# APPENDIX A

## Existing Conditions

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# EXISTING CONDITIONS

Appendix A describes the existing conditions of the groundwater resources in the Susquehanna River Basin.

First, it is important to understand that although all earth materials (rocks and unconsolidated materials) have the potential to store and transmit water in the subsurface, some have greater abilities to do so than others. There are commonly three types of aquifers in the Susquehanna River Basin: karst, fractured bedrock, and porous media (stratified drift, alluvium, and colluvium). Each type possesses its own unique hydrogeologic properties. The areal extent of these aquifers is commonly limited in comparison to many of the regional aquifers within the United States. These small basin aquifers are maintained by an annual infusion of recharge.

Existing groundwater conditions in the basin result from a number of factors, including *climate, physiography, land use, groundwater quality,* and *groundwater use*. The following sections describe how each of these factors relates to the occurrence, movement, and management of the resource.

## Climate

Climatic conditions control the quantity and timing of precipitation, as well as evapotranspiration, and thus, recharge potentially available to the groundwater system. As a humid region in the northeastern United States, the Susquehanna River Basin receives a generous amount of precipitation, averaging 40 inches annually (National Oceanic and Atmospheric Administration, 2002). Most of the precipitation is in the form of rain, although the northern portions of the basin can receive significant amounts of snowfall. During any given year, variation in precipitation throughout the basin can be significant (Figure A.1).

Weather patterns in the northern and western areas of the basin are primarily influenced by systems moving from the mid-West United States, and “lake-effect” systems moving across northwestern Pennsylvania from Canada. The southern part of the basin tends to exhibit mild climatic conditions, controlled largely by weather systems moving into the region from the southern and coastal areas. Climatic conditions for the central part of the basin are generally transitional between the northwestern and southern portions of the basin, and largely controlled by the Appalachian Mountains.

Based on the regional climate patterns, most groundwater recharge in the basin tends to occur in the spring and fall. During the spring months, recharge from snowmelt and rain showers occurs in significant quantities before increased air temperatures and vegetative growth occur. Recharge also is significant after leaf fall and before the ground begins to freeze.

Water levels in the small aquifers in the Susquehanna River Basin are maintained by the annual infusion of recharge. A basinwide estimation of recharge to groundwater resources during average conditions is on the order of 13 inches. However, recharge is less than this amount half of the time, and water management decisions based on average conditions will fall short half of the time.

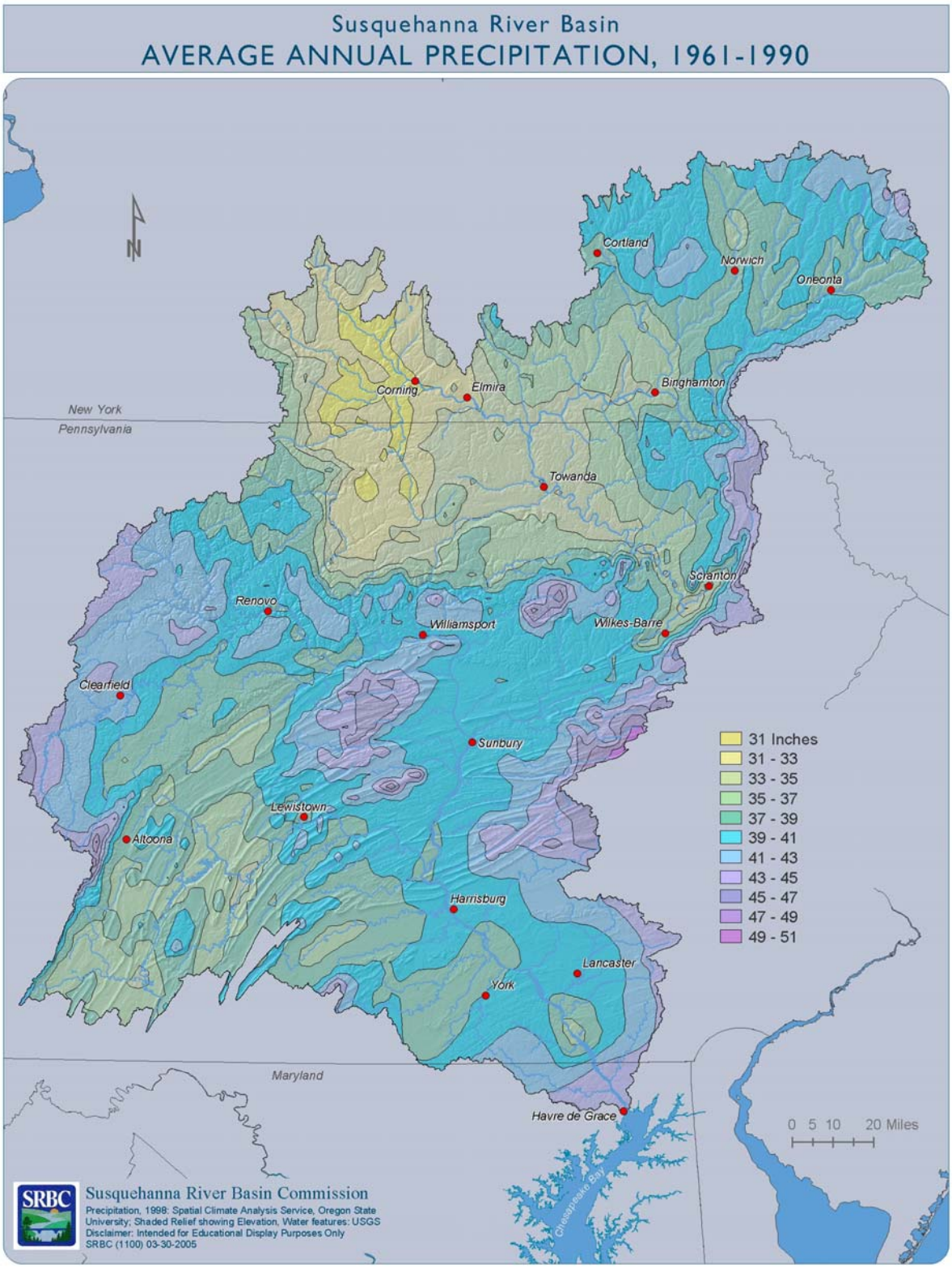


***Figure A.1. Long-Term Average Annual Precipitation in the Susquehanna River Basin***

A drought with a 1-in-10-year recurrence interval would trigger a “drought warning” designation, one of the three levels of drought stage defined according to the Commission's Drought Coordination Plan. Water resource management agencies monitor four hydrometerological parameters, along with public water supply reservoir levels, to form a regional picture indicating the onset and easing of drought conditions across the basin. One of the parameters is groundwater level measured in the USGS observation well network, which is generally comprised of one well per county, basinwide. The other two stages are “drought watch,” indicated when conditions generally reach a 1-in-4-year frequency event, and drought emergency, indicated when conditions reach a 1-in-20-year frequency event. Depending on the areal extent of precipitation deficiencies, drought can impact portions of, or the entire, Susquehanna Basin during any given event.

During periods of extended drought, fractured bedrock aquifers tend to deplete the most rapidly, while karst and porous media aquifers show signs of depletion later. Conversely, during periods of recovery from drought conditions, fractured bedrock aquifers are the first to recover, followed by porous media aquifers and then karst aquifers. The reason for this phenomenon is that fractured bedrock aquifers generally have the least amount of available groundwater storage and aquifer transmissivity, while the other two types have substantial underground storage and high transmissivity. As a result, water levels in fractured bedrock aquifers are an excellent early indicator of the onset of drought conditions. Droughts are not considered over until porous media and, particularly, karst aquifers recover into normal ranges. Although some fractured rock aquifers which have high amounts of groundwater storage due to the presence of deep residuum or deep weathering, such as many of the Piedmont metamorphic crystalline aquifers, are far less sensitive to drought.

In recent years, drought conditions have persisted for many consecutive months, resulting in multiyear drought events. Most of these events were caused by insufficient groundwater recharge occurring during the period of leaf fall through spring runoff to bring aquifer levels back into normal ranges. Consequently, groundwater storage was abnormally low before the peak summer demand period began. With little summer recharge, streamflows were at abnormally low base-flow levels for most of the growing season (five or six months). Ultimately, these extended drought periods resulted in widespread well failures. The wells most vulnerable to failure were those developed in fractured bedrock aquifers having low storativity and transmissivity, especially those located on hilltops and hillsides.

The drought of 2002 is an example of a multiyear regional drought event that began in fall 2001. In fact, this multiyear drought event would have extended back to a beginning in 1998 had it not been for the twin hurricanes, Dennis and Floyd, occurring in September 1999. Figure A.2 shows the precipitation deficits that had accrued for the drought from October 2001 through December 2002. For precipitation deficits accumulated over 11 months, 12 inches of deficiency indicate a drought emergency. However, precipitation deficits are only one of five drought-monitoring parameters. Although the deficits do not alone trigger a drought emergency, the magnitude and timing of the deficits is significant. Most of the precipitation deficiencies accrued over the fall and winter seasons during the period critical for groundwater recharge. This condition caused drought conditions to be worse than those indicated by precipitation deficits alone.

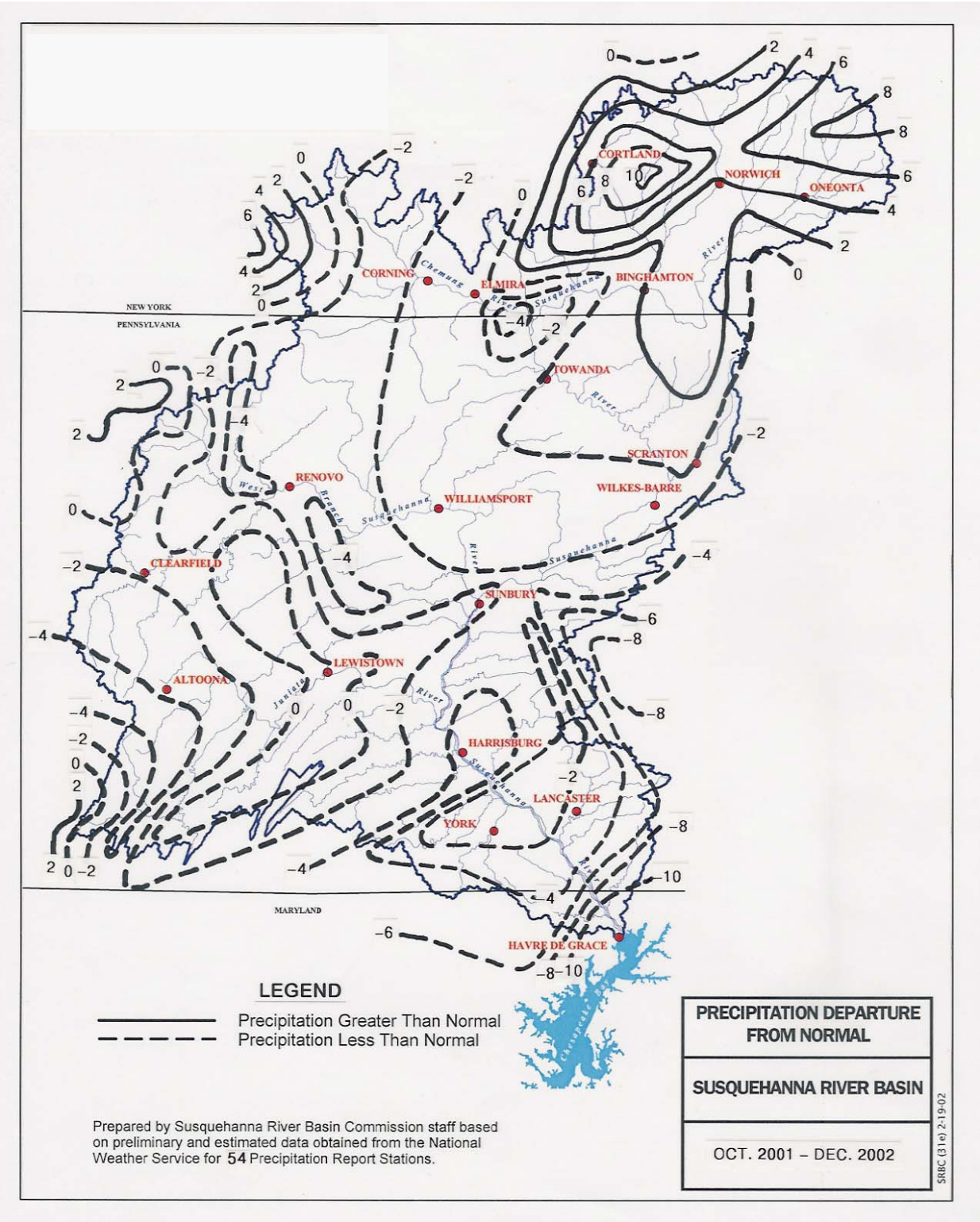


***Figure A.2. Precipitation Departure From Normal, Susquehanna River Basin, October 2001 through December 2002***

Figure A.3 presents the monthly average depth-to-water plotted against the historic record (about 40 years) for 6 basin USGS observation wells. The Dauphin and Cumberland County wells, within the most severely impacted drought area, indicate numerous record monthly low levels before the recovery began in October 2002. Illustrating the extent of the drought-affected area, the Union and Bradford County wells also experienced near record low groundwater levels during the summer months.

More often than not, droughts, particularly within the southern and eastern portions of the basin, are ended with a tropical storm tracking across the basin. Examples of this activity occurred in 1999 with Hurricanes Dennis and Floyd, and in September 1985, when Hurricane Gloria ended that year's drought in the eastern portion of the basin. September is the peak of the hurricane season, and is normally when base flow and groundwater levels are at their lowest. Therefore, “drought-busting” tropical storms are most likely to occur during that month.

Droughts also are frequently terminated by “nor'easters,” occurring when a cold air high pressure system in the north stalls, and moist air is pumped inland from an East Coast low pressure system. Nor'easters result in heavy snow or intense rainfall events, particularly in the eastern portion of the basin. Nor'easters generally occur between mid-October and February.

## Physiography

The physiography, determined by soils, geology, and local relief, has a strong influence on the infiltration, storage, and movement of water in the subsurface. To some degree, the physiographic setting also affects climatic conditions. Within the Susquehanna Basin, there are three predominant physiographic provinces (Figure A.4) that can be used to characterize the hydrogeologic setting. The principal physiographic provinces, from north to south, are the Appalachian Plateaus, Valley and Ridge, and Piedmont. In addition, a small portion of the Blue Ridge Province extends into the southern area of the basin, between the Valley and Ridge and the Piedmont. Each of these provinces has distinct physical characteristics (topography, geology, soils) that influence groundwater conditions.

The Appalachian Plateaus Province**,** comprising approximately 40 percent of the basin, is characterized by nearly flat-lying sedimentary rocks that have been dissected by streams to form deeply incised valleys. The hydrogeology within the Appalachian Plateaus Province is characterized by confined and semi-confined fractured bedrock aquifers. Aquifers in this province, unlike most of the basin, can have significant lateral extent. Overall, recharge rates typically associated with the mixed siliciclastics of this province are approximately 700,000 gallons per day per square mile (gpd/mi$^2$) (Taylor and others, 1983).

More than half of the Appalachian Plateaus Province within the basin was glaciated during the Pleistocene, and many of the valleys are partially filled with stratified drift and alluvium. The valley-fill aquifers are composed of interlayered and interlensing sand, gravel, and clay, and vary in thickness and composition throughout the province. The valley-fill aquifers are locally important, high-yielding, porous media aquifers (Taylor, 1984). Recharge to these aquifers tends to be higher than the fractured rock aquifers, and much of this recharge is provided by infiltration of runoff from adjacent bedrock uplands. The valley-fill aquifers are commonly in close communication (hydraulically connected) with the streams flowing across them. Therefore, wells in the valley-fill aquifers commonly induce infiltration of substantial quantities of surface water; the aquifer essentially serving as a natural gravel filter (Reynolds, 1987).

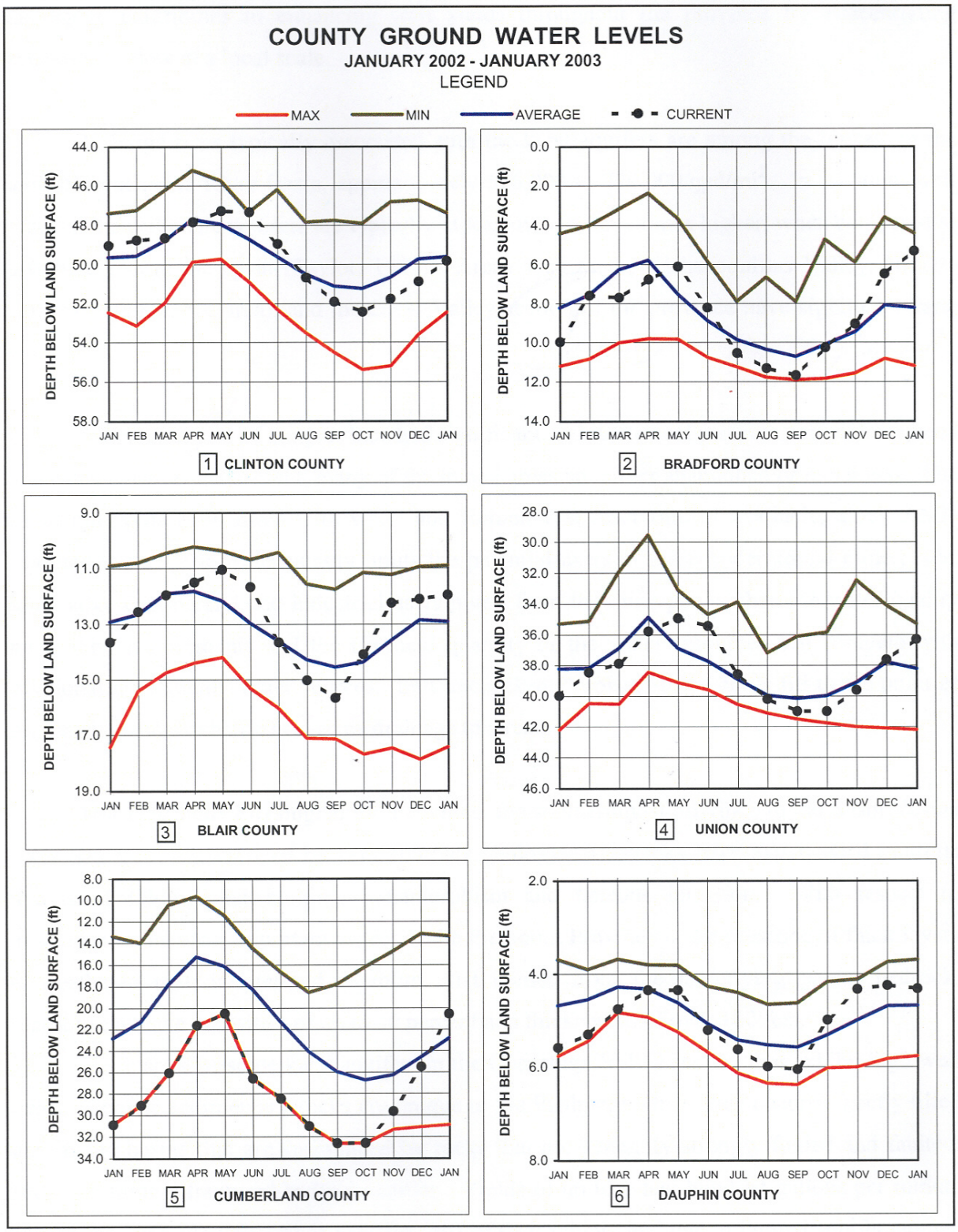


***Figure A.3. County Groundwater Levels, January 2002 through January 2003***

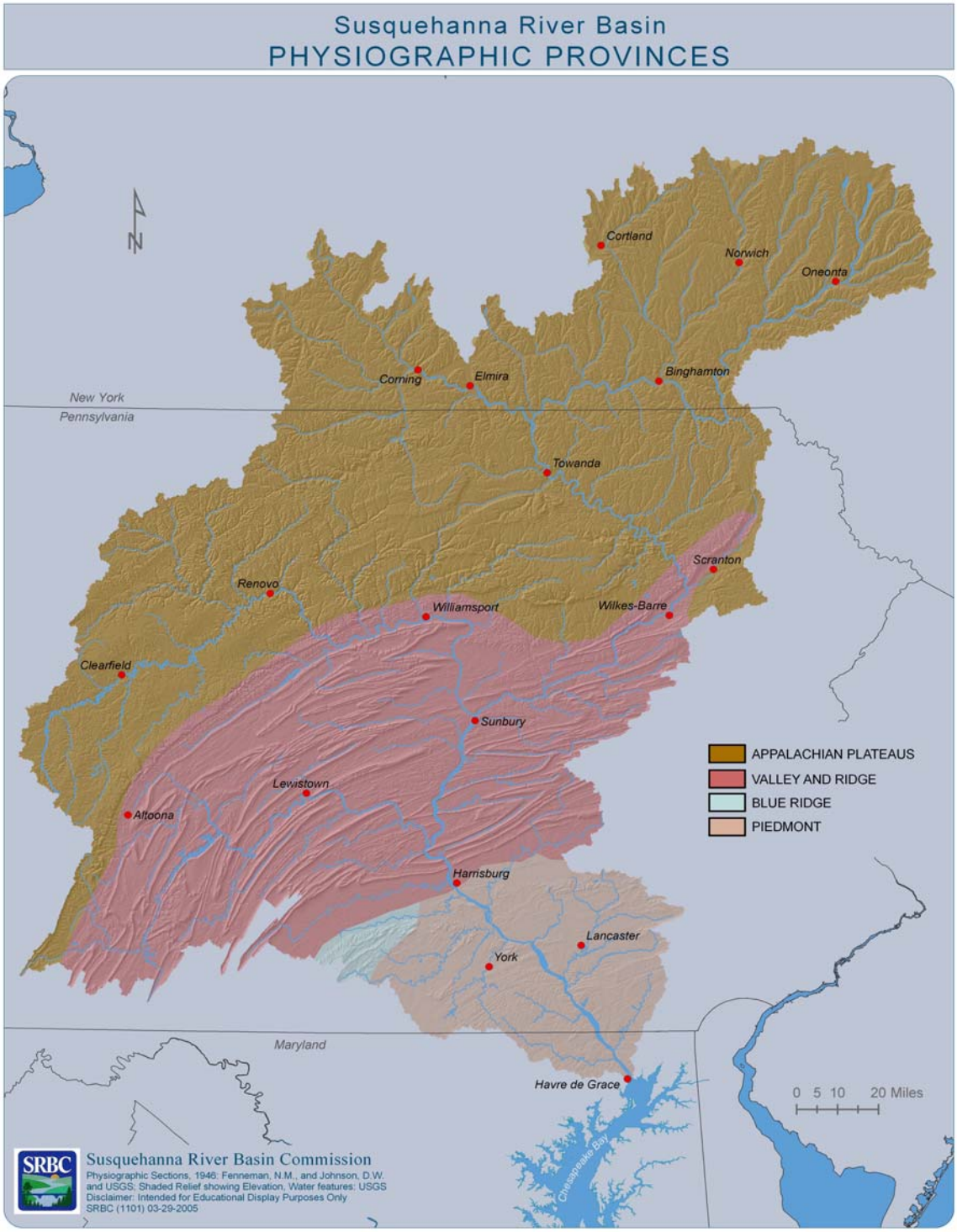


***Figure A.4. Physiographic Provinces in the Susquehanna River Basin***

In the western portion of the Appalachian Plateaus Province, bituminous coal reserves have been mined extensively in the past, and continue to be mined today. Mining has compromised the water quality in many watersheds and limits the potential areas available for groundwater development. However, mining has created many artificial high storage, high transmissivity aquifers (e.g., "mine pools"), resulting in an opportunity for increased water use if problems of water quality can be solved.

The Valley and Ridge Province is characterized by folded and faulted sedimentary rocks, typical of the Appalachian Mountains. The hydrogeology within the Valley and Ridge Province is characterized by fractured bedrock and karst aquifers of relatively small areal extent. The more erosion-resistant sandstones form the ridges, while the more productive fractured bedrock and karst aquifers lie in the valleys. The folding that is typical within the Valley and Ridge contributes a regular, systematic fracture permeability that enhances groundwater flow and well yields.

Recharge rates associated with the karst aquifers are among the highest in the entire Susquehanna River Basin, approximately 700,000 to 1,000,000 gpd/mi$^2$. In addition, well yields in the karst aquifers commonly exceed 1,000 gallons per minute (gpm) for professionally sited wells. Areas such as the Kishacoquillas Valley, Nittany Valley (State College area), and the Great Valley section of the province have important, aerially extensive karst aquifers.

The eastern portion of the province had significant anthracite coal reserves that have been extensively mined. At present, many of the mined areas are either abandoned or reclaimed. As in the western bituminous coal fields, the mined-out voids have filled with water and formed vast reservoirs of available, albeit acid mine drainage (AMD)-impacted, water. The water quality limits the potential use of these underground mine pools. Some large commercial and industrial users pump from the mine pools when the water quality meets their requirements, and the cost and quantity of the water resources can compete with traditional high quality water sources. Left unchecked, "orphan" mine pools fill to the point of overflowing and discharge AMD to streams.

The Piedmont Province, the southernmost province in the Susquehanna River Basin, is characterized by very complex geology. The rocks have experienced multiple periods of folding and faulting, metamorphism and igneous intrusion. With respect to groundwater, the most important aspect of the metamorphic-rock terrain of the Piedmont Province is the presence of thick layers of saprolite, a material that forms from isovolumetric weathering of the underlying parent bedrock. Saprolite can have porosities of up to 40 percent, and thicknesses of over 100 feet. There also are some karst aquifers in the Conestoga Valley section of the Piedmont that exhibit high well yields, similar to their counterparts in the Valley and Ridge Province.

Triassic sedimentary rocks are unique to the Piedmont. These rocks occur in gently-tilted and faulted basins that are surrounded by older, more indurated, strongly-folded and faulted rocks. The Triassic sedimentary rocks constitute a fractured bedrock aquifer. Yields of up to a few hundred gallons per minute are possible, but the yields often decline to less than half of their initial yield due to limited aquifer storage and fracture collapse caused by dewatering near the well. The Piedmont also is noteworthy for having the Triassic-Jurassic diabase intrusives. These are massive, crystalline rock bodies with weathering and fracturing extending to only shallow depths. The diabase intrusives have a very limited capacity to store and transmit groundwater, and are among the worst aquifers in the Susquehanna River Basin.

## Land Use

Land cover data for the entire Susquehanna River Basin were collected in the early 1990s (Figure A.5, Figure A.6), so trends in land use were not analyzed. The information was derived from USEPA Multi-Resolution Land Cover (MRLC) 1993 Landsat Thematic Mapper data, developed by the USGS Early Resources Observation Systems Data Center. United States Census Bureau data collected on populations, surveyed in 1990 and 2000, were used to assist with the general trends in population in the basin.

The Appalachian Plateaus Province consists of uplands that are separated by steep valleys. Much of the land is steeply sloped with hills and ridges dominated by forested land. Agricultural activity is split almost evenly between cropland and pasture grazing. Agricultural cropland occupies the valley areas possessing the more productive alluvial soil types. Pasture grazing is primarily on moderately to gently sloped uplands.

Small villages exist throughout the province. The major population centers in the province are Binghamton and Elmira/Corning, New York, and Towanda and Clearfield, Pennsylvania. Census data indicate that the population in the province has decreased slightly, or remained fairly constant from 1990 through 2000.

As mentioned in the "Physiography" section above, extensive bituminous coals fields within the province were mined in the past, and continue to be mined today on a more limited scale. The effects of mining on the subsurface hydrology are significant, particularly with respect to water quality.

The Valley and Ridge Province contains some of the most forested areas in the basin. These are primarily located on the long, even-crested, mountain ridges. Compared to the Appalachian Plateaus Province, the Valley and Ridge is significantly more developed, with concentrations of urban/residential development in the Scranton/Wilkes-Barre, State College, Sunbury, Altoona, and Harrisburg areas. Development has increased rapidly in the area with the addition of housing at the expense of traditionally agricultural areas. The Scranton/Wilkes-Barre corridor represents a very intensely urbanized area, extending over 20 miles in the Wyoming Valley.

Overall, census data indicate the population has increased by more than five percent within the province over the last decade. Most of this increase is focused in the Nittany Valley, surrounding the State College area. The State College area has been experiencing fairly rapid growth over the last 10 to 15 years. The province is facing increasing development pressure with the addition and improvement of several travel corridors. Interstate 99 is currently being built to connect Interstate Routes 76/70 and 80, which run parallel to each other in an east-west direction across Pennsylvania.

State Route 322, which travels northwest into the province from Harrisburg, was recently expanded to accommodate four lanes of traffic. With this expansion, the increased accessibility to the Harrisburg metropolitan area has spurred development in the counties north of this capitol city. The predominant trend in land use within the province is the conversion of the rich cropland developed on the carbonate bedrock aquifers to residential and commercial development.

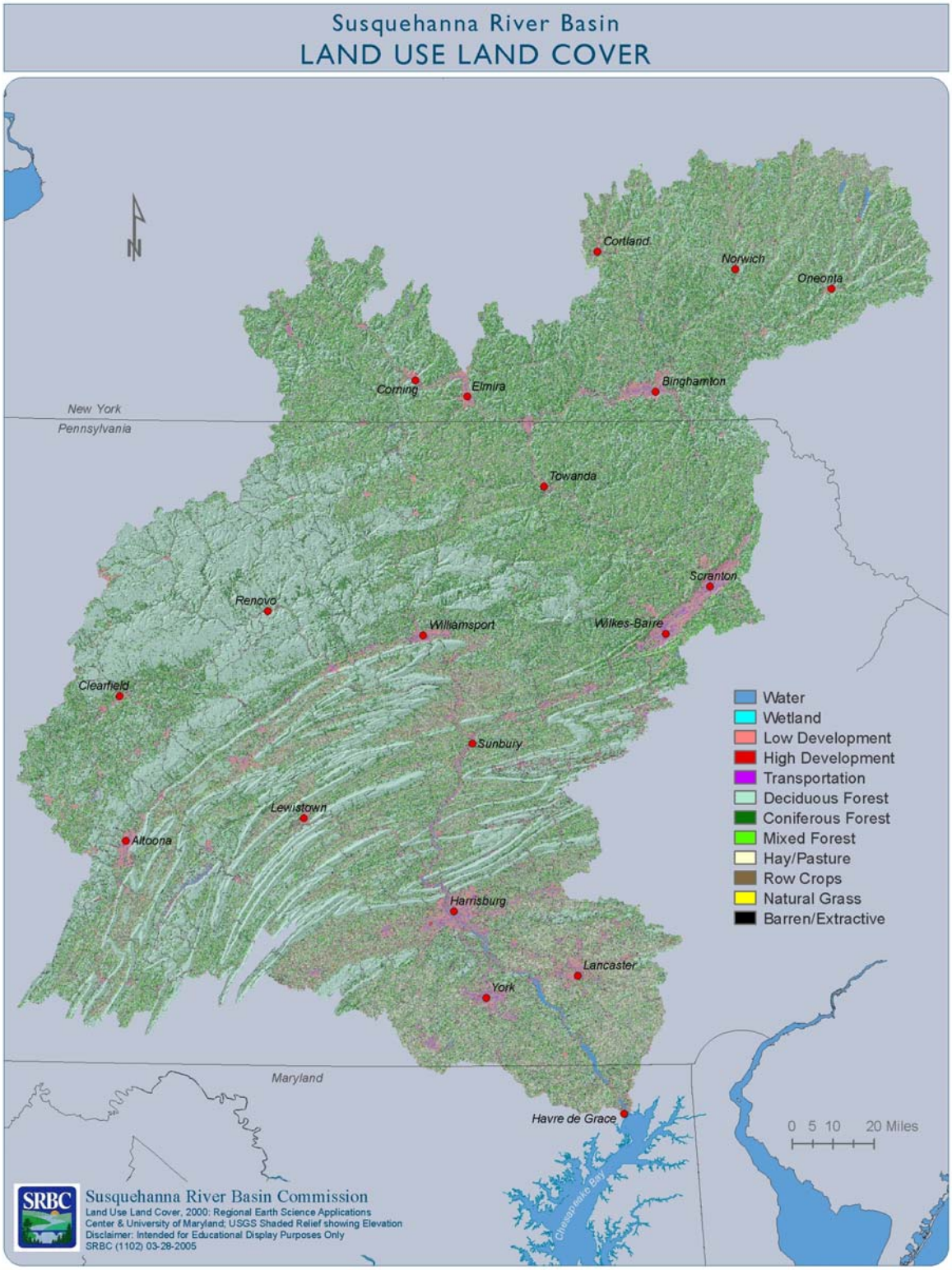


***Figure A.5. Land Use for the Susquehanna River Basin***

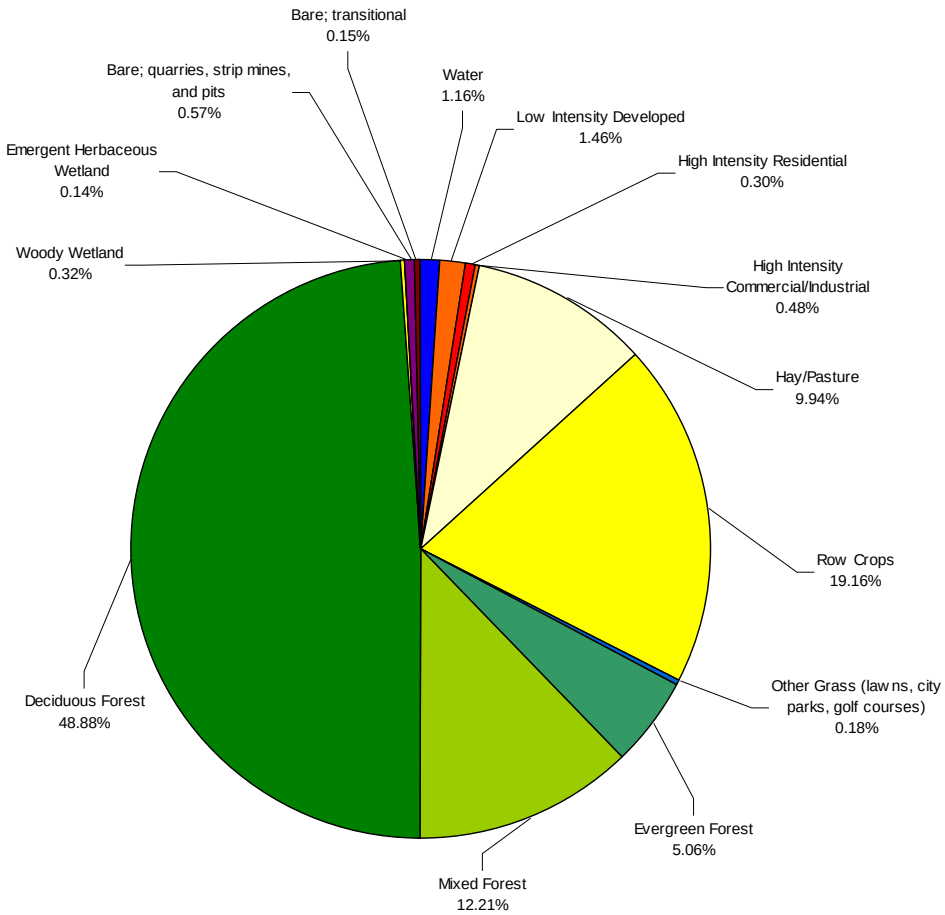


***Figure A.6. Land Use for the Susquehanna River Basin***

The Piedmont Province contrasts greatly in comparison to the other provinces in the basin with respect to land use, due, in part, to the unique terrains that constitute the province. Fifty percent of the province is dedicated to agricultural activities. Most of the agricultural land use is in the Triassic Lowlands and in the Conestoga Valley Sections. The Conestoga Valley Section possesses some of the most productive soils in the state of Pennsylvania. A significant amount of effort is being placed on preserving current agricultural activities.

Urban and suburban development accounts for greater than five percent of total land use, although more recent data suggest this estimate should be higher. Census data indicate that population growth in the metropolitan areas within the subbasin has increased over 10 percent since 1990. Additionally, there is a significant amount of growth occurring in Pennsylvania, along the southern portions of Adams and York Counties, as a result of commuter expansion from the Baltimore-Washington metropolitan area.

## Groundwater Quality

Groundwater quality in the Susquehanna River Basin is typically good and, for the most part, influenced by geology and land use. However, influences from land use present some common problems experienced throughout the basin. State 305(b) water quality reports indicate significant impacts to water

quality from abandoned mine lands, agriculture, and developed areas. Contaminants from these land uses can range from metals and low pH conditions, to excessive nutrient, pathogen, and organic contaminant levels. Outside of these land use types, problems can also arise from transportation corridors and rural septic systems. Although any given area of the basin can exhibit water quality problems, each of the physiographic provinces, or regions of the basin, generally have some dominant contaminant sources that affect quality.

The Appalachian Plateaus Province exhibits fairly good groundwater quality. However, iron and manganese are two constituents that typically exceed limits recommended by the USEPA. These two metals occur naturally in the sedimentary rocks (sandstone, siltstone, and shale) in the province, although concentrations in some portions of the province have been exacerbated by abandoned coal mine workings. Within the areas affected by bituminous coal mining, the groundwater resource is largely unavailable for most uses, due to the extreme degradation of water quality. Some of the discharges from abandoned mine lands represent some of the worst water quality conditions in the basin. To a lesser extent, there also are localized problems with elevated nitrate from septic systems and agricultural activities.

The Valley and Ridge Province also exhibits good water quality, although the effects of land use play a larger role in influencing groundwater quality. Again, iron and manganese are the leading constituents that cause exceedences of USEPA-recommended limits. Although some of the elevated concentrations are associated with natural conditions, abandoned coal mine workings are the dominant source in the province. The anthracite region possesses some of the highest concentrations of iron and manganese sampled from groundwater. Unfortunately, these conditions exist in close proximity to the more densely-populated regions of the basin, namely the Scranton and Wilkes-Barre areas. Agricultural and residential/urban activities also play a significant role with influencing groundwater quality, particularly in the karst aquifers. USGS studies in the early 1990s (Lindsey and others, 1998) indicate wells sampled for pesticides in agricultural areas exhibit some of the highest detection frequencies in the United States. Nitrate concentrations in these same areas commonly exceed USEPA drinking water limits. In addition, the karst areas within the Great Valley Section overlain by urban/residential land uses showed some of the highest frequency of detections of volatile organics contaminants (VOCs) and other organic contaminants in the United States (Lindsey and others, 1998).

Overall, the Piedmont Province exhibits good groundwater quality. However, the higher yield karst aquifers in the province exhibit problems associated with agricultural and urban/residential areas. Nitrate-nitrogen concentrations within these areas of York and Lancaster Counties are commonly in excess of USEPA's drinking water standards of 10 milligrams per liter (mg/l). And similar to the urban settings in the Valley and Ridge karst areas, organics and other man-made contaminants are increasingly detected in groundwater samples (Lindsey and others, 1998).

## Groundwater Use

The use of groundwater resources within the basin is extensive. In particular, groundwater plays a critical role in supplying the population's drinking water and maintaining the economic viability of communities. Outside of the major population centers, drinking water supplies are heavily dependent on groundwater supply wells. General household use from private wells is also a significant portion of the basin's overall use. In addition, business and industry dependent on the basin's groundwater resources employ thousands of people and contribute billions of dollars to local/regional economies through payrolls, product distribution, and product sales. Examples of some of these industries include food production, such as fruit juices and snack foods. Another large business sector includes material (metal, paper, plastics, etc.) and chemical production. Agriculture and mining also withdraw groundwater for irrigation/livestock needs and dewatering operations, respectively.

The Commission recognizes the importance of managing the resource to encourage continued economic growth and sustainability, while at the same time maintaining ecosystem. In order to balance the demands on groundwater resources in the basin most efficiently, it is important to have an accurate inventory of groundwater uses and their associated quantities.

Groundwater use data are collected throughout the basin by a number of different agencies, using a number of different methods and criteria. Currently, there are no datasets that provide an accurate, comprehensive and consistent assessment of groundwater use basinwide. The Commission only compiles a subset of overall groundwater use in the basin, with regulations covering users greater than 100,000 gpd for a 30-day consecutive period, and 20,000 gpd consumptively. Prior to establishment of the Compact, overall groundwater use within the basin was estimated to be approximately 290 million gallons per day (mgd). The following section describes some of the readily available historical information on groundwater use, and this document outlines several needs for the improvement of data collection efforts.

The USGS compiles one of the more comprehensive datasets on water use, although the method of collection/compilation can vary from state to state. The assessment also relies on data provided by other state/federal agencies, which are incomplete in many cases. The USGS compiles readily available water use data for each state by 8-digit hydrologic unit codes (HUC).

For the purposes of this plan, groundwater use was reviewed for the years available; 1985, 1990, and 1995. The 2000 data became available in November 2004, while this document was being drafted. However, the methodology differed so greatly from the previous years that the data were not comparable to the earlier datasets. In addition, the information was incomplete. The lack of reliable basinwide groundwater use data emphasizes the need for better information, as outlined in recommendations cited later in this document.

Using the best available data, the major categories of use include public supply, commercial, domestic, industrial, thermoelectric power, mining, livestock, and irrigation. In general terms, this section will describe these uses. Table 2.1 shows groundwater use by 8-digit HUC. Figure A.7 exhibits the same data shown in Table A.1.

Approximately 20 percent of the basin population is served by public water suppliers that use groundwater as a source. In comparison to a surface water source, groundwater quality is generally better, more consistent, and requires fewer resources for treatment.

As shown in Table A.1, according to the USGS data, public supply is the dominant use of groundwater for the basin, at approximately 115.30 mgd. However, mining and industrial use exceeds public supply in the lower basin. The highest producing public supplies generally correspond to the valley-fill aquifers in the glaciated terrain (Chenango, Owego, Chemung), and the karst aquifers in the Valley and Ridge Province (Bald Eagle, Lower Susquehanna). With population increases in various portions of the basin, there has been an increasing need for public water supply wells.

Use of groundwater by public water suppliers is monitored by a number of agencies, because the member jurisdictions, as well as the Commission, regulate the withdrawal. Public water supply use comprises the majority of the number of the Commission's approvals since 1995.

According to the USGS data, mining comprises the second largest groundwater use within the basin. The dominant mining processes that involve groundwater withdrawal in the Lower Susquehanna are coal mining and quarry operations, while the dominant mining process in the Upper Susquehanna and Chemung Subbasins is open-pit mining for sand and gravel.

***Table A.1. Groundwater Use Data for the Susquehanna River Basin***

| HUC | Public Supply | Commercial | Domestic | Industrial | Thermo-electric Power Use | Mining | Livestock | Irrigation | Total |
|---|---|---|---|---|---|---|---|---|---|
| Upper Susquehanna | 6.09 | 0.60 | 4.53 | 1.69 | 0.00 | 0.81 | 1.37 | 0.07 | **15.16** |
| Chenango | 11.65 | 0.84 | 3.54 | 2.78 | 0.00 | 0.25 | 1.48 | 0.09 | **20.63** |
| Owego-Wappasening | 15.44 | 0.98 | 2.88 | 2.50 | 0.00 | 0.15 | 0.76 | 0.16 | **22.87** |
| Tioga | 3.99 | 0.29 | 2.59 | 0.84 | 0.00 | 0.24 | 0.92 | 0.31 | **9.18** |
| Chemung | 11.78 | 0.83 | 4.22 | 2.61 | 0.00 | 0.13 | 0.77 | 0.29 | **20.63** |
| Upper Susquehanna-Tunkhannock | 3.19 | 0.21 | 5.01 | 5.30 | 0.00 | 0.00 | 1.86 | 0.10 | **15.67** |
| Upper Susquehanna-Lackawanna | 8.09 | 1.13 | 6.82 | 2.07 | 0.00 | 3.42 | 0.68 | 0.18 | **22.39** |
| Upper West Branch Susquehanna | 2.21 | 0.19 | 1.45 | 0.03 | 0.00 | 5.98 | 0.44 | 0.10 | **10.40** |
| Sinnemahoning | 0.10 | 0.00 | 0.43 | 0.01 | 0.00 | 0.24 | 0.13 | 0.03 | **0.94** |
| Middle West Branch Susquehanna | 0.01 | 0.00 | 0.04 | 0.15 | 0.00 | 0.07 | 0.19 | 0.15 | **0.61** |
| Bald Eagle | 12.58 | 2.71 | 1.75 | 0.27 | 0.00 | 5.13 | 0.38 | 0.12 | **22.94** |
| Pine | 0.29 | 0.00 | 0.64 | 0.03 | 0.00 | 0.50 | 0.49 | 0.14 | **2.09** |
| Lower West Branch Susquehanna | 2.54 | 0.41 | 4.32 | 1.40 | 0.27 | 6.15 | 1.33 | 0.35 | **16.77** |
| Lower Susquehanna-Penns | 4.75 | 0.31 | 5.01 | 0.43 | 2.45 | 7.56 | 3.29 | 0.36 | **24.16** |
| Upper Juniata | 3.47 | 0.69 | 2.29 | 5.22 | 0.00 | 1.05 | 1.06 | 0.16 | **13.94** |
| Raystown | 0.87 | 0.04 | 2.01 | 0.10 | 0.00 | 0.43 | 0.87 | 0.04 | **4.36** |
| Lower Juniata | 0.90 | 0.06 | 3.45 | 0.98 | 0.00 | 0.75 | 3.24 | 0.14 | **9.52** |
| Lower Susquehanna-Swatara | 9.61 | 1.55 | 13.15 | 15.23 | 1.24 | 39.20 | 5.25 | 0.72 | **85.95** |
| Lower Susquehanna | 17.74 | 0.96 | 15.75 | 6.58 | 0.00 | 17.54 | 12.32 | 1.70 | **72.59** |
| **TOTAL** | **115.30** | **11.80** | **79.88** | **48.22** | **3.96** | **89.60** | **36.83** | **5.21** | **390.80** |

(All values are expressed in million gallons per day (mgd). Data source—U. S. Geological Survey National Water-Use Data Files, 1995).

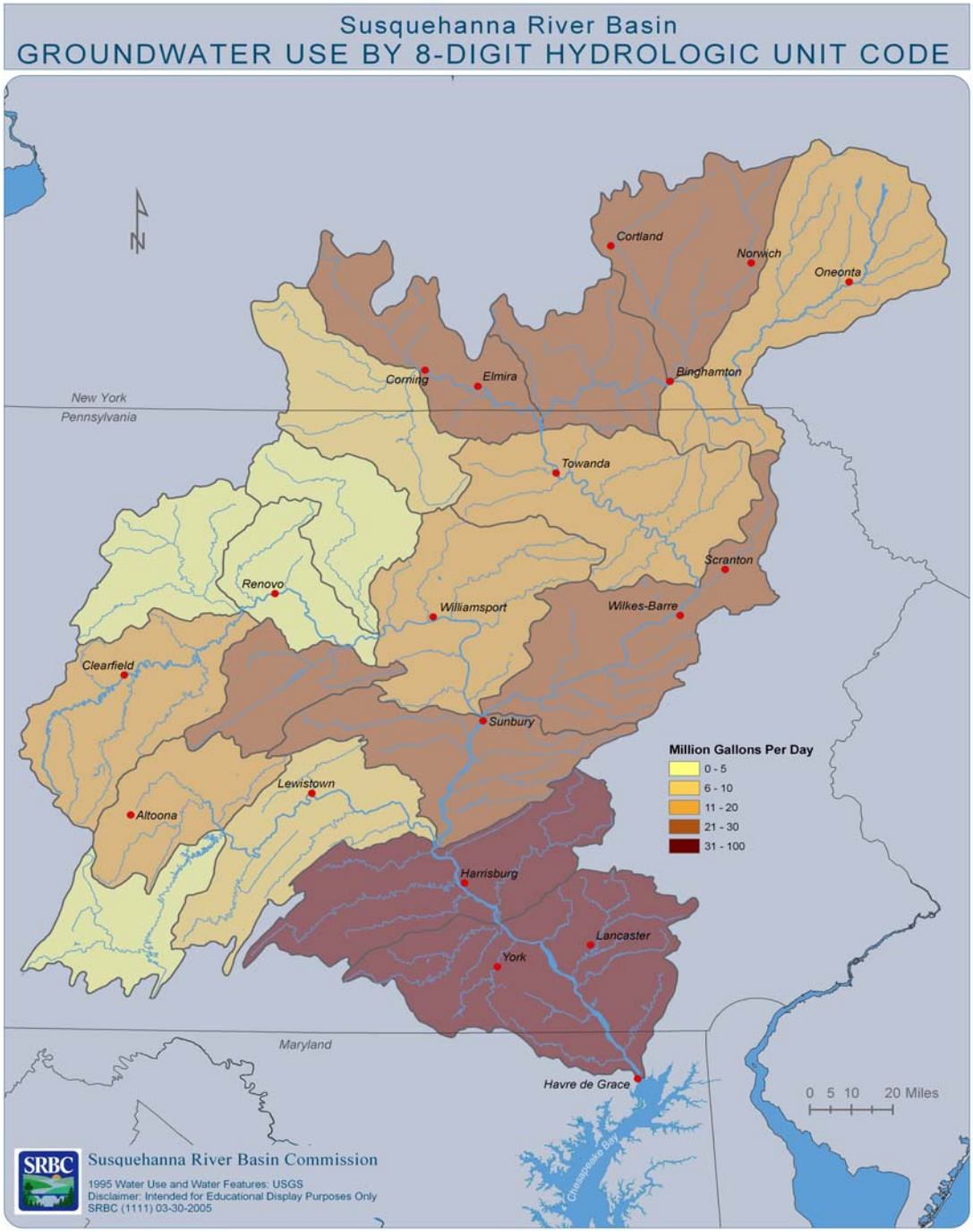


***Figure A.7. Groundwater Use in the Susquehanna River Basin*** *(Data source—United States Geological Survey National Water-Use Data Files, 1995)*

Carbonate quarry operations, both dolomite and limestone, are particularly heavy users of groundwater in the Great Valley section and Piedmont carbonate areas. Most of the water withdrawn is drained away from the local groundwater flow system and discharged to local streams. The groundwater withdrawal by mining operations within the limestone and dolomite belts in the lower basin is substantial, and very likely comprises the largest groundwater withdrawal category in this area. In Pennsylvania, the Commission currently is developing a metering and data collection mechanism to track these large withdrawals and account for the impacts to other groundwater users. While some of the mines and quarries in the basin were in operation before the Compact, and certainly before the groundwater withdrawal regulation was adopted in July 1978, new mining operations and modifications to existing operations are being proposed and opened ever year.

In the Upper Susquehanna and Chemung Subbasins, substantial groundwater use is related to sand and gravel mining below the water table. Unlike the quarrying and mining operations in the rest of the Susquehanna River Basin, this type of open-pit mining below the water table does not withdraw groundwater and discharge it to streams. In areas where the water table is below the root zone, these open pits potentially expose large amounts of groundwater to evaporation. Individual mines can encompass up to 100 acres and evaporate in excess of 500,000 gallons of water per day. When mining has ceased, the open pits are not reclaimed and become lakes that continue to evaporate water. Unlike man-made lakes created with dams, these lakes do not fill by building storage during periods of high runoff. No conservation releases are made because the lakes do not have outlets to streams.

Within the states of New York, Pennsylvania, and Maryland, a dominant portion of the rural community depends on water from private wells, withdrawing approximately 79.88 mgd for domestic use. With less than three percent of the Susquehanna Basin intensely developed, the remaining populated areas of the basin typically are not serviced by a public water supply. Based on USGS water-use data and the 1990 United States Bureau of Census figures, approximately one-third of the population within the basin depends on self-supplied groundwater for domestic use. With increases in sprawl in many areas of the basin, the demand for groundwater from adequately producing wells will increase.

Overall, industrial groundwater use in the basin is approximately 48.22 mgd. Concentration of industrial activity, with respect to groundwater use, is primarily in the lower portions of the basin. Most of the activity is associated with industrial processes and wash water, as well as manufacturing producers. Some of the largest users in the region are food processing, concrete, and glass products. Commercial use, approximately 11.80 mgd, is largely concentrated around the urban centers in the basin (Scranton/Wilkes-Barre, State College, greater Harrisburg metropolitan area). Increasing use by the bottling industry also accounts for a notable portion of this use. In addition, the increasing practice of golf course fairway irrigation accounts for a portion of commercial use as well. With increasing population growth, commercial and industrial uses are expected to increase in some portions of the basin, particularly the State College area and portions of the lower basin.

The predominant use of groundwater for agricultural purposes is associated with livestock and irrigation. The combined total average use is 42.04 mgd in a year with normal precipitation. Livestock activities within the basin comprise the bulk of the use—88 percent—in a normal year, and are primarily associated with the production of meat, poultry, and dairy products. Crop irrigation, although usually a much smaller component of groundwater use at about 5.21 mgd, can be much more substantial in years with significant rainfall deficits. Land use trends over the past few years indicate significant amounts of land converting from agriculture to urban, residential, commercial, or golf course use. As this occurs, reliance on groundwater for livestock and irrigation will decrease in areas not shifting to concentrated feeding operations, and demand most likely will shift to another use category.

As seen in Table A.1, groundwater used for thermoelectric power is fairly insignificant within the basin. Use of groundwater includes wash water and water for drinking and sanitary purposes. The bulk of the water use related to power production is for cooling purposes, and that is typically supplied through surface water sources. Thus, future groundwater demands in this category are expected to be negligible.

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