.

Recommendation

Lost River Site 4 and Site 10 have been evaluated as potential public water supply sources. Both sites have adequate storage capacity to supply water and also have public land available at both sites for construction of a water treatment plant. It is recommended that these sites be further developed as water supply sources for the central portion of the county. It is also recommended that the length and extent of transmission lines be determined for each system and added to the GIS.

Table 7-7
SUMMARY OF SYSTEM STORAGE IN HARDY COUNTY

Water System Name	Tank ID	Age	Size and Dimensions			Material Type	Base Elevation (ft)	Top Elevation (ft)	Reported Condition
			Volume (gal)	Height (ft)	Diameter (ft)				
Moorefield	Cold Spring	12	1.5M	50	72	Steel	1,000	1,050	Good
	Paskell Hill	25	1.0M	50	58	Steel	1,000	1,050	Good
	Paskell Hill	7	1.25M	50	65	Steel	1,000	1,050	Good
Wardensville Water	Anderson Ridge	32	100,000	Not Provided	--	Steel	1,200	1,232	Good
	Warden Acres	15	300,000	Not Provided	--	Steel	1,040	1,055	Good
Hardy County PSD 220 South	Wolfe Mountain	11	100,000	24	27	Steel	1,210	1,234	Good
Hardy County PSD 220 North	Route 55	6	142,000	38	25	Steel	1,278	1,316	Good
Hardy County PSD Trout Run	Trout Run	3	53,000	Not Provided	--	Steel	1,200	--	Good
Hardy County PSD	Carla's Acres	1	158,000	28	31	Steel	1,186	1,210	Good
Hardy County PSD	Barr Run	1	54,000	24	20	Not Provided	1,518	1,542	Good
Hardy County PSD	County Line	1	22,000	19	14	Not Provided	1,898	1,917	Good

CHAPTER 8 LOST RIVER TREATMENT PLANT COST

An engineering study was conducted by Gannett Fleming, Inc., under contract to NRCS, to determine the estimated cost of constructing a new water treatment plant near the Lost River Site 10 impoundment. The impoundment is currently under construction and will provide flood control as well as water supply to residents in the Lost River Valley and downstream. The impoundment was enlarged to include 400 acre feet of water supply that will serve as a municipal water source for residents and businesses in that area.

Safe Yield Analyses

A safe yield analysis was conducted for Lost River Site 10 and also for Lost River Site 4, which may potentially serve as a water supply source in the future. The safe yield investigations for this study are based on analyses using 80 years of streamflow and climatic records (1923 to 2003). The method of analysis involved programming a custom computer model to simulate the daily operation of each reservoir. The results of the safe yield analyses for Lost River Site Nos. 4 and 10 are presented in Table 8-1. The safe yield values presented in Table 8-1 assume no reservoir conservation releases or seepage losses.

Table 8-1
SUMMARY OF SAFE YIELD ANALYSES

Project Site	Worst Drought of Record Between 1923 and 2003			
	Begin Drawdown	Lowest Storage	Complete Refill	Safe Yield (gpd)
Lost River No. 4	June 21, 1965	Feb. 2, 1966	Feb. 15, 1966	1,560,000
Lost River No. 10	May 11, 1930	March 1, 1931	April 13, 1931	690,000

Drawdown Analyses

Drawdown analyses for both reservoirs, assuming a constant draft rate of 375,000 gpd, indicate that reservoir drawdown for both reservoirs at this draft rate should not be significant. Almost no drawdown should theoretically be expected at Lost River Site No. 4 because of the large drainage area and corresponding runoff and base flow into this reservoir. An additional simulation was made for Lost River No. 4 assuming a constant draft rate of 375,000 gpd with a 1,000,000 gpd allowance for seepage and reservoir releases in order to determine the reservoir drawdown statistics for this scenario. Even with the additional 1,000,000 gpd reservoir losses, the reservoir levels at Lost River Site No. 4 are relatively stable and the reservoir should remain full most of the time. Reservoir elevation statistics for the period from 1923 to 2003 for the aforementioned draft rates are presented in the full report, as referenced in the ***Executive Summary*.**

Water Treatment Plant Costs

Water treatment plant costs were evaluated based on treated water production at a constant rate of 375,000 gallons per day. Costs were based on a water treatment process typically used and proven to be effective for upland reservoir sources with raw water quality similar to Lost River Reservoir No. 4 and

Reservoir No. 10. Debt service costs were computed assuming a 30-year evaluation period with a prime interest rate of 4.0 percent. Annual operating costs were computed assuming a 16-year service life. Capital costs, annual operating costs, and debt service costs are summarized in table 8-2.

Table 8-2
SUMMARY OF WATER TREATMENT PLANT COSTS

	Single Plant	Both Plants
Construction Cost	$3,300,000	$6,600,000
Engineering Design and Construction Management [1]	$750,000	$1,030,000
Total Capital Cost:	$4,050,000	$7,630,000
Debt Retirement (Interest = 4%, 30-year period)	$234,210	$441,240
Average Annual Operating Cost	$195,000	$390,000

(1) Engineering cost for two plants reflects economies realized by engineering both plants simultaneously

Newer technologies, such as membrane filtration, are available that may reduce construction and operating costs, if they can be shown to adequately treat raw water from these sources. Alternate technologies would require pilot testing to confirm their application to these source waters.

Recommendations

The safe yield analyses performed in this study were based on the assumptions that no reservoir conservation releases are required from either reservoir and that reservoir seepage is insignificant. Should minimum conservation releases become a requirement for either project, the safe yield available from either source may need to be re-evaluated, especially if the release requirement is variable. For most reservoirs the release requirement is an established minimum rate of flow judged necessary to support biological demands or aesthetic characteristics within the stream channel downstream of the dam. Often the actual release achieved is the lower of the target minimum flow or the actual reservoir inflow.

Review of analysis results indicates a possible discrepancy between observed conditions at Lost River Site No. 4 during the 2002 drought event and the simulated conditions of the system using reservoir inflows transposed from downstream gaging stations for this same period. As noted in the report, possible explanations for this discrepancy may include: (1) unregulated withdrawals from the streams that discharge into the reservoir by farmers or other users, (2) discrepancies between the transposed flows from the downstream stream gaging stations and the actual flows in to the reservoir, and/or, (3) undetected seepage from the dam or reservoir.

Prior to developing either Lost River Site No. 4 or Lost River Site No. 10 as raw water sources for water supply, it is recommended that detailed analyses of seepage from the dams be performed as well as investigations to establish current and future unregulated withdrawals from the contributing drainage system upstream of the dams. If it is determined that either of these losses are significant, the safe yield values presented in this study should be updated and adjusted accordingly.

It is also recommended that alternate water treatment processes be reviewed and evaluated by pilot testing prior to proceeding with design of water treatment facilities at Lost River Site Nos. 4 and 10.

RECOMMENDATIONS

This report provides a comprehensive look at water resources in Hardy County. Several recommendations are provided throughout the report for specific resource issues. Those recommendations are repeated here as key conclusions and actions that should result from this study.

Recommendation for Ground Water Monitoring

It is highly recommended that Hardy County initiate a ground water monitoring program. Cooperating parties in the county have done an excellent job of identifying and assimilating much of the data needed for resource planning. A critical element still missing is data on aquifer response, specifically ground water levels. The basic data needed for ground water analysis begins with water level monitoring data. Ground water levels in wells change annually and seasonally due to changes in pumping and precipitation. Monitoring the ground water level should occur every year at the approximately same time. This data is critical to the effective evaluation of recharge, water withdrawal rates, and aquifer response with respect to sustainable use of the resource. In the eastern United States, spring time water level measuring in agricultural areas is the most common. This is because recharge has been maximized during the rainy season of winter and spring and water use is minimal. Ground water level monitoring is easy to do accurately and is inexpensive, and the resulting data base is invaluable for assessment of aquifer conditions, trends in water levels, and of impacts of changing water use patterns.

Recommendation for Springs

Highland Spring, Big Spring and Dumpling Run Spring have significant flows and could serve as potential water supply sources. As demonstrated by the Wardensville System, which relies on the Hawkins Farm Spring, springs can serve as viable water supply sources. In the event that additional water supply is needed in the vicinity of these spring locations, they should be considered as potential sources. Additional flow and water quality evaluations would be necessary for each spring.

Recommendation for Wastewater

Much of Hardy County is unserved by an organized wastewater collection and treatment system. A number of existing systems/private homes provide collection with no treatment before discharging directly into surface waters. Countywide, the lack of proper wastewater handling capability can have a negative impact on water resources. This may be evidenced, at least in part, by the presence of fecal bacteria detected by several sampling programs in surface and ground waters at various locations. As the population grows, the impacts of wastewater on water resources will continue to increase. It is recommended that a more comprehensive approach to wastewater and sewage collection be adopted by Hardy County.

Recommendation for Water Supply in the Lost River Valley

Lost River Site 4 and Site 10 have been evaluated as potential public water supply sources. Both sites have adequate storage capacity to supply water and also have public land available at both sites for construction of a water treatment plant. It is recommended that these sites be further developed as water supply sources for the central portion of the county. The Hardy County Commission should pursue an agreement with WV-DNR to utilize Lost River Site 4 for potential water supply.

The safe yield analyses performed in this study were based on the assumptions that no reservoir conservation releases are required from either reservoir and that reservoir seepage is insignificant. Should minimum conservation releases become a requirement for either project, the safe yield available from either source may need to be re-evaluated, especially if the release requirement is variable. For most reservoirs the release requirement is an established minimum rate of flow judged necessary to support biological demands or aesthetic characteristics within the stream channel downstream of the dam. Often the actual release achieved is the lower of the target minimum flow or the actual reservoir inflow.

Review of analysis results indicates a possible discrepancy between observed conditions at Lost River Site No. 4 during the 2002 drought event and the simulated conditions of the system using reservoir inflows transposed from downstream gaging stations for this same period. As noted in the report, possible explanations for this discrepancy may include: (1) unregulated withdrawals from the streams that discharge into the reservoir by farmers or other users, (2) discrepancies between the transposed flows from the downstream stream gaging stations and the actual flows in to the reservoir, and/or, (3) undetected seepage from the dam or reservoir.

Prior to developing either Lost River Site No. 4 or Lost River Site No. 10 as raw water sources for water supply, it is recommended that detailed analyses of seepage from the dams be performed as well as investigations to establish current and future unregulated withdrawals from the contributing drainage system upstream of the dams. If it is determined that either of these losses are significant, the safe yield values presented in this study should be updated and adjusted accordingly.

It is also recommended that alternate water treatment processes be reviewed and evaluated by pilot testing prior to proceeding with design of water treatment facilities at Lost River Site Nos. 4 and 10.

Recommendation for GIS Database

It is also recommended that a plan for maintaining and updating the GIS database that accompanies this report be formulated by the Hardy County Commission. A central point of contact should be established so that the database is maintained by one entity and shared with all other planning organizations in the county. Maintenance is critical so that the database reflects the most current water and sewer distribution lines, system upgrades, changes in roads, additions of key facilities, and other information that allows the system to be used for planning.