



GROUNDWATER MANAGEMENT PLAN FOR THE SUSQUEHANNA RIVER BASIN

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The Susquehanna River Basin Commission was created as an independent agency by a federal-interstate compact* among the states of Maryland, New York, Commonwealth of Pennsylvania, and the federal government. In creating the Commission, the Congress and state legislatures formally recognized the water resources of the Susquehanna River Basin as a regional asset vested with local, state, and national interests for which all the parties share responsibility. As the single federal-interstate water resources agency with basinwide authority, the Commission's goal is to effect coordinated planning, conservation, management, utilization, development and control of basin water resources among the government and private sectors.

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Cover Photos: Lititz Springs, Lititz, Pennsylvania: top photo shows drought conditions (by Robert Pody); bottom photo shows average conditions (by Andrew Gavin).

EXECUTIVE SUMMARY

This Groundwater Management Plan has been prepared by the Susquehanna River Basin Commission (Commission) under the general oversight of its Water Resources Management Advisory Committee (WRMAC). A critical and long-term part of the Commission's mission, as reflected in the 1971 Susquehanna River Basin Compact (Compact), is the achievement of a balance among environmental, human, and economic needs in the management of the basin's water resources. The recommended water resource management actions in the plan were formulated with the goal of balancing economic development and environmental protection as a primary consideration. This was achieved by carefully considering: (1) sustainability of the resources for future generations; (2) protection of existing users; (3) adverse environmental impacts and actions to minimize the impacts; (4) protection of high quality water from degradation; (5) effective interagency coordination; and (6) public understanding of groundwater issues.

The plan also represents a comprehensive revision to the Commission's first Groundwater Management Plan, which was prepared in 1993. Appendix E of this report contains the list of the 1993 plan recommendations, which have either been implemented or are not relevant today. There were 37 additional recommendations identified in the 1993 plan that have not been implemented, and those served as an initial basis for the updated management plan.

This current, updated plan addresses existing and anticipated groundwater issues. To develop the plan, the Commission assessed groundwater problems and management issues, compiled groundwater management principles and tools, identified actions needed to address issues and problems, selected the management plan, and defined implementation aspects of the plan. All of these elements are presented in the plan. The information contained in this plan is based on available data, records, and past reports. No new data collection, analyses, or research efforts were undertaken. Based on professional judgment and experience, the available information was determined to be sufficient to develop a sound and effective management plan. Additional updates are contemplated in the future as new information is gathered and new management issues emerge.

Groundwater resource problems were assessed by reviewing issues and impacts that have developed in the last few decades. Many problems have been brought about by human activities, either directly related to increasing demands for groundwater or indirectly when development alters the natural flow regime in a non-beneficial manner. Other problems are related to water scarcity. Many water resource problems have been solved by human engineered solutions and, in some cases, fortuitously and unintentionally through human activity.

Of particular significance was the identification of several Potentially Stressed Areas (PSAs) in the basin where the utilization of groundwater resources is potentially approaching or has exceeded the sustainable limit of the resources, defined as the average annual base flow (recharge) available in the "local" watershed during a 1-in-10-year average annual drought. Using a series of criteria, Commission staff identified a number of PSAs. They include seven areas in Pennsylvania: the Manheim/Lititz/Ephrata Valley, the Fruit Belt (in York and Adams Counties), Hanover Area, Hershey Area (Spring Creek Basin), Fredericksburg Area, Roaring Spring Area, and State College Area; and the Corning area in New York State. Applications submitted to the Commission for review of projects located in PSAs receive a greater degree of scrutiny. The requests for groundwater withdrawals will be considered in relation to the availability of groundwater and they may be denied, approved for lower quantities than requested, or approved with conditions. Included in the PSAs are several low-yielding (low permeability) bedrock units in the southern Pennsylvania portion of the basin. These units will produce only limited amounts of groundwater to support water resource development, and, for this reason, are called Water Challenged Areas (WCAs). While the area-specific conditions in PSAs vary, all

of them share certain conditions, including well interference, exceedance of sustainable yield, and loss of recharge area. Section 2.1 contains more detailed information on PSAs and WCAs.

Several topics of particular interest were identified as management issues, including multi-agency coordination, changes to water resource utilization over time, regulatory changes, and the performance, accountability and updating of this plan. As an important adjunct, Commission co-leadership or support for actions by others to address certain groundwater issues and problems was identified. These areas of interest include: (1) protection of both specific groundwater sources of water supply and aquifers; (2) water use and availability information; and (3) well requirements such as construction standards, availability of well data, certification and training for well drillers, and improvements for the basinwide observation well network. The Commission also supports periodic assessments of state groundwater programs to identify needed improvements and plan for their implementation.

Using sound groundwater principles and available tools, the Commission identified actions to address all issues and problems. A series of 39 recommendations was then developed to encompass the actions to be taken by the Commission and others, including federal, state, and local governments, and the private sector. The goal of balancing economic development and environmental protection was a primary consideration in establishing the recommended actions. The current set of recommendations represent significant additions, deletions, and modifications to the 1993 recommendations. The recommendations constitute the majority of the Groundwater Management Plan and are summarized in the following list. Sections 2, 3, and 4 of the plan contain details on the issues and problems that are the basis for the recommendations. A summary list and detailed list of the issues, problems, and recommendations are contained in Tables 6.1 and E1 (Appendix E), respectively.

Recommendations

A. Actions to Address Groundwater Resource Issues and Problems

1. Areas of Intense Growth and Development and Consequent Water Resource Development—
 - a. Use groundwater modeling and/or water level monitoring to evaluate potential well interference. Mitigation may be necessary.
 - b. Require groundwater availability analyses for new projects and for areas where the sustainable yield has been exceeded. Develop water budgets for all PSAs. Adjust withdrawal rates for sustainability, if needed.
 - c. Base sustainable yields for wells on post build-out conditions and encourage the use of best management practices (BMPs) to minimize loss of recharge.
2. Intensive Water Use in Small Basins—
 - a. Educate the public and local officials about the sustainability of headwater areas, and the need to properly manage them.
 - b. Evaluate headwater areas for the purpose of managing water quantity and quality.
3. Watershed “Transfers”—Educate professional groups about the options of maintaining groundwater withdrawals and post-use discharges in the same watershed.

4. Loss of “Clean” Water Input to Acid Mine Drainage (AMD)-Impacted Streams—Evaluate cumulative impacts from consumptive water uses to downstream water quality in AMD-impacted areas.
 5. Unknown and Unregulated Groundwater Use—
 - a. Collect information on unknown and unregulated withdrawals to improve evaluation for new projects.
 - b. Perform water budget and cumulative impact analyses, and manage groundwater withdrawals to address any adverse impacts.
 - c. Perform water budget analyses and consider options to address overdraw.
 6. Scarcity of Clean Water in Coal-Mined Areas—Manage quantity and quality in non-AMD-impacted watersheds recognizing that water resources are necessary for the economic growth of mining-affected regions; educate local officials and consultants; coordinate with state and federal agencies; and encourage grayfields initiatives.
 7. Drought Impact to Base Flow—Educate local jurisdictions about stormwater managements, critical aquifer recharge areas (CARAs), and other BMPs for development, and improve scientific basis for instream use protection.
 8. Impacts of Mining—
 - a. Encourage cooperative efforts to develop reliable water supplies related to mining operations.
 - b. Delineate the area of influence and capture area for the mine withdrawal and identify the impacts and method of impact mitigation, when needed.
 - c. Reduce impacts of mine pumpage through the grouting of water inflow points if economically and technically feasible.
 9. Flow Compensation for Consumptive Water Uses—Bring together key stakeholders to help promote use of groundwater stored in “artificial” aquifers to offset consumptive water uses and support instream flow needs.
- B. Actions to Address Management Issues
1. Multi-agency Coordination—Enhance the Commission's water resources procedures and project review coordination activities with involved agencies to avoid conflicting actions.
 2. Changes to Water Resource Utilization Over Time—
 - a. Assess water resource utilization periodically and make appropriate changes in policies, procedures, and project review process.
 - b. Strengthen water conservation requirements and encourage use of treated wastewater and conjunctive use.

3. **Regulatory Duplication**—Maintain close and effective coordination among the Commission, member jurisdictions, and key agencies to include possible formal arrangements such as memoranda of understanding.
 4. **Increased Knowledge About Groundwater as a Resource**—
 - a. Capture and compile collected data for use by the Commission, agencies, and others.
 - b. Identify the constituency for an outreach and education program, and develop tools for their decision-making.
 - c. Encourage and assist local governments to include groundwater management concepts in planning and land use control.
 - d. Incorporate a variety of methods into a multifaceted outreach and education program.
 5. **Plan Performance and Accountability**—Provide periodic reporting on implementation of the Groundwater Management Plan and new significant groundwater issues.
 6. **Review and Update of the Plan**—Conduct comprehensive reviews and revisions of this plan at intervals not to exceed 10 years.
 7. **Funding to Implement Plan**—Funding to implement the plan's recommended actions should be made available and/or proactively sought by the lead jurisdiction(s) for each action.
- C. **Groundwater Management Support Programs**
1. **Protection of Groundwater Sources of Supply and Aquifers**—
 - a. Encourage states and local jurisdictions to develop regulations and programs to protect critical aquifers from contamination.
 - b. Continue and expand monitoring and research in cooperation with states related to nonpoint source contamination, and support the assessment and implementation of such actions, including total maximum daily loads (TMDLs), the United States Environmental Protection Agency's (USEPA's) 319 Nonpoint Source Program, and United States Department of Agriculture/Natural Resource Conservation Service (USDA/NRCS) water programs.
 - c. Support member jurisdictions in their efforts to consider the effect of wastewater discharges on groundwater, including sensitive recharge areas, when issuing National Pollutant Discharge Elimination System (NPDES) or State Pollutant Discharge Elimination System (SPDES) permits.
 - d. Assist communities with groundwater source protection by utilizing existing source water assessment data and aquifer test data to provide educational and technical assistance in formulation of protection plans.

2. Water Use and Availability Information—
 - a. Require large volume groundwater users (>10,000 gallons per day [gpd]) to register (document) their use and to re-register (update documentation) periodically. Coordinate with member states and others to maintain a vibrant data set.
 - b. Maintain a centralized database containing information on large users, and make this data available to planners and managers throughout the basin, subject to security considerations.
 - c. Maintain a centralized database containing well location information, and make the data available to planners and managers throughout the basin, subject to security considerations.
 - d. The Commission should partner with appropriate agencies to develop groundwater availability and yield information and make it available on-line.
3. Well Requirements—
 - a. Support state and local programs for well construction and abandonment standards, and improved controls to prevent pollution.
 - b. Support legislation that works toward the development of a well driller's certification program in Pennsylvania and support the improvement of programs that provide training and licensing/certification for all well drillers in the basin's states.
 - c. Provide effective maintenance and work toward improvements for the basinwide observation well network with a goal of having real-time monitoring capability in each county in the basin.
4. Assessment of State/Federal Groundwater Programs and Program Coordination—The Commission's member jurisdictions should continue periodic assessments of their groundwater programs to identify needed improvements and plan for their implementation.

This plan has been prepared to provide a framework that will allow the Commission, within the scope of the Commission's mission, powers, and duties, to effectively manage groundwater resources in the basin, in cooperation with member jurisdictions and other organizations. Within this framework, the plan sets forth actions to address a variety of groundwater issues and problems. The plan is broad-based, and is not meant to be a detailed implementation document for all recommendations. However, there are a number of actions that can be taken in the near term. Twelve continuing actions (of the total of 39 recommended actions) are identified in Section 6.2 and are defined to be those actions that should be initiated and/or implemented relatively easily and quickly under existing programs, although full implementation of some initiated actions may take years. The remaining actions are defined to be short-term (initiate within two years) or long-term (two to five years), and will require implementation measures such as development of new guidelines or regulations, provision of adequate resources, and interagency coordination.

The management plan is fairly evenly balanced among regulatory, planning, public outreach/education, and management actions. Of the 39 recommended actions included in the plan, 13 are regulatory in nature, 11 are related to planning, and 15 involve outreach/education and management.

The Commission, its four member jurisdictions (New York, Pennsylvania, Maryland, and the federal government), local jurisdictions, and the private sector are called upon to implement the plan. Each party's role and responsibilities are presented as part of plan implementation, and each party is responsible for allocating the resources necessary to implement its element of the plan, using a prioritized and phased approach, as needed. A rating system for prioritizing actions and assigning schedules was developed for the management plan to enhance implementation. This resulted in 10 actions being rated as top priority, 20 as high priority, and 9 as priority. In terms of scheduling, 12 actions were determined to be continuing, 16 short-term, and 11 long-term efforts. Section 6 of the plan contains details on plan implementation.

Prior to finalizing this plan, the Commission provided for a 90-day public review and comment period to a draft plan from June to September 2004. The Commission's objective was to receive constructive input and comments as a result of public review to produce a high quality Groundwater Management Plan. Three public workshops were held in July 2004, to present the draft plan and provide an opportunity for the approximately 175 attendees to make oral comments. Written comments were also received from 21 interested parties during the review period. More than 400 comments were received from the workshops and written submittals. Appendix F includes a summary of the most significant comments received, organized by major topics, and a summary response for each topic. The final plan has incorporated additional or revised information, as needed, to reflect changes made in response to the comments.

The Commission has approved this management plan to effectively address major groundwater resource issues in the basin that are within the Commission's purview. The Commission will monitor plan implementation and periodically review and update the plan.

In addition to this complete management plan, a short summary of the plan has been prepared for general distribution. The full plan will be most useful to those having a need for or interest in the details of the plan, particularly the recommended actions and their implementation. The summary version presents an overview of the full plan and is intended to provide a basic understanding of the plan's development and results.

GROUNDWATER MANAGEMENT PLAN FOR THE SUSQUEHANNA RIVER BASIN

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1.0 INTRODUCTION

The Susquehanna River Basin Commission (Commission) is a federal-interstate body, formed by a 1971 compact to enhance public welfare through comprehensive planning, water supply allocation, and management of the water resources of the Susquehanna River Basin. The term of the Susquehanna River Basin Compact (Compact) is 100 years. The fundamental principle of the Commission is to manage water resources from a watershed perspective, not by political boundaries. To fulfill its mission, the Commission must balance environmental protection with meeting the needs for adequate water supply and economic development.

The Compact contains the powers and duties of the Commission, and states in Section 3.1 that “The Commission shall develop and effectuate plans, policies, and projects relating to the water resources of the basin. It shall adopt and promote uniform and coordinated policies of water resources conservation and management in the basin.” In addition, Sections 3.4.2 to 3.4.5 of the Compact discuss the powers the Commission has in dealing with groundwater resources in the basin. The Commission's *Comprehensive Plan for Management and Development of the Water Resources of the Susquehanna River Basin*, June 1987, provides a broad-based strategy for “the development, use, control, management, and conservation of the water resources of the basin....”

1.1 Background Information

The Commission has collected data for groundwater resource evaluation since its inception. In 1978, the Commission promulgated regulations specifically addressing large groundwater withdrawals to fill an identified gap in the regulatory authority of its member jurisdictions (New York, Maryland, Pennsylvania, and the federal government). In the early 1980s, the Commission conducted special studies of the groundwater resources of the basin, which included reconnaissance level appraisals, as well as numerical flow models of critical areas. The Commission adopted its first “Groundwater Management Plan” for the Susquehanna River Basin in July 1993.

The 1993 plan was prepared by Commission staff under the general guidance of the Commission's Water Resources Management Advisory Committee (WRMAC). The plan contains a summary of the water resources of the basin, as well as a description of the regulatory framework existing at that time within the basin, and identified the appropriate regulatory role for the member jurisdictions and the Commission. Perhaps the most important section of the plan consisted of a compilation of key groundwater-related issues in the basin, along with recommendations for proposed solutions and management actions. These included the compilation of accurate information on water use, a registration program for withdrawals exceeding 10,000 gallons per day (gpd), Commission allocation of groundwater through project approval (docket) based on long-term conservation management that considered the

reasonable needs of project sponsors, and education and outreach programs to assist local government in understanding groundwater management issues and responsibilities.

A recent, in-depth review of the 1993 plan's 60 recommendations determined that 23 of these recommendations have been implemented or are no longer relevant. The remaining 37 recommendations served as an initial basis for developing the current management plan. One of the 1993 recommendations was to conduct a periodic comprehensive review and update of the Groundwater Management Plan, which is accomplished by completion of this new plan. Appendix E of this report contains both the complete list of current recommendations and the 1993 plan recommendations that have been implemented or are not relevant today.

The need to review the 1993 plan and comprehensively update the groundwater issues, problems, and recommendations is due to changed conditions, programmatic revisions, and technological advances. The following information is pertinent to the purpose, objectives, scope, and existing conditions, groundwater resource, programs, and management principles and tools considered in the current plan.

1.2 Purpose and Objectives

This plan has been prepared to provide a framework that will allow the Commission, within the scope of the Commission's mission, powers and duties, to effectively manage groundwater resources in the basin, in cooperation with member jurisdictions and other organizations. The Commission meets its groundwater management responsibilities by regulation of withdrawals and consumptive use of water, coordination of groundwater quality issues, conducting planning studies, and public outreach and education. Withdrawals and consumptive water use are regulated under Commission Regulation §803.4, relating to projects requiring review and approval by the Commission. Regulation §803.42, effective since 1971, covers all sources consumptively using water in excess of 20,000 gpd, based on a consecutive 30-day average. In 1978, the Commission promulgated further regulation of groundwater withdrawals for large users (greater than 100,000 gpd) under Regulation §803.43.

Within this framework, the plan sets forth actions to address a variety of groundwater issues and problems. The plan is broad-based and is not meant to be a detailed implementation document for all recommendations. However, actions that can be taken in the near term toward implementation and be done relatively easily and quickly under existing programs were identified.

The vision reflected in the plan is for an organized and cooperative effort among the Commission, the federal government, the Commission's member states, local jurisdictions, business and environmental interests, and the public to make sound decisions for use and protection of groundwater resources in the Susquehanna River Basin. The plan will promote and serve as a catalyst for more effective management of groundwater, enhanced coordination, and improved knowledge of the resource and its use.

A critical part of the Commission's mission, as reflected in the 1971 Susquehanna River Basin Compact, is the achievement of a balance among environmental, human, and economic needs in the management of the basin's water resources. This is done by careful consideration of a wide range of factors, including water resource sustainability, protection of existing users, adverse environmental impacts, actions to minimize or mitigate impacts, protection of high quality water from degradation, effective interagency coordination, and public understanding of groundwater issues. The recommended actions in the plan were formulated with the goal of balancing economic development and environmental protection as a primary consideration.

Objectives of the Groundwater Management Plan are to:

1. Describe the existing conditions;
2. Describe the management framework of groundwater resources in the basin;
3. Discuss the management principles and various tools;
4. Assess the problems related to groundwater resources;
5. Recommend specific groundwater management actions for the basin; and
6. Prepare a management plan that includes the selected actions and implementation requirements.

1.3 Scope

The Susquehanna River Basin is defined by the surface water drainage area, as shown on Figure 1.1. The basin is divided into six major hydrologic subbasins. While groundwater divides may differ locally from surface water divides, the difference between the groundwater and surface water drainage areas for the Susquehanna River Basin is very small.

The Groundwater Management Plan addresses a number of issues and problems concerning the interaction of groundwater and surface water resources and, in particular, streamflow. Groundwater commonly supplies more than half of streamflow, and is the primary source of water for streamflow during periods between surface water runoff events (rainfalls and snowmelts). During periods of low flow (i.e., normal summer conditions and droughts), virtually all of the water flowing in stream channels is supplied by groundwater.

The plan covers all groundwater activities that currently fall within the purview of the Commission. The plan also identifies actions that are directly related to the Commission's program but are to be undertaken or recommended to be undertaken by its member jurisdictions and local jurisdictions.

Preparation of the Groundwater Management Plan was accomplished with guidance from the Commission's WRMAC. WRMAC is comprised of Commission staff and representatives of the four member jurisdictions, all of whom have extensive technical and/or management experience in water resources. Their expertise and contacts were of significant value in developing the plan. WRMAC members by jurisdiction and agency affiliation are the New York State Department of Environmental Conservation (NYSDEC), Pennsylvania Department of Environmental Protection (PADEP), Maryland Department of the Environment (MDE), United States Army Corps of Engineers (USACE), and Commission staff. In addition to the information provided by WRMAC members and the agencies they represent, Commission staff contacted a number of key agencies, including New York State Department of Health (NYSDOH), Pennsylvania Department of Conservation and Natural Resources (PADCNR), United States Environmental Protection Agency (USEPA), United States Fish and Wildlife Service (USFWS), and United States Geological Survey (USGS) to obtain information, views, and opinions.

1.4 Existing Groundwater Conditions

This section describes the existing conditions in the Susquehanna River Basin that affect groundwater resources. These conditions include aquifer characteristics and a number of other factors, including climate, physiography, groundwater quality, and groundwater use. More detailed information on groundwater conditions is contained in Appendix A.

1.4.1 Aquifers

There are commonly three types of aquifers found in the Susquehanna Basin: karst, fractured bedrock, and porous media (stratified drift, alluvium, and colluvium). Each aquifer type possesses unique hydrogeologic characteristics that influence groundwater occurrence and movement. The aerial extent of these aquifers is commonly limited and the aquifers are dependent on an annual infusion of recharge.

1.4.2 Climate

Although the Susquehanna River Basin receives a generous amount of precipitation (an average of 40 inches annually) in the form of snow and rain, the estimated recharge to groundwater resources during average conditions is 13 inches. Droughts have been fairly common during the last decade, causing some concern about groundwater use and availability in certain parts of the basin. In recent years, drought conditions have persisted for many consecutive months, resulting in multiyear drought events. A significant drought impact is insufficient groundwater recharge occurring during the period from the fall through spring runoff when aquifer levels are typically brought back into normal ranges. Consequently, groundwater storage can be abnormally low before the peak summer demand period begins. The 2002 drought is an example of a multiyear regional drought event that began in fall 2001.

1.4.3 Physiography

Groundwater geohydrology in the basin can best be described in the context of the three dominant physiographic provinces: the Appalachian Plateaus, Valley and Ridge, and Piedmont. Each province possesses distinct physical characteristics (topography, geology, and soils) that influence groundwater conditions within the Susquehanna Basin.

The predominantly forested Appalachian Plateaus Province, comprising approximately 40 percent of the basin, is characterized by nearly flat-lying sedimentary rocks with confined and semi-confined fractured bedrock aquifers of significant lateral extent. The other dominant aquifers, most common in the New York part of the province, are the valley-fill aquifers that communicate with the streams flowing across them.

The Valley and Ridge Province, located entirely in the Pennsylvania portion of the basin, is characterized by fractured bedrock and karst aquifers of relatively small areal extent. Recharge rates associated with the more extensive karst aquifers are among the highest in the entire Susquehanna River Basin, and are commonly associated with the more agriculturally productive valleys in the Commonwealth.

The Piedmont Province, within the Pennsylvania and Maryland portions of the basin, is comprised of complex geologic terrain with a very limited capacity to store and transmit groundwater, representing some of the least productive aquifers in the Susquehanna River Basin. However, there are some high yield aquifers that coincide with the presence of thick layers of saprolite within the metamorphic terrain in York/Lancaster Counties, as well as some karst aquifers in the Conestoga Valley.

1.4.4 Groundwater Quality

Groundwater quality in the basin is typically good; however, significant impacts to water quality from abandoned mine lands, agriculture, and developed areas have stressed the resource in certain areas of the basin. In addition to these land use impacts, problems can also arise from transportation corridors and rural septic systems. Specific groundwater quality issues in portions of the basin include elevated iron, manganese, nitrates, and organic contaminants.

1.4.5 Groundwater Use and Availability

The use of groundwater resources within the basin is extensive. In particular, groundwater plays a critical role in supplying drinking water and maintaining the economic viability. 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. 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, raw material, and chemical production.

The major categories of groundwater use include public water supply, commercial, domestic, industrial, thermoelectric power, mining, livestock, and irrigation. The best data available show a total groundwater use in the basin of about 391 million gallons per day (mgd). The largest users are public water suppliers (115 mgd), mining (90 mgd), domestic withdrawals (80 mgd), industrial (48 mgd), agriculture (42 mgd), and commercial (12 mgd).

From a basinwide standpoint, groundwater resources are in good condition, and generally of sufficient quantity and quality to meet both human and environmental needs. However, groundwater availability faces challenges in some areas of the basin. Some of the highest producing aquifers are located in the most developed areas of the basin, and are subject to competing uses, loss of recharge areas, diminishing stream/spring flows, and threatened water quality. These problems are only exacerbated during periods of drought. Areas with naturally low-yielding aquifers show stress even during normal hydrologic conditions. In the Pennsylvania portion of the basin, there is a significant problem with degradation of groundwater quality from acid mine drainage (AMD), making the resource largely unavailable for most uses in these areas. To a lesser extent, there also are localized problems with elevated nitrate from agricultural activities and septic systems. These situations put increasing pressure on already resource-constrained upstream headwater areas as communities and industry look for high quality groundwater resources.

1.5 Management and Regulatory Programs

There are long-standing and diverse authorities that require the federal government, Commission, states and local jurisdictions to manage, regulate, and protect various elements of groundwater resources. The groundwater responsibilities of the Commission and key federal and state agencies are briefly discussed in this section. In addition, local jurisdictions and watershed organizations play important roles in groundwater issues and these also are discussed. More detailed information on the agencies and local groups is included in Appendix B.

1.5.1 Federal Government

United States Geological Survey (USGS). The USGS collects data and maintains databases on streamflow from its stream gaging network, on groundwater levels from its monitoring well network, and on ambient water quality.

United States Environmental Protection Agency (USEPA). The USEPA regulates activities that have the potential to pollute either surface water or groundwater. Additionally, the USEPA oversees the remediation of pollution sites when no responsible party can be identified.

United States Fish and Wildlife Service (USFWS). The USFWS investigates potential impacts to threatened and endangered species. If groundwater use is expected to cause impacts to natural resources, the USFWS can provide recommendations for mitigation of the impacts and protection of the resources.

United States Army Corps of Engineers (USACE). The USACE can provide technical and planning assistance to address water resources problems and needs, including those related to groundwater.

1.5.2 Susquehanna River Basin Commission

A critical part of the Commission's mission, as reflected in the 1971 Compact, is to achieve a balance among environmental, human, and economic needs when managing the basin's water resources. The Commission carries out its groundwater management responsibilities in a number of ways. These include regulating withdrawals and consumptive use of water, coordinating groundwater quality issues, conducting a variety of planning studies (watershed based, special studies, and water budget analyses), conducting public outreach and education, and preparing this Groundwater Management Plan.

1.5.3 New York State

New York State Department of Environmental Conservation (NYSDEC). The NYSDEC's Division of Water (DOW) issues permits for all takings for public water supply, from groundwater or surface water sources. Detailed information on completed water wells is submitted to NYSDEC for use in groundwater resource evaluation and development of a database. The DOW, in partnership with the USGS, conducts statewide aquifer mapping to obtain information on significant water-bearing formations. The DOW also issues permits for discharges of wastewater and stormwater, and works closely with local governments to implement nonpoint source control and groundwater resource protection programs.

New York State Department of Health (NYSDOH). Water that has been withdrawn by public water suppliers for distribution to the consumer is regulated by the NYSDOH. Other tasks performed by the NYSDOH are the establishment of state drinking water standards and enforcement of both state and federal drinking water standards.

1.5.4 Commonwealth of Pennsylvania

Pennsylvania Department of Environmental Protection (PADEP). PADEP conducts many groundwater management activities, most of which relate to groundwater pollution and quality. Public groundwater supplies are regulated and monitored by field staff with a primary concern being water potability. Pennsylvania's Wellhead Protection Program and Ambient Groundwater Monitoring Network Program are administered by PADEP. Other actions that can impact groundwater and are regulated by PADEP include sewage disposal, solid waste activities, coal mining operations, and oil and gas drilling. Comprehensive water resource planning for the Commonwealth (e.g., the State Water Plan) is done by PADEP.

Pennsylvania Department of Conservation and Natural Resources (PADCNR). The Bureau of Topographic and Geologic Survey in PADCNR conducts groundwater studies and administers the Water Well Drillers License Act 610, which provides a mechanism to obtain groundwater and subsurface data. This bureau also maintains inventories of water well records.

1.5.5 State of Maryland

Maryland Department of the Environment (MDE). The Water Management Administration (WMA), through its Water Rights Division (WRD), has the responsibility for issuing groundwater appropriation permits for most new uses of groundwater. The WRD analyzes the area-wide effects of collective water appropriations and formulates management alternatives to resolve problems when needed. The MDE has the primary responsibility for protection of groundwater quality from contamination. Other MDE activities related to groundwater include administration of the state's Wellhead Protection Program, regulation of well construction, review and approval of county comprehensive water and sewage plans, and permitting of municipal waste landfills and other environmentally sensitive actions.

Maryland Department of Natural Resources (MDNR). Within MDNR, the Maryland Geological Survey is responsible for the maintenance of a statewide water-data network and the investigation of the hydrologic and geologic characteristics of Maryland's water resources.

1.5.6 Local Governments

Within the basin, there are a total of about 1,350 municipalities that control land use, land development, stormwater management, and several aspects of water resource management and use. Local government has a responsibility to both promote and protect the integrity of water resources, including groundwater. It is, therefore, incumbent upon local governments to become advocates for the control of land use policies that foster prudent water resource protection and development.

1.5.7 Watershed Organizations

There are approximately 189 watershed and lake organizations in the Susquehanna River Basin. These grassroots organizations seek solutions for water resource problems and issues, conduct grant-funded studies and research, and participate in local education and environmental planning with local governments.

1.6 Management Principles and Tools

This section discusses principles considered to be fundamental to groundwater management and tools available to achieve management goals. While the information is presented in relation to the Commission's groundwater management activities, it has applicability to programs and projects of others. More detailed information on groundwater management tools is presented in Appendix C.

1.6.1 Management Principles

Certain principles form the foundation for management of the groundwater resources by the Commission. Many are basic facts or axioms—propositions that are universally recognized as indisputable—and are reviewed below as background for the discussion of management. Others are concepts adopted from the successes of a variety of existing and ongoing efforts. Overall, the principles serve to guide the Commission in its policy development and its actions to implement management goals.

1. Water is a valuable asset and a finite natural resource; it is essential to all life.
2. Groundwater occurs almost everywhere beneath the land surface. However, earth materials differ widely in their ability to store and transmit water, which causes a disparate distribution of groundwater resources in watersheds and poses a challenge for equitable allocation and use. Furthermore, the volumes of water pumped from a groundwater system must come from somewhere and must cause a change in the groundwater flow system.
3. From the standpoint of water use and water management, all groundwater is not equal—the quality of the water may make it unsuitable for some uses without treatment. Groundwater quality is a key consideration in developing water management strategies.
4. Groundwater management needs to be consistent with the objectives of the Compact to promote the “orderly, integrated and comprehensive development, use and conservation” of the basin's waters and to secure and maintain “a proper balance among industrial, commercial, agricultural, water supply, residential, recreational, and other legitimate uses of the water resources of the basin.” As the Susquehanna River Basin continues to experience growth in population and economic enterprise, and as our communities continue to develop and mature, it is essential that the Commission practice good stewardship and utilize the basin's water resources in a thoughtful and balanced fashion to serve all legitimate purposes.
5. The use of groundwater resources needs to be managed to promote sustainability in the face of short-term and long-term growth. Sustainable development requires the development and use of groundwater in a manner that yields can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences. Sustainability requires a long-term perspective to groundwater management.

The Commission has defined the sustainable limit of water resource development as the average annual base flow (recharge) available in the “local” watershed during a 1-in-10-year average annual drought. That is, the total amount of water withdrawn by all users on an annual basis should only exceed the normal amount of water recharge on an average of once every 10 years. Users draw a higher percentage of water from groundwater storage during the drought years than they do during non-drought years, and the groundwater system is allowed to recover (that is, storage refills) during the intervening years. The selection of the 1-in-10-year drought recharge standard strikes a balance among resource conservation, environmental needs, regulatory restriction of growth and development, and the need for adequate and often expensive constructed water storage facilities.

6. Water resources management, and particularly groundwater resources management, requires an integrated approach, recognizing that the chemical, biological, and physical aspects of groundwater systems are interrelated; that many natural processes and human activities affect these interactions; that water supply and water quality cannot be managed separately; and that groundwater and surface water are inextricably linked parts of the same resource. Integrated management means that the Commission, in its decision-making, needs to consider all of the aspects of the water resource that are fundamentally interrelated.
7. Decision-making should be based on sound scientific principles, policies, and requirements in laws and regulations.
8. For proper management and protection, the Commission, as well as its member jurisdictions, should work to build long-term, local capability to foster critical “local stewardship” of water

- resources. Whenever possible, the Commission should be involved in establishing and nurturing watershed organizations, assisting in the development of local plans, and supporting enactment of appropriate local ordinances, especially those concerning land use.
9. Prudent groundwater management requires that the Commission and its member jurisdictions recognize the likelihood of continuing limitations in fiscal and staffing resources, and focus on key issues where they can make a positive and substantial impact. The Commission must strive for the most efficient use of its human and technical resources and prioritize its efforts accordingly. This should be done for all program areas, including when considering regulatory options such as general permits, as appropriate, and selecting priority items such as “Potentially Stressed Areas” (PSAs) as a focus for its management program. Implementation of actions related to the plan should be staged over time as resources are available.
 10. Coordination among member state and federal agencies and the Commission results in efficient data collection, planning, monitoring, and management of the basin's groundwater resources.

1.6.2 Resource Evaluation

The Commission evaluates groundwater availability, utilization, and potential environmental impacts using a number of different analytical methods and tools which are discussed in this section. Areas having intense water resource utilization require additional analyses to maintain a balance between groundwater withdrawals and aquifer recharge on a local level in order to prevent local resource depletion, environmental impacts, and water supply failure.

Water Budget Analysis. A water budget analysis treats the water resources of an area as an account, with income (recharge), expenses (withdrawals and instream flow needs), and savings (storage). The natural flow system that encompasses all the budget expenses (wells, springs, stream intakes, instream flow needs, etc.) and their recharge areas must be carefully defined. On a project-specific basis, this will generally correspond to a subsection of a local watershed. Water budgets are useful for evaluating the groundwater resources available for development, troubleshooting water supply and well interference issues, and planning for future water needs (expenses).

Critical Aquifer Recharge Areas. Critical aquifer recharge areas (CARAs) are land surface areas that are responsible for a large fraction of the recharge to a well capture area and/or are closely hydraulically coupled to a withdrawal or area of discharge (spring, stream, or wetland). An area may be classified as a CARA by virtue of its high aquifer permeability, soil characteristics, vegetative cover, and location with respect to discharge areas and/or withdrawals, topographic setting, or a combination of these. Delineation and proper management of CARAs will help to ensure that the amount of water allocated (e.g., in a project approval action) will be available for the duration of the approval and to preserve the local base flow in streams.

Water Level Monitoring. The flow of groundwater from recharge areas to areas of discharge is driven by the difference in water levels (head) of these areas. The monitoring of water levels in an area of concentrated development can provide information on the functioning of the groundwater flow system and an early warning of over utilization.

Special Studies and Models. Special studies and/or modeling are used to check the “health” and utilization level of the groundwater flow system in areas with concentrated water resource development, or address other water resource management issues. A current example of such an effort by

the Commission is a special study of alternative management options for both surface water and groundwater to address agricultural consumptive use in the Susquehanna River Basin in Pennsylvania.

Water Resource Management Database. A large amount of water resource management-related information is available from many sources and in various formats. In order to efficiently and most effectively use this information, it can be organized under a common database and placed in a Geographic Information System (GIS). A GIS-based database can greatly facilitate cumulative impact analyses, water budgets, and the delineation of CARAs.

1.6.3 Regulatory Program

The primary groundwater management “tool” used by the Commission is its regulatory program. The various facets of the program are discussed below.

Registration. The Commission adopted water withdrawal registration regulations to document water use throughout the basin and provide the necessary data to make informed water management decisions. Registration is important to the Commission's permitting activities because it provides basic water use data, thereby allowing the Commission to protect existing uses. Information on water use is important for other Commission water management activities, including preparation of water budgets.

Regulation of Groundwater Withdrawals. The Commission adopted withdrawal regulations to manage large water users (in excess of 100,000 gpd or 20,000 gpd used consumptively) in order to avoid conflicts between users and to ensure beneficial management of the water resources. By regulation, withdrawals are limited to the amount (quantity and rate) that is needed to meet the reasonably foreseeable needs of a project and that can be withdrawn without causing adverse impacts. The Commission's application process has a number of standard criteria that are applied to all projects. These include a constant-rate pumping test, metering, monitoring and reporting, mitigation of adverse impacts, water conservation, and a docket reopener provision.

The Commission's staff formulates specific recommendations so that the project can operate without causing any undesirable environmental effects. Water quantities and rates of withdrawal can be reduced from those requested or otherwise limited, as necessary, to protect other uses or mitigate impacts. Many projects are conditioned with instream passby flow requirements or a minimum groundwater level that must be maintained in the production well.

Compliance Monitoring and Enforcement. The Commission's objective is to have all water users in the basin in compliance with the Commission's water management regulations in order to properly manage the basin's water resources. The Commission requires certain monitoring data be submitted for approved projects.

Protected Areas. The Compact allows for the creation of protected areas in regions of water shortage within the basin. According to the Compact, protected areas are intended to correct, mitigate, and manage local area water supply shortfalls or threatened shortfalls on a quantitative basis. Protected areas may be managed to limit groundwater withdrawals, surface water withdrawals, both groundwater and surface water withdrawals, and cumulative consumptive water uses. To date, the Commission has not exercised its protected areas authority, but could do so if needed.

Development of Standards and Guidance. Commission staff has developed both standards and internal and external guidance to promote consistency and efficiency in the Project Review Program. The most important of these, from a groundwater perspective, is the Pumping Test Guidance

(2002) that specifies the procedures, monitoring, evaluation, and data analyses needed for conducting constant-rate pumping tests. Other guidance includes passby flow evaluations, out-of-basin diversion protocol, criteria for waiving pumping tests, guidance for evaluating cumulative impacts, establishing “grandfathered” quantities, and reviewing consumptive water uses. The development of standards and guidance is an ongoing process, and will continue as important issues arise and time permits.

Water Conservation. A requirement to institute appropriate water conservation measures is included, by regulation, for any project that is subject to Commission approval. A number of specific requirements apply to public water suppliers (source and customer metering, unaccounted-for water to be less than 20 percent, an appropriate rate structure, etc.). The regulations do not include specific conservation measures for other water users. Incentives for promoting conservation measures and implementing technical solutions may also be considered by the Commission.

Water Reuse. Groundwater used by municipalities and industries is typically treated and discharged to a stream. AMD from many flooded underground coal mines is treated and discharged to streams. The quality of treated water is generally quite good and is potentially usable for many non-potable uses. The reuse of treated wastewater will allow the water budget to be “stretched” in areas of rapid growth and limited water resources.

Conjunctive Use. The availability of groundwater and surface water resources frequently varies in a complementary manner during the year, such that one of them is relatively abundant while the other is relatively scarce. Water users can develop both groundwater and surface water sources, and rely on each as it is “in season.” This approach is called conjunctive use and it should be generally encouraged and, perhaps, incentivised in areas where groundwater resources are nearing exhaustion.

1.6.4 Public Outreach and Education

Public outreach and education on groundwater concepts are important for managing the resource. Since most issues concerning groundwater availability and use hinge on land use planning and development decisions, local government and citizens are a critical audience for focusing efforts on outreach and education. Other groups concerned with water resource issues are important to the process and they include professional organizations, watershed organizations, and schools. Topics such as recharge, conservation, and water reuse/recycling are an important component of groundwater resource education.

Outreach and education can be conducted effectively using a variety of methods. These include presentations, publications, multimedia products, seminars, and interagency coordination of workgroups and task forces. The Commission is active in all these endeavors.

2.0 GROUNDWATER RESOURCE ISSUES, PROBLEMS, AND RECOMMENDATIONS

The purpose of this section is to lay out the broad range of issues and concerns regarding groundwater conditions in the basin, identify recommended actions to address these issues, and identify the several key areas where the Commission should focus its efforts. Because conditions and needs are constantly changing, it is necessary to continue identifying new problems and working to maintain and improve conditions through planning and cooperative management. Many problems have been brought about by human activities, either directly related to increasing demands for groundwater or indirectly when development alters the natural flow regime in a non-beneficial manner. Other problems are related to water scarcity. Many water resource problems have been solved by human engineered solutions and, in some cases, fortuitously and unintentionally through human activity.

The groundwater issues, problems, and solution alternatives are summarized in Table 2.1 and were developed from the shared experience of groundwater professionals working in the Susquehanna River Basin. The table is meant to introduce the relationship of groundwater problems with the wide array of available alternative solutions. Each groundwater problem is then further discussed in the following sections and the best solution(s) is identified in a recommended action.

Some confusion exists in discussions of groundwater management issues regarding several key terms relating to the impacts of groundwater withdrawals. The five most important of these terms are: (1) *aquifer dewatering*; (2) *safe yield*; (3) *sustainable yield*; (4) *overdraft*; and (5) *groundwater mining*. Definitions of these key terms are included in the Glossary of Terms, though they are discussed here to better clarify their interrelationship and relative meanings (Alley, et. al., 1999; Alley and Leake, 2004; Sophocleous, 1997; Sophocleous, 2000; Bredehoeft, 1997).

All groundwater withdrawals from the water table or unconfined aquifers cause some amount of *aquifer dewatering* as a cone of depression develops around the point of withdrawal. Averaged over a period of years, the cone of depression reaches equilibrium or “steady state.” However, most established cones of depression in seasonally variable climates, such as that for the Susquehanna River Basin, are in quasi-equilibrium. Cones of depression grow during periods of low recharge and shrink during periods of high recharge. Cones of depression also fluctuate in lateral and vertical extent if the amount of withdrawal is variable over time.

The *safe yield* is generally considered to be less than or equal to the average annual recharge for a groundwater basin. Such a withdrawal maintains a long-term balance between the amount of water received and the amount of water withdrawn. *Safe yield* ignores the natural (pre-development) balance between recharge to and discharge from a groundwater basin. Therefore, development of groundwater up to the *safe yield* will result in a substantial reduction in natural discharge. Streamflow, spring flow, and wetlands would be substantially impacted.

The *sustainable yield* is equal to the *safe yield* minus the amount of water needed to maintain groundwater dependent ecosystems. The amount of flow required to meet ecosystem needs is dependent on the nature, sensitivity, and quality of the habitat. The Commission currently uses an instream flow model to evaluate impacts and determine instream flow needs.

Table 2.1. Groundwater Resource Issues, Problems and Solution Alternatives

Groundwater Issues	Groundwater Problems	Groundwater Problem Solution Alternatives									
		Local Water Budgets	Protected Areas	Groundwater Preserves	Critical Aquifer Recharge Areas	Cumulative Impact Analysis	Compliance Enforcement	Upgraded Project Reviews	Water Use (GIS-based) Data Management System	Regional Hydro-geological Information	Interagency Coordination
Areas of Intensive Growth/Development and Consequent Water Resource Development	Well Interference	X			X	X	X	X	X	X	X
	Exceedence of Sustainable Yield	X	X		X	X	X	X	X	X	X
	Loss of Recharge Areas	X	X		X	X		X	X	X	X
Intensive Water Use in Small Basins	Loss of Base Flow	X		X	X		X	X		X	X
	Loss of Perennial Streamflow	X		X	X		X	X		X	X
Watershed Transfers	Wastewater Not Returned to Watershed Where It Was Withdrawn	X				X	X	X	X		
Loss of Clean Water Input to AMD-Impacted Streams	Degradation of Trunk Stream Quality	X		X			X			X	X
Unknown and Unregulated Groundwater Use	Data Gaps Can Prevent Evaluation of True Sustainability and Cumulative Impact	X	X			X	X		X		X
	Severe Loss of Base Flow During the Growing Season	X	X			X	X				
	Interference with Existing Water Sources	X	X			X	X				

2.0 Groundwater Resource Issues, Problems, and Recommendations

Table 2.1. Groundwater Resource Issues, Problems and Solution Alternatives (Continued)

Groundwater Issues	Groundwater Problems	Groundwater Problem Solution Alternatives										
		Local Water Budgets	Protected Areas	Groundwater Preserves	Critical Aquifer Recharge Areas	Cumulative Impact Analysis	Compliance Enforcement	Upgraded Project Reviews	Water Use (GIS-based) Data Management System	Regional Hydro-geological Information	Interagency Coordination	
Scarcity of Clean Water in Coal-Mined Areas	Preferential Development of High Quality Groundwater Sources				X							X
Drought Impact to Base Flow	Insufficient Streamflow to Sustain Instream Flow Needs or Down-stream Water Supplies	X			X	X				X		X
Impacts of Mining	Beneficial Use of Discharged Water for Water Supply	X				X						X
	Extensive Aquifer Dewatering	X				X						X
	Exceedence of Sustainable Yield	X				X				X		X
Flow Compensation for Consumptive Water Uses	Need for Additional Low Flow Augmentation	X				X						X

2.0 Groundwater Resource Issues, Problems, and Recommendations

If the annual withdrawal exceeds the average annual recharge rate, the *sustainable yield* is exceeded. If the withdrawal also substantially reduces stream and spring flow and dries up wetlands, the *sustainable yield* is exceeded. A groundwater withdrawal that causes harm, such as the conversion of perennial reaches of a stream to intermittent or ephemeral reaches, but does not cause persistently declining groundwater levels, has exceeded the *sustainable yield* of the aquifer.

A cone of depression that is in quasi-equilibrium during years of normal recharge grows in size during drought years, and then shrinks again during high or normal recharge periods, has created an *overdraft* during the drought period. Such *overdraft* could also be termed *seasonal depletion*, and if some form of harm is caused during the period of *overdraft* (e.g., creation of seasonal dry reaches of stream that would normally be perennial), then it would also constitute *exceedence of sustainable yield*.

A groundwater withdrawal or combination of withdrawals that far exceeds average recharge and that causes groundwater levels in an aquifer to persistently decline is termed either a *persistent overdraft* or *groundwater mining*.

Problems of true *groundwater mining* (persistent *overdrafts*) are rare in the basin, though problems relating to extensive *aquifer dewatering* (e.g., mining cones of depression covering several square miles) and exceedence of *sustainable yield*, are fairly common. Also, several areas, herein called PSAs, are approaching the *sustainable yield* of the local groundwater basin.

A guidepost of the plan is to manage the use of water resources to promote sustainability in the face of short-term and long-term growth. The Commission has defined the sustainable limit of water resource development as the average annual base flow (recharge) available in the “local” watershed during a 1-in-10-year average annual drought. This level of recharge represents about 60 percent of the average annual recharge. The total amount of water withdrawn by all users on an annual basis should only exceed the average amount of water recharge on an average of once every 10 years. Users draw water from groundwater storage to meet their needs during the drought years, and the groundwater system is allowed to recover (that is, storage refills) during the intervening years.

2.1 Issue: Areas of Intense Growth and Development, and Consequent Water Resource Development

While the population in the basin has grown only slightly over the last decade, the growth has largely been concentrated in a few metropolitan areas. This growth has resulted in a greater demand for groundwater resources and, at the same time, has impacted the quantity and quality of those resources and their availability to serve as reliable water supplies. Development of water supplies to serve the local needs is particularly challenging in areas where natural conditions severely limit the amount of groundwater resources available and aquifers will support very little water resource development. As such, these areas should be identified for potential project sponsors.

The Commission has identified several geographic PSAs in the basin where existing or projected withdrawals and uses are anticipated to exceed long-term sustainability or cause prevalent conflicts among users. These include areas previously mapped as PSAs and “Water Challenged Areas” (WCAs). The identification of PSAs is a tool developed by Commission staff for the review of projects as part of its regulatory program. As new information becomes available, the identification of these areas is subject to revision on an annual basis as a part of the Commission's Water Resources Program.

To identify PSAs, Commission staff evaluates the following criteria and areas that meet two or more of the criteria are identified:

2.0 Groundwater Resource Issues, Problems, and Recommendations

- Diminishing groundwater yields.
- Declining groundwater levels.
- Diminishing stream or spring flows.
- Expanded dry stream reaches.
- Withdrawals* within a groundwater basin exceed the recharge during a 1-in-10-year average annual drought based on a water budget analysis.
- Known withdrawals* in rapidly developing areas that exceed 50 percent of the recharge during a 1-in-10-year average annual drought.
- Area where increased withdrawals from a poor or low-yielding (low permeability) bedrock unit cause conflicts among users.

* Note: Includes existing withdrawals (current use approved by the Commission, plus those not requiring approvals; i.e., residential use, grandfathered uses, and uses below the minimum Commission approval threshold) plus additional approved groundwater use amounts not currently being withdrawn.

Applications submitted to the Commission for review of projects located in PSAs receive a greater degree of scrutiny. The requests for groundwater withdrawals may be denied, approved at a lesser quantity than requested, or approved with conditions such as water level monitoring, streamflow monitoring, water table mapping, preparation of a water resource management plan, and/or a mitigation strategy such as relocating a discharge location. The additional information is used to provide a clearer picture of the available water resources and allow additional steps to be taken to formulate an effective solution and mitigate potential adverse, or cumulatively adverse, impacts from the withdrawal, as needed.

The Commission will provide available technical information to project proponents for their use in the preparation of project material and in scoping a sound project. Commission staff can attend stakeholder meetings, if requested, to help identify potential solutions to groundwater use problems. If hydrogeological conditions warrant, a water budget analysis can be developed for a local jurisdiction, provided that Commission staff can be made available and adequate funding is available. In the rare event that issues and/or conflicts cannot be resolved, the Commission has the authority to take actions to assure an equitable use of groundwater resources among competing legitimate users.

The PSAs that have been identified to date are shown on Figure 2.1 and are briefly discussed below. The information on these areas is provided to illustrate the variable factors that can lead to overuse of groundwater resources.

Manheim/Lititz/Ephrata Valley. This is a rapidly growing area. A water budget (submitted by a project applicant) indicates that approximately 50 percent of the 1-in-10-year drought recharge is currently being utilized in this rapidly growing area. The Commission completed a detailed water budget for this area in June 2005.

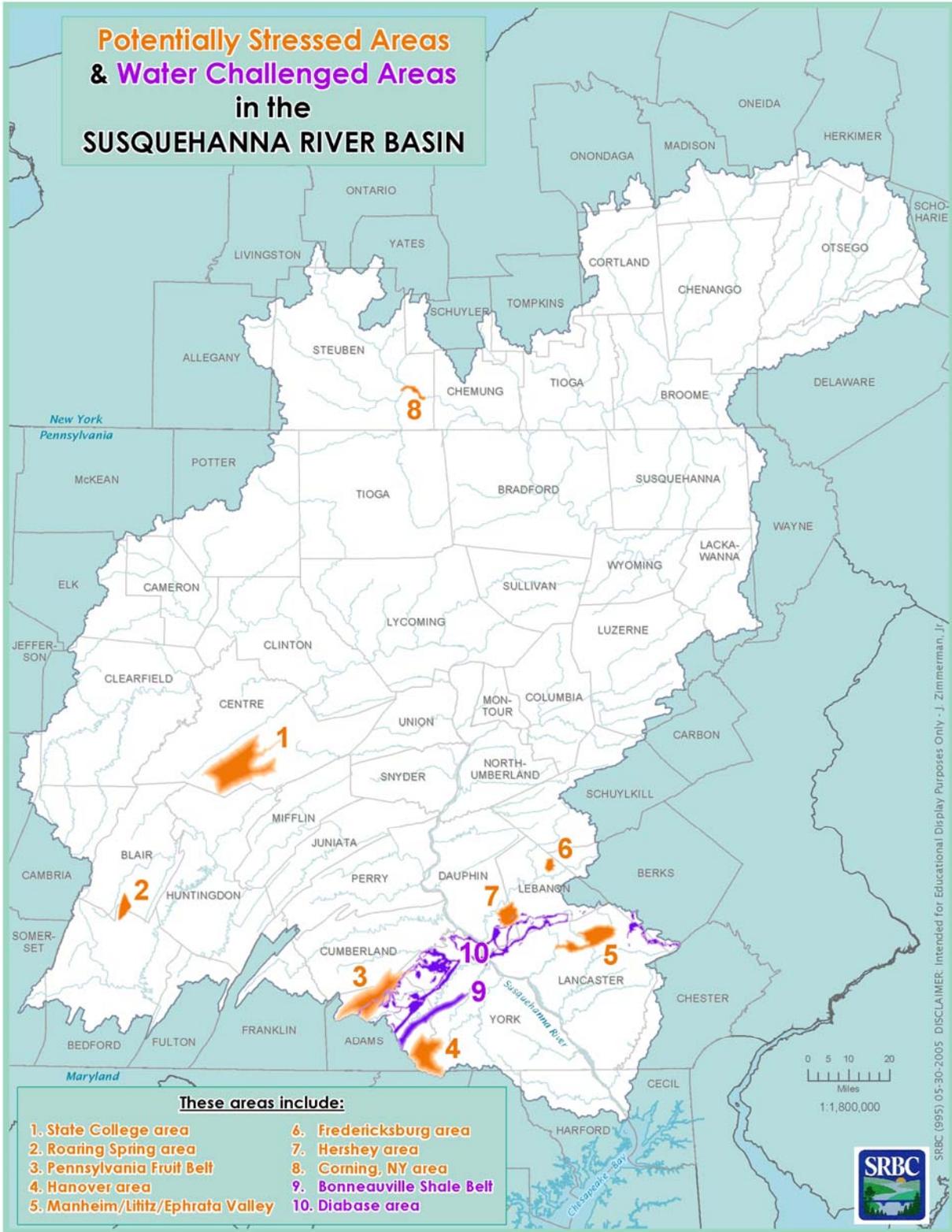


Figure 2.1. Potentially Stressed Areas and Water Challenged Areas in the Susquehanna River Basin

2.0 Groundwater Resource Issues, Problems, and Recommendations

The Fruit Belt. This is an area in York and Adams Counties with very intensive fruit production, both orchards and processing, that extends into the Potomac River Basin, and ends near the Pennsylvania-Maryland state line. The fruit growers in this area of York and Adams Counties are gradually turning to irrigation to meet their orchards' water needs, and fruit processing facilities have expanded their operations from primarily seasonal fruit processing to year-round food production. This area includes one of the lowest yielding (Catoctin Formation Metavolcanics) and one of the higher yielding (Gettysburg Formation) bedrock units in the region. The natural ability of the low-yielding Catoctin Formation to provide groundwater is limited. Numerous low-capacity wells in the poor aquifers and stream intakes are utilized to supply the water for irrigation, fruit processing, and food production. Many of the uses are consumptive and do not return any water to surface or groundwater locations.

Hanover Area. This area is located on the divide between the Potomac and Susquehanna River Basins. The Hanover area has historically relied on surface water reservoirs for its water supply. However, watersheds are small and Hanover Borough's reservoirs have very long refill times, which has caused water shortages during recent droughts. This is a rapid growth area, particularly in terms of residential development, and commercial and industrial expansions have increased the demand for reliable water supplies.

With the exception of a relatively small area (approximately nine square miles) of carbonate rock, the aquifers do not produce or support the high well yields needed for municipal water supply wells. The carbonate aquifer has well-developed karst permeability, substantial water resource potential, and is essentially the only significant source of groundwater available to the area. But, the carbonate aquifer is continuously depleted by a quarrying operation due to mine dewatering, resulting in widespread perching of streams and widespread depressed groundwater levels during even unusually wet years.

Hershey Area (Spring Creek Basin). This area is undergoing rapid commercial, institutional, recreational, industrial, and residential development. A water budget, submitted by a project applicant to the Commission, indicates that virtually 100 percent of the 1-in-10-year drought recharge is already being utilized, even though most of the area's municipal public water needs are being supplied by a stream intake on Swatara Creek. Interestingly, while the Hershey area has reached a PSA status through recent growth and increased water use, this area was the scene of a large-scale, mid-20th century dispute over issues of groundwater withdrawal and artificial recharge to groundwater between two large neighboring water users: a key industry in the basin and a nearby mining company.

Fredericksburg Area. This area is undergoing rapid commercial, industrial, and residential development. A water budget, submitted by a project applicant to the Commission, indicated that virtually 100 percent of the 1-in-10-year drought recharge is being utilized. Withdrawals by food processors and a public water supplier are concentrated at the downstream end of three small watersheds and utilize essentially all of the 1-in-10-year flow. The proposed development of groundwater resources in the upstream areas to support substantial planned residential development could adversely impact the existing major withdrawals.

Roaring Spring Area. This area has substantial, well-established commercial and industrial water users, including a public municipal water supply, a paper plant, a quarrying operation, and a bottled water company, and is undergoing rapid residential development. A water budget analysis, including substantial detailed geologic mapping and a sophisticated groundwater model, indicated that virtually 100 percent of the 1-in-10-year drought recharge is being utilized. Nearly the entire flow from the spring is utilized during severe droughts. Resource development is well beyond the 1-in-10-year drought recharge for the spring basin. Development of groundwater within the Roaring Spring Watershed to support new uses would impact existing users of the spring.

2.0 Groundwater Resource Issues, Problems, and Recommendations

More than 80 percent of the spring water withdrawn is discharged as treated effluent to an adjacent watershed where sufficient dilution flows are available. This has resulted in a greatly diminished flow in the stream reach between the spring and the Frankstown Branch of the Juniata River. Also, the capacity of the municipal wastewater treatment plant is capped by the limited available dilution flow.

A further complication is the large quarry downstream of the spring, which plans to mine some highly permeable carbonates below stream level and adjacent to the stream. Pumping tests performed on monitoring wells adjacent to the stream suggest that the dewatering required to mine the high calcium beds could impact streamflow.

State College Area. This PSA includes most of the Spring Creek Watershed and some of the headwaters of the Spruce Creek Watershed. The area is served by one of the largest regional karst carbonate aquifers in Pennsylvania. The PSA status for the State College area is a result of several factors:

- The State College area is undergoing rapid growth. The area has been growing for several decades, but the nature of the growth has changed from residential and industrial to dominantly residential, educational, and commercial, with a more diverse employment base. The new growth pattern has created stormwater and impervious cover issues.
- The area includes several groundwater contamination sites. As a result, groundwater in some areas is unusable without expensive treatment.
- The mining of high calcium limestone at the foot of the mountains has removed portions of the karst aquifer that previously collected runoff from the mountain slopes. The mine dewatering at some of the quarries has resulted in aquifer dewatering and stream perching.
- Municipal water is currently drawn from several widely scattered well fields located in headwater areas, but is discharged from a single wastewater treatment plant located downstream. This results in the loss of flow in headwater areas upstream of the treated wastewater discharge. Also, some of the water is being withdrawn from the headwaters of the Spruce Creek Watershed, and that water is discharged to the Spring Creek Watershed. This has resulted in diminished flow, and the loss of perennial flow in streams and springs in the Spruce Creek headwaters. The “Living Filter” project, developed by the Pennsylvania State University, utilizes the natural filtration and recharge capability of native soils to return treated wastewater to the regional carbonate aquifer. Similar facilities distributed in the headwaters of the Spring Creek and Spruce Creek Watersheds would help restore natural stream and spring flow in the headwaters areas.
- Municipal well fields contain multiple high capacity wells. These are generally located on fracture traces, which often coincide with stream valleys. The fracture traces are desirable sites for high capacity wells because of the intensive karst conduit development along them. The streams in these valleys have naturally gaining and losing reaches, their behavior often varying seasonally. The drawdown from the municipal wells interacts with the natural flow system, causing additional losing reaches, increased flow loss, and additional instream sinkholes.

Corning Area. This area from the confluence of the Tioga River and the Chemung River downstream to South Corning, and surrounding the town of Corning has substantial, well-established

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commercial and industrial water users, along with public water supply wells. Many of the industrial users are “grandfathered” by the Commission. The high capacity wells are drilled in the glacial valley fill and many induce infiltration from the Chemung River. As in many historic industrial centers, groundwater in some of the area is contaminated, which can limit the availability for some users. As the area continues to evolve as a regional center, future requests for water withdrawals will require special attention because of this combination of factors.

Low Yielding Aquifers in Developing Areas. Several bedrock units in the basin are quite low yielding (poor aquifers), particularly certain units in the Piedmont and Blue Ridge Provinces. Where these low yielding bedrock units occur in developing areas, they severely limit groundwater supply availability. Examples in the Gettysburg-Newark Lowland Section of the Piedmont include Triassic diabase and certain portions of the Triassic sedimentary-rock aquifers, such as a small portion of the Gettysburg Formation, informally termed herein the “Bonneauville Shale Belt.” Certain zones within the metamorphic schists of the Piedmont Uplands, and certain zones within the metavolcanics of the Catoclin Formation in the South Mountain Section of the Blue Ridge Province, are also low yielding bedrock units.

Diabase. Diabase is widely known as one of the lowest yielding aquifers in the Susquehanna River Basin. It is a massive, poorly fractured igneous rock formation and occurs as bands, typically ½ to 2 miles wide and 10's of miles long, and as narrower belts, with irregular patches covering several square miles. Areas underlain by diabase are characterized with thin soils and abundant boulder fields, a relatively high percentage of wetland area and wetlands springs, and a relatively high density of small streams.

There is a high percentage of low yielding wells in the diabase, and many diabase wells rely on shallow water-bearing zones. Locally, large quantities of water may be obtainable by drilling through the diabase where it is not deep rooted (often several hundred to more than 1,000 feet thick) into the underlying strata. However, this deep groundwater is often not potable, exceeding safe drinking water standards for hardness, total dissolved solids, sulfate, iron, and manganese.

Bonneauville Shale Belt. The Bonneauville Shale Belt is informally named after the Borough of Bonneauville in Adams County, where the aquifer consists of the poorly bedded silty shale (technically mudstone) at the base of the Gettysburg Formation. Most of the Gettysburg Formation is a moderate to high bulk permeability, and in some cases, this unit supports wells with yields of hundreds of gallons per minute, though the lower portion of the formation appears to have a relatively low bulk permeability based on a pattern of low well yields. The shale belt is three to five miles wide over most of its length, and extends from the vicinity of Dover Borough in York County, southwestward through Adams County into Maryland, south of Gettysburg, near the Monocacy River.

The majority of the Bonneauville Shale Belt consists of broad, low relief hills (interfluves) that are suitable for limited agricultural development. Valleys are broad and seasonally wet, even with extensive tiling. Stream base flows are extremely low, while storm flows are very high.

Several groundwater problems typically occur in areas of intense growth and development. They include well interferences, exceedence of sustainable yield, and loss of recharge areas.

Problem: Well interference.

Increasing water demands have been met by the development of new water sources, many of which are wells. The new sources typically are located close to the area of need at the periphery of the growing metropolitan area. When wells are located too close together, drawdown areas for

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the wells may overlap and result in decreased yields. The loss of operational yield is due to the increased head against which the pumps must work and a less available drawdown.

The overlapping of drawdown areas that result in well interference and the attendant loss of yield often cannot be directly predicted by the pumping test required by the Commission. Long-term drawdown patterns may require months to years of operation to develop, depending on the hydrogeological setting. However, the information derived from the pumping tests from wells in the area of intensive development provides the input needed for developing a groundwater model. Such models can be used to evaluate the results of long-term well operation. They also can be used to evaluate the problem of additional proposed wells.

The relatively long period over which well interference develops allows the use of water level monitoring as an evaluation tool. Such monitoring would require the periodic measurement of the water level in a few existing or new wells. As the drawdown areas of the individual wells are observed, well interference can be anticipated and appropriate water resource planning actions taken. The monitoring results also may be used in the development and refinement of a groundwater model.

Recommendation: Where time and water resources are limited, a groundwater model should be used to provide a rapid prediction and evaluation. The use of a model would take into account the appropriateness of the particular approach, as well as the capabilities/limitations of the chosen model. In situations where the availability of water resources allows a more flexible, less time-sensitive approach, water level monitoring is recommended. For many cases, a combination of these approaches will provide the most effective solution, which could include mitigation of impacts. The implementation of such plans may require the coordination of appropriate federal, state and local agencies.

Problem: *Exceedence of sustainable yield.*

The sustainable yield of an aquifer is exceeded when the withdrawal of groundwater causes undesirable effects, such as environmental damage. The clustering of water supply wells around growth centers has locally resulted in loss of base flow in area streams and total maximum daily load (TMDL) exceedences. In the State College area, for example, several widely spaced, dry stream segments have developed on previous perennial stream reaches. These undesirable effects, including environmental damage, are an indication that the sustainable yield of the aquifer has been exceeded.

The Commission has developed and implemented pumping test guidelines that include the requirement for a groundwater availability analysis (water budget) for each new well being submitted for Commission review and approval. The level of effort and sophistication required are determined by the hydrogeological setting and the current and projected level of groundwater development in the area. For PSAs, detailed water budgets should be developed to assist in management of the resource.

Recommendation: Continue to require and review groundwater availability analyses for new projects and detailed water budgets for PSAs. For areas where undesirable effects have stemmed from groundwater withdrawals, and sustainable yields have been exceeded during the last few decades, review and reopen dockets, require a water budget analysis, and adjust the withdrawal rates for sustainability.

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Problem: Loss of recharge areas.

As metropolitan areas grow, recharge areas that were once rural are gradually developed (Figure 2.2). Commercial, industrial, and residential development typically results in the creation of impervious surfaces and the interception and diversion of precipitation into nearby streams. The impervious cover is in the form of buildings, walkways, roads, and parking lots. Water from these areas is collected and managed through engineered stormwater drainage systems. These systems are designed to efficiently collect, detain, and dispose of the rejected recharge and surface runoff.

However, a portion of the flow is redistributed. A large portion of what would normally have infiltrated and become base flow is conveyed to storm-water storage basins where it is retained and released as surface water. Many storm water basins allow some infiltration; and current best management practices are encouraging storm water infiltration or artificial recharge over detention and release as surface water. The result, absent current application of best management practices encouraging artificial recharge, is a decrease in the amount of groundwater available to water supply wells, a loss of habitat-sustaining base flow, and loss of recharge to the aquifer. An example is the Pump House Springs well field operated by the Borough of Shrewsbury, where a well field located in a small headwater watershed has been gradually surrounded by three malls, an interstate interchange and several commercial complexes.

Slope alteration, usually in the form of leveling, is also done in preparation for development. In most cases, the slopes defining the natural drainage net for the area are completely removed. The land then receives a new cover, generally a combination of buildings, pavement, and turf. Of these, only the turf could have a significant infiltration rate. The infiltration rate for turf is among the lowest for all vegetated surfaces. Destruction of soil structure and micropores (decayed rootlets, worm burrows and ice wedging) also substantially reduces the infiltration rate.

Recommendation: The Commission should base its sustainable yield determination for approval quantities on estimates of the recharge available to a well that include post build-out conditions.

Further, the Commission should encourage the use of “best management practices” (BMPs) that minimize the loss of recharge, such as those developed by the Commission's member jurisdictions. Available recharge should be verified after build-out and the approval amount increased (or decreased), based on the outcome of the verification study.

2.2 Issue: Intensive Water Use in Small Basins

The amount of groundwater available at a given location is proportional to the catchment or recharge area for the aquifer, upgradient of the point of withdrawal. Small groundwater basins have a relatively limited amount of groundwater. Water intensive uses such as quarries, golf courses (for irrigation), and other recreation activities, water exports for bottling operations, and concentrated animal feedlot operations (CAFOs) are rapidly growing in the small headwater basins.



Photo by Andrew Gavin

Figure 2.2. Subdivision Development Resulting in Potential Loss of Recharge Area

Problem: Loss of base flow.

The withdrawal of large quantities of groundwater from small, headwater basins reduces the groundwater contribution to headwater streams. The amount of taking is constant, and so constitutes a larger fraction of the total base flow at longer drought recurrence intervals. The reduced base flow during periods of drought can strongly impact stream life, because the instream flow needs are not met. The groundwater contribution to headwater streams tends to be of a higher quality given a high percentage of forest cover and a lack of anthropogenic sources of contamination.

Large withdrawals (greater than 100,000 gpd) may constitute a large fraction of the available groundwater in a small basin. In these cases, and especially if the water use is consumptive, withdrawals can cause a severe loss of headwaters streamflow, dewater springs and wetlands, and, hence, exceed sustainable yield. Common examples of large withdrawals in small basins include quarries, golf courses, ski resorts, CAFOs and spring/bottled water operations.

Recommendation: In recognition of the importance of headwater areas with respect to water quality, the Commission, in cooperation with member jurisdictions and other organizations, should educate the public and local land-use planners about the sustainability of these areas and the need to properly manage them.

Problem: Loss of perennial streamflow.

The reduction in base flow may actually exceed the drought groundwater discharge rate to the nearby stream, thereby changing the previous intermittent reaches to ephemeral reaches, and the uppermost perennial reaches to intermittent reaches. The loss of perennial stream aquatic habitat occurs due to the development of dry stream segments. While the loss of perennial stream length is generally a small fraction of that for the entire stream, it often represents the most pristine portion of the watershed with respect to water quality and habitat.

Recommendation: The Commission, in cooperation with member jurisdictions and other organizations, should evaluate headwater streams with respect to habitat, and apply special conditions prescribing passby and conservation flows to its approvals for both surface water and groundwater withdrawals in order to manage water quantity and quality of the stream. The recognition and management of critical recharge areas also would benefit these areas.

2.3 Issue: Watershed “Transfers”

Groundwater frequently is withdrawn from one watershed and, after use and treatment, discharged to a neighboring watershed.

Problem: Wastewater is not returned to the watershed where it was withdrawn.

In order to maintain streamflow quantity, discharges should be located in the same watershed as their associated groundwater withdrawals. Preferably, they should be located close to the area of withdrawal in order to minimize the length of stream with diminished flow. However, in considering where water is withdrawn and returned, a myriad of factors are at work. On the one hand, many have advocated that we avoid sprawl, and concentrate development in and around existing communities rather than spread growing populations across open lands (and open watersheds). This means, in many cases, that the people are located in areas that may not have local water supplies to support that density, thus requiring that water supplies be brought to the people and related enterprises. The alternative policy option is to move the people to the water, which is precisely contrary to the policy goal of preserving open space and avoiding sprawl.

Further, watershed transfers are in some cases virtually mandated by some of our water quality management policies, which practically preclude or strongly discourage return of water to particular watersheds. Specifically, communities located in watersheds whose streams have been designated as special protection (high quality or exceptional value) find it extremely difficult or impossible to permit new or increased discharges in their host watersheds (even using state-of-the-art tertiary treatment technology). The result is the siting of treatment plants elsewhere, including neighboring watersheds that do not bear such special protection classifications.

Recommendation: The Commission, in cooperation with member jurisdictions and other organizations, should educate the appropriate professional groups about the options of maintaining groundwater withdrawals and post-use discharges in the same watershed, and the factors involved in this decision. The Commission should evaluate the transfer of water from the source basin during its review.

2.4 Issue: Loss of “Clean” Water Input to AMD-Impacted Streams

Many watersheds in coal-mined areas are strongly impacted by AMD (Figures 2.3 and 2.4). Considerable time, effort, and money have been expended by state and federal agencies to mitigate this water quality problem. Often, most of the clean water received by these streams is from tributaries draining strata without coal mines, such as the Pocono and Mauch Chunk sandstones and their equivalents.

Problem: *Degradation of stream quality.*

Most AMD-impacted watersheds have adjacent, tributary watersheds that are not AMD impacted due to a lack of coal and related mining activities. These AMD-free water resources are currently under substantial commercial development pressure for use as bottled and spring water, which are consumptive uses. The consumptive use of clean groundwater in the headwaters of a watershed impacted by AMD deprives the watershed of scarce freshwater sources, degrading stream water quality and quantity. This is especially important in small watersheds and headwater areas where springs provide a large portion of the total flow in the stream. In recent years, a number of springs in AMD-impacted watersheds have been developed for bottled/spring water, and such withdrawals deprive the stream of fresh water. An example of this type of problem exists in the upper reaches of Wiconisco Creek, near Tower City, Pennsylvania, where two spring basins currently are used as spring water sources, and two more are under development. Such business ventures are quite profitable due to the strong demand for bottled spring water. However, as this industry grows, the fresh water input to the AMD-impacted streams is cutoff, spring by spring.

The loss of the flow from these AMD-free watersheds could be a major setback to state, federal, and Commission efforts at mitigating the AMD problem. Substantial financial, material, and energy resources are being directed at mitigating the AMD problem through various approaches at cleaning the water or preventing the conversion of clean water to AMD-impacted water. Dilution by naturally clean water is far less costly than an equivalent level of mitigation achieved by chemical treatment, constructed wetland treatment, and pump and treat methods.

Tributaries by their nature are smaller than the streams they feed. Hence, the loss of flow from any one area may not be deemed significant unless the cumulative impacts from consumptive uses or inter-watershed transfers are considered. Evaluation of impacts, based on the cumulative effects, will prevent the loss of these clean water contributions in a piecemeal fashion.

Recommendation: The Commission's permitting process should include an evaluation of cumulative impacts from consumptive water uses to downstream water quality in AMD-impacted areas. The review of consumptive water use projects in watersheds that are tributary to streams not meeting state and federal water quality standards should consider cumulative impacts and the cost of mitigating the impacts. The Commission should coordinate with the appropriate state and federal agencies in its evaluation.

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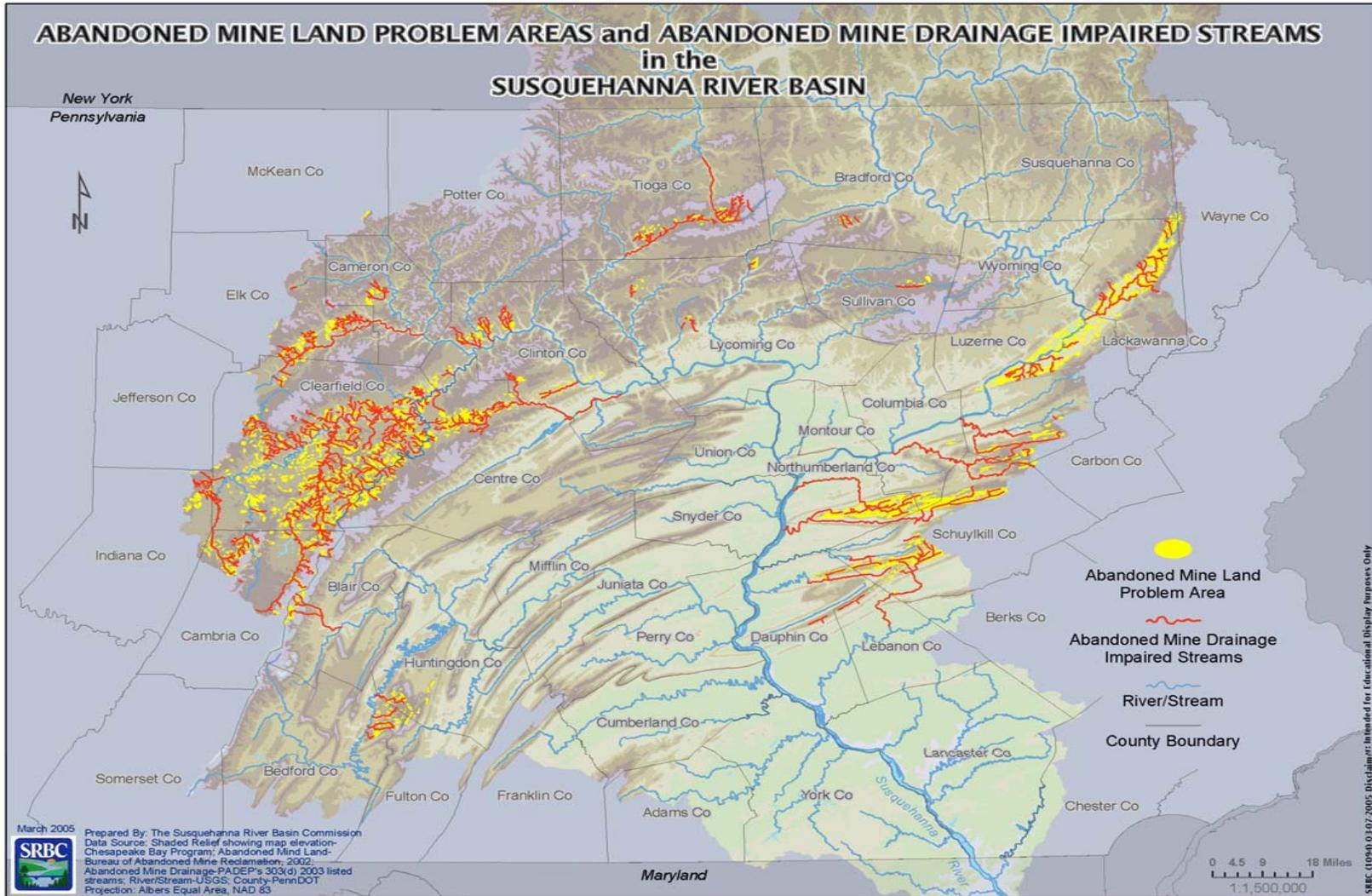


Figure 2.3. Extent of AML and AMD Influence in the Susquehanna River Basin



Photos by Jennifer Orr

(A)

(B)

Figure 2.4. *Clean Headwaters of the Tioga River (A), Pennsylvania, Degraded Downstream by Acid Mine Drainage (B)*

2.5 Issue: Unknown and Unregulated Groundwater Use

Groundwater used by the agricultural community, mining industry, and other unknown or unregulated water users is a potentially beneficial and important use of the Susquehanna Basin's resources. While it is known that agriculture, mining, etc. use groundwater, the quantity and location of many of the withdrawals are unknown. Agricultural groundwater uses include crop irrigation, orchard irrigation, and livestock watering. However, no states within the Susquehanna Basin require metering of agricultural water use, and little is known about the actual amounts and locations of agricultural groundwater withdrawals and uses. Maryland and Pennsylvania have registration programs for users greater than 10,000 gpd; however, the level of participation with registration programs has generally been lower than desired. In addition, the information collected is an estimate, and not the result of metered measurements. Groundwater use in the mining industry is essential to the production of earth resources. Common water uses include product washing, sorting and refining, dust control, and a variety of other uses. A variety of municipal, industrial, mining, and other groundwater withdrawals and consumptive uses predates the Commissions regulations, and are considered "grandfathered" under the Commissions regulations. These withdrawals and uses not regulated by the Commission are generally undocumented or poorly documented, and are not monitored.

Problem: *Data gaps can prevent evaluation of true sustainability and cumulative impact.*

Information on the magnitude, location, and seasonality of unknown or unregulated withdrawals and uses is needed in order to evaluate sustainability and cumulative impacts to avoid conflicts among users and to assure that adequate water is available for existing and new projects.

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Recommendation: The Commission should collect information on the magnitude, location and seasonality of agricultural, grandfathered, and unknown or unregulated withdrawals to improve its evaluation of the resources available to new projects.

Problem: *Loss of base flow during the growing season.*

Streams in areas of intensive irrigation and food processing, such as in Pennsylvania's fruit growing belt (York-Adams Counties), have experienced drastically-reduced base flows due to groundwater withdrawal. This problem is especially acute during the late summer and early fall months, when temperatures are high, precipitation is at a seasonal minimum, and withdrawals peak. Loss of base flow during low flow periods may result in loss and damage to habitat and the instream community, as well as a reduction in water available to other users.

Recommendation: Where loss of base flow is a recurring problem, a water budget and cumulative impact analysis will be essential tools needed to manage withdrawals for sustainability, and minimize impact to other water sources and the environment. Adverse impacts to base flow during periods of low flow should be addressed by managing withdrawals, storage, and conjunctive water use.

Problem: *Interference with existing water sources.*

Interference with neighboring water sources is usually an indication of a local overdraw from the aquifer. Water supplies may be impacted downstream of large unregulated or unknown withdrawals. Such occurrences are contrary to the Commission's goal of management for sustainability.

Water supplies with a passby flow requirement have to reduce or cease their withdrawals when streamflow is insufficient, and thus may be impacted during seasonal low flows, especially when these coincide with peak unregulated or unknown water use. For example, production from the Hegins Township Authority well field had to be drastically reduced during the 2001 drought, because agricultural water use upstream of the well field reduced streamflow and triggered the authority's passby flow requirement.

Recommendation: A water budget should be performed to determine the available water resources. Alternating and/or non-synchronous pumping of interfering sources will often address local, marginal overdrafts.

2.6 Issue: Scarcity of Clean Water in Coal-Mined Areas

In the areas of the basin of extensive coal mining, AMD impacts are widespread and most of the coal-bearing aquifers have been impacted. However, anticlinal geologic structures locally bring older (pre-Pennsylvanian) geologic formations to the surface that do not contain economic coal reserves. Some of these produce high-quality, AMD-free groundwater. The groundwater basins/watersheds situated in pre-Pennsylvanian rocks are often the primary source of clean water in the coal-mined areas.

Problem: *Preferential development of high quality groundwater sources.*

Most AMD-impacted watersheds have adjacent, tributary watersheds that are not AMD impacted due to a lack of coal and related mining activities. Development is occurring preferentially in the areas not impacted by coal mining activities in order to avoid problems, including AMD, subsidence, and over-steepened slopes. These AMD-free water resources are an important and often sole source of clean water for community water supplies. In addition, these watersheds are characterized by their relatively pristine environment and habitat. They are currently under substantial development pressure both for their water resources and developable land that carries

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no environmental liability. As a result, the water resources in the small, clean-water watersheds are in jeopardy. Many communities in the western part of the basin rely heavily on such areas for their water supplies.

Recommendation: The Commission, in cooperation with member jurisdictions and other organizations, should act to manage the quantity and quality of water from these watersheds, recognizing that water resources are necessary for the economic growth of mining-affected regions. Education of local government officials and municipal engineering firms is imperative. In the long-term, this would be most effectively accomplished through coordination among the Commission, the appropriate state and federal agencies, and other organizations. The Commission and others must recognize, however, that if municipalities in coal mining affected areas are to experience beneficial economic growth and development, they must turn to these clean watersheds for water supply while maintaining a balance with the need to protect aquatic resources. The Commission should also support efforts by the member jurisdictions for “grayfields” initiatives which encourage the beneficial use of AMD-affected waters.

2.7 Issue: Drought Impact to Base Flow

During the time between precipitation runoff events, surface water flow is sustained by the discharge of groundwater to streams, termed base flow. During a drought, aquifers steadily release water to streams, but are un-replenished by precipitation for an extended period. As groundwater levels decline, base flow, by necessity, gradually declines. Downstream and instream users of the stream are accustomed to base flows sustained by average precipitation levels. Their demands and needs remain unchanged during periods of drought, despite diminishing supply.

Problem: *Insufficient streamflow to sustain instream flow needs or downstream water supplies.* During periods of extended drought, base flow may decline to levels that are insufficient to sustain downstream surface water supplies and instream flow needs (Figure 2.5). Many municipalities, industries, and power generation facilities use surface water for their water supplies. In most cases, these needs cannot be significantly reduced without impairment to human health, welfare, and the economy. As a result, sustained droughts have the potential to cause streamflows to diminish to the point where users are impacted. Further, aquatic communities, including both warm and cold water sport/game fisheries, are critically dependent on base flow during periods of extended drought. Damage to, or collapse of, these aquatic communities represents a severe decline in environmental quality, and carries economic impacts as well. In extreme cases, fish kills may occur. The impacts can occur in the local, small headwater basins and can contribute to problems in downstream areas due to the cumulative effect of reduced flows in the headwater areas. Therefore, users in both the local and downstream areas would benefit from actions to maintain streamflows during drought conditions.

The Commission can play a positive role in helping to bring together the key stakeholders in areas affected by growing populations and mineral extraction operations, to help promote the development of reliable surface water supplies and instream flow needs. Mining operations frequently intercept groundwater that might otherwise infiltrate a mine, and release that water to surface streams where it becomes available to downstream communities, habitat, and other users. Indeed, for many years, flows in the Saucon Creek in the Delaware Basin was substantially supported by water pumped from the New Jersey Zinc Mine until the mine was closed. In some areas of the country, including Pennsylvania, both active and abandoned quarries have provided resources for community water systems, and similar cooperative efforts should be promoted in this basin.



Photo by Robert Pody

Figure 2.5 *Dry Stream Reach Resulting from Base Flow Decline During Drought Conditions*

Recommendation: The Commission, in cooperation with member jurisdictions and other organizations, should act to maintain stream base flow by protecting the groundwater flow that sustains it by: (1) educating local jurisdictions about maximizing high quality groundwater recharge through the support for implementation of stormwater management practices that promote infiltration, identification of CARAs, and application of “best management practices for development”; and (2) carrying out and/or supporting research on fisheries, particularly warm-water fisheries, to provide improved knowledge of required conditions for their survival and a scientific basis for their protection.

2.8 Issue: Impacts of Mining

Surface and underground mining of consolidated rock and mineral deposits provides valuable raw materials and rock products, including coal, dimension stone, aggregate, and high-calcium lime. In addition, sand and gravel deposits in the glaciated part of the Susquehanna River Basin are excavated, sometimes leaving large (more than 10 acres) lakes. There are no economically viable alternative sources for these materials, and the Commission recognizes mining as historically important to the economies of its member jurisdictions.

Mining often substantially alters the landscape in ways that affect groundwater, surface water, and environmental resources (Figure 2.6). Streams, springs, and wetlands are often substantially altered, or even removed, from the landscape. Surface mines, by their nature, result in the removal of the landscape within the footprint of the open pit. The removal of key hydrologic landscape elements, such as sinkholes, streams, and springs, may result in substantial alteration of groundwater flow patterns, quantity, and quality. Once mining is completed, abandoned water-filled mines often become an asset to water resource management, given the creation of large volumes of water in storage that previously did not exist. For instance, the abandoned Cornwall Iron Mine in Lebanon County has been used for low

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Photos by Andrew Gavin



Figure 2.6. Examples of Mining Impacts on Hydrologic Landscape Element

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streamflow augmentation, and abandoned mines have been used as water supplies at several locations in the basin. Also, potential use of water stored in abandoned, water-filled quarries to offset agricultural consumptive water losses is currently under investigation by Commission staff.

Problem: *The positive and beneficial use of water discharged from mining operations is underutilized as a resource.*

The Commission can play a positive role in helping to bring together the key stakeholders in areas affected by growing populations and mineral extraction operations, to help promote the development of reliable water supplies. Beneficial use requires careful evaluation of water quality to insure its suitability as a source of supply. Although mining operations are seen sometimes as a “negative” to watersheds, mining operations frequently intercept groundwater that might otherwise infiltrate a mine, and release that water to surface streams where it becomes available to downstream communities and other users. Quarrying operations in Hanover, Pennsylvania, discharge groundwater to Slagel’s Run, which is used by the Borough of Hanover as one of several sources for the public water supply system. Flows are sustained as long as quarrying continues below the water table, even during periods of drought. In some areas of the country, including Pennsylvania, both active and abandoned quarries have provided resources for community water systems, and similar cooperative efforts should be promoted in this basin.

Mine water pools also can supply non-potable uses, such as a golf course in the anthracite region that has tapped a mine pool for irrigation water. A proposed coal waste gasification and liquefaction plant in Schuylkill County, Pennsylvania, is evaluating a flooded deep coal mine for its large (7.0 mgd) withdrawal and consumptive use.

Recommendation: The Commission should encourage cooperative efforts to promote the development of reliable water supplies related to active and abandoned mining operations, for public drinking water, commercial operations, and industrial supplies.

Problem: *Extensive aquifer dewatering.*

Mining of consolidated rock and mineral deposits below the water table requires that enough water be pumped to keep the mine workings dry. The magnitude of the pumping is often very high, being equivalent to that of a small to medium size city. However, while cities usually withdraw from multiple sources that are aerially distributed, mine pumping is concentrated at the mine and strives to maintain constant drawdown of the water table. This often results in aquifer dewatering of a scale unique to mining, and causes severe impacts to springs, streams, and wetlands. The reduced groundwater flow and groundwater discharge to streams (base flow) frequently results in reduced water availability to existing users and impacts to aquatic resources. Much of the pumped water is discharged to local streams, mitigating the reduced groundwater discharge downstream of the mine discharge point.

Recommendation: The area of influence and capture area for the mine withdrawal should be delineated, and the impacts identified. This is best accomplished through a study, which may incorporate a water budget analysis, field mapping of aquifer permeability features and water levels, and groundwater modeling. Once identified, the impacts may be mitigated through a variety of methods, including redirection/redistribution of the mine pumpage and modification or replacement of impacted sources. Where exceedence of sustainable yield is occurring, mine pumpage can be reduced through the grouting of water inflow points, or other methods as appropriate, if economically and technically feasible.

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Problem: Exceedence of sustainable yield.

When the quantity of groundwater that must be withdrawn to maintain operational conditions in mines exceeds the sustainable yield of the aquifer, a variety of problems occur, including loss of stream base flow, sinkholes, and loss of well yield.

Recommendation: Where mining withdrawals of groundwater exceed sustainable yield, mine pumpage can be reduced through the grouting of water inflow points if technically and economically feasible, or other methods, as appropriate. In cases where the aquifer is otherwise unused, the effects of exceedence of sustainable yield may be mitigated by various means as appropriate. These mitigation procedures should be coordinated through the appropriate state and federal agencies, in concert with the project's engineering and hydrogeological staff and consultants. Mine pumpage may reach or exceed the sustainable groundwater yield of a basin, and thus effectively limit the potential for other withdrawals to be approved.

2.9 Issue: Flow Compensation for Consumptive Water Uses

Only a limited number of reservoirs release additional stored water during low flow periods that provides flow compensation for consumptive water uses. Many existing reservoirs have other demands on them, including recreational and public water supply that limit or preclude releases for the purpose of consumptive use compensation.

Mining operations frequently intercept groundwater that might otherwise infiltrate a mine and release that water to surface streams where it becomes available to downstream communities, habitat, and other users. The flow augmentation commonly is continuous, although the quantity of water released declines during extended droughts.

However, mining operations can provide opportunities for water storage, either as “artificial” aquifers with storage in underground voids created where minerals or rock was removed, or as flooded pits in strip mines or quarries. In Pleasant Gap, Pennsylvania, a flooded limestone quarry is storing water to offset the consumptive use of two mining projects. The Commission is investigating the possibility of using abandoned mines such as Barnes and Tucker in Barr Township, Cambria County, Pennsylvania, as a source of make-up water for consumptive water users.

Problem: Need for additional low flow augmentation to compensate for consumptive water uses.

Recommendation: The Commission should bring together key stakeholders to help promote the use of groundwater stored in “artificial” aquifers created by mining or flooded quarries to offset consumptive water uses and support instream flow needs during droughts.

3.0 MANAGEMENT ISSUES AND RECOMMENDATIONS

The purpose of this section is to describe some of the policies and issues related to the management of groundwater resources and identify recommended actions. Included are issues related both to the Commission and other agencies that manage groundwater resources and to the Commission's interaction and coordination with those agencies.

3.1 Issue: Multi-Agency Coordination

Coordination among member state and federal agencies and the Commission results in efficient data collection, planning, monitoring, and management of the basin's water resources. Coordination among member state and federal permitting programs and the Commission's Project Review Program results in consistent approvals, appropriate conditional requirements, and sound management of the water resource.

Problem: *Coordination among water resource agencies can be ineffective or incomplete.*

Limitations in resources among member state and federal water resource management agencies, and the Commission, dictate the efficient use of human and technical resources and avoidance of duplication of effort among agencies in order to effectively achieve agency goals and objectives. Therefore, ongoing communications and coordination in water resource data collection, planning, monitoring, and management programs is essential. Similarly, within member state and federal water quality and quantity permitting programs and the Commission's regulatory program, sharing written review memoranda, correspondence, and other ongoing communication is essential to the coordination necessary to eliminate conflicting approvals, inappropriate conditional requirements, and unilateral action.

Conflicting and/or unilateral approval actions can undermine the water resource management goals and objectives and program effectiveness of other water resource agencies. Lack of coordination between water resource permitting agencies occurs when water quantity permitting programs fail to consider water quality permitting issues and vice-versa in processing an approval. Also, lack of coordination among program areas beyond water supply, such as mining and waste management, can lead to conflicting approvals. Other water resource considerations such as water-related recreation, wetlands, endangered species, TMDLs, archeological sites, and historic sites must be considered and coordinated.

The Commission's water resource data collection, planning, monitoring, and management procedures must be closely coordinated. Multi-agency coordination committees, such as Chesapeake Bay Program, Water Resources Management Advisory Committee, Agricultural Water Use Advisory Committee, Nutrient Management Committee, Public Drinking Water Advisory Committee, Drought Task Force, Capital Region Water Board, Interstate Council on Water Policy, Flood Forecast and Warning Committee, and Nonpoint Source Workgroup can be helpful in this respect. Ultimately, however, coordination depends upon the vigilance of the Commission's Project Review Program to avoid conflicting actions between water resource agency permitting programs.

The approach to managing groundwater resources should be a cooperative one among involved regulatory agencies, and all efforts should be undertaken to insure effective communication. The Commission's Project Review Program should closely communicate with all appropriate agencies during the course of a project's review, and when possible, member state and federal water resource agency staff should be invited to meetings with project sponsors in order to insure essential coordination. In addition, appropriate agencies should be copied on correspondence

through electronic and traditional paper communication when appropriate. When questioning whether coordination on a specific issue is needed with another water resource agency, it is better to solicit agency input, rather than to act unilaterally based on program assumptions.

Recommendation: The Commission's water resource data collection, planning, monitoring, and management procedures should be closely coordinated through multi-agency committees, and the Commission and all appropriate agencies should closely communicate on the Project Review Program to avoid conflicting actions.

3.2 Issue: Changes to Water Resource Utilization Over Time

Differing economics, land use, and growth conditions result in changes in the utilization of the basin's water resources. Additionally, new technology affords opportunities for more efficient evaluation and monitoring of the basin's water resources.

Problem: *Water resource management programs can become less efficient with changes in technology and water use.*

The Commission must review and adapt its technical and management programs to effectively consider changing land use and growth, while fully utilizing new technology as it emerges. As part of the process of reformulating Commission policies and procedures to meet the basin's changing needs, a periodic update of the Groundwater Management Plan is required.

Experience has demonstrated that updates to the Groundwater Management Plan are needed at least every 10 years in order for the plan to maintain its continuing viability. As a part of these regular updates, the Commission should report on water resource utilization throughout the basin using the best available technology and make appropriate changes in its policies, procedures, and project review process, as necessary.

An assessment of the utilization of current water resources can best be accomplished through updated water budget analyses, preferably for watersheds at a scale of between 15 and 25 square miles. Updated water budget analyses need not be conducted basinwide, but should be focused on areas of the basin where the water resources are stressed or are likely to be stressed within the next decade. Criteria for prioritizing watersheds for analysis should be developed, and the analyses should be conducted on an ongoing basis.

Water use data for water budget updates should be the most current data available, taking full advantage of the latest water registration updates. In addition, for those users having projects approved by the Commission, the most recent water withdrawal and consumptive water use data from the project review database should be utilized. Where peak daily or peak monthly water use is required, data should be retrieved from the most recent drought year available in the database.

On the supply side, the water budget analyses should utilize current streamflow and base flow statistics updated with the additional daily streamflow records occurring since the last water budget update. This update of basin streamflow and base flow statistics should be conducted for all gauged watersheds having relatively unregulated streamflow records. Flow statistics requiring updates include mean and median flows (annual), low flow statistics such as Q7-10, and base flow separations using the local-minimum method or another accepted base flow separation method for recurrence intervals of 2, 10, 25, and 50 years. Additionally, average monthly depth to water percent exceedence statistics (for the observation well network) and streamflow percent exceedence statistics ("flow-duration curves") for the gauged streamflow network need to be regenerated periodically for drought monitoring, utilizing the additional daily records.

Recommendation: To effectively manage changes in the utilization of the basin's water resources, the Commission must assess water resources utilization periodically through updated water budget analyses, preferably for watersheds at a scale of between 15 and 25 square miles focusing on PSAs of the basin, and make appropriate changes in its policies, procedures, and project review process.

Problem: *Water supply sustainability and stream low flow conditions can be adversely impacted by lack of the best and most efficient use of groundwater resources.*

Threatened water supply shortfalls can be addressed and limited water supplies can be stretched with adequate foresight and implementation of innovative water management strategies, including water conservation, water reuse, and conjunctive use of groundwater and surface water. These strategies would be particularly prudent in areas of rapid growth and limited water availability, such as PSAs.

Water conservation requirements, specified in the Commission Regulations, Part 804, Subpart B, §804.20-22, require that any project subject to Commission approval under Parts 803 or 804, proposing to withdraw water either directly or indirectly (through another user), shall institute appropriate water conservation measures. The regulations specify a number of requirements for public water suppliers (source and customer metering, unaccounted-for water to be less than 20 percent, an appropriate rate structure, etc.). However, for other types of projects, the regulation is silent on important conservation measures. Commission staff has recognized that these regulations should be strengthened.

Groundwater used by municipalities and industries, as well as AMD from many flooded underground coal mines, is typically treated and discharged to streams. The quality of treated water discharged from municipal, industrial, and mine treatment plants, while generally not meeting safe drinking water standards, is typically quite good and is potentially usable for many non-potable uses such as irrigation and non-contact cooling. The reuse of treated wastewater would decrease the amount of groundwater withdrawn by the amount of water that is reused.

The availability of groundwater and surface water resources frequently varies in a complementary manner during the year, such that one of them is relatively abundant while the other is relatively scarce. Water users can develop both groundwater and surface water sources and rely on each as it is "in season." A community, recreational facility, or industry may rely on surface water during periods of high flow, then switch over to groundwater when surface flows diminish during the late summer and early fall. Where only groundwater is available naturally, a surface water impoundment may be constructed to capture snowmelt, spring precipitation, and stormwater runoff. This stored water may be used when groundwater resources are stressed, or may be used to provide a passby flow during low flow periods.

Recommendation: The Commission, in cooperation with member jurisdictions and other organizations, should strengthen requirements for water conservation and encourage reuse of treated wastewater and conjunctive use of groundwater and surface water.

3.3 Issue: Regulatory Duplication

Changes in legislation and promulgation of new regulations result in changes to water resource management programs and possible duplication of programs.

Problem: *Change in the regulatory programs of the member jurisdictions may make some of the Commission's regulatory program redundant, inefficient, or inappropriate.*

Effective coordination is needed among the Commission, its member jurisdictions, and key agencies to ensure success of groundwater management actions, including those set forth in this plan. Close coordination needs to be maintained in order to implement the plan recommendations and share resources, information, and technology, while ensuring consistency of groundwater management actions. The coordination needs to consider the requirements of recent legislation and current agency programs, as well as their changes through time. To facilitate key coordination efforts, the following should be considered: (1) the process for the new Pennsylvania State Water Plan, initiated in 2003; (2) requirements of Section 15-1525 (certification of registration of well drillers and other groundwater provisions) of New York's Environmental Conservation Law's 1999 amendments; (3) requirements contained in COMAR, the Maryland Code of Regulations; and (4) programs of the USGS. Formal coordination arrangements, such as memoranda of understanding, should be considered to facilitate coordination, as appropriate.

If no or limited action on implementation of this plan's recommendations is taken, then coordination would continue on an as-needed, case-by-case basis, for groundwater issues with little to no program level coordination. A more effective approach involves both short- and long-term coordination on all major aspects of groundwater management, including both programmatic and project-specific issues.

Recommendation: Close and effective coordination, including the use of formal arrangements such as memorandum of understanding, should be maintained among the Commission, its member jurisdictions, and key agencies to ensure that implementation of this plan's recommendations is effective, current groundwater information and technology are shared, consistency is maintained, and redundancy is minimized.

3.4 Issue: Increased Knowledge About Groundwater as a Resource

Groundwater is a hidden resource, and there are many misconceptions about its occurrence, availability, and potential impacts related to its development. Further, groundwater managers, planners, and decision-makers often do not have ready access to fundamental information on groundwater.

Problem: *Useful information about groundwater occurrence, availability, transmissivity, and yield is collected by various government permitting agencies and others, but is not compiled and shared among agencies nor disseminated to the professional community, developers of policy, or local decision-makers.*

The Commission's water resource data collection, monitoring and management procedures are closely coordinated to avoid conflicting actions among water resource agency permitting programs. However, much of the data itself has not been compiled and shared among agencies.

From the Commission's perspective, it would be useful to review the Commission's files and compile all the pumping test data submitted in support of groundwater withdrawal applications into a single aquifer test database, linked to a GIS system. Under Pennsylvania's Act 220 Program, the Commission has proposed an effort to provide these groundwater data to PADEP. This effort should be expanded to cover the entire Susquehanna River Basin. Other agencies probably have similar types of data that should be reviewed, compiled, and made available to decision-makers.

A compilation of pumping test data would help establish the probable range of transmissivity, by aquifer, weighted to the higher end of the range as most supply wells are selectively developed in high permeability zones as opposed to randomly sited wells. Further, the database would allow, for example, the aquifer transmissivity values to be sorted by formation, physiographic province, county, etc. A compilation of all the pumping test data would form the basis for future management efforts, special studies, or regional modeling efforts.

Recommendation: Capture and compile groundwater data submitted to the Commission by project sponsors to allow its use by the Commission and others.

Problem: *Lack of fundamental knowledge of groundwater resources by many policy/decision-makers at the local, municipality level and by their constituents, and at the corporate level of private businesses, has hindered the understanding of sound groundwater management practices.* Decision-makers on groundwater management issues need to have supporting knowledge to evaluate alternatives provided by consultants and other professionals in order to make sound groundwater management decisions. One example includes the development of hydrogeologic maps for the entire New York portion of the basin. There is the need to develop this type of information for such management decisions, and make it available in user-friendly formats through such media as the internet. This knowledge also will make possible the more efficient use of existing federal, state, and Commission programs and assistance.

Recommendation: Identify the various constituents that would benefit from a multifaceted outreach and educational program, including local governments; regulated community and related associations; consultants; environmental, conservation and citizen organizations; and possibly colleges and high schools. Develop tools these groups can use to make informed decisions.

Problem: *Lack of consideration of factors important to groundwater protection and sustainability within the municipal planning process, resulting from limited knowledge of groundwater resources, has hindered the implementation of sound groundwater management practices.*

In following with the previous issue, education can lead to improved management of groundwater resources. However, there must be some assistance provided to implement the required actions after a management plan is developed. Municipal planners, and the public, need to know what tools they can use to implement actions such as land use controls for wellhead protection or protection of a critical aquifer recharge area. Many times the problems associated with a groundwater source are known; however, the means to address the problem are not.

Recommendation: Encourage and assist local governments to include groundwater management concepts in planning and land-use control. Use the various tools identified below, including video, information sheets, informational meetings, etc.

Problem: *There is the absence of an educational framework needed to present groundwater concepts and issues to a variety of audiences through several forms of media.*

In order to provide education to a wide audience, a program must be targeted to specific audiences and be versatile in its outreach and delivery methods. While printed literature is an excellent way to distribute educational materials, providing staff time for making presentations on selected groundwater topics is important for creating a forum for discussion. This method allows for interaction with the audience, answers specific questions, and provides clarifications. Multimedia formats are becoming increasingly useful for reaching a wide variety of audiences. The Internet, in particular, is a low-cost means for presenting information to a large audience. The use of websites and bulletin boards provides a convenient means for accessing and

exchanging information. The use of all the aforementioned methods can be used to provide a complete outreach and educational program for many of the groundwater management topics presented in this plan. Any education program must be evaluated periodically to assess its effectiveness.

Recommendation: Incorporate the following methods into the multifaceted outreach and education program:

Publications: Periodically publish articles in the Commission quarterly newsletter; draft and submit articles to be published in the various constituents' publications; produce related information sheets, etc.

Conferences, workshops, and informational meetings: Identify the various constituents' conferences and determine their schedules; create new exhibits/displays on the topic; exhibit and/or speak at the conferences, workshops and information meetings; conduct Commission-sponsored conferences, workshops, and informational meetings, as the need arises.

Speakers' Bureau: Update and enhance the Commission's existing groundwater management presentation and publicize its availability.

Web Site: Establish a new link and announce the availability of the plan on CD-Rom, any related information sheets or related links, and short video clips (see below).

Video: Obtain funds to produce a video targeted particularly to local governments (short clips of the video can be included in the web site).

Media Relations: Issue a press release on the new plan, pointing out key benefits and uses; periodically submit articles on the benefits of groundwater planning and management; and periodically participate in radio and television talk shows.

3.5 Issue: Plan Performance and Accountability

Subsequent to the Commission adopting the Groundwater Management Plan, the Commission and its member jurisdictions need to ensure that the plan is being carried out, and that the goals of the plan are being met. The Commission needs to track the performance of plan implementation and the effectiveness of the plan's recommendations.

Problem: *The management plan will not be productive unless the tasks identified are performed and accountability for accomplishing the tasks is established.*

Following adoption of this plan, it is in the interest of all member jurisdictions to ensure that the responsible parties implement the plan's recommendations. A periodic progress report on actions taken in line with the management plan is desirable. Implementation of the plan's recommendations and new issues that arise after the plan is completed are of particular interest. The progress report should be made to Water Resources Management Advisory Committee by Commission staff. An implementation schedule should be established and followed by lead agencies, and the Commission should review progress periodically. Any issues related to plan implementation should be identified and resolved on an ongoing basis.

Recommendation: Periodic reporting on implementation of the plan's recommendations by the accountable agencies and groups and any new and significant groundwater management issues should be made by Commission staff to WRMAC.

3.6 Issue: Review and Update of the Plan

It is recognized that changed conditions, new legislation, improved technology, etc., could impact the effectiveness of some aspects of this management plan.

Problem: *This management plan needs to be reviewed and updated on a recurring basis in order to be current and of continuing value.*

While continued planning will allow modifications within the framework of the plan, it is prudent to complete a comprehensive review and revision of the plan periodically. Experience with the past plan has demonstrated the need to revisit the management plan to ensure continuing relevancy of the document. This current revision is taking place 12 years after the management plan was adopted. While there may be significant points at which review is critical, for example, if the Commission's regulations are revised, a periodic comprehensive review should also be accomplished. No action implies that this plan would remain in effect indefinitely with no revisions. It is important that a long-term action result in a periodic comprehensive review and revision of the plan.

Recommendation: While the overall planning process should be continuous, a more comprehensive review and revision of this plan by WRMAC should occur at intervals not to exceed 10 years.

3.7 Issue: Funding to Implement the Plan

The benefit of good planning is only realized to the degree that the recommended actions are taken.

Problem: *Adequate long-term funding needs to be made available to implement the actions recommended in the plan.*

The plan lays out the broad range of issues and concerns regarding groundwater conditions across the basin, and prioritizes problems and recommendations. Adequate funding at all levels will be paramount in implementing the plan. It is believed that a prioritized and phased approach can be taken to use existing funding sources beneficially and to support increased funding levels. Significant delays in having adequate funding available will exacerbate groundwater issues and problems. See Section 6.3 for additional information on implementation costs.

Recommendation: Funding to implement the plan's recommended actions should be made available and/or proactively sought by the lead jurisdiction(s) for each action.

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4.0 SUPPORT PROGRAMS AND RECOMMENDATIONS

There are a number of management and regulatory programs that are applicable to many of the groundwater problems and groundwater management issues previously discussed. The following section outlines some specific program areas in which the states provide a lead role in the management of the basin's groundwater resources. These programs need to receive continued support and, in many instances, substantial expansion. In the following section, the groundwater management issues are discussed and recommendations for improvement are made.

4.1 Issue: Protection of Groundwater Sources of Supply and Aquifers

Problem: *Contamination of groundwater resources from the affects of improper land use planning and zoning.*

The Wellhead Protection Program and regulations only provide for the protection of public supply wells, and only within the immediate vicinity of the wells. Proper land use planning and zoning are essential for protecting critical groundwater recharge areas, as well as areas of high yield, from contamination. Many times these critical areas lie outside of the zone protected under the current regulations. Although non-regulatory, state/local source water protection plans are critical to protecting aquifers and critical sources of groundwater. With increasing development in many areas, source water protection plans provide the framework for proactive planning to prevent groundwater pollution from occurring in critical recharge areas, which improves the chances of protecting future sources of water supply as well.

Recommendation: Encourage the states and local jurisdictions to develop regulations and programs designed to protect critical aquifers from contamination because wellhead protection programs do not provide for protecting future public supply wells, domestic wells, and other uses of wells.

Problem: *Lack of comprehensive groundwater quality datasets showing the extent and severity of nonpoint source pollution affecting groundwater resources basinwide, and the lack of management plans necessary for improving conditions.*

Nonpoint source contamination is the leading cause for contamination of water resources within the basin. According to the most recent state 305(b) water quality reports, the two most dominant sources of contamination include AMD and agriculture. Currently, state programs emphasize surface water quality monitoring, with very little resources dedicated to groundwater quality monitoring at a regional scale. Less than 10 percent of the aquifers in the basin are monitored for quality on a regular and continuous basis. Although all public water suppliers are required to monitor water quality parameters regularly, the information is not compiled and analyzed by hydrogeologic unit. There is a need to compile this type of information, and collect additional data, to better determine the water quality health of aquifers and water-bearing zones in order to assess trends. The monitoring efforts that do exist focus on just a few of the more heavily utilized aquifers in the basin.

No new actions would mean continued limits on groundwater quality monitoring resources and a lack of the continuous monitoring needed to determine trends. As nonpoint source contamination increases from growing development, these developing communities could be at a greater risk of pollution.

Recommendation: Continue and expand monitoring and research, in cooperation with member jurisdictions, related to nonpoint source contamination, including agricultural and other sources of groundwater. In addition, the Commission has in the past used private/existing wells to collect

monitoring data, and plans to continue such efforts when appropriate. The Commission recommends encouraging such cooperative efforts both for Commission initiatives, and those initiated by other agencies and local jurisdictions. The information obtained can be used to assess the severity of the problem and the need for management initiatives. Several programs support the assessment and implementation of such actions and include TMDLs, USEPA's 319 Nonpoint Source Program, and United States Department of Agriculture/Natural Resource Conservation Service (USDA/NRCS) water programs.

Problem: *Degradation of water quality conditions in aquifers from point source discharges.*

Groundwater is hydraulically connected to the surface water. This connection is fairly direct in many of the higher yielding aquifers in the basin. Valley fill and karst aquifers are many times closely linked to surface waters, based on proximity to streams and presence of sinkholes, respectively. In the case of the valley fill aquifers in the northern parts of the basin, water frequently migrates back and forth between the stream/river and the sand/gravel aquifers located adjacent to the stream/river. In areas where the surface water body recharges the aquifer, a pollutant discharge in close proximity to this recharge zone could have an adverse influence of water conditions within the aquifer. In karst areas, sinkholes can provide the same type of conduit to aquifers, carrying pollutants from a nearby discharge. In cases such as these, surface discharge permit issuances should be sensitive to aquifer recharge areas.

Recommendation: Support the member jurisdictions in their efforts to consider the affect of wastewater discharges on groundwater, including sensitive recharge areas, when issuing National Pollutant Discharge Elimination System (NPDES) or State Pollutant Discharge Elimination System (SPDES) permits. This should potentially include the installation of monitoring wells in particularly vulnerable aquifers.

Problem: *Limited support for local development of source water protection plans.*

Section 1442 of the Safe Drinking Water Act (SDWA) requires states to assess the vulnerability of public drinking water sources to raw water contamination. After the assessment process is complete, there is no mandate for the formulation of protection plans based on the assessment results. In addition, a very limited number of resources are dedicated to promotion of source-water protection, as well as the technical guidance needed to implement such plans. Many times, the communities responsible for implementing source-water protection efforts lack the technical expertise needed to properly utilize the data and information compiled during the assessment phase. There needs to be experienced technical staff available to guide protection efforts, or refer communities to the resources best suited to assist their efforts. All three member states are working towards shifting priorities from assessment to protection, providing assistance through grants and workshops, guidance documents, technical assistance, and establishment of spill detection and early warning systems. However, the absence of sufficient resources prevents a comprehensive and sustained approach to addressing the problem.

Recommendation: Assist communities with groundwater source protection by utilizing existing source-water assessment data and aquifer test data to provide educational and technical assistance in formulation of protection plans. The overwhelming need for education on this subject far exceeds the resource capabilities of any one agency or organization. The success of source water education and protection activities resides with building broad partnerships among both public and private partners, based on the need for the protection of water supplies to span a number of issues/areas (i.e., land use planning, hazardous material handling, municipal ordinances, water quality monitoring).

When appropriate, the Commission will continue to be involved with source water protection activities at all levels, and continue to partner with the PRWA and others involved with source water education (i.e., League of Women Voters, AWWA, AWRA), providing a regional, basinwide framework.

4.2 Issue: Water Use and Availability Information

Problem: *Not all large volume withdrawals (>10,000 gpd) are registered (documented).*

Without documentation of large volume users, groundwater use and availability assessments would be incomplete. Cumulative impact analysis is essential to proper management of the groundwater resource.

Recommendation: Require large volume users of groundwater (>10,000 gpd) to register (document) their use. In addition, require all registered (documented) withdrawals to be reregistered (updated) periodically. Coordinate with member states and others to maintain a vibrant data set.

Problem: *Data on large volume users needs to be available for management use.*

In order to properly track use and availability, a centralized database should be developed to enhance the capabilities for management of the resource. Cumulative impacts are an increasing concern in many areas of the basin. If planners and managers were able to keep track of potential areas where cumulative impacts are likely, a proactive approach to management could be employed prior to problems arising.

Recommendation: Maintain a centralized database containing information on large users, and make these data available to planners and managers throughout the basin. Access and use of the information would be subject to security considerations.

Problem: *Well information (water use) is not available to all agencies and local managers.*

In order to properly track use and availability, a centralized database should be developed to enhance the capabilities for management of the resource. Cumulative impacts are an increasing concern in many of the basin. If planners and managers were able to keep track of potential areas where cumulative impacts are likely, a proactive approach to management could be employed prior to problems arising.

Recommendation: Maintain a centralized database containing well location information, and make these data available to planners and managers throughout the basin. Access and use of the information would be subject to security considerations.

Problem: *Groundwater managers, planners, and decision-makers often do not have ready access to fundamentally important, basinwide information on groundwater.*

The availability of groundwater is often critical to the success of a private, community, or industrial project. However, in many instances, projects are well underway before water availability problems are discovered. Ready access to groundwater availability and yield information would help in screening sites and projects for feasibility. The data could readily be portrayed on maps that could be made available on-line.

Recommendation: The Commission should partner with the appropriate agencies to develop the required information for the entire basin, and make it available on-line at an appropriate web location.

4.3 Issue: Well Requirements

Problem: *Improper well construction and abandonment procedures can cause aquifer contamination.*

Under normal conditions, water that falls to the ground surface and recharges aquifers is filtered as it passes through the soil zone. This process generally removes many of the possible contaminants picked up from land surface. If a well is not constructed or abandoned properly, the well can act as a conduit for quickly transmitting potentially polluted surface waters to an aquifer.

Recommendation: Support state and local programs for well construction and abandonment standards and improved controls to prevent pollution. Several towns and municipalities in the basin have established successful ordinances to protect groundwater quality through controls on well abandonment and construction procedures. Examples are available from the state or respective state rural water associations. The Commission will continue to support state/local efforts for developing construction standards, as outlined in the Commission's Annual Water Resources Program document.

Problem: *Lack of certification program for drillers in Pennsylvania and the need for improving existing licensing/certification programs and well driller training in other basin states.*

Proper installation of a well should be performed by a licensed and certified professional to ensure that public health standards are met, and aquifer integrity is preserved. Currently, Pennsylvania has a licensing program for well drillers in the state. However, the only requirement for licensing is a nominal fee. There needs to be a certification program in place to further ensure that both groundwater resources, and the health of the public dependent on those resources, are protected.

Recommendation: Support legislation that works toward the development of a well driller's certification program in Pennsylvania, and support the improvement of programs that provide training and licensing/certification for all well drillers.

Problem: *The observation well network does not have the capability to monitor the dynamic response of aquifers in the basin to changes in precipitation.*

The observation well network should have adequate geographic coverage, measurement frequency, and sufficiently rapid reporting time to monitor aquifer responses to rainfall events and droughts, and make timely water management decisions. It also is important to provide good maintenance of all observation wells. This information is useful to water managers in evaluating drought impacts to water supplies and drought recovery. In the Susquehanna Basin, observation wells are located in nearly every county (67 in Pennsylvania, 7 in New York, and 4 in Maryland), which provides for adequate geographic coverage. However, the well in Otsego County, New York (OG-23), has a depth of 15 feet, is located in low permeability glacial till, and should be replaced with a deeper well in an aquifer more typical of those used for water supply in the area, and provides a more accurate and meaningful reflection of groundwater response to precipitation. Water levels in some of the network wells are measured only monthly, and measurements should be continuous or otherwise increased in order to adequately monitor aquifer response. In addition, to maximize the utility of the network for water managers, automatic recorders and telemetry platforms should be installed in all wells to allow for the timely acquisition and evaluation of the data.

With the current monitoring instrumentation, real-time data is available from the observation wells in Pennsylvania. However, assessment of groundwater conditions in Maryland and New York during critical drought periods will be a minimum of four to six weeks behind real-time

conditions. A long-term action is for New York and Maryland, in cooperation with USGS, to place real-time data monitoring wells in their Susquehanna Basin counties.

Recommendation: The Commission should support effective maintenance of the observation well network by the USGS, and work toward improving the network, through cooperative agreements between USGS and the member jurisdictions. The goal is to provide a useful observation well with real-time monitoring capability in each county in the basin. Well OG-23 should be replaced with a well located in an aquifer that is commonly used for water supply and constructed to provide accurate monitoring of the water table or aquifer head.

4.4 **Issue: Assessment of State/Federal Groundwater Programs and Program Coordination**

Problem: *State and federal agencies need to ensure their groundwater programs are current and responsive. In addition, these programs need to coordinate management activities to enhance program effectiveness and efficiency.*

The three states in the basin and the federal government have important and active groundwater programs that address many key issues. There is a need to make periodic assessments of their separate programs to identify gaps, changes required, major unresolved issues, etc. Pennsylvania is addressing groundwater issues and management as part of its ongoing water resource planning effort (Act 220). Maryland makes an annual report on groundwater protection. New York is currently undergoing a review of its groundwater program, and reevaluations will be conducted, as needed. The federal government is guiding state source water assessment and protection programs, as well as addressing other groundwater pollution issues (i.e., Chesapeake Bay Program nutrient issues, Superfund cleanup).

In addition, agencies should ensure that their own departments and programs are effectively communicating internally to provide for optimal use and protection of the resource. In particular, programs charged with environmental protection and resource extraction should coordinate to preserve the sustainability and integrity of groundwater resources.

Recommendation: The Commission's member jurisdictions should continue periodic assessments of their groundwater programs to identify needed improvements and plan for their implementation.

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5.0 THE MANAGEMENT PLAN

The plan development process included an assessment of groundwater problems and issues in the basin, a compilation of available tools for groundwater management, and an identification of alternative actions to address the specific problems and issues. The key result of this process was a series of recommended actions for the Commission and others to best address the widespread and major groundwater resources problems and issues that were identified.

As discussed in Section 2, Groundwater Resource Issues, Problems, and Recommendations, some of the recommendations can be applied to address site-specific physical problems in areas with: (1) intensive growth and development; (2) intensive water use in small basins; (3) watershed transfers; (4) loss of clean water input to AMD-impacted streams; (5) unknown and unregulated groundwater use; (6) scarcity of clean water due to widespread AMD impacts; (7) drought impacts to base streamflow; (8) impacts from mining; and (9) unmet flow compensation needs.

The recommendations presented in Section 3, Management Issues and Recommendations, include actions to address: (1) multi-agency coordination; (2) changes to water resource utilization over time; (3) regulatory duplication; (4) increased knowledge about groundwater as a resource; (5) performance and accountability of this management plan; (6) review and update of the plan; and (7) funding to implement the plan. Taken together, the recommendations, contained in Sections 2 and 3 of the plan and summarized in Section 6 and Appendix E, constitute the major element of the Groundwater Management Plan.

The plan also includes actions for enhancing groundwater management support programs. Implementation responsibility for these supported actions lies mainly with federal, state, and local governments. The Commission does have co-lead responsibilities on five actions and assistance or support for seven actions. Issues to be addressed can be grouped into several topics: (1) protection of groundwater sources of water supply and aquifers; (2) water use and availability information; (3) well requirements; and (4) assessment of state and federal groundwater programs. Recommendations for addressing these issues are discussed in Section 4, Support Programs and Recommendations. These recommendations also are summarized in Section 6 and Appendix E, and constitute a second and important element of the Groundwater Management Plan.

The management plan is fairly evenly balanced among regulatory, planning, public outreach/education, and management actions. Of the 39 recommended actions included in the plan, 13 are regulatory in nature, 11 are related to planning, and 15 involve outreach/education and management.

In addition to this document, a short summary of the plan has been prepared for general distribution. The full plan will be most useful to those having a need for or interest in the details of the plan, particularly the recommended actions and their implementation. The summary version presents an overview of the full plan and is intended to provide a basic understanding of the plan's development and results.

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6.0 IMPLEMENTATION OF THE MANAGEMENT PLAN

The Groundwater Management Plan will meet its established goals and result in positive actions only to the degree that it is successfully implemented. If the plan is not implemented, then it becomes an “on-the-shelf” document of little value. There are several key factors to consider for plan implementation. These include roles and responsibilities for key agencies and groups, prioritization of actions, implementation schedule, costs, and other major issues affecting implementation to include selection and resourcing of actions in a phased approach. The purpose of this section is to discuss the key factors and set reasonable expectations for successful implementation of the Groundwater Management Plan.

6.1 Roles and Responsibilities

The scope of the management plan includes the groundwater activities of the Commission and actions of others that directly relate to the Commission's program. The authority for the Commission to undertake its roles and responsibilities is set forth in the 1971 Susquehanna River Basin Compact, P.L. 91-575, 84 Stat. 1509 et seq., and Commission Regulations (18 CFR Parts 803, 804, and 805).

Compact Section 3.4(2) states the Commission may “establish standards of planning, decision, and operation of all projects and facilities in the basin to the extent they affect water resources....” Section 3.4(9) allows the Commission to “adopt, amend, and repeal rules and regulations to implement the Compact”, and Section 15.2 states the Commission may “make and enforce regulations for effectuation, application, and enforcement of the Compact....” Concerning protection of certain valuable areas (e.g., water preserves), Section 9.4 states that a purpose of the Compact is to effectuate the conservation and management of water resources to preserve and promote the economic and other values inherent in historic, scenic, and other natural amenities of the basin. The basis for dissemination of information to the public and coordination of activities and programs is set forth in Sections 3.4(6) and 3.7, respectively, of the Compact.

Commission Regulations §803.4, relating to projects subject to review and approval under the regulations, and §803.42, relating to the consumptive use of water, states that compensation shall be required for projects using water from any source (including groundwater) during periods of low flow. The Commission's groundwater and surface water regulations state that withdrawals may be denied or limited for a number of reasons, including protection of streamflows and perennial streams, protection of competing supplies, prevention of water quality degradation, and prevention of harm to fish and wildlife. If major changes to programs or regulations flow from the plan, criteria, policies, procedures, and guidelines will have to be developed, as applicable.

The plan includes certain roles and responsibilities for the Commission, the federal government, the states of Maryland and New York, the Commonwealth of Pennsylvania, local jurisdictions, the private sector (e.g., project sponsors), and other groups. A wide variety of capabilities and expertise can be provided by the other groups in support of implementing the plan's recommendations. Some of the diverse groups that can be involved include professional, environmental, and nonprofit organizations; the private sector; and civic associations. Examples of these groups could include the Nature Conservancy, the Pennsylvania Aggregate and Concrete Association, the Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation, and the Pennsylvania Planning Association.

The Commission has lead responsibility for 15 of the 39 recommended actions included in the management plan, a co-leadership role in 17 areas, and a support role for the remaining 7 actions. Similarly, the states have lead responsibilities for 2 recommendations and co-lead responsibilities for another 23. The federal government has a co-lead responsibility for five recommendations, and local

jurisdictions have one lead and seven co-lead responsibilities. Project sponsors, which can be federal or state agencies, local jurisdictions, or private groups, have an important role to play through accomplishment of the analyses (often done by professional consultants) needed to support their proposed projects in line with 12 of the plan's recommendations.

The key agencies in the three member states of the Commission that have groundwater responsibilities include: New York – Department of Environmental Conservation and Department of Health; Pennsylvania – Department of Environmental Protection and Department of Conservation and Natural Resources; and Maryland – Department of the Environment and Department of Natural Resources. The Commission's Groundwater Management Program is complimentary to and aligned with the state programs. As an example, Pennsylvania is actively pursuing groundwater planning and management improvements under its Act 220 Program (State Water Plan). This effort includes water budget analyses which are recognized in this plan as being critical to sound groundwater management in areas of high demand in relation to sustainable water supply. PADEP's Division of Drinking Water Management has offered to assist the Commission in implementing various actions recommended in this Groundwater Management Plan (e.g., those related to well interference, groundwater mining, and loss of aquifer recharge). Their assistance will be coordinated during the implementation phase for this plan's recommended actions.

Table 6.1 summarizes the lead, co-lead, support, and analysis roles and responsibilities for all parties. The “other” designation in Table 6.1 is for local jurisdictions; the private sector; professional, environmental, and nonprofit organizations; and civic associations. Where applicable, the known lead “other” group(s) is noted in Table 6.1.

A lead or co-lead designation means that the group(s) noted would be responsible to see that the action is accomplished, but the actual work can be done by the lead group and/or others in a cooperative effort. A support designation means that the group(s) noted would be able to provide management support and/or technical assistance for actions led by others. Table 6.1 also notes where analyses would be required by project sponsors to address several of the identified problems. Professional consultants would normally do the analyses, and are expected to submit complete and technically correct work. The action items listed in the table are the full set of 39 recommendations (summarized for brevity of presentation in some cases) included as part of the management plan, and are presented in the same order as discussed in Sections 2, 3, and 4, and as presented in Appendix E.

6.2 Prioritization of Actions and Schedule

Effective implementation of the Groundwater Management Plan is enhanced by the prioritization and scheduling of all recommended actions. In order to accomplish this, a priority rating system and implementation schedule parameters were considered for each action.

Factors included as part of the prioritization rating system include importance, coverage under existing programs, timing and sequencing, and ease/difficulty of implementation of the recommended actions. For each factor, professional judgment and experience were used to consider the following types of priority information:

Table 6.1. Plan Implementation Roles and Responsibilities¹

A. Actions to Address Groundwater Resource Issues and Problems	Commission	States	Other
<p>1. Issue: Areas of Intense Growth and Development and Consequent Water Resource Development</p>	<p>Lead</p> <p>Lead</p> <p>Lead</p>		<p>Analysis (project sponsor)</p> <p>Analysis (project sponsors)</p> <p>Analysis (project sponsor)</p>
<p>2. Issue: Intensive Water Use in Small Basins</p>	<p>Co-lead</p> <p>Co-lead</p>	<p>Co-lead</p> <p>Co-lead</p>	<p>Co-lead</p> <p>Co-lead; Analysis (project sponsors)</p>
<p>3. Issue: Watershed “Transfers”</p>	<p>Co-lead</p>	<p>Co-lead</p>	<p>Co-lead</p>

¹NOTE: A lead or co-lead designation means that the group(s) noted would be responsible to see that the action is accomplished, but the actual work can be done by the lead group and/or others in a cooperative effort. A support designation means that the group(s) noted would be able to provide management support and/or technical assistance for actions led by others. An analysis designation means that the project applicants would be required to analyze problems in line with the recommendations.

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

A. Actions to Address Groundwater Resource Issues and Problems		Commission	States	Other
4. Issue: Loss of “Clean” Water Input to AMD-Impacted Streams	<p>Problem: Degradation of stream quality.</p> <p>Recommendation: Evaluate cumulative impacts from consumptive water uses to downstream water quality in AMD-impacted areas.</p>	Lead		Analysis (project sponsors)
5. Issue: Unknown and Unregulated Groundwater Use	<p>Problem: Data gaps can prevent evaluation of true sustainability and cumulative impact.</p> <p>Recommendation: Collect information on unknown and unregulated withdrawals to improve evaluation for new projects.</p>	Lead		Analysis (project sponsors)
	<p>Problem: Loss of base flow during the growing season.</p> <p>Recommendation: Perform water budget and cumulative impact analyses, and manage groundwater withdrawals to address any adverse impacts.</p>	Lead		Analysis (project sponsors)
	<p>Problem: Interference with existing water sources.</p> <p>Recommendation: Perform water budget analyses and consider options to address overdraw.</p>	Lead		Analysis (project sponsors)
6. Issue: Scarcity of Clean Water in Coal-Mined Areas	<p>Problem: Preferential development of high quality groundwater sources.</p> <p>Recommendation: Manage quantity and quality in non-AMD-impacted watersheds recognizing that water resources are necessary for the economic growth of mining-affected regions; educate local officials and consultants; coordinate with state and federal agencies; and encourage grayfields initiatives.</p>	Co-lead	Co-lead	Co-lead; Analysis (project sponsors)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

A. Actions to Address Groundwater Resource Issues and Problems		Commission	States	Other
7. Issue: Drought Impact to Base Flow	<p>Problem: Insufficient streamflow to sustain instream flow needs or downstream water supplies.</p> <p>Recommendation: Educate local jurisdictions about stormwater management, CARAs, and other BMPs for development, and improve scientific basis for instream use protection.</p>	Co-lead	Co-lead	Co-lead; Analysis (project sponsors)
8. Issue: Impacts of Mining	<p>Problem: Water discharged from mining operations is underutilized.</p> <p>Recommendation: Encourage cooperative efforts to develop reliable water supplies related to mining operations.</p>	Co-lead	Co-lead	Co-lead
	<p>Problem: Extensive aquifer dewatering.</p> <p>Recommendation: Delineate the area of influence and capture area for the mine withdrawal and identify the impacts and method of impact mitigation, when needed.</p>	Co-lead	Co-lead	Analysis (project applicants)
	<p>Problem: Exceedence of sustainable yield.</p> <p>Recommendation: Reduce impacts of mine pumpage through the grouting of water inflow points if economically and technically feasible.</p>	Co-lead	Co-lead	Analysis (project sponsors)
9. Issue: Flow Compensation for Consumptive Water Uses	<p>Problem: Need for additional low-flow augmentation to compensate for consumptive water uses.</p> <p>Recommendation: Bring together key stakeholders to help promote use of groundwater stored in “artificial” aquifers to offset consumptive water uses and support instream flow needs.</p>	Co-lead	Co-lead	Co-lead
B. Actions to Address Management Issues		Commission	States	Other
1. Issue: Multi-agency Coordination	<p>Problem: Coordination among water resource agencies can be ineffective or incomplete.</p> <p>Recommendation: Enhance the Commission's water resources procedures and project review coordination activities with involved agencies to avoid conflicting actions.</p>	Lead		

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

B. Actions to Address Management Issues		Commission	States	Other
2. Issue: Changes to Water Resource Utilization Over Time	<p>Problem: Water resource management programs can become less efficient with changes in technology and water use.</p> <p>Recommendation: Assess water resource utilization periodically and make appropriate changes in policies, procedures, and project review process.</p>	Lead		
	<p>Problem: Water supply sustainability and stream low flow conditions can be adversely impacted by lack of the best and most efficient use of groundwater.</p> <p>Recommendation: Strengthen water conservation requirements and encourage use of treated wastewater and conjunctive use.</p>	Co-lead	Co-lead	Co-lead
3. Issue: Regulatory Duplication	<p>Problem: Change in the regulatory programs of the member jurisdictions may make some of the Commission's regulatory program redundant, inefficient, or inappropriate.</p> <p>Recommendation: Maintain close and effective coordination among the Commission, member jurisdictions, and key agencies to include possible formal arrangements such as memoranda of understanding.</p>	Co-lead	Co-lead	Co-lead (EPA)
4. Issue: Increased Knowledge About Groundwater as a Resource	<p>Problem: Useful groundwater information is collected by the Commission, agencies, and others, but is not compiled and shared.</p> <p>Recommendation: Capture and compile collected data for use by the Commission, agencies, and others.</p>	Lead		
	<p>Problem: Lack of fundamental knowledge of groundwater resources by many policy/decision-makers has hindered the understanding of sound groundwater management practices.</p> <p>Recommendation: Identify the constituency for an outreach and education program, and develop tools for their decision-making.</p>	Co-lead	Co-lead	Co-lead (GW professionals and local jurisdictions)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

B. Actions to Address Management Issues		Commission	States	Other
4. Issue: Increased Knowledge About Groundwater as a Resource (Continued)	Problem: Lack of consideration of factors important to groundwater protection and sustainability within the municipal planning process has hindered implementation of sound groundwater management practices. Recommendation: Encourage and assist local governments to include groundwater management concepts in planning and land use control.	Co-lead	Co-lead	Co-lead (GW professionals and local jurisdictions)
	Problem: Absence of an educational framework to present groundwater concepts and issues to a variety of audiences. Recommendation: Incorporate a variety of methods into a multi-faceted outreach and education program.	Co-lead	Co-lead	Co-lead (GW professionals and local jurisdictions)
5. Issue: Plan Performance and Accountability	Problem: The management plan will not be productive unless the tasks identified are performed and accountability for accomplishing the tasks is established. Recommendation: Provide periodic reporting on implementation of the Groundwater Management Plan and new significant groundwater issues.	Lead		
6. Issue: Review and Update of the Plan	Problem: This management plan needs to be reviewed and updated on a recurring basis in order to be current and of continuing value. Recommendation: Conduct comprehensive reviews and revisions of this plan at intervals not to exceed 10 years.	Lead		
7. Issue: Funding to Implement the Plan	Problem: Adequate long-term funding needs to be made available to implement the actions recommended in the plan. Recommendation: Funding to implement the plan's recommended actions should be made available and/or proactively sought by the lead jurisdiction(s) for each action.	Co-lead	Co-lead	Co-lead (EPA, USGS, local jurisdictions)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

C. Groundwater Management Support Programs		Commission	States	Other
1. Issue: Protection of Groundwater Sources of Supply and Aquifers	<p>Problem: Contamination of groundwater resources from effects of improper land use planning and zoning.</p> <p>Recommendation: Encourage states and local jurisdictions to develop regulations and programs to protect critical aquifers from contamination.</p>	Support	Co-lead	Co-lead (local jurisdictions)
	<p>Problem: Lack of comprehensive groundwater quality datasets showing the extent and severity of nonpoint source pollution affecting groundwater resources basinwide, and the lack of management plans necessary for improving conditions.</p> <p>Recommendation: Continue and expand monitoring and research in cooperation with states related to nonpoint source contamination, and support the assessment and implementation of such actions, including TMDLs, USEPA's 319 Nonpoint Source Program, and USDA/NRCS water programs.</p>	Co-lead	Co-lead	
	<p>Problem: Degradation of water quality conditions in aquifers from point source discharges.</p> <p>Recommendation: Support member jurisdictions in their efforts to consider the effect of wastewater discharges on groundwater, including sensitive recharge areas, when issuing NPDES or SPDES permits.</p>	Support	Lead	
	<p>Problem: Limited support for local development of source water protection plans.</p> <p>Recommendation: Assist communities with groundwater source protection by utilizing existing source water assessment data and aquifer test data to provide educational and technical assistance in formulation of protection plans.</p>	Support	Support	Lead (local Jurisdictions)

Table 6.1. Plan Implementation Roles and Responsibilities (Continued)

C. Groundwater Management Support Programs		Commission	States	Other
2. Issue: Water Use and Availability Information	<p>Problem: Not all large volume withdrawals are registered (documented). Recommendation: Require large volume groundwater users (>10,000 gpd) to register (document) their use and to re-register (update documentation) periodically. Coordinate with member states and others to maintain a vibrant data set.</p>	Co-lead	Co-lead	
	<p>Problem: Data on large volume users needs to be available for management use. Recommendation: Maintain a centralized database containing information on large users, and make this data available to planners and managers throughout the basin, subject to security considerations.</p>	Co-lead	Co-lead	
	<p>Problem: Well information is not available to all agencies and local managers. Recommendation: Maintain a centralized database containing well location information, and make the data available to planners and managers throughout the basin, subject to security considerations.</p>	Co-lead	Co-lead	
	<p>Problem: Groundwater managers, planners, and decision-makers do not have ready access to important groundwater information. Recommendation: The Commission should partner with appropriate agencies to develop groundwater availability and yield information and make it available on-line.</p>	Co-lead	Co-lead	Co-lead (USGS and local jurisdictions)
3. Issue: Well Requirements	<p>Problem: Improper well construction and abandonment procedures can cause aquifer contamination. Recommendation: Support state and local programs for well construction and abandonment standards, and improved controls to prevent pollution.</p>	Support	Co-lead	Co-lead (local jurisdictions)

- **Importance**—Recognizing that all recommended actions are essential for sound groundwater management, which actions are most critical or critical versus others that are important?
- **Coverage Under Existing Programs**—What are the significant groundwater management needs that either have little or no, limited, or incomplete coverage under existing programs?
- **Timing and Sequencing** —Are there any considerations, such as developmental time for programs and regulations that require actions to be phased in over time? Do any of the plan's recommendations rely upon another action(s) to be done first?
- **Ease/Difficulty of Implementation**—Given the many parameters to be considered for implementation, which actions are relatively easy versus difficult? Some of the parameters to consider include technology available, staffing, in terms of manpower and subject matter expertise, competing program priorities and workload, legal or policy constraints, and public support.

Each recommended action was evaluated, using the factors listed above, to determine ratings of top priority, high priority, and priority. The importance factor was given added weight by requiring an action to be rated as a top or high priority in importance before it can have an overall rating of top or high priority, respectively. Table 6.2 summarizes the prioritization rating system.

Table 6.2. Prioritization Ratings System for Essential Groundwater Management Actions

Rating Factor	Top Priority	High Priority	Priority
Importance	Most critical	Critical	Important
Coverage Under Existing Programs	Little or no coverage	Limited coverage	Incomplete coverage
Timing and Sequencing	No other action required	Other short-term action(s) required	Other long-term action(s) required
Ease/Difficulty of Implementation	Expect fairly easy implementation	Expect fairly easy implementation, but some difficulties possible	Expect some difficulty in implementation
Priority Level for a Selected Action	Importance and two or more other factors rated as Top Priority	Importance and two or more other factors rated as Top/High Priority	Importance and two or more other factors rated as Priority

The specific implementation schedule for each element of the management plan is dependent on the priority and resources given to the elements by the Commission and other lead jurisdictions. For the purpose of this management plan, implementation scheduling was addressed by grouping actions under the following three time frames. Again, professional judgment and experience were used to assign schedule time frames.

- **Continuing Actions**—Those actions of any priority level that should be initiated and/or implemented relatively easily and quickly under existing programs. Full implementation of some initiated actions may take years, however.
- **Short-Term Actions**—Those actions of any priority level that should be initiated and/or effectively implemented within two years. Full implementation of some initiated actions may take longer than two years, however.
- **Long-Term Actions**—Those actions of any priority level that should take from two to five years to initiate and effectively implement.

An example of a continuing action is ongoing program changes such as those that require new information to be submitted to the Commission by project sponsors. Accordingly, an action the Commission can take now is to require that the review of groundwater use applications incorporate a check for consistency with the actions recommended in this plan. Short- and long-term actions, such as additional improvements to the basinwide system of observation wells, will require positive program and budget decisions in the future. The Commission will take a proactive approach to implementing the plan's recommendations in a timely manner. It is anticipated that the other lead jurisdictions also will be proactive in plan implementation. The annual progress report on implementation of the plan will address the schedule of both ongoing work and that work expected to be initiated in the upcoming year, and plans for future work.

The results of the prioritization rating evaluation and assessment of implementation schedules are summarized in Table 6.3. The recommended actions are grouped by the three priority levels and include an implementation time frame for each. There are 10, 20, and 9 top priority, high priority, and priority actions, respectively. From a scheduling perspective, there are 12, 16, and 11 actions that should be implemented as continuing, short- and long-term actions, respectively.

This plan has been prepared to provide a framework to effectively manage groundwater resources in the basin, is broad-based, and is not meant to be a detailed implementation document for all recommendations. However, the 12 continuing actions represent early steps that can be taken without significant further work. The remaining 27 short-term or long-term actions will require implementation measures such as development of new guidelines or regulations, provision of adequate resources, and interagency coordination.

Table 6.3. Plan Implementation—Prioritization and Scheduling

TOP PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	PROBLEMS AND RECOMMENDATIONS	SCHEDULE
A. Actions to Address Groundwater Resource Issues and Problems		
1. Areas of Intense Growth and Development and Consequent Water Resource Development	Problem: Loss of recharge areas. Recommendation: Base sustainable yields for wells on post-build-out conditions and encourage the use of BMPs to minimize loss of recharge.	Short-Term Action
2. Intensive Water Use in Small Basins	Problem: Loss of perennial streamflow. Recommendation: Evaluate headwater areas for the purpose of managing water quantity and quality.	Short-Term Action
5. Unknown and Unregulated Groundwater Use	Problem: Data gaps can prevent evaluation of true sustainability and cumulative impact. Recommendation: Collect information on unknown and unregulated withdrawals to improve evaluation of new projects.	Short-Term Action
8. Impacts of Mining	Problem: Extensive aquifer dewatering. Recommendation: Delineate the area of influence and capture area for the mine withdrawal and identify the impacts and method of impact mitigation, when needed.	Short-Term Action
B. Actions to Address Management Issues		
1. Multi-agency Coordination	Problem: Coordination among water resource agencies can be ineffective or incomplete. Recommendation: Enhance the Commission's water resources procedures and project review coordination activities with involved agencies to avoid conflicting actions.	Continuing Action
3. Regulatory Duplication	Problem: Change in the regulatory programs of the member jurisdictions may make some of the Commission's regulatory program redundant, inefficient, or inappropriate. Recommendation: Maintain close and effective coordination among the Commission, member jurisdictions, and key agencies to include possible formal arrangements such as memoranda of understanding.	Continuing Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

TOP PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	PROBLEMS AND RECOMMENDATIONS	SCHEDULE
B. Actions to Address Management Issues (Continued)		
4. Increased Knowledge About Groundwater as a Resource	<p>Problem: Lack of consideration of factors important to groundwater protection and sustainability within the municipal planning process has hindered implementation of sound groundwater management practices.</p> <p>Recommendation: Encourage and assist local governments to include groundwater management concepts in planning and land use control.</p>	Short-Term Action
	<p>Problem: Absence of an educational framework to present groundwater concepts and issues to a variety of audiences.</p> <p>Recommendation: Incorporate a variety of methods into a multifaceted outreach and education program.</p>	Short-Term Action
5. Plan Performance and Accountability	<p>Problem: The management plan will not be productive unless the tasks identified are performed and accountability for accomplishing the tasks is established.</p> <p>Recommendation: Provide periodic reporting on implementation of the Groundwater Management Plan and new significant groundwater issues.</p>	Continuing Action
7. Funding to Implement the Plan	<p>Problem: Adequate long-term funding needs to be made available to implement the actions recommended in the plan.</p> <p>Recommendation: Funding to implement the plan's recommended actions should be made available and/or proactively sought by the lead jurisdiction(s) for each action.</p>	Short-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

HIGH PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	PROBLEMS AND RECOMMENDATIONS	SCHEDULE
A. Actions to Address Groundwater Resource Issues and Problems		
1. Areas of Intense Growth and Development and Consequent Water Resource Development	<p>Problem: Well interference. Recommendation: Use groundwater modeling and/or water level monitoring to evaluate potential well interference. Mitigation may be necessary.</p> <p>Problem: Exceedence of sustainable yield. Recommendation: Require groundwater availability analyses for new projects and for areas where sustainable yield has been exceeded. Develop water budgets for all PSAs. Adjust withdrawal rates for sustainability, if needed.</p>	<p>Short-Term Action</p> <p>Short-Term Action</p>
2. Intensive Water Use in Small Basins	<p>Problem: Loss of base flow. Recommendation: Educate the public and local officials about the sustainability of headwater areas and the need to properly manage them.</p>	Short-Term Action
5. Unknown and Unregulated Groundwater Use	<p>Problem: Loss of base flow during the growing season. Recommendation: Perform water budget and cumulative impact analyses, and manage groundwater withdrawals to address any adverse impacts.</p> <p>Problem: Interference with existing water sources. Recommendation: Perform water budget analyses and consider options to address overdraw.</p>	<p>Short-Term Action</p> <p>Short-Term Action</p>
7. Drought Impact to Base Flow	<p>Problem: Insufficient streamflow to sustain instream flow needs or downstream water supplies. Recommendation: Educate local jurisdictions about stormwater management, CARAs, and other BMPs for development, and improve scientific basis for instream use protection.</p>	Long-Term Action
8. Impacts of Mining	<p>Problem: Water discharged from mining operations is underutilized. Recommendation: Encourage cooperative efforts to develop reliable water supplies related to mining operations.</p> <p>Problem: Exceedence of sustainable yield. Recommendation: Reduce impacts of mine pumpage through the grouting of water inflow points if economically and technically feasible.</p>	<p>Continuing Action</p> <p>Continuing Action</p>
9. Flow Compensation for Consumptive Water Uses	<p>Problem: Need for additional low flow augmentation to compensate for consumptive water uses. Recommendation: Bring together key stakeholders to help promote use of groundwater stored in “artificial” aquifers to offset consumptive water uses and support instream flow needs.</p>	Short-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

HIGH PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	PROBLEMS AND RECOMMENDATIONS	SCHEDULE
B. Actions to Address Management Issues		
2. Changes to Water Resource Utilization Over Time	<p>Problem: Water resource management programs can become less efficient with changes in technology and water use.</p> <p>Recommendation: Assess water resource utilization periodically and make appropriate changes in policies, procedures, and project review process.</p>	Short-Term Action
4. Increased Knowledge About Groundwater as a Resource	<p>Problem: Useful groundwater information is collected by the Commission, agencies, and others but is not compiled and shared.</p> <p>Recommendation: Capture and compile collected data for use by the Commission, agencies, and others.</p> <p>Problem: Lack of fundamental knowledge of groundwater resources by many policy/decision-makers has hindered the understanding of sound groundwater management practices.</p> <p>Recommendation: Identify the constituency for an outreach and education program, and develop tools for their decision-making.</p>	<p>Long-Term Action</p> <p>Continuing Action</p>
6. Review and Update of the Plan	<p>Problem: This management plan needs to be reviewed and updated on a recurring basis in order to be current and of continuing value.</p> <p>Recommendation: Conduct comprehensive reviews and revisions of this plan at intervals not to exceed 10 years.</p>	Long-Term Action
C. Groundwater Management Support Programs		
1. Protection of Groundwater Sources of Supply and Aquifers	<p>Problem: Limited support for local development of source water protection plans.</p> <p>Recommendation: Assist communities with groundwater source protection by utilizing existing source water assessment data and aquifer test data to provide educational and technical assistance in formulation of protection plans.</p>	Continuing Action
2. Water Use and Availability Information	<p>Problem: Not all large volume withdrawals are registered (documented).</p> <p>Recommendation: Require large volume groundwater users (>10,000 gpd) to register (document) their use and to register (document) their use and to re-register (update documentation) periodically. Coordinate with member states and others to maintain a vibrant data set.</p>	Long-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

HIGH PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	PROBLEMS AND RECOMMENDATIONS	SCHEDULE
C. Groundwater Management Support Programs (Continued)		
2. Water Use and Availability Information (Continued)	<p>Problem: Data on large volume users needs to be available for management use.</p> <p>Recommendation: Maintain a centralized database containing information on large users, and make this data available to planners and managers throughout the basin, subject to security considerations.</p>	Long-Term Action
	<p>Problem: Well information is not available to all agencies and local managers.</p> <p>Recommendation: Maintain a centralized database containing well information, and make the data available to planners and managers throughout the basin, subject to security considerations.</p>	Long-Term Action
3. Well Requirements	<p>Problem: Improper well construction and abandonment procedures can cause aquifer contamination.</p> <p>Recommendation: Support state and local programs for well construction and abandonment standards, and improved controls to prevent pollution.</p>	Continuing Action
	<p>Problem: The observation well network does not have the capability to monitor the dynamic response of aquifers in the basin to changes in precipitation.</p> <p>Recommendation: Provide effective maintenance and work toward improvements for the basinwide observation well network with a goal of having real-time monitoring capability in each county in the basin.</p>	Long-Term Action
4. Assessment of State/Federal Groundwater Programs and Program Coordination	<p>Problem: State and federal agencies need to ensure their groundwater programs are current and responsive, with management activities well coordinated.</p> <p>Recommendation: The Commission's state members should continue periodic assessments of their groundwater programs to identify needed improvements and plan for their implementation.</p>	Continuing Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	PROBLEMS AND RECOMMENDATIONS	SCHEDULE
A. Actions to Address Groundwater Resource Issues and Problems		
3. Watershed “Transfers”	Problem: Wastewater is not returned to the watershed where it was withdrawn. Recommendation: Educate professional groups about the options of maintaining groundwater withdrawals and post-use discharges in the same watershed.	Continuing Action
4. Loss of “Clean” Water Input to AMD-Impacted Streams	Problem: Degradation of stream quality. Recommendation: Evaluate cumulative impacts from consumptive water uses to downstream water quality in AMD-impacted areas.	Short-Term Action
6. Scarcity of Clean Water in Coal-Mined Areas	Problem: Preferential development of high quality groundwater sources. Recommendation: Manage quantity and quality in non-AMD-impacted watersheds recognizing that water resources are necessary for the economic growth of mining-affected regions; educate local officials and consultants; coordinate with state and federal agencies; and encourage grayfields initiatives.	Long-Term Action
B. Actions to Address Management Issues		
2. Changes to Water Resource Utilization Over Time	Problem: Water supply sustainability and stream low flow conditions can be adversely impacted by lack of the best and most efficient use of groundwater. Recommendation: Strengthen water conservation requirements and encourage use of treated wastewater and conjunctive use.	Short-Term Action

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

Table 6.3. Plan Implementation—Prioritization and Scheduling (Continued)

PRIORITY ACTIONS		
ISSUE (numbered per Table 6.1) 1/	PROBLEMS AND RECOMMENDATIONS	SCHEDULE
C. Groundwater Management Support Programs		
1. Protection of Groundwater Sources of Supply and Aquifers	<p>Problem: Contamination of groundwater resources from effects of improper land use planning and zoning. Recommendation: Encourage states and local jurisdictions to develop regulations and programs to protect critical aquifers from contamination.</p> <p>Problem: Lack of comprehensive groundwater quality datasets showing the extent and severity of nonpoint source pollution affecting groundwater resources basinwide, and the lack of management plans necessary for improving conditions. Recommendation: Continue and expand monitoring and research in cooperation with states related to nonpoint source contamination, and support the assessment and implementation of such actions, including TMDLs, USEPA's 319 Nonpoint Source Program, and USDA/NRCS water programs.</p> <p>Problem: Degradation of water quality conditions in aquifers from point source discharges. Recommendation: Support member jurisdictions in their efforts to consider the effect of wastewater discharges on groundwater, including sensitive recharge areas, when issuing NPDES or SPDES permits.</p>	<p>Long-Term Action</p> <p>Continuing Action</p> <p>Continuing Action</p>
2. Water Use and Availability Information	<p>Problem: Groundwater managers, planners, and decision-makers do not have ready access to important groundwater information. Recommendation: The Commission should partner with appropriate agencies to develop groundwater availability and yield information and make it available on-line.</p>	<p>Long-Term Action</p>
3. Well Requirements	<p>Problem: Lack of certification program for drillers in Pennsylvania and need for improving existing licensing/certification programs and well driller training in other basin states. Recommendation: Support legislation that works toward the development of a well driller's certification program in Pennsylvania and support the improvement of programs that provide training and licensing/certification for all well drillers in the basin's states.</p>	<p>Long-Term Action</p>

1/ The issues are numbered in the same manner as for Table 6.1 and for this reason they are not consecutively numbered in Table 6.3.

6.3 Costs

The implementation costs of the elements of the management plan will vary and need to be addressed for both the short- and long-term. There will be financial requirements for the Commission and other lead jurisdictions, but there are ways to address these. The annual increase in costs can be balanced by a phased approach to implementation. Many of the plan elements are modifications to existing programs of the Commission and its member jurisdictions. It is believed that some program funding can be redirected toward making these modifications in a prioritized and phased approach. This plan can be used to help support and justify increased funding through federal and state appropriations, grants, redirection of available program resources, etc. Continuing major initiatives to obtain additional program and/or specific project funding should be undertaken at all levels with the goal of obtaining long-term sustained funding. In addition to funding actions recommended in this report, there are other significant water resources efforts that can be of benefit to groundwater resources and need sufficient funds. An example of an important program requiring sufficient funding is Pennsylvania's State Water Plan (Act 220) which began in 2002.

A few examples of funding needs are instructive in gaining an appreciation of the magnitude of costs of plan implementation. Water budget analyses are recommended as a means to assess water availability and demand in stressed areas and to protect the groundwater resource. The Commission recently initiated a three-year water budget analysis for a 32,000-acre-groundwater area in northern Lancaster County, Pennsylvania, in partnership with the County Conservation District and five local watershed groups. The total cost of the analysis is \$180,000, and is funded by a \$121,000 grant from PADEP's Growing Greener Program and resources being provided by local interests and the Commission. Additional water budget work would require similar funding for each study, depending on the size and complexity of the study area. However, future water budget analyses will be done selectively for specific areas in the basin where water supply versus demands are a significant issue, local jurisdictions support the need for the analyses, and funding is available. Another example of increased costs is for the addition/modification of 11 observation wells in Maryland and New York to provide real-time monitoring data. This cost is estimated to total approximately \$40,000 in a one-time capital cost for the 11 wells, plus an annual operation and maintenance cost of \$4,000 per well. The costs can be cost shared by the states and USGS. A third example is the additional cost for Commission staff to critically review more detailed and complex analyses required of project sponsors pursuant to certain plan recommendations, e.g., cumulative impact analyses. Estimates of the additional staff costs vary widely, depending on project scope and location, but a typical cost is estimated to be \$1,000 to \$2,000 for each project review. The additional annual cost to the Commission would be \$30,000 to \$60,000, based on 30 project applications involving groundwater use in a typical year.

It must be recognized that significant delays in funding will exacerbate groundwater problems and issues. For instance, if cumulative impacts of groundwater withdrawals are not fully assessed, unexpected adverse effects can occur and be costly to remedy. In another aspect of enhanced management of groundwater resources, the Commission has a policy dealing with violations by water users. Review of projects would be required, as recommended in this plan, to determine when violations occur and enforcement actions are required.

6.4 Major Issues

From an implementation standpoint, there are two major issues that the Commission and other lead jurisdictions must address. First, the lead group responsible for each element of the plan must decide on which of the recommended actions to take in a phased and prioritized approach. Second, sufficient manpower and funding resources must be made available, over time, to take the priority actions identified. It is recognized that current staffing and funding may have to be redirected or increased to

accomplish all elements of the plan. A major effort should be made at all levels to obtain sustained long-term funding for addressing groundwater actions. The scope of the recommended actions requires that they be implemented by a combination of management and regulatory program efforts. “Business as usual” through regulatory program requirements will not be adequate to address critical actions, such as public outreach and education.

The Commission has decided to keep its Groundwater Management Plan Team active as a means to continue the process from the planning phase through the implementation phase. The Groundwater Management Plan Team will be recommending and accomplishing annual groundwater program actions to be taken in accordance with this plan's findings. Considerations will include the priorities of actions, funding availability, and competing workload. The goal of the Commission is to implement all recommended actions for which it is responsible in an orderly and efficient manner. Implementation of the recommended actions will remain a long-term Commission priority. Annual progress reports will be made by the Groundwater Management Plan Team to assess the degree of success in taking action. Both the Commissioners and WRMAC will be kept apprised of progress. Other jurisdictions with lead responsibilities on recommended actions are encouraged to take steps similar to that of the Commission in order to focus on plan implementation.

If the essential steps discussed above are not taken, plan implementation will be delayed. Undoubtedly, there also will be technical and administrative issues that will arise. These issues also will need to be effectively addressed so that plan implementation can continue in a timely manner. An example of this is changes in laws and regulations, which will occur and must be addressed with regard to impact on groundwater resources.

6.5 Public Review of the Plan

The Commissioners approved the draft version of this Groundwater Management Plan for public release at their business meeting on June 9, 2004. A full and open 90-day public review and comment period was initiated on June 9, 2004, with a widely distributed news release. For this process, the public was defined as all people, groups, agencies, etc. outside of the Susquehanna River Basin Commission. The Commission's objective was to receive constructive input and comments as a result of public review in order to produce a high quality Groundwater Management Plan.

Three public workshops were held in July 2004 to present the draft plan and provide the opportunity for attendees to make oral comments. The workshops were held in Harrisburg and State College, Pennsylvania, and Owego, New York, with a total of approximately 175 people in attendance. A record of all comments from the workshops was made and is available in Commission files. More formal written comments (by letter and/or e-mail) were also received by the Commission from 21 interested parties during the review period. Over 400 comments were received from the workshops and written submittals.

All comments received were reviewed and addressed. The review comments were organized by the major topics for effective presentation. Appendix F includes a summary of the most significant comments received, organized by major topics, and a summary response for each topic. A concerted effort was made to include representative and significant comments while accounting for numerous similarities in input received from multiple sources at workshops or in written form. The final plan has incorporated additional or revised information, as needed, to reflect changes in response to the comments. The responses in Appendix F state where revisions were made in the plan.

6.6 Future Review and Revision of the Plan

It is recognized that the Groundwater Management Plan will take years to be fully implemented. During this time, new issues, changed conditions, and technological advances are likely to occur. It is prudent that a comprehensive review of the plan be done and revisions made, as needed. A recommendation included in the management plan calls for a comprehensive review and revision of the plan at an interval not to exceed ten years. This action will help ensure that the plan is current and remains viable as a tool for managing groundwater resources.

7.0 CONCLUSIONS

During preparation of the Groundwater Management Plan, several major conclusions were drawn as the work proceeded. Initially, the Commission concluded that the previous (1993) Groundwater Management Plan needed a comprehensive review and revision. The assessment of groundwater issues and problems, including management issues, was the first major work task and it identified the significant and widespread groundwater needs in the basin to be addressed. Actions were considered for each issue and problem, a conclusion was reached, and recommendations made on how to best address each of them. The selected management plan was then developed based on the series of recommended actions.

A critical and long-term part of the Commission's mission, as reflected in the 1971 Compact, is the achievement of a balance among environmental, human, and economic needs in the management of the basin's water resources. This is done by careful consideration of a wide range of factors including water resource sustainability, protection of existing users, adverse environmental impacts, actions to minimize or mitigate impacts, protection of high quality water from degradation, effective interagency coordination, and public understanding of groundwater issues. The recommended water resource management actions in the plan were formulated with the goal of balancing economic development and environmental protection as a primary consideration.

Implementation of the management plan is dependent on the Commission, federal government, member states, local jurisdictions, and project sponsors making resources available for this purpose on a phased and prioritized approach. Conclusions have been reached and documented on which group(s) has the lead, co-lead, or support responsibility for each of the elements of the management plan and where project sponsors need to do required analyses. It is anticipated that all parties will make a "good faith" effort to fulfill their responsibilities. All recommended management actions also were assessed to determine prioritization ratings and schedule time frames. Conclusions were reached on assigning top priority, high priority, or priority ratings and continuing, short- or long-term schedules.

The Commission has approved this plan to effectively address major groundwater resource issues in the basin that are within the Commission's purview. With adoption of the plan, and in recognition of the significant relationship between groundwater and surface water, the Commission has taken an important step toward a unified management of water resources. The Commission will monitor progress on plan implementation and periodically review and update the plan.

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GLOSSARY OF TERMS

Alluvium – Clay, silt, sand, gravel or similar material deposited by stream water in a valley or floodplain.

Anticlinal Geologic Structure – A geologic structure in which the rock layers have been folded, generally convex upward, and whose core contains the chronologically older rocks.

Area of Influence – The area within which the water surface of an aquifer is lowered by withdrawal of water through a well or other structure designed for the purpose.

Aquifer Terms –

Aquifer – A body of rock that is sufficiently permeable to conduct groundwater and to yield economically significant quantities of water to wells and springs.

Aquifer Dewatering – The process of removing groundwater from aquifer storage.

Aquifer Recharge – The process by which water migrates from the ground surface to the zone of saturation within an aquifer.

Critical Aquifer Recharge Areas (CARAs) – Land surface areas that are responsible for a large fraction of the recharge to a well capture area and/or are exceptionally efficient producers of recharge.

Karst Aquifer – An aquifer with groundwater storage and flow properties that are largely determined by an abundance of interconnected voids and caves formed by the action acidic groundwater on naturally soluble rocks such as limestone, dolomite, and gypsum.

Fractured Bedrock Aquifer – An aquifer with groundwater storage and flow properties that are largely determined by an abundance of interconnected fractures, joints, and faults in hardened or cemented rock formations such as granite, shale, limestone, and schist.

Stratified Drift Aquifer – An aquifer characterized by layers of clay, silt, sand, gravel, and boulders deposited by meltwater from glaciers.

Base Flow – The portion of streamflow contributed by the discharge of groundwater as springs and seeps in a streambed. Between precipitation and meltwater events, most of the water in a stream is base flow.

Capture Area – The land surface overlying that portion of the aquifer contributing water to a well. The area of an aquifer from which water is captured by a well.

Colluvium – Loose, mixture of soil and rock fragments deposited at the base of steep slopes and formed by the downslope movement of a slurry of saturated weathered material from mountainsides. Examples include mud flows and landslide debris.

Consumptive Use – Water that is used and not returned to the watershed or groundwater basin from which it was withdrawn. Examples of consumptive use include evaporation from evaporative cooling units, irrigation, and incorporation into products such as concrete and bottled water.

Drawdown – A lowering of the water level in an aquifer caused by the withdrawal of groundwater from a well.

Diabase – A dark gray to black massive, crystalline rock formed by the gradual cooling and solidification of molten rock that migrated upward from deep within the earth's crust.

Ephemeral Reaches – Sections of streams or waterways that are at all times above the water table, and have flow only for short periods in response to surface runoff resulting from precipitation or the melting of snow.

Geomorphic – Of or relating to the form of the land surface. Geomorphology is the study of the processes by which the land surface is formed and history of their development.

Groundwater – All subsurface water, as distinct from surface water, that is in the zone of saturation and supplies wells and springs.

Groundwater Mining – The process of extracting groundwater from a source at a rate so in excess of the recharge that the groundwater level declines persistently, threatening exhaustion of the supply or at least a decline of pumping levels to uneconomic depths.

Grandfathered Use – Water use that is exempted from regulations put into effect after the use was begun. As an example, consumptive water use in the Susquehanna River Basin begun before 1971 is exempt from Commission regulations.

Head – The difference in elevation between two points in a body of water.

Hydrogeology – The science that deals with subsurface waters and with related geologic aspects of surface water. Also used in the more restricted sense of groundwater geology only.

Intermittent Reaches – Sections of streams or waterways that are above the water table for a part of the year and at or slightly above the water table for the remainder of the year. When the channel is above the water table, as during dry periods, they flow for short periods in response to stormwater or meltwater runoff. When the channel is at or below the water table, the flow is continuous and sustained by groundwater discharge to the channel. Intermittent reaches are located between ephemeral reaches in the upstream direction, and perennial reaches in the downstream direction.

Isovolumetric – Equal in volume. Said of a weathering process that changes the chemical composition of a rock, but leaves the size or volume unaltered.

Landscape Ecology – The study of the relationships and interactions between living organisms and the landscape they inhabit.

Landscape Hydrology – The study of the relationships and interactions between the landscape and the science that deals with water, its properties, circulation, and distribution, on and under the earth's surface as affected by the association of landforms, especially as modified by geologic forces.

NPDES – National Pollutant Discharge Elimination System

Perennial Flow – Water flow that is continuous and present year-round and whose upper surface generally stands lower than the water table in the region adjoining the stream.

Saprolite – A soft, earthy, typically clay-rich, thoroughly decomposed rock, formed in place by chemical weathering of igneous, sedimentary, and metamorphic rocks.

Siliciclastics – Rocks which are primarily composed of silicate minerals, and that are only very slightly soluble in naturally occurring precipitation, surface water, and groundwater.

SPDES – State Pollutant Discharge Elimination System

Storativity – The characteristic of an aquifer relating to its ability to store groundwater.

Water Budget Analyses – An accounting or bookkeeping approach to the evaluation of the quantity of water resources available. Quantifies and compares the water income (recharge), expenses (water withdrawals), and savings (groundwater and surface water storage).

Water Level Monitoring – The measuring and recording of water levels in an aquifer to determine long-term trends in the levels.

Well Interference – The condition occurring when the area of influence of a well overlaps that of a neighboring well, as when two wells are pumping from the same aquifer and are located near each other.

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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.

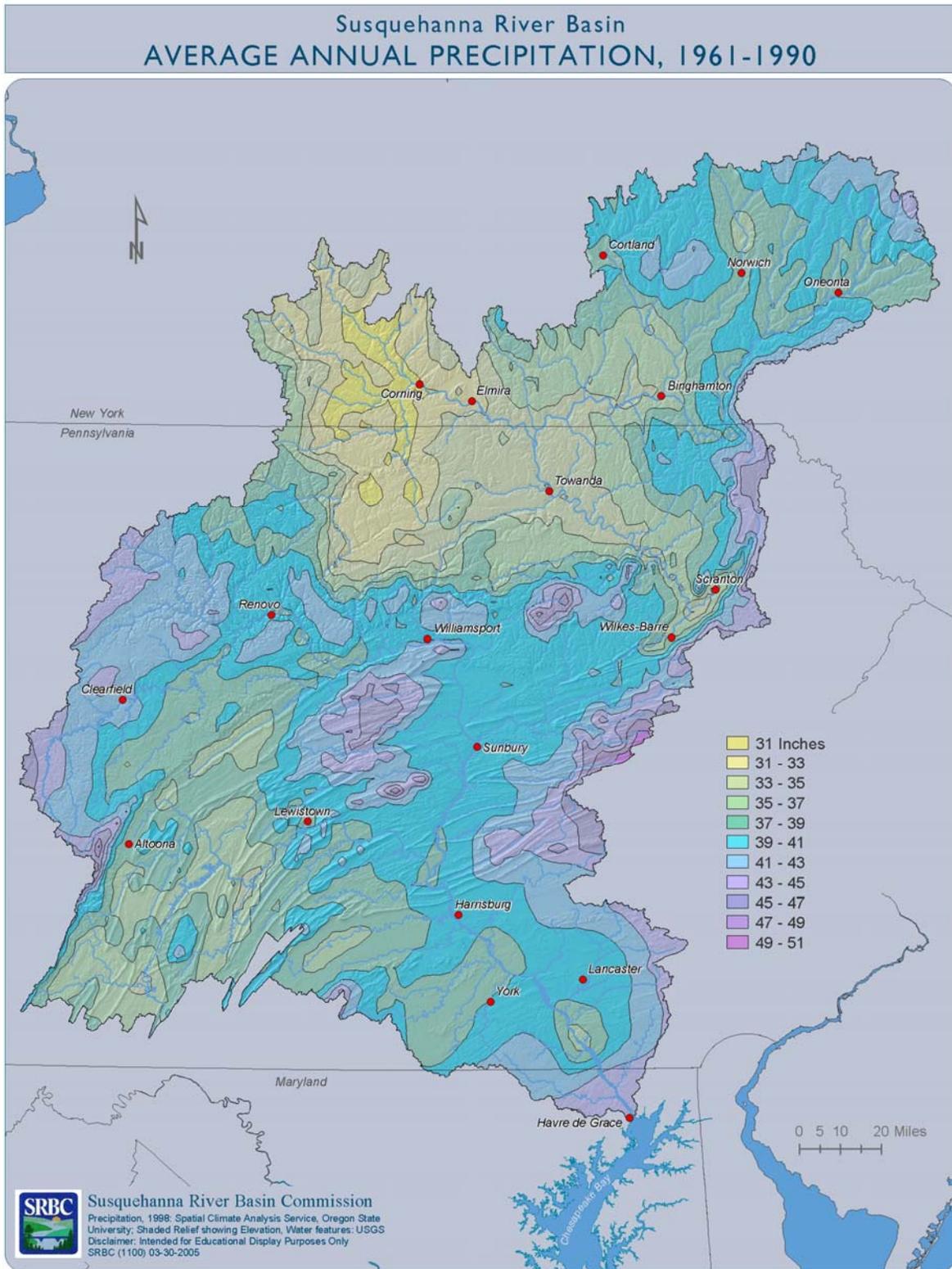


Figure A.1. Long-Term Average Annual Precipitation in the Susquehanna River Basin

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 hydrometeorological 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.

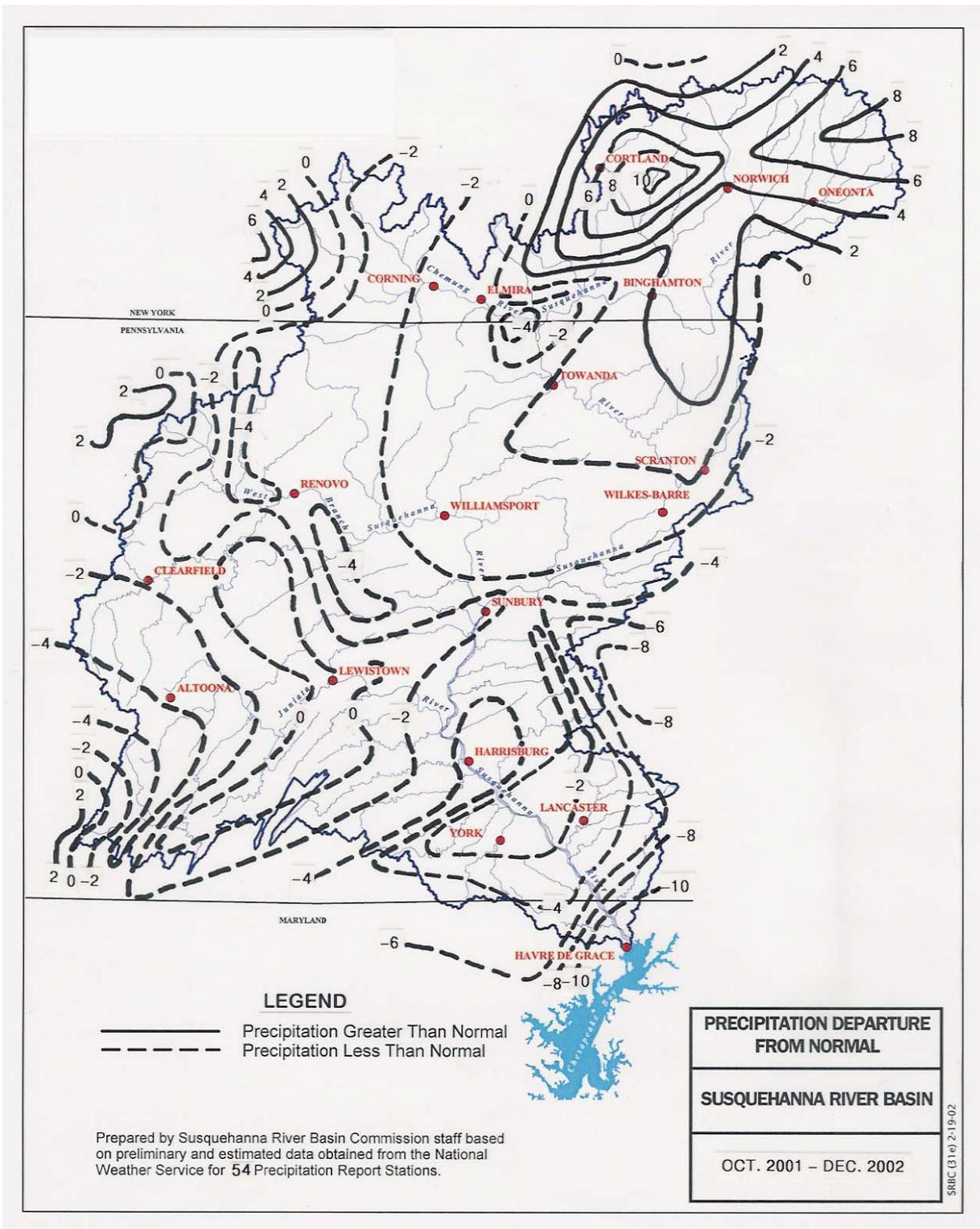


Figure A.2. Precipitation Departure From Normal, Susquehanna River Basin, October 2001 through December 2002

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/mi²) (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).

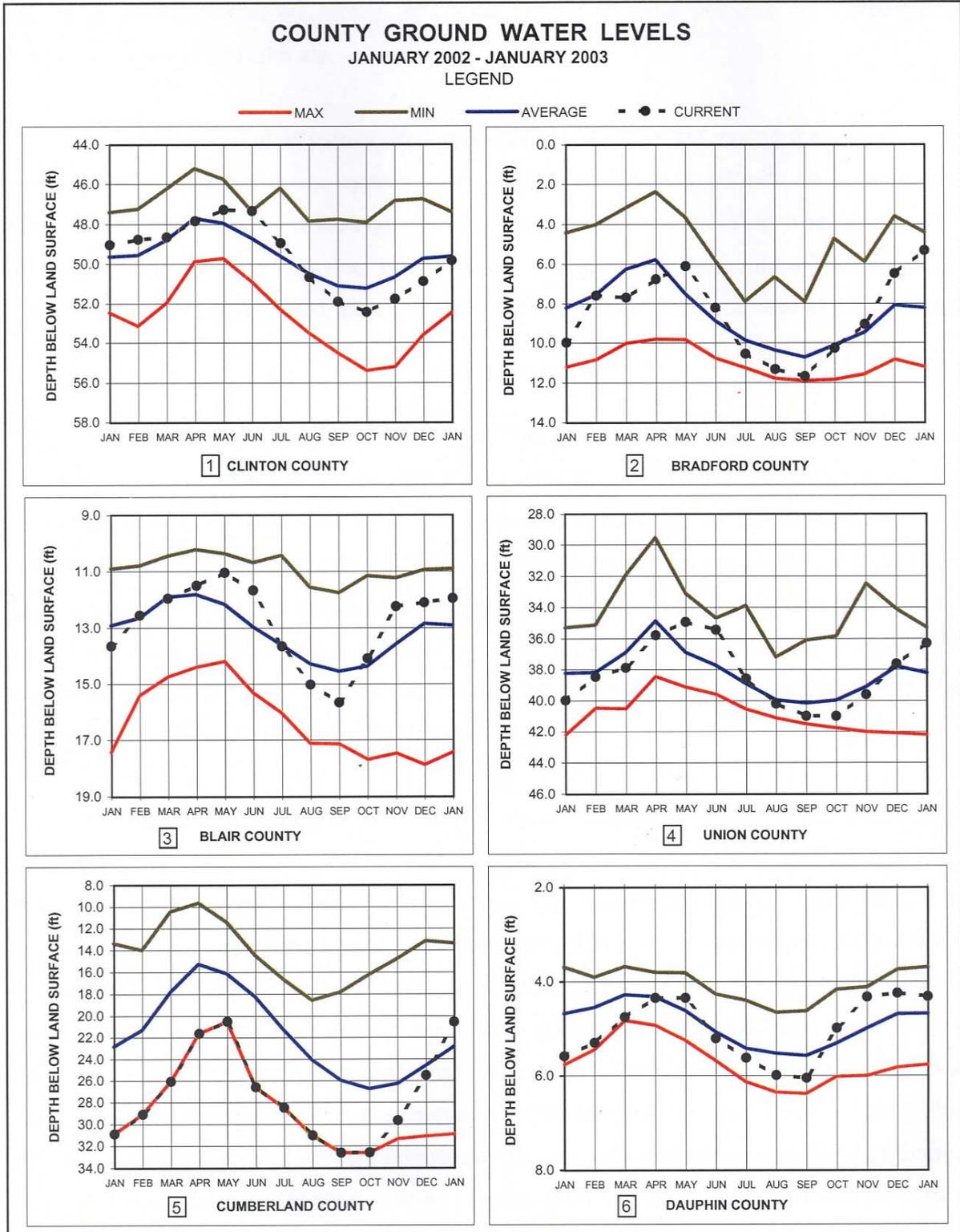


Figure A.3. County Groundwater Levels, January 2002 through January 2003

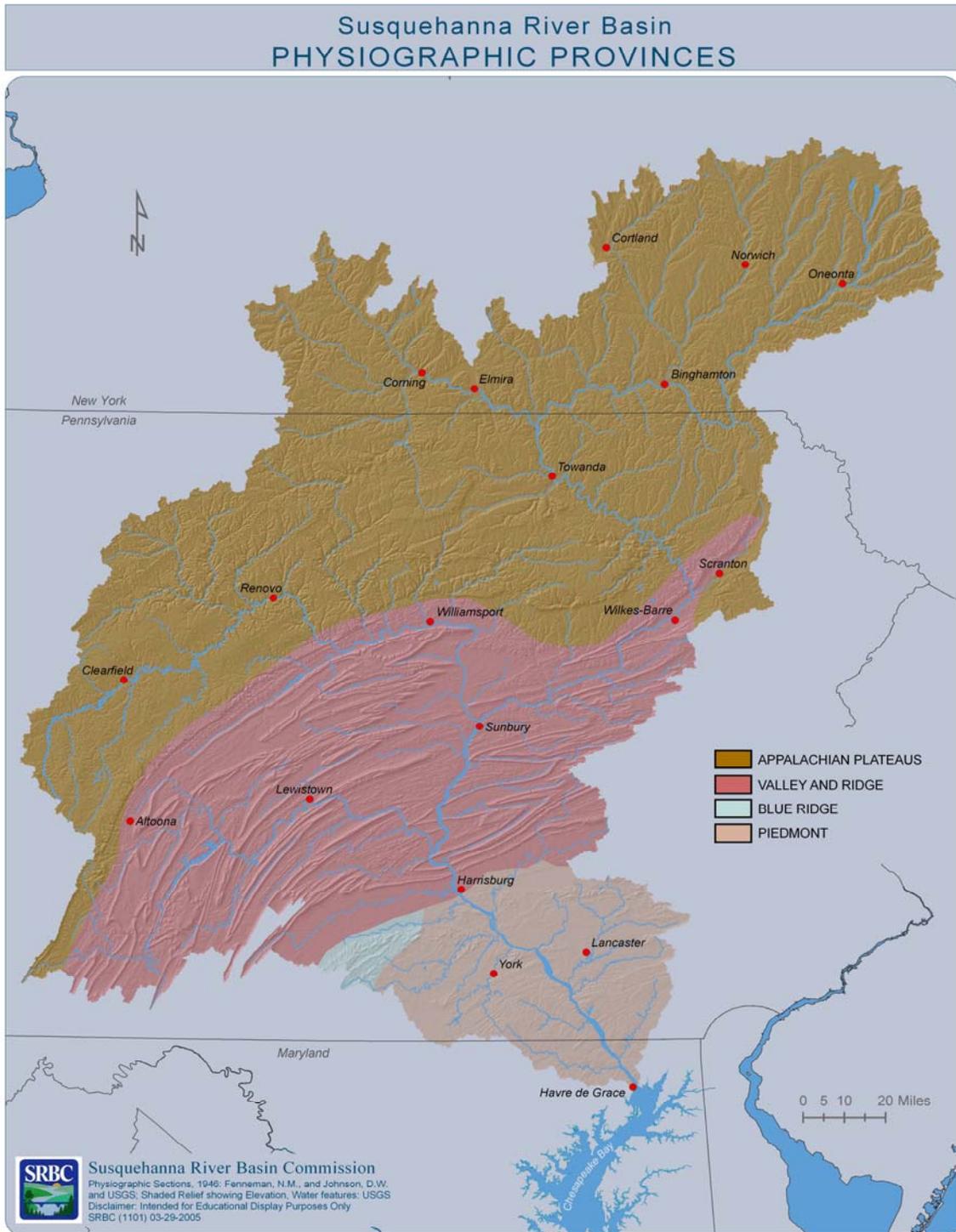


Figure A.4. Physiographic Provinces in the Susquehanna River Basin

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/mi². 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.

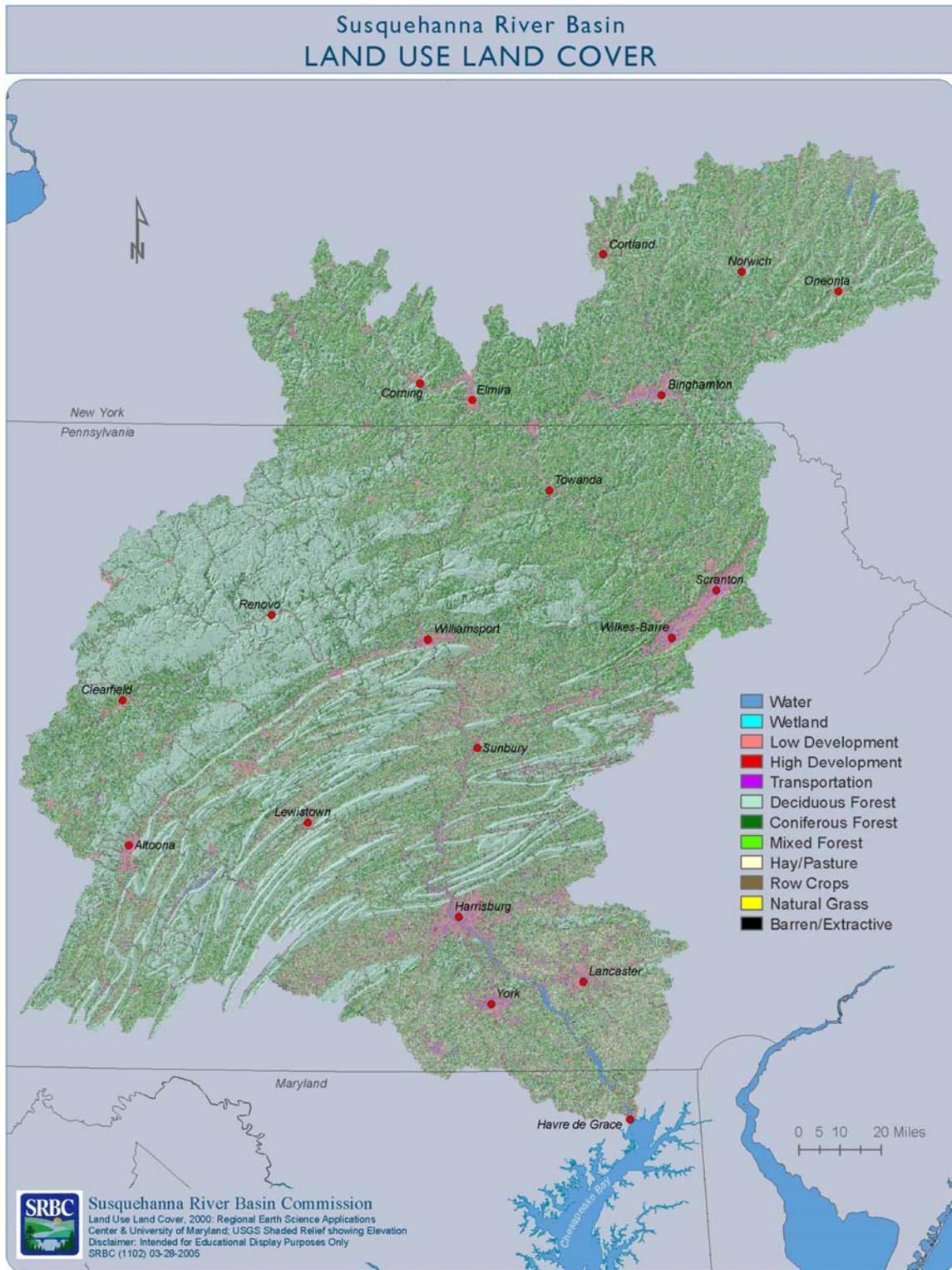


Figure A.5. Land Use for the Susquehanna River Basin

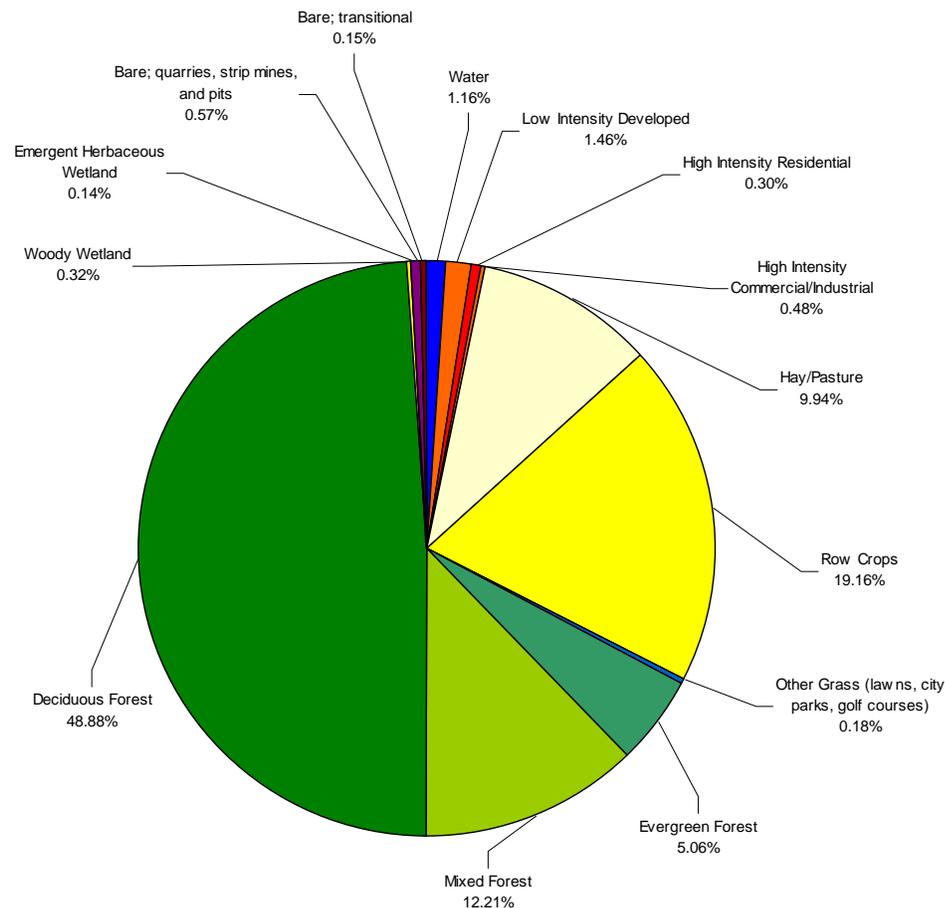


Figure A.6. Land Use for the Susquehanna River Basin

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).

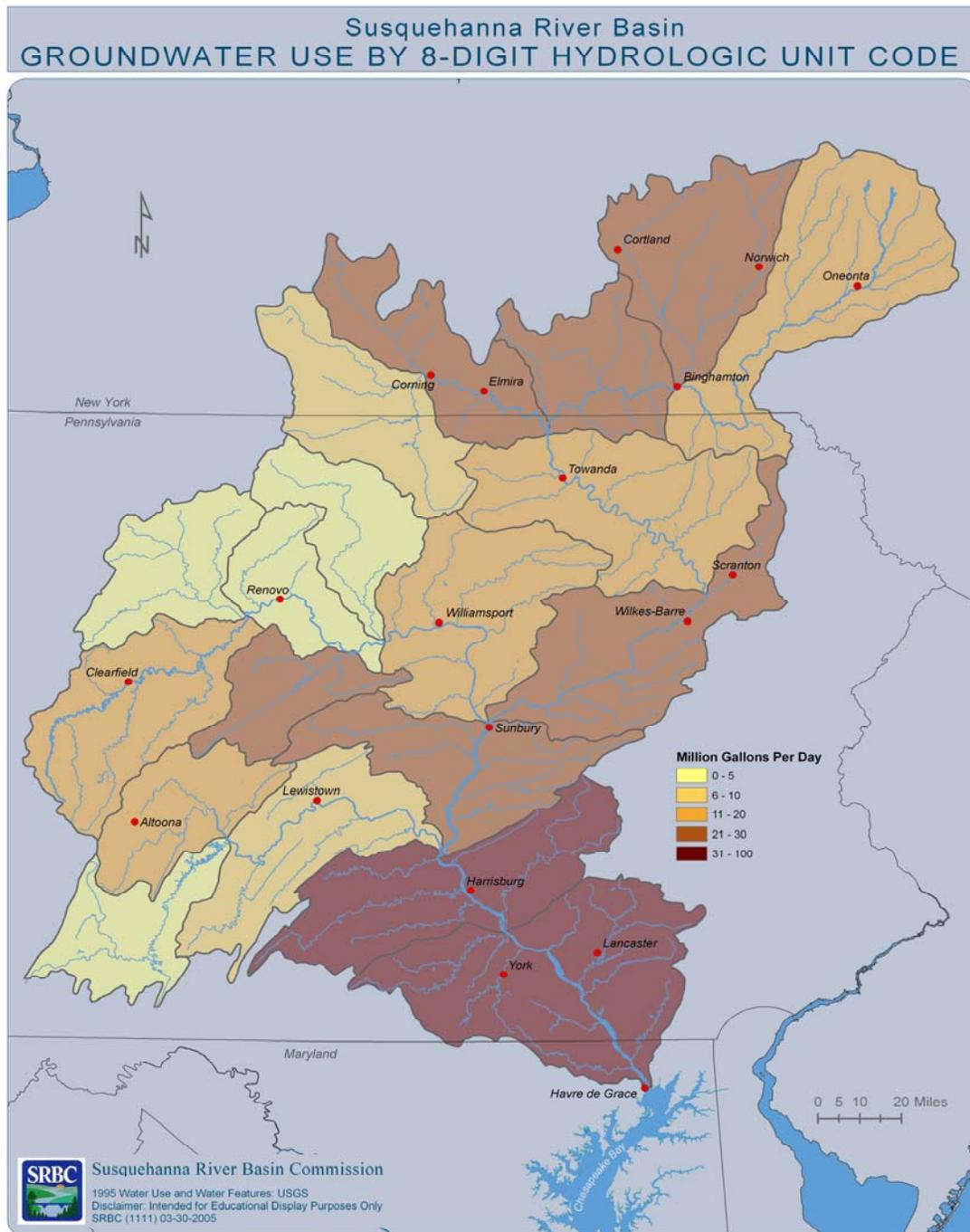


Figure A.7. Groundwater Use in the Susquehanna River Basin (Data source—United States Geological Survey National Water-Use Data Files, 1995)

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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APPENDIX B
Management and Regulatory Programs

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MANAGEMENT AND REGULATORY PROGRAMS

Appendix B describes the management and regulatory programs of the federal government, the Commission, and state and local governments that provide a framework for the management of those groundwater resources. The important role of watershed organizations also is discussed. There are long-standing and diverse authorities that require the states, local jurisdictions, and federal government to manage, regulate, and protect various elements of groundwater resources. The key federal and state agencies with groundwater responsibilities are listed below, and contact information for each agency is available at the end of this appendix.

Federal Government	--	United States Geological Survey
	--	United States Environmental Protection Agency
	--	United States Army Corps of Engineers
	--	United States Fish and Wildlife Service
	--	Natural Resources Conservation Service
New York	--	Department of Environmental Conservation
	--	Department of Health
Pennsylvania	--	Department of Environmental Protection
	--	Department of Conservation and Natural Resources
Maryland	--	Department of the Environment
	--	Department of Natural Resources

In addition, local jurisdictions and watershed organizations play important roles in groundwater issues.

The purpose of the following section is to describe the existing management framework and the integration of regulatory and management activities for groundwater resources among the Commission, its member jurisdictions, the federal government, and local interests.

Federal Government

United States Geological Survey (USGS). The USGS has an important, and somewhat unique, role in groundwater, given its expertise in groundwater science and the depth and breadth of groundwater data. The USGS collects data and maintains databases on streamflow from its stream gaging network, groundwater levels from its monitoring well network, and ambient water quality. The USGS provides the science that sets the standards in monitoring, management, and data gathering and presentation.

The USGS manages a network of observation wells in the basin, in conjunction with New York, Pennsylvania, and Maryland. Data generated from these wells, like the stream gaging data, are available on-line (although not on a real-time basis for all wells) and are published annually in its series of Water Resource Data Reports. Pennsylvania is currently working with the USGS to revise its groundwater monitoring program to collect better data across the state, which will eventually translate into more groundwater data for the Susquehanna Basin. The USGS cooperates with the states in performing areal groundwater resource investigations and mapping bedrock throughout the basin. Local governments also have cooperated with the USGS in groundwater projects.

The network of stream gages in the basin managed by USGS are critical to surface water data collection and analyses. The knowledge of groundwater and surface water interaction requires good data.

The need for an effective network of existing stream gages, plus new ones where needed, cannot be overstated.

United States Environmental Protection Agency (USEPA). The USEPA is empowered by a variety of federal laws to regulate activities that have the potential to pollute either surface water or groundwater. Additionally, the USEPA oversees the remediation of pollution sites when no responsible party can be identified. In many instances, the states within the basin have accepted primacy over the federal programs and, thus, provide the actual implementation of remediation programs.

The principle federal regulatory program relating to groundwater is the Safe Drinking Water Act (SDWA) of 1974 (authorized by P.L. 93-523 and P.L. 99-339). The SDWA authorizes USEPA to set maximum contaminant levels and monitoring requirements for public water supply systems. All of the member jurisdictions of the Commission have assumed primacy for this program. The act provides for “sole source” drinking water aquifers, source funding for state programs of public water supply regulation, and the authorization for states to develop wellhead protection programs.

SDWA also instructed USEPA to set up a program to prevent contamination of underground sources of drinking water by underground injection of contaminants, called the Underground Injection Control (UIC) Program. The USEPA directly implements the UIC program in New York, Pennsylvania, and Maryland.

The USEPA leads the federal government's participation in the Chesapeake Bay Program, a federal-state-local partnership that directs and conducts the restoration of the Chesapeake Bay. Groundwater resources are one aspect of this large restoration effort.

USEPA, under its Section 106 Program and others, funds groundwater initiatives of the Commission and its member jurisdictions through grants.

United States Fish and Wildlife Service (USFWS). The USFWS is involved in the protection of the groundwater resources of the basin through its protection of federally listed, proposed, and candidate species under the jurisdiction of the Endangered Species Act of 1973. Wetlands associated with groundwater discharges provide very unique habitats that serve as breeding, supporting, and forage grounds for federally protected species, such as the bog turtle (*Clemmys muhlenbergii*), Bald Eagle (*Haliaeetus leucocephalus*), and Northern bulrush (*Scirpus ancistrochaetus*). When proposed development and withdrawals by projects have the potential to impact groundwater resources, the USFWS cooperates in performing investigations for threatened and endangered species under its protection. The USFWS provides recommendations for mitigation and protection that are critical for resource protection, particularly if groundwater may be intercepted or the flow system altered in and adjacent to sensitive aquatic habitats.

United States Army Corps of Engineers (USACE). Although not its primary mission, the USACE participates in various studies related to groundwater resources. Under authorities such as Section 22 of the Water Resources Development Act of 1974, the USACE can provide technical and planning assistance for water resources. A current example of this technical groundwater assessment to the Commonwealth of Pennsylvania is found in the Swatara Creek Water Supply Study.

Susquehanna River Basin Commission

The primary responsibility for managing the waters of the Susquehanna River Basin falls on the three states in the Commission—New York, Pennsylvania, and Maryland. The Compact recognizes the powers and duties of the states. Each Compact state has varying levels of water management authority

and regulations. The Commission addresses some of the groundwater management and regulatory gaps that exist among the states' programs.

A critical part of the Commission's mission, as reflected in the 1971 Compact, is the achievement of a balance among environmental, human, and economic needs in the management of the basin's water resources. This is done by careful consideration of a wide range of factors, including the fundamental need for and benefits of economic growth, water resource sustainability, protection of existing users, adverse environmental impacts, actions to minimize or mitigate impacts, protection of high quality water from degradation, effective interagency coordination, and public understanding of groundwater issues.

The Commission carries out its coordination role by:

1. Utilizing the powers vested in the commissioners through the Compact and the respective state water management agencies; and
2. Applying the standards in the Commission's *Comprehensive Plan for the Management and Development of the Water Resources of the Basin* (1987).

To ensure that the requirements under the Compact and the Commission's Comprehensive Plan are being met basinwide, the Commission is authorized by the Compact to assume responsibility in any matter affecting water resources when a Compact state is unable to do so. The Commission can assume that responsibility until the state has the proper regulatory authority or is willing to carry out the water management requirements. The preparation of this Groundwater Management Plan is a good example of the Commission's management and coordination role.

Project Review Program. Section 1.1 of this plan discusses the regulatory basis for the Commission's Project Review Program. The main purposes of the Commission's regulations are to:

- Manage water as a sustainable/renewable resource;
- Avoid conflicts among water users;
- Protect public health, safety, and welfare;
- Foster economic development; and
- Protect fisheries, aquatic habitat, and the environment.

Prior to the previously mentioned dates for each regulation, the Commission recognizes documented water use as being “grandfathered.” However, any withdrawal increases above the “grandfathered” quantity in excess of 100,000 gpd, or 20,000 gpd consumptively, are regulated.

As part of the application approval process, the Commission may limit the amount (quantity and rate) of water withdrawn by the project sponsor to the amount required to meet reasonably foreseeable needs. An application may be denied, or special conditions added to an approval—referred to as a “docket”—if the Commission determines that the new withdrawal would not be sustainable, significantly affect or interfere with an existing water user, or impact important environmental resources. Special conditions can include water level monitoring, allowing for passby flows, or requiring the project sponsor to provide a replacement water supply—at the project sponsor's expense. When a docket is approved, the user is required, by the regulation, to meter, monitor, and periodically report the operation's water usage. Compliance with these conditions, and any other conditions of approval, are subject to enforcement actions by the Commission.

The Commission staff conducts an independent review of project applications, and the Commission coordinates its actions on projects involving public water supplies with the regulatory

agencies of the member jurisdictions, including NYSDEC, PADEP, and MDE. Coordination with these agencies ensures that all issues and concerns are resolved prior to Commission action. When a state's regulatory agency or any political subdivision of the agency (i.e., local government) having jurisdiction over the project denies or otherwise disapproves an aspect of the project, the Commission will suspend its review for up to three years (pending final resolution) or terminate its review.

In recognition of the economic burden that compensation for consumptive water use imposed on individual farmers, the Commission's consumptive use regulation has been suspended from application to the agricultural industry since 1992. This suspension is intended to remain in effect until a long-term solution to the consumptive water needs of agriculture in the basin can be implemented. See the discussion of special studies in this section of the plan for information on a Commission effort to evaluate alternative solutions for Pennsylvania.

Groundwater Quality Coordination. Article 5, Section 5.2(b), of the Compact emphasizes the primary role of the member jurisdictions in water quality management and control. The Commission can impose its own standards only if the member jurisdictions fail to achieve the basic requirements of the Commission's Comprehensive Plan. However, the Commission ordinarily acts in an advisory capacity in matters related to groundwater quality, and performs some grant-funded work related to groundwater quality. To enhance coordination efforts, the Commission holds regular meetings twice a year with member jurisdictions through its Water Quality Advisory Committee.

With respect to its regulatory function, the Commission conducts an environmental screening as part of its Project Review Program. Through this effort, the Commission coordinates extensively with appropriate agencies concerning water quality issues. In addition, the Watershed Assessment and Protection Division is involved in a number of basinwide efforts to address pollution associated with AMD, agricultural, and urban-related sources.

Watershed Studies, Special Studies, and Water Budget Analyses. In practice, the Commission's Comprehensive Plan and regulations form the basis for the groundwater management activities of the Commission. On an occasional basis, as resources (financial and staff) become available, the Commission has developed and participated in various studies related to groundwater resources. These include local and regional resource appraisals and water resource management plans.

The resource evaluations commonly include water budgets, an accounting of the water resources of an area (a watershed or part of a watershed). A water budget is used to evaluate the quantity of groundwater resources available for development, and for planning for future needs.

In the early 1980s, the Commission completed or assisted in the completion of resource appraisals, including water budgets for various areas, as part of its special groundwater study. The Commission provided technical assistance to the Spring Creek Watershed Study (Taylor, 1997), through its work on the water budget. The Commission also has studied the Hazleton area (the Jeddo Mine Drainage Tunnel) (Hollowell, 1999). Current examples of watershed studies include the Swatara Creek Watershed Water Supply Study (United States Army Corps of Engineers, 2003) and the northern Lancaster County Water Budget Study.

Currently, Commission staff is conducting a special study of alternative management options for both surface water and groundwater to address agricultural consumptive use in the Susquehanna River Basin in Pennsylvania. The study is being funded by the Commonwealth of Pennsylvania, and its objective is to develop reasonable and sustainable solutions to compensate, to the fullest extent practicable, for the impacts of agricultural consumptive use during drought periods. The Commission

will consider the results of the special study and decide if they need to be incorporated into ongoing Commission programs.

While there are other opportunities and needs for groundwater studies, the Commission's ability to take on additional studies is limited by available staff resources.

Protected Areas. Section 11.2 of the Compact describes the determination and delineation of areas in the basin where the demands upon supply made by users have developed or have threatened to develop to such a degree as to create a water shortage. In these so called "protected areas," the Commission may regulate diversions or withdrawals of water for domestic, municipal, agricultural, or industrial uses. To date, the Commission has not exercised its authority in these matters.

Groundwater Management Plan. The Commission has been involved in the evaluation and management of groundwater since it was established in 1971. Initially, groundwater activities were guided by the general references about groundwater in the Commission's Comprehensive Plan. Then, in 1993, the Commission prepared its first Groundwater Management Plan to supplement the Comprehensive Plan by providing detailed recommendations for the management of the basin's groundwater resources.

New York State

New York State Department of Environmental Conservation (NYSDEC). Within NYSDEC, the Division of Water (DOW) has primary responsibility for management and regulation of groundwater resources in New York State.

DOW issues permits for all takings for public water supply, from groundwater or surface water sources. As part of this process, the project sponsor must provide data that the supply is adequate and necessary, and that the taking is equitable to nearby municipalities in regard to their present and future water resource needs.

In 1999, New York amended the Environmental Conservation Law (1972) to include Section 15-1525 entitled, "Water well drillers in New York state to obtain certificates of registration." Water well driller registration (certification) is required statewide. Detailed water well completion information is submitted for use in groundwater resource evaluation and development of a database. Other requirements of the law are to be more fully addressed in regulations prepared by NYSDOH.

The DOW has several ongoing programs relating to the management and protection of groundwater. The DOW, in partnership with the USGS, conducts statewide aquifer mapping to obtain information on significant water-bearing formations. The information from this activity is available in several formats, including print, CD-ROM, and on-line. The DOW also issues permits for discharges of wastewater, and stormwater, to surface water and groundwater, ensuring that the discharges are consistent with effluent limitations and water quality standards. The DOW also works closely with local governments and supports their efforts to implement nonpoint source control and groundwater resource protection programs.

Other programs affecting groundwater management and regulation include NYSDEC's Divisions of Environmental Remediation, Mineral Resources, and Solid and Hazardous Materials.

New York State Department of Health (NYSDOH). The NYSDOH is responsible for protecting public health and assuring the potability of drinking water supplies for the state's citizens. Water that has been withdrawn by public water suppliers for distribution to the consumer is regulated by the NYSDOH.

The NYSDOH reviews public water supply facility design and construction and requires periodic monitoring of the quality of water delivered to the tap. The NYSDOH provides emergency response to water supply systems experiencing critical water quality or quantity problems. Establishment of state drinking water standards and enforcement of both state and federal drinking water standards are tasks performed by the NYSDOH.

County Health Agencies. Six counties within the Susquehanna River Basin are served by county health departments: Allegany, Chemung, Broome, Tioga, Tompkins, and Cortland Counties. These agencies help administer, through delegation, major elements of state level NYSDEC and NYSDOH programs for water pollution control and water supply regulation.

Commonwealth of Pennsylvania

Pennsylvania Department of Environmental Protection (PADEP). The PADEP was created to promote compliance with environmental regulations using a partnership approach. PADEP conducts many groundwater management activities, most of which relate to groundwater pollution and quality. Almost all PADEP permits are issued through the agency's six regional offices or six district mining offices. Program support is provided by the central office bureaus, as described below.

Public groundwater supplies are regulated and monitored by field staff assigned to the Water Supply Management (WSM) Program, under the guidance of the central office Bureau of Water Supply and Wastewater Management. Although primarily concerned with the potability of the water, PADEP regulations also deal with source quantity requirements and effects of a water withdrawal on other resources protected by laws administered by the PADEP¹. WSM field staff specify maximum pumping rates for public water supply wells in permits that are issued, because maximum pumping rate is a basic parameter for design of water treatment facilities. The maximum permissible pumping rate, which is primarily determined by extended duration pump testing, is also the largest rate that PADEP determines can be withdrawn without causing an undesired result, such as dewatering of an aquifer. WSM field staff also respond to complaints and checks various chemical parameters associated with domestic water supplies.

Pennsylvania's Wellhead Protection Program was submitted to USEPA in March 1998 and approved by USEPA in March 1999. It serves as the cornerstone of the Source Water Assessment and Protection Program, which is administered by the central office Bureau of Watershed Management and the regional offices. This bureau and the regions also manage and carry out an Ambient Groundwater Monitoring Network Program.

Under the guidance of the Bureau of Watershed Management, the WSM field staff also issues surface water allocation permits to public water suppliers that withdraw surface waters. The Bureau of Watershed Management also is responsible for comprehensive water resource planning for the Commonwealth (State Water Plan).

The Bureau of Water Supply and Wastewater Management regulates sewage disposal by both on-lot and community systems, spray irrigation, underground injection of wastes, surface impoundments (nonhazardous waste), and underground storage tanks. This bureau responds to miscellaneous groundwater pollution incidents, including hydrocarbon spills, and those resulting from the areal

¹ Oley Township v. PADEP and Wissahickon Spring Water, Inc. 1996 EHB 1098 (October 24, 1996).

application of agricultural fertilizers and pesticides. There are no groundwater uses or standards set by regulation in Pennsylvania.

Solid waste is regulated by the Bureau of Waste Management. All facilities for the storage, treatment, and disposal of municipal, residual, or hazardous waste are permitted, including, but not limited to, landfills, incinerators, and land application sites. Storage and treatment facilities also pose a potential threat to the groundwater, and also are permitted by this bureau.

The Bureau of Mining and Reclamation and the district mining offices permit surface mines, deep mines, coal preparation plants, coal refuse disposal sites, and insures regulatory compliance of all permitted activities. District mining offices are charged with monitoring of groundwater quality around all regulated activities, and protecting the yield of groundwater sources (wells and springs) from being severely diminished as a result of surface mining activities. Impoundments associated with surface and deep mining activities also are regulated by district mining offices. The Bureau of Mining and Reclamation licenses mine operators.

The Bureau of Oil and Gas Management and the regional offices protect groundwater through programs that regulate the casing of wells through the potable groundwater zone, well plugging, waste disposal, and injection wells (both disposal and enhanced recovery).

Pennsylvania Department of Conservation and Natural Resources (PADCNR). The Bureau of Topographic and Geologic Survey conducts groundwater studies, some in cooperation with the USGS. This bureau administers the Water Well Drillers License Act 610, which is solely a mechanism to obtain groundwater and subsurface data. This bureau maintains both analog and computerized inventories of water well records (Pennsylvania GWIS) based on drillers' completion reports. Webdriller is a voluntary mechanism to capture water-well drillers' data digitally and to improve the accuracy of well location data. There are no regulations for private water well location or construction in Pennsylvania.

State of Maryland

Maryland Department of the Environment (MDE) The Water Management Administration (WMA), through its Water Rights Division (WRD), has the responsibility for issuing "groundwater appropriation permits" for most new uses of groundwater (either from wells or springs). Permits are not required for wells drilled for domestic use, other than for heating and cooling, and the permit is voluntary for agricultural wells producing less than 10,000 gpd.

Proposed withdrawals from wells or springs are reviewed for effect on surface water, other users (well interference), and the aquifer. Withdrawals are limited to the "sustained yield" of the aquifer.

The WRD may require an "aquifer yield test" for some projects. The project sponsor has the responsibility to analyze the test data to address such issues as: (1) determining aquifer hydraulic characteristics; (2) establishing long-term well yield and projected drawdown in the pumping well; (3) making time/distance-drawdown projections in affected aquifers; and (4) evaluating the potential for saltwater intrusion or other groundwater contamination. The project sponsor must collect a sample for water quality during the final hour of pumping.

Permittees with an average water use of 10,000 gpd, or greater, must submit reports of monthly water use twice a year. The permit is in force for up to 12 years, and is reviewed every 3 years to insure that the water appropriated is being used in conformance with the permit.

The Planning and Engineering Section of the WRD analyzes the area-wide effects of collective water appropriations in view of a region's future water supply and demand. If problems are identified, the section formulates management alternatives to resolve them.

The MDE has the primary responsibility for protecting groundwater quality from contamination caused by human activities. The agency administers several programs regarding groundwater quality.

The WMA, through the Water Supply Program (WSP), is responsible for implementing the SDWA. Most of the WSP activities relate to the quality of finished potable water.

The WSP also has the responsibility for administering Maryland's Wellhead Protection Program. WSP's role includes developing the program, organizing citizen participation, and providing technical assistance to local governments and public water supply system owners. The individual public water supply system owners are responsible for delineating their wellhead protection areas.

Well construction regulations are enforced by the Groundwater Permits Program within WMA, in coordination with county health departments. The Water Quality Infrastructure Program has the responsibility for reviewing and approving of comprehensive water and sewerage plans prepared by each county.

The Waste Management Administration permits and monitors municipal waste landfills, sewage sludge application sites, sites used for the disposal of hazardous wastes, environmental restoration, and oil control.

The Water and Wetlands and Waterways, and Minerals, Gas, and Oil Programs of the WMA are responsible for developing, managing, conserving, and protecting the state's water and mineral resources. Policies are implemented through the issuance and enforcement of permits for groundwater and surface water appropriation, surface mining, gas and oil exploration and production, waterway construction, and tidal and nontidal wetlands development.

Maryland Department of Natural Resources (MDNR). The Hydrogeology and Hydrology Program of the Maryland Geological Survey is responsible for the maintenance of a statewide water-data network, and the investigation of the hydrologic and geologic characteristics of Maryland's water resources. The groundwater-data network provides information on water levels and ambient water quality in selected wells throughout the state, and measures the effects of long-term changes in pumpage, land use patterns, and precipitation.

County Health Departments. The MDE has delegated several important groundwater management activities to local health officers. These include overseeing the siting of private wells and septic systems, insuring adequate quantity and quality of well water for both new dwellings and those changing ownership, reviewing subdivision plans concerning environmental impacts, sampling monitoring wells at sanitary landfills, and sampling private wells, upon owner request, for bacterial and chemical quality.

Local Governments

Within the basin, there are several forms of local government, including counties, cities, townships, boroughs, towns, villages, and authorities. These include a total of about 1,350 municipalities. Within this complex and multilayered network of regulatory bodies lies the control of land use, land development, stormwater management, and several aspects of water resource management and use. One of the purposes of the Susquehanna River Basin Compact is to apply the principle of uniform treatment to

all users of water, without regard to political boundaries. Applying this principle of uniform treatment of water users within this local government network is challenging.

Because of the interrelationship between economic development and the availability of an adequate water supply, local governments have the responsibility to both promote and protect the integrity of the resource, including the groundwater component. Municipalities must plan for and accommodate different types of land uses and their water demands within their respective municipal boundaries.

Stormwater management and water resource planning and use are best addressed through multi-jurisdictional coordination or on a watershed basis. Watershed boundaries and groundwater basins, or aquifers, do not usually coincide with a single municipal boundary. A municipality that is a good steward of a resource may be juxtaposed with municipal neighbors that are not. The consequences are that the benefits derived from the stewardship could be exploited by the neighbors, leading to a competition by the good steward to exploit its own resource. The end result is that the resource is depleted, and any economic gains are short-lived or unsustainable.

It is, therefore, incumbent upon local governments to become advocates for the control of land use policies that foster prudent resource protection and development through the variety of legal tools available.

The framers of the Compact recognized the problem of too many government agencies attempting to manage the waters of the Susquehanna. Duplicative, overlapping, and uncoordinated activities were resulting in a splintering of authority and responsibility in the basin. To prevent this splintering, the framers concluded in the Compact that “a single administrative agency is essential for effective and economical direction, supervision, and coordination of water resources efforts and programs of federal, state, and local governments and of private enterprise.” The Commission is that single agency.

The Commission's groundwater regulations preempt local groundwater regulations for projects that meet the Commission's criteria as large water users, and provide a basis for managing water regionally as a shared resource. In combination with the special conditions it places on projects, they provide the necessary safeguards to protect adjoining well owners.

That notwithstanding, local governments are a valuable part of the groundwater resource management picture. Municipalities and counties are notified of project applications (as required by regulation), and the Commission, in its decision-making, carefully weighs any comments they submit. Local governments can exert control over many projects and activities through resource planning, land use controls, and zoning ordinances.

Watershed Organizations

Although the number of associations varies, currently there are 187 watershed and lake associations in the Susquehanna River Basin Commission's database (Figure B.1). These grassroots organizations can be a powerful force in setting priorities on the public agenda. Not only are watershed organizations capable of motivating members of the general public to seek solutions for water resource problems and issues, but they also can conduct grant-funded studies and research, such as watershed assessment planning, watershed restoration and protection activities, and participate in local education and environmental planning with local governments. Land trusts, although not exclusively linked to watershed organizations, can play a special role in local land use issues, including developing and implementing watershed conservation plans and strategies, identifying critical habitats and parcels within

watersheds, and even removing land from development pressures through acquisitions and conservation easements.

In addition to the grass-roots organizations described above, state rural water associations (New York, Pennsylvania, and Maryland) are not-for-profit organizations that promote the development, improvement, and sound operation of rural drinking water and wastewater systems. These organizations promote the effective exchange of knowledge among systems, and serve as liaisons among the government, public, and rural water and wastewater systems.

State rural water associations hold a variety of training programs and offer on-site assistance in areas of management compliance, operation, maintenance, finance, and governance. The training sessions for water and wastewater industry professionals allow system operators, managers, and elected officials to upgrade their skills, improve the quality of their utility's service, and protect their users' health. On-site, hands-on technical assistance to rural and small community water and wastewater systems is commonly free to association members.

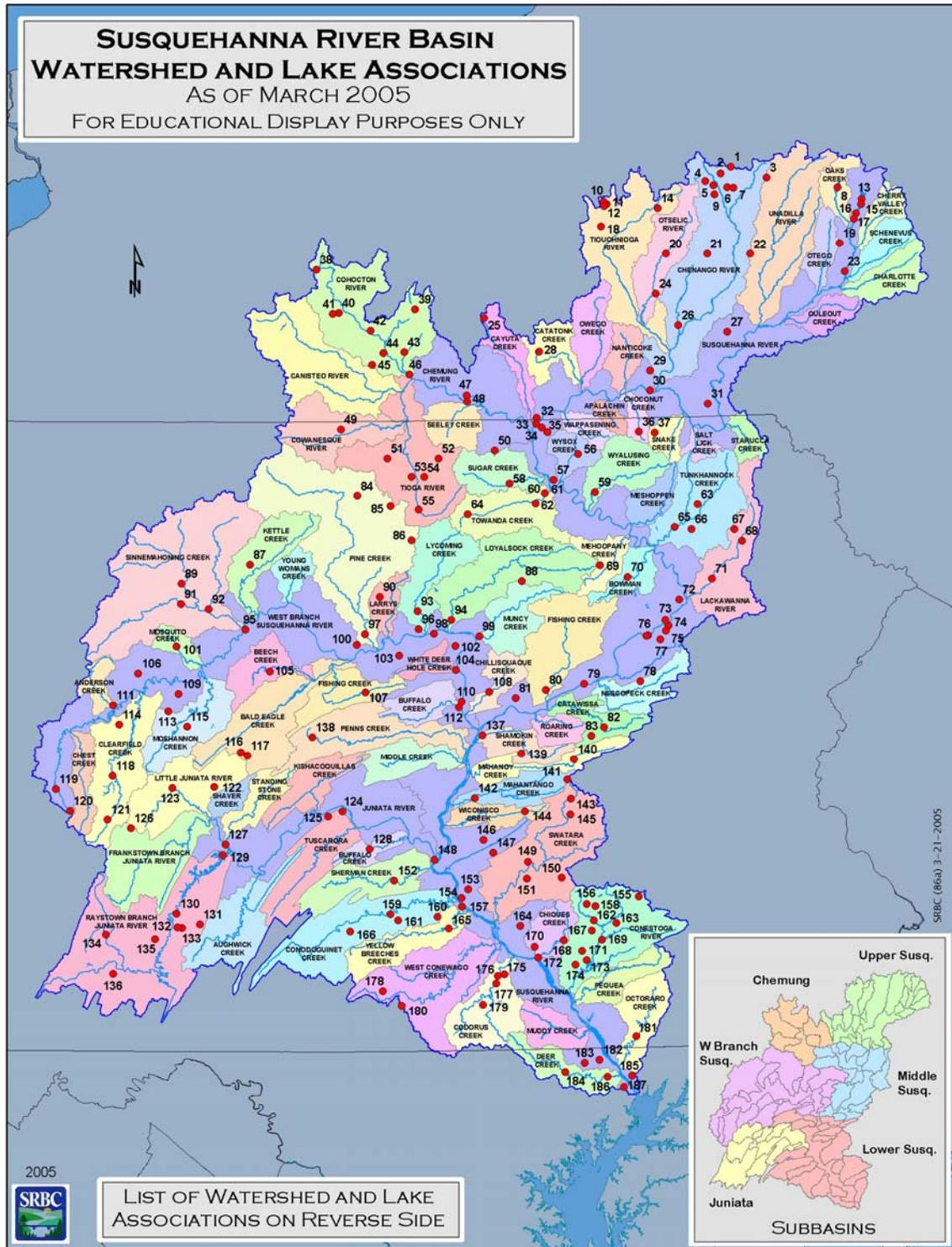


Figure B.1. Watershed and Lake Associations in the Susquehanna River Basin
 (See next page for list of associations.)

Table B.1. Susquehanna River Basin Watershed and Lake Associations

March 2005

Please note that the map points are spatially depicted in a north-to-south orientation

Upper Susquehanna Subbasin	Association	125 Juniata Valley PaSEC
1 Madison Lake Association	66 Lake Sheridan Tarn Watch	126 Blair County PaSEC
2 Leland Pond Betterment Association	67 Newton Lake Watershed Association	127 Juniata Clean Water Partnership
3 Gorton Lake Association	68 Lackawanna River Corridor Association	128 Buffalo Creek Watershed Alliance
4 Eatonbrook Reservoir Association	69 Mehoopany Creek Watershed Association	129 Friends of Raystown Lake
5 Lake Moraine Association	70 Bowmans Creek Watershed Association	130 Shoups Run Watershed Association
6 Lake Craine Lot Owners Association	71 Lackawanna County PaSEC	131 Trough Creek Watershed Association
7 Tuscarora Lake Association	72 Hicks Creek Watershed Association	132 Broad Top Twp./Coaldale Borough Watershed Committee
8 Canadarago Lake Association	73 Eastern Pennsylvania Coalition for Abandoned Mine Reclamation	133 Six Mile Run Area Watershed Committee
9 Lebanon Reservoir Association	74 Luzerne-Wyoming County PaSEC	134 Bob's Creek Stream Guardians
10 Crooked Lake Home Owners Association	75 Wyoming Valley Watershed Coalition	135 Yellow Creek Coalition
11 Tully Lake Property Owners Association	76 Nanticoke Conservation Club	136 Southern Alleghenies Conservancy
12 Song Lake Association	77 Earth Conservancy	Lower Susquehanna Subbasin
13 Otsego Lake Association	78 Friends of the Nescopeck	137 Little Shamokin Creek Watershed Association
14 Toughnioga Lake Association	79 Briar Creek Watershed Association	138 Penns Valley Conservation Association
15 Otsego Lake Watershed Council	80 Fishing Creek Watershed Association	139 Shamokin Creek Restoration Alliance
16 Otsego 2000	81 Mahoning Creek Watershed Association	140 Mahanoy Creek Watershed Association
17 Otsego County Conservation Association	82 Eastern Middle Anthracite Region Recovery, Inc.	141 Schuylkill County PaSEC
18 Little York Improvement Society	83 Catawissa Creek Restoration Association	142 Tri-Valley Watershed Association
19 Arnolds Lake Association	West Branch Susquehanna Subbasin	143 Northern Swatara Watershed Association
20 Otselic River Riparian Working Group	84 Pine Creek Headwaters Protection Group	144 Wiconisco Creek Restoration Association
21 Plymouth Reservoir Association	85 Babb Creek Watershed Association & Reclamation Task Force	145 Sweet Arrow Lake Conservation Association
22 Chenango Lake Property Owners Association	86 Blockhouse Creek Preservation Group	146 Powell's & Armstrong Creeks Watershed Association
23 Goodyear Lake Association	87 Kettle Creek Watershed Association	147 Stony Creek Watershed Association
24 Melody Lake Association	88 Eagles Mere Lake and Watershed Committee	148 Central Pennsylvania Conservancy
25 Cayuta Lake Property Owners Association	89 Sterling Run Watershed Association	149 Swatara Creek Watershed Association
26 Geneganslet Lake Association	90 Lawshe Run Watershed Association	150 Lebanon Valley Conservancy
27 Echo Lake Association, Inc.	91 Bennett Branch Watershed Association	151 Quittapahilla Watershed Association
28 Citizens for the Catatonk Creek	92 Bucktail Watershed Association	152 Shermans Creek Conservation Association
29 Lake Warn Association	93 Lycoming Creek Watershed Association	153 Paxton Creek Watershed and Education Association
30 Upper Susquehanna Coalition	94 Loyalsock Creek Watershed Association	154 Susquehanna River Trail Association
31 Broome County Beaver Lake Association	95 Centre County PaSEC	155 Berks County Conservancy
32 Valley Project Impact	96 North Central Pennsylvania Conservancy	156 Furnace Run/Segloch Run Watershed Alliance
33 Carantouan Greenway	97 Pine Creek Preservation Association	157 Susquehanna River Wetlands Trust
34 Upper Susquehanna Riverkeeper	98 Lycoming-Clinton PaSEC	158 Middle Creek Watershed Association
35 Satterlee Creek Watershed Association	99 Muncy Creek Watershed Association	159 Conodoguinet Creek Watershed Association
36 Choconut Creek Watershed Association	100 Chatham Run Concerned Citizens	160 Capitol Region PaSEC
37 Snake Creeks Watershed Association	101 Mosquito Creek Sportman's Watershed Association	161 LeTort Regional Authority
Chemung Subbasin	102 Black Hole Creek Watershed Association	162 Hammer Creek Watershed Association
38 Loon Lake Association	103 Greater Nippenose Valley Watershed Association	163 Save Our Creek
39 Lamoka-Waneta Lakes Association, Inc.	104 White Deer Creek Watershed Association	164 Tri-County Conewago Creek Association
40 Loucks Pond Association	105 Beech Creek Watershed Association	165 Yellow Breeches Watershed Association
41 Smith Pond Sportsmen's Association	106 Clearfield County PaSEC	166 Big Spring Watershed Association
42 Lake Salubria Association	107 Sugar Valley Watershed Association	167 Lititz Run Watershed Alliance
43 Meads Creek Watershed Association	108 Chillisquaque/Limestone Watershed Association	168 Chiques Creek Watershed Alliance
44 Tanglewood Lake Association	109 Hubler Run Watershed Association	169 Cocalico Creek Watershed Association
45 Lake Demmon Association	110 Merrill Linn Conservancy	170 Donegal Fish and Conservation Association
46 Chemung Basin River Trail Partnership	111 Anderson Creek Watershed Association	171 Lancaster County PaSEC
47 Town of Elmira Storm Water Task Force	112 Union-Snyder Counties PaSEC	172 Little Chiques Watershed Association
48 Town of Southport Drainage Committee	113 Emigh Run/ Lakeside Watershed Association	173 Lancaster County Conservancy
49 Cowanesque Valley Watershed Association	114 Little Clearfield Creek Watershed Association	174 Little Conestoga Watershed Alliance
50 Penn-York Bentley Creek Watershed Association	115 Moshannon Creek Watershed Association	175 Watershed Alliance of York County
51 Crooked Creek Coalition	116 Spring Creek Watershed Community	176 Codorus Creek Improvement Partnership
52 Mill Creek Association	117 ClearWater Conservancy	177 York County PaSEC
53 Ellen Run Watershed Projects	118 Beaverdam Branch Watershed Coalition	178 Adams County PaSEC
54 Corey Creek Watershed Association	119 West Branch Susquehanna River Rescue	179 Codorus Creek Watershed Association
55 Tioga County Concerned Citizens Committee	120 West Branch Susquehanna River Watershed Association	180 Watershed Alliance of Adams County
Middle Susquehanna Subbasin	121 Clearfield Creek Watershed Association	181 Octoraro Watershed Association
56 Wysox Creek Watershed Association	Juniata Subbasin	182 Lower Susquehanna Heritage Greenway
57 Laning Creek Watershed Association	122 Spruce Creek Watershed Association	183 Broad Creek Civic Association
58 Sugar Creek Watershed Association	123 Friends of Sinking Valley	184 Deer Creek Scenic River Advisory Board
59 Wyalusing Creek Watershed Association	124 Muddy Run Watershed Association	185 Upper Chesapeake Watershed Association
60 Stephen Foster Lake Association		186 Deer Creek Watershed Association, Inc.
61 Bradford County Lakes & Ponds Organization		187 Upper Western Shore Tributary Team
62 Schrader Creek Watershed Association		
63 Countryside Conservancy		
64 Towanda Creek Watershed Association		
65 Tunkhannock Creek Watershed		

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New York State Geological Survey

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Pennsylvania State Government

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APPENDIX C
Management Principles and Tools

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MANAGEMENT PRINCIPLES AND TOOLS

Appendix C discusses principles considered to be fundamental to groundwater management and tools available to achieve management goals.

Management Principles

Certain principles form the foundation for management of the groundwater resources by the Commission. Many are basic facts or axioms—propositions that are universally recognized as indisputable—and are reviewed below as background for the discussion of management. Others are concepts adopted from the successes of a variety of existing and ongoing efforts. Overall, the principles serve to guide the Commission in its policy development and its actions to implement management goals.

1. Water is a valuable asset and a finite natural resource; it is essential to all life.
2. Groundwater occurs almost everywhere beneath the land surface. However, earth materials differ widely in their ability to store and transmit water, which causes a disparate distribution of groundwater resources in watersheds and poses a challenge for equitable allocation and use. Furthermore, the volumes of water pumped from a groundwater system must come from somewhere and must cause a change in the groundwater flow system.
3. From the standpoint of water use and water management, all groundwater is not equal—the quality of the water may make it unsuitable for some uses without treatment. Groundwater quality is a key consideration in developing water management strategies.
4. Groundwater management needs to be consistent with the objectives of the Compact to promote the “orderly, integrated and comprehensive development, use and conservation” of the basin's waters and to secure and maintain “a proper balance among industrial, commercial, agricultural, water supply, residential, recreational, and other legitimate uses of the water resources of the basin.” As the Susquehanna River Basin continues to experience growth in population and economic enterprise, and as our communities continue to develop and mature, it is essential that the Commission practice good stewardship and utilize the basin's water resources in a thoughtful and balanced fashion to serve all legitimate purposes.
5. The use of groundwater resources needs to be managed to promote sustainability in the face of short-term and long-term growth. Sustainable development requires the development and use of groundwater in a manner that yields can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences. Sustainability requires a long-term perspective to groundwater management.

The Commission has defined the sustainable limit of water resource development as the average annual base flow (recharge) available in the “local” watershed during a 1-in-10-year average annual drought. That is, the total amount of water withdrawn by all users on an annual basis should only exceed the normal amount of water recharge on an average of once every 10 years. Users draw a higher percentage of water from groundwater storage during the drought years than they do during non-drought years, and the groundwater system is allowed to recover (that is, storage refills) during the intervening years. The selection of the 1-in-10-year drought recharge standard strikes a balance among resource conservation, environmental needs, regulatory restriction of growth and development, and the need for adequate and often expensive constructed water storage facilities.

6. Water resources management, and particularly groundwater resources management, requires an integrated approach, recognizing that the chemical, biological, and physical aspects of groundwater systems are interrelated; that many natural processes and human activities affect these interactions; that water supply and water quality cannot be managed separately; and that groundwater and surface water are inextricably linked parts of the same resource. Integrated management means that the Commission, in its decision-making, needs to consider all of the aspects of the water resource that are fundamentally interrelated.
7. Decision-making should be based on sound scientific principles, policies, and requirements in laws and regulations.
8. For proper management and protection, the Commission, as well as its member jurisdictions, should work to build long-term, local capability to foster critical “local stewardship” of water resources. Whenever possible, the Commission should be involved in establishing and nurturing watershed organizations, assisting in the development of local plans, and supporting enactment of appropriate local ordinances, especially those concerning land use.
9. Prudent groundwater management requires that the Commission and its member jurisdictions recognize the likelihood of continuing limitations in fiscal and staffing resources, and focus on key issues where they can make a positive and substantial impact. The Commission must strive for the most efficient use of its human and technical resources and prioritize its efforts accordingly. This should be done for all program areas, including when considering regulatory options such as general permits, as appropriate, and selecting priority items such as “Potentially Stressed Areas” (PSAs) as a focus for its management program. Implementation of actions related to the plan should be staged over time as resources are available.
10. Coordination among member state and federal agencies and the Commission results in efficient data collection, planning, monitoring, and management of the basin's groundwater resources.

Resource Evaluation

The Commission evaluates groundwater availability, utilization, and potential environmental impacts using a number of tools. During the mid- to late-80s, the Commission, in cooperation with the Pennsylvania Geological Survey (PGS) and the USGS, performed and published water resource evaluations of four major tributaries to the Susquehanna River (Taylor, 1984, 1997; Taylor and others, 1982, 1983, 1984). These studies provided information on the amount of surface water and groundwater received by the subject basins, and provided the basis for developing water budgets. For the most part, the Commission reviewed groundwater projects on a case-by-case basis.

In recent years, withdrawals in some areas are at, or approaching, a sufficient concentration and magnitude to create problems of well interference and local depletion of groundwater and/or surface water resources. To prevent local resource depletion, environmental impacts, and water supply failure, areas having intensive water resource utilization require additional analysis. There are a number of analytical methods and tools available to meet this goal.

Water Budget Analysis

A water budget analysis treats the water resources of an area as an account, with recharge serving as the income, withdrawals and instream flow needs as the expenses, and storage as savings. Recharge is the fraction of precipitation received by the groundwater flow system. The recharge received

during a one-year period is generally recalculated to an average daily amount. In a natural groundwater flow system, “expenses” generally include discharges to springs and streams, and the loss of water to plants, and evaporation (evapotranspiration) in areas where the water table approaches the ground surface. In most areas of the basin, expenses also include man-made uses, such as water supply wells and interbasin diversions (Figure C.1). The amount of groundwater in storage varies with the position of the water table. Storage is highest during high-water table periods and least during extreme low-water table periods (i.e., severe droughts).

If a water budget is used for the review of a project, it must include the area of the natural flow system that encompasses all the budget expenses (wells, springs, stream intakes, and instream flow needs, etc.) and their recharge areas. On a project-specific basis, this will generally correspond to a subsection of a local watershed. The water budget may be calculated for a year with an average amount of precipitation or for a drought year with a specified recurrence interval. The Commission currently utilizes the 1-in-10-year average annual drought as a “water income” design level. The design level sets an upper limit of the resource available for the Commission to approve for development (withdrawal). Water budgets are useful for evaluating the groundwater resources available for development, troubleshooting water supply and well interference issues, and planning for future water needs (expenses).

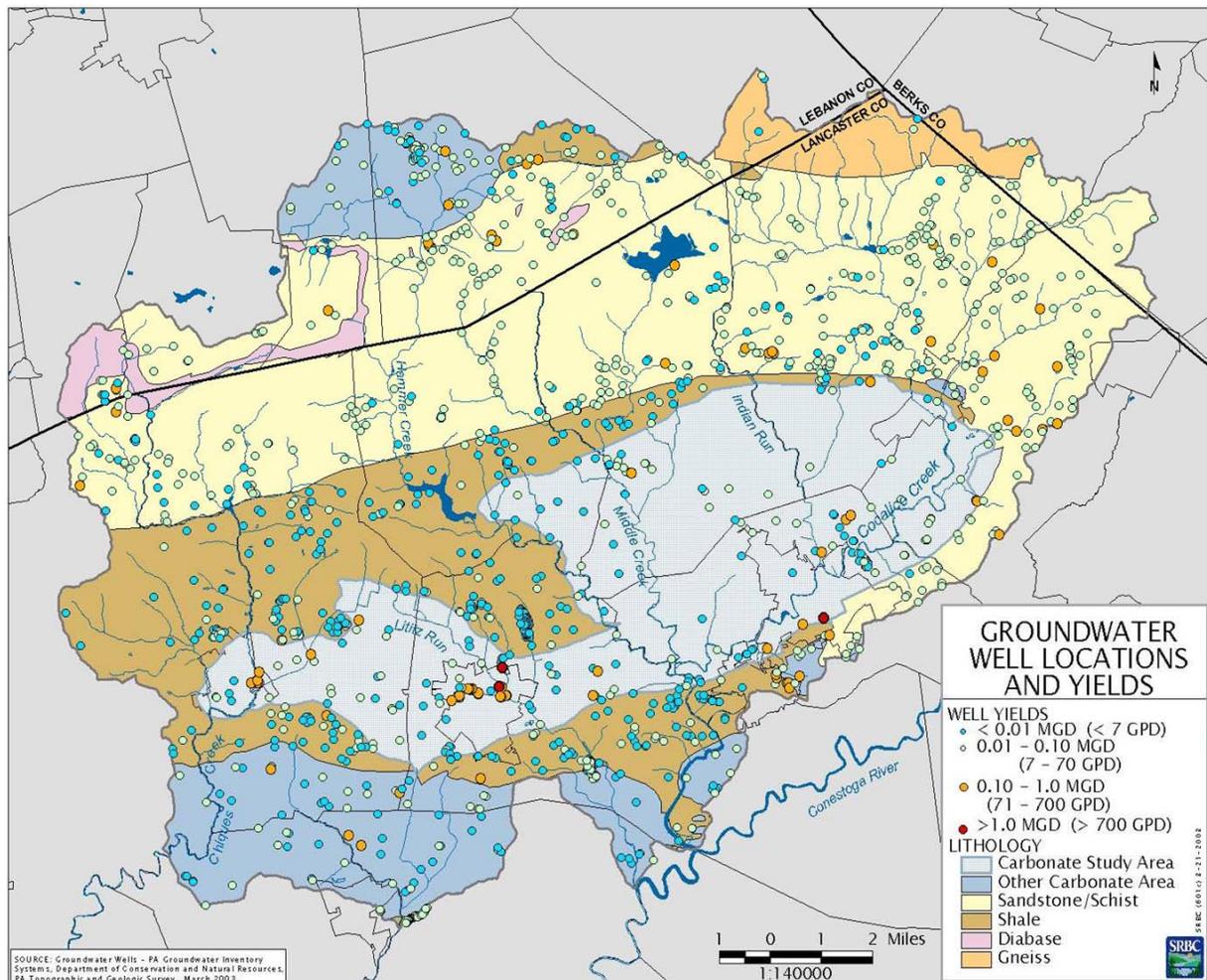


Figure C.1. Well Yields Used as One Component of a Water Budget Analysis

Critical Aquifer Recharge Areas

Critical aquifer recharge areas (CARAs) are areas having high recharge productivity. They are land surface areas that are responsible for a large fraction of the recharge to a well capture area and/or are closely hydraulically coupled to a withdrawal or area of discharge (spring, stream, or wetland). As such, a CARA is a relatively small area and linked to a groundwater source. An area may be classified as a CARA by virtue of its high aquifer permeability, soil characteristics, vegetative cover and location with respect to discharge areas and/or withdrawals, topographic setting, or a combination of these. The maintenance of the recharge received from these areas is best assured by land development and use that either: (1) minimizes impervious cover, destruction of soil structure, and changes to the vegetative cover and the topography; or (2) offsets any negative impacts to recharge resulting from such changes through engineered solutions.

Delineation and proper management of CARAs, on a project-by-project basis, will help to ensure that the amount of water allocated to a project in an approval will be available for the duration of the approval, and will help to preserve the local base flow in streams. Delineating CARAs will help preserve existing water supply well capacity and provide for planning and zoning to ensure that development and land use will be beneficial for water resources. The protection of CARAs can be coordinated with existing programs and regulatory processes, including wellhead protection areas, zoning ordinances, and land use planning (borough, township, or county).

Water Level Monitoring

The flow of groundwater from recharge areas to areas of discharge is driven by the difference in water levels (head) of these areas. As an aquifer approaches depletion, the head that drives the flow of water through the aquifer gradually decreases in magnitude and approaches the head in the stream or lake into which the groundwater is discharging. Aquifer depletion caused by the excessive withdrawal of groundwater may cause head levels to fall below local base level, resulting in losing or dry stream reaches. Monitoring water levels in an area of concentrated development can provide information on how that area's groundwater flow system functions and serve as an early warning of over-utilization.

Special Studies and Models

The Commission may perform, or require the performance of, special studies or models. Such studies are used to check the “health” and use level of the groundwater flow system in areas with concentrated water resource development or address other water resource management topics. The Commission has required several project sponsors to perform water resource evaluations as a condition of project approval. These projects were large and dominant water users in small groundwater and surface water basins, and so the special studies provided the necessary information for the Commission to review the projects. In each case, the study not only assisted the Commission in making its review, but also formed the basis for future water management planning and monitoring by the project sponsors.

Where a special study encompasses several municipalities, the Commission may provide organization or leadership. In 2005, the Commission completed a detailed water budget study of a carbonate/karst aquifer in northern Lancaster County, Pennsylvania. The study area was chosen because of intense urban development around three urban centers, and the fact that its natural groundwater basin covers seven watersheds. If the Commission had not taken the lead on this study, a similar result would require the cooperative and possibly fragmented effort of the three boroughs, seven townships, and three watershed groups and/or the integration of seven watershed-based studies.

At the time of developing this plan, the Commission was also performing a detailed study to develop methods or alternatives to compensate for agricultural consumptive use during times of low flow. The alternatives are intended to find options for agriculture to comply with the Commission's consumptive water use regulation. The study has identified, and explored, the use of a number of innovative solutions and technologies.

Water Resource Management Database

There are many sources for existing water resource management-related information in various formats. To efficiently and most effectively use this information, it can be organized under a common database and placed into a Geographic Information System (GIS) for enhanced utility. Using GIS, a variety of information types (topographic contours, land use, vegetation, wetlands, etc.) can be overlaid on maps of optimum scale. In this way, spatial relationships can be recognized and considered in management decisions. A GIS-based database will greatly facilitate cumulative impact analysis, water budgets, and the delineation of CARAs. A GIS database will take these, and many other water resource management tasks that are currently in the realm of research projects, and enable them to be used as practical management tools.

Regulatory Program

The primary groundwater management “tool” used by the Commission is its regulatory program.

Registration

The Commission adopted water withdrawal registration regulations to document water use throughout the basin and provide the necessary data to make informed water management decisions. Registration is important to the Commission's permitting activities because it provides basic water use data, thereby allowing the Commission to protect existing uses. Information on water use is important for other Commission water management activities, including preparation of water budgets.

Water withdrawal registration is codified in the Commission Regulations, Part 804, Subpart A, §804.1-5. The regulation requires that, subject to the consent of the affected member state to the requirement, all persons withdrawing or diverting in excess of an average of 10,000 gpd for any consecutive 30-day period, from groundwater or surface water sources, shall register the amount of the withdrawal with the Commission. Re-registration also is required.

Grandfathered withdrawals are not required to secure Commission approval. As a result, there is a deficit of information on this use. In developing areas, grandfathered sources may share the same groundwater basin with newer sources. To evaluate the sustainability of new withdrawals, and their impacts to existing sources and the environment (wetlands, springs, and streams), all major withdrawals (including grandfathered) must be considered. The registration of grandfathered withdrawals will allow these evaluations and protect the grandfathered withdrawals.

The Commission can arrange for states to carry out this registration requirement, as has been done in Maryland and, most recently, in the Commonwealth of Pennsylvania, under the Pennsylvania Water Resources Planning Act of 2002.

Regulation of Groundwater Withdrawals

The Commission adopted withdrawal regulations to avoid conflicts between water users and to ensure beneficial management of the water resources. By regulation, withdrawals are limited to the amount (quantity and rate) that is needed to meet the reasonably foreseeable needs of a project and that can be withdrawn without causing adverse impacts. Adverse impacts include: excessive lowering of water levels; rendering competing supplies unreliable; causing permanent loss of aquifer storage capacity; degradation of water quality that may be injurious to any existing or potential water use, adversely affecting fish, wildlife, or other living resources or their habitat; and substantially impacting the low flow of perennial streams.

The Commission's water withdrawal regulations are designed to manage large water users, that is, those users withdrawing groundwater or surface water in excess of 100,000 gpd. Potential water users meeting this requirement must first apply to the Commission.

The Commission recognizes “grandfathered” quantities withdrawn prior to the effective dates of the regulations, provided that the project sponsor can provide adequate documentation.

The Commission's application process has a number of standard requirements that are applied to all projects. Project sponsors requesting approval of a groundwater withdrawal are required to conduct a constant-rate pumping test (commonly 48 hours in duration), which is used to evaluate the production capability of the well, the aquifer, and the local groundwater basin, and to evaluate potential impacts to existing users and to the environment. These must be adequate to supply the needs of the project, and do so without causing significant adverse impact to neighboring water supplies, surface water bodies, and wetlands.

The Commission adopted pumping test guidelines in 2002 to assist in the development of acceptable plans for the constant-rate pumping test. The guidelines require a groundwater availability analysis that demonstrates sufficient recharge to support the desired withdrawal during a 1-in-10-year average annual drought and a hydrogeologic description of the test site in addition to the testing plan.

During technical review, the Commission's staff evaluates the impact (including cumulative impacts) of the proposed withdrawal or use on public concerns and interests, and reflects the Commission's concern for both protection and utilization of water resources within the basin.

The Commission's staff formulates specific recommendations so that the project can operate without causing any undesirable environmental effects. Water quantities and rates of withdrawal can be reduced from those requested, or otherwise limited, as necessary, to protect other uses or mitigate impacts. Many projects are conditioned with passby flow requirements. The intent of the passby flow requirement is to protect streams during low flow conditions by determining a prescribed quantity of water that must pass a specific point downstream from a water intake at any time a withdrawal occurs. Other projects require a minimum groundwater level that must be maintained on the production well. For all projects, the appropriate monitoring requirements are established during the technical review phase so that the Commission staff can track project operations over the term of an approval. There are some standard docket conditions contained in the Commission's approvals:

Metering—The Commission requires metering on both withdrawals and consumptive water uses to measure and track water use throughout the basin. In certain situations, there is an allowance for modeling and certain analytical methods to calculate use, particularly for projects with consumptive water uses.

Monitoring and Reporting—The Commission requires monitoring and reporting of withdrawal quantities (commonly daily) so the agency can undertake the broader management responsibilities and ensure that the project sponsors are in compliance with their requirements. Projects with groundwater withdrawals also report water levels and water quality in approved wells.

Mitigation—On occasions, when a project sponsor's use does cause an adverse impact either to the resources or to another user, the Commission requires the project sponsor to mitigate those impacts. The Commission could restrict their usage, require them to develop an alternative water supply, or provide other appropriate mitigating measures.

Water Conservation—The Commission requires, as a general rule, that project sponsors maintain certain minimum water conservation standards to minimize water usage. These standards include the use of applicable water conservation devices, recirculation and reuse strategies, properly designed irrigation systems, and metering for sources and customers.

Docket Reopener—A standard provision in all dockets gives the Commission the right to reopen any project docket to modify and issue such additional orders, as may be necessary, to mitigate or avoid adverse impacts either to the resources or other water users.

The Commission also regulates large withdrawals from surface water (consecutive 30-day average of more than 100,000 gpd), Commission Regulation §803.44 (effective date: November 11, 1995), and consumptive water use, Commission Regulation §803.42 (effective date: January 23, 1971). Consumptive use of water means the water will be used and not returned to the Susquehanna River system, usually because it evaporates, is diverted, or is incorporated into products such as concrete. Regulated consumptive water users are required to compensate for their consumptive use during times of critical low flows through one of several options. The three primary methods of compliance listed in the regulations and utilized by most project sponsors are use of storage to mitigate any adverse impact during low flow periods, discontinuance of the consumptive use of water during low flow conditions, or payments in-lieu-of providing actual compensation water. The Commission also can review and evaluate other alternatives proposed by project sponsors.

Consumptive uses generally peak during the summer months. Unfortunately, this also is the period when streamflows and groundwater levels are at their lowest. Maximum consumptive water use in the Susquehanna Basin has increased from about 270 mgd in 1970 to about 500 mgd in 2000, and is projected to continue increasing in the future, by as much as 55 percent by 2020. The Commission adopted the consumptive water use regulations to ensure adequate flows for the many competing water uses, including public water supplies, industries, agriculture, and recreation, and to protect aquatic life, habitat, and water quality during times of critical low flows.

Compliance Monitoring and Enforcement

The Commission's objective is to have all water users in the basin in compliance with the Commission's water management regulations. Universal compliance enhances the Commission's ability to properly plan for and manage the basin's water resources.

The Commission requires approved projects to submit monitoring data related to withdrawals and use and any special conditions contained in the approved docket. These data are used to evaluate whether additional water is available for use.

Protected Areas

Article 11, Section 11.2, of the Compact allows for the creation of protected areas in regions of water shortage within the basin. An area may be designated as a protected area with the consent of the member (or members) from the affected state or states. Designated areas are flexibly sized and may be watersheds, aquifers, groups of municipalities, or entire counties. William Voigt, in *The Susquehanna Compact, Guardian of the River's Future*, gives some insight into the intent of the drafters of the Compact by indicating that protected areas should be: (1) smaller, rather than larger; (2) implemented in advance of water shortage emergency conditions in order to have sufficient time to manage the water resources; and (3) balanced in terms of supplies and demands.

Water budgets, comparing available supply with projected demand for varying magnitudes of drought, as previously described in Section 3.1.1, are the most effective tool available for identifying water shortage areas requiring protected area status.

According to the Compact, protected areas clearly are intended to correct, mitigate, and manage local area water supply shortfalls or threatened shortfalls on a quantitative basis. However, the Compact is silent with respect to whether the shortages might be derived from groundwater or surface water withdrawals or consumptive water uses. Consequently, protected areas may be managed to limit groundwater withdrawals, surface water withdrawals, both groundwater and surface water withdrawals, or cumulative consumptive water uses.

For protected areas involving only groundwater supplies, aquifers may be the appropriate unit for protected area designation. However, since most groundwater divides within the Susquehanna River Basin roughly coincide with surface water divides, the watershed may be an appropriate unit for designation.

How large should the units for designation of protected areas be? A reasonable size for watershed assessments within protected areas is believed to be about 25 square miles in area. Watersheds of significantly greater size than 25 square miles could possibly result in management and implementation problems because of difficulties in coordination and consensus among multiple municipalities. Coordination and consensus among municipalities are essential for effective water resources planning and management. Conversely, watersheds less than 10 square miles are thought to be too small for meaningful management at the Commission level.

For groundwater-protected areas, cumulative groundwater withdrawals generally are limited to some acceptable aquifer recharge or base flow frequency level, such as the 25-year frequency base flow. Cumulative consumptive water use limits have never been established or implemented by a water resource management agency. However, this approach may prove to be the most effective tool of all for managing future protected areas.

As a final note, the original Compact drafters, in Section 11.2, acknowledged that they could not foresee all possible future uses for protected area designation when they added the caveat “or conflict with the requirements or effectuation of the comprehensive plan” in their definition of protected area. Thus, the Compact leaves some discretion for the Commission to determine other beneficial uses and applications for the designation. Naturally, the Commission would have to exercise this power very judiciously. Conceivably, the goals of protection through special water management practices can be

accomplished through adding an objective to the Commission's Comprehensive Plan that would allow for a new designation. The Comprehensive Plan has legal standing in the Compact, and the Commission can assume jurisdiction in virtually any water resource matter to fulfill the requirements of the Comprehensive Plan.

Development of Standards and Guidance

Commission staff has developed both internal and external guidance documents, as necessary, to promote consistency and efficiency in the Project Review Program. The most important of these, from a groundwater perspective, is the Pumping Test Guidance (2002), written for project sponsors and specifying the necessary procedures, proper monitoring, and evaluation and data analyses for conducting the required constant-rate pumping test for submission with a groundwater withdrawal application. Other guidance includes passby flow guidance (Susquehanna River Basin Commission, 2003), out-of-basin diversion protocol (Susquehanna River Basin Commission, 1998), criteria for waiving pumping tests, internal guidance for evaluating cumulative impacts (draft), establishing “grandfathered” quantities, and reviewing consumptive water uses.

Commission staff also prepares fact sheets about a variety of topics, including the project review process, the regulations, and individual projects, as needed, to inform and help educate the public.

The development of standards and guidance is an ongoing process, and will continue as important issues arise and time permits.

Water Conservation

Water conservation requirements are specified in the Commission Regulations, Part 804, Subpart B, §804.20-22. The regulation requires that any project that is subject to Commission approval under Part 803 or 804 proposing to withdraw water either directly or indirectly (through another user) shall institute appropriate water conservation measures. The regulations specify a number of requirements for public water suppliers (source and customer metering, unaccounted-for water to be less than 20 percent, an appropriate rate structure, etc.). However, for other types of projects, the regulation is silent on important conservation measures. Commission staff has recognized that these regulations should be strengthened at the time of the next revision of the regulations, and may consider incentives for promoting conservation measures and implementing technical solutions.

Water Reuse

Groundwater used by municipalities and industries is typically treated and discharged to a stream. AMD from many flooded underground coal mines is treated and discharged to streams. The quality of treated water from municipal, industrial, and mine treatment plants, while generally not meeting safe drinking water standards, is generally quite good before it is discharged to streams. It is potentially usable for many non-potable uses such as irrigation and non-contact cooling. The reuse of treated wastewater would decrease the amount of groundwater withdrawn by the amount of water that is reused. Reuse will allow the water budget to be “stretched” in areas of rapid growth and limited water resources such as the PSAs (see Section 2.1). The Commission should develop incentives for reuse.

Conjunctive Use

The availability of groundwater and surface water resources frequently varies in a complementary manner during the year, such that one of them is relatively abundant while the other is relatively scarce. Water users can develop both groundwater and surface water sources and rely on each

as it is “in season.” A community, recreational facility, or industry may rely on surface water during periods of high flow, then switch over to groundwater when surface flows diminish during the late summer and early fall. Where only groundwater is available naturally, a surface water impoundment may be constructed to capture snowmelt, spring precipitation, and stormwater runoff. This stored water may be used when groundwater resources are stressed, or may be used to provide a passby flow during low flow periods. Conjunctive use should be generally encouraged and, perhaps, incentivised in areas where groundwater resources are nearing exhaustion, such as the PSAs.

Public Outreach and Education

Public outreach and education on groundwater concepts are important for managing the resource. With increasing water demands in some portions of the basin, coupled with several recent drought years, there exists a need to balance availability with use. Since most issues concerning availability and use hinge on land use planning and development decisions, local government and citizens are a critical audience for focusing efforts on outreach and education. Topics such as recharge, conservation, and water reuse/recycling are an important component of groundwater resource education as well. Additionally, other groups concerned with water resource issues are important to the process both as an audience and as partners, in efforts to improve the management of groundwater resources. These groups may include professional organizations, watershed organizations, and schools.

Outreach and education can be conducted effectively using a variety of methods. The following paragraphs detail some of the methods employed by the Commission.

Presentations

The Commission regularly gives presentations or participates in panel discussions on various water resource issues before audiences of wide-ranging background and experiences. Presentations of groundwater resource issues may be requested by the public, or initiated by the Commission, if a need is identified. Additionally, the Commission can give oral presentations or display exhibits at various constituents' workshops and conferences. The Commission currently maintains a speakers' bureau, which provides the public an opportunity to request presentations by the appropriate staff member, or volunteer experts, on numerous water resource issues. The Commission's presentations concerning groundwater concepts/resources can be updated, and new material created, based on the information presented in this Groundwater Management Plan.

Publications

The Commission publishes a quarterly newsletter, brochures, and technical reports, and produces many information sheets and issue-specific information pieces, as needed, on various water resources issues within the Susquehanna Basin. The Commission also issues press releases, editorials, and letters to the editor. Using these forms of printed media, the Commission can focus periodically on specific groundwater issues in the basin, as well as feature educational articles explaining important groundwater concepts. In addition, the Commission drafts and submits articles for other agency and organization publications. Publications produced by the Commission that are related to the issues and recommendations outlined in this plan can be found in Appendix D.

Multimedia Products

The Commission currently operates and maintains a website. The Groundwater Management Plan has been posted to the website, making it available for a large audience. A section of the website also can be dedicated to groundwater information developed under this plan. In addition, the

same type of materials can be made available on a compact disk for distribution at meetings and conferences, or upon request from the public. Educational videos also have been a successful method for conveying information on water resource issues. The Commission could partner with other organizations to produce videos highlighting important groundwater resource issues. Similar to compact disks, videos are easy to duplicate and distribute to the public, and are an excellent outreach tool for school groups.

Seminars

The Commission has held seminars in the past covering a variety of topics related to water and the environment. With respect to groundwater, Commission staff has held several educational seminars on the occurrence and movement of groundwater in the Susquehanna Basin at the request of the public. These seminars were held in communities within the basin that experienced a significant strain on their groundwater supplies during the recent droughts. The seminars provided a needed forum for the public to voice concerns about their own private wells and public supply and to ask questions, while, at the same time, expanding their understanding of various concepts such as the affect of recharge and withdrawals on groundwater availability. Seminars also provide the opportunity to provide technical guidance on the proper use and management of groundwater resources.

Interagency Coordination of Workgroups and Task Forces

As an interstate agency, the Commission is in a unique position to assist state/federal/local agencies in water resource management issues that cross jurisdictional boundaries. The Commission actively maintains relations with water resource partners at all levels, from the federal level to citizen groups and local municipalities. The Commission can facilitate efforts to address groundwater resource problems on a basinwide approach, bringing to bear a wide range of both the technical and financial resources needed to solve complex problems. Interagency coordination efforts, led by the Commission in the past, have included the Sediment Task Force, Agricultural Advisory Committee, Water Quality Advisory Committee, and Flood Forecast and Warning System. These coordination efforts have focused on pertinent water resource issues, and assisted with moving toward solutions using interagency/interstate cooperation. The use of websites and bulletin boards provide a convenient means for accessing and exchanging information.

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APPENDIX D

Commission Publications Related to Groundwater Issues

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Appendix D lists Commission publications related to the issues and recommendations outlined in this plan. It is important to note that this list is solely those publications produced under the control of the Commission. This list of studies and documents does not include related publications produced by other agencies.

<u>Report Number</u>	<u>Report Title</u>
1.	Susquehanna River Basin Compact – May 1972
7.	Coal Mine Drainage in the Susquehanna River Basin, Executive Summary –September 1973
8.	Coal Mine Drainage in the Susquehanna River Basin – September 1973
10.	Comprehensive Plan for Management & Development of the Water Resources of the Susquehanna River Basin – December 1973
28.	Regulations & Procedures for Review of Projects – June 1975
34.	Nonpoint Source Pollution Assessment of the Chemung & Susquehanna River Subbasins – September 1975
43.	Staff Review of Eastern Susquehanna River Basin Regional Water Resources Planning Board, Final Draft Report for the Eastern Susquehanna River Basin – September 1976
48.	Commission Review of Signatory Parties' Laws & Regulations Relating to Underground Waste Discharges – January 1977
50.	Proceedings on Water Quality Management in the Susquehanna River Basin – Second Quarterly Meeting – April 1977
54.	Nonpoint Source Pollution Assessment of the Lower Susquehanna River Basin – November 1977
55.	Nonpoint Source Pollution Assessment of Two Susquehanna River Subbasins in Pa.: 1. Between the New York Border & Sunbury, 2. West Branch Susquehanna River – December 1977
59.	Staff Review of Signatory Parties Laws & Regulations Relating to the Management of Hazardous Wastes – November 1978
75.	Water Use Data in the Susquehanna Basin: Part I Status of Data Collection – February 1982
81.	Special Ground-Water Study, Executive Summary – May 1983

- 85. Water Use Data in the Susquehanna Basin, Part II Water Use Inventory in New York – December 1983
- 96-1. Staff Summary – Drought Conditions – May 1985
- 96-2. Staff Summary – Drought Conditions – June 1985
- 98. Review of New York's Section 208 Water Quality Management Plan & Pa.' s Comprehensive Water Quality Mgt. Plan for Interstate Streams – July 1985
- 115. Ground-Water Resources of the Chemung River Basin, N.Y. & Pa. – March 1988
- 116. Ground-Water Flow Model of the Corning Area, N.Y. – March 1988
- 117. Eastern Subbasin Low Flow Management Framework Plan – April 1988
- 121. West Branch Susquehanna River Subbasin Low Flow Mgt. Framework Plan – March 1989
- 126. Juniata Subbasin Low Flow Management Framework Plan – January 1990
- 137. The Susquehanna River – A Characterization of its Water Resources & Water Supply Demand – March 1991
- 138. Upper Susquehanna Subbasin Low Flow Management Framework Plan – September 1991
- 144. Water Quality Assessment Report Susquehanna River Basin – January 1992
- 154. Ground-Water Management Plan – July 1993
- 155. Water Quality and Hydrogeology of Two Small Agricultural Basins in Central Pennsylvania – September 1993
- 156. Development of Technical Procedures for Managing Nonpoint Source Pollution – October 1993
- 168. Susquehanna River Basin Commission Strategic Plan
- 169. Nitrate Reduction in the Armstrong Creek Basin – January 1996
- 175. Chesapeake Bay Low Flow Strategy Study – September 1996

- 176. The 1996 Susquehanna River Basin Water Quality Assessment 305(b) Report – November 1996
- 184. Water Budget for the Spring Creek Basin – April 1997
- 197. Use of a Field Drain and an Artificial Wetland to Minimize Ground-Water Contamination from an Agricultural Site – July 1998
- 201. The 1998 Susquehanna River Basin Water Quality Assessment 305(b) Report
- 204. Assessment of Conditions Contributing Acid Mine Drainage to the Little Nescopeck Creek Watershed, Luzerne County, Pennsylvania, and an Abatement Plan to Mitigate Impaired Water Quality in the Watershed – July 1999
- 208. Water Balance for the Jeddo Tunnel Basin, Luzerne County, Pennsylvania – August 1999
- 212. Susquehanna River Basin Drought Coordination Plan – August 2000)
- 219. Use of a Constructed Reedbed Wetland in the Mitigation of Highway Runoff on the Ground-Water Quality in Carbonate Areas, January 2002
- 220. The 2002 Susquehanna River Basin Water Quality Assessment 305(b) Report – March 2002

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APPENDIX E

**Summary of 2005 and 1993 Groundwater
Management Plan Recommendations**

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Appendix E presents summary lists of the recommendations developed for the current Groundwater Management Plan and those recommendations from the previous (1993) plan that either have been implemented or are no longer applicable.

Table E1 contains a list of current recommendations categorized into the topics of: (1) actions to address groundwater resource issues and problems; (2) actions to address management issues; and (3) groundwater management support programs. A discussion of the issues and problems that each recommendation addresses is presented in the main report Sections 2, 3, and 4.

Table E2 is a summary list of those recommendations from the Commission's 1993 Groundwater Management Plan that either have been implemented or are not applicable today due to changed conditions or criteria. Information included in the list for each recommendation is its location in the 1993 report on the plan and a summary of actions taken since 1993.

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Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan

Issues	Problems	Recommendations
A. ACTIONS TO ADDRESS GROUNDWATER RESOURCE ISSUES AND PROBLEMS		
<p>1. Areas of Intense Growth and Development, and Consequent Water Resource Development (see Section 2.1 in main report)</p>	<p>Well interference.</p> <p>Exceedance of sustainable yield.</p> <p>Loss of recharge areas.</p>	<p>Where time and water resources are limited, a groundwater model should be used to provide a rapid prediction and evaluation. The use of a model would take into account the appropriateness of the particular approach, as well as the capabilities/limitations of the chosen model. In situations where the availability of water resources allows a more flexible, less time-sensitive approach, water level monitoring is recommended. For many cases, a combination of these approaches will provide the most effective solution, which could include mitigation of impacts. The implementation of such plans may require the coordination of appropriate federal, state and local agencies.</p> <p>Continue to require and review groundwater availability analyses for new projects and detailed water budgets for PSAs. For areas where undesirable effects have stemmed from groundwater withdrawals, and sustainable yields have been exceeded during the last few decades, review and reopen dockets, require a water budget analysis, and adjust the withdrawal rates for sustainability.</p> <p>The Commission should base its sustainable yield determination for approval quantities on estimates of the recharge available to a well that include post build-out conditions.</p> <p>Further, the Commission should encourage the use of “best management practices” (BMPs) that minimize the loss of recharge, such as those developed by the Commission's member jurisdictions. Available recharge should be verified after build-out and the approval amount increased (or decreased), based on the outcome of the verification study.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
A. ACTIONS TO ADDRESS GROUNDWATER RESOURCE ISSUES AND PROBLEMS (Continued)		
<p>2. Intensive Water Use in Small Basins (see Section 2.2 in main report)</p>	<p>Loss of base flow.</p> <p>Loss of perennial streamflow.</p>	<p>In recognition of the importance of headwater areas with respect to water quality, the Commission, in cooperation with member jurisdictions and other organizations, should educate the public and local land-use planners about the sustainability of these areas and the need to properly manage them.</p> <p>The Commission, in cooperation with member jurisdictions and other organizations, should evaluate headwater streams with respect to habitat, and apply special conditions prescribing passby and conservation flows to its approvals for both surface water and groundwater withdrawals in order to manage water quantity and quality of the stream. The recognition and management of critical recharge areas also would benefit these areas.</p>
<p>3. Watershed “Transfers” (see Section 2.3 in main report)</p>	<p>Wastewater is not returned to the watershed where it was withdrawn.</p>	<p>The Commission, in cooperation with member jurisdictions and other organizations, should educate the appropriate professional groups about the options of maintaining groundwater withdrawals and post-use discharges in the same watershed, and the factors involved in this decision. The Commission should evaluate the transfer of water from the source basin during its review.</p>
<p>4. Loss of “Clean” Water Input to AMD-Impacted Streams (see Section 2.4 in main report)</p>	<p>Degradation of stream quality.</p>	<p>The Commission's permitting process should include an evaluation of cumulative impacts from consumptive water uses to downstream water quality in AMD-impacted areas. The review of consumptive water use projects in watersheds that are tributary to streams not meeting state and federal water quality standards should consider cumulative impacts and the cost of mitigating the impacts. The Commission should coordinate with the appropriate state and federal agencies in its evaluation.</p>
<p>5. Unknown and Unregulated Groundwater Use (see Section 2.5 in main report)</p>	<p>Data gaps can prevent evaluation of true sustainability and cumulative impact.</p>	<p>The Commission should collect information on the magnitude, location and seasonality of agricultural, grandfathered, and unknown or unregulated withdrawals to improve its evaluation of the resources available to new projects.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
A. ACTIONS TO ADDRESS GROUNDWATER RESOURCE ISSUES AND PROBLEMS (Continued)		
5. Unknown and Unregulated Groundwater Use (Continued)	<p>Loss of base flow during the growing season.</p> <p>Interference with existing water sources.</p>	<p>Where loss of base flow is a recurring problem, a water budget and cumulative impact analysis will be essential tools needed to manage withdrawals for sustainability, and minimize impact to other water sources and the environment. Adverse impacts to base flow during periods of low flow should be addressed by managing withdrawals, storage, and conjunctive water use.</p> <p>A water budget should be performed to determine the available water resources. Alternating and/or non-synchronous pumping of interfering sources will often address local, marginal overdraws.</p>
6. Scarcity of Clean Water in Coal-Mined Areas (see Section 2.6 in main report)	Preferential development of high quality groundwater sources.	<p>The Commission, in cooperation with member jurisdictions and other organizations, should act to manage the quantity and quality of water from these watersheds, recognizing that water resources are necessary for the economic growth of mining-affected regions. Education of local government officials and municipal engineering firms is imperative. In the long-term, this would be most effectively accomplished through coordination among the Commission, the appropriate state and federal agencies, and other organizations. The Commission and others must recognize, however, that if municipalities in coal mining affected areas are to experience beneficial economic growth and development, they must turn to these clean watersheds for water supply while maintaining a balance with the need to protect aquatic resources. The Commission should also support efforts by the member jurisdictions for “grayfields” initiatives which encourage the beneficial use of AMD-affected waters.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
A. ACTIONS TO ADDRESS GROUNDWATER RESOURCE ISSUES AND PROBLEMS (Continued)		
<p>7. Drought Impact to Base Flow (see Section 2.7 in main report)</p>	<p>Insufficient streamflow to sustain instream flow needs or downstream water supplies.</p>	<p>The Commission, in cooperation with member jurisdictions and other organizations, should act to maintain stream base flow by protecting the groundwater flow that sustains it by: (1) educating local jurisdictions about maximizing high quality groundwater recharge through the support for implementation of stormwater management practices that promote infiltration, identification of CARAs, and application of “best management practices for development”; and (2) carrying out and/or supporting research on fisheries, particularly warm-water fisheries to provide improved knowledge of required conditions for their survival and a scientific basis for their protection.</p>
<p>8. Impacts of Mining (see Section 2.8 in main report)</p>	<p>The positive and beneficial use of water discharged from mining operations is underutilized as a resource.</p> <p>Extensive aquifer dewatering.</p>	<p>The Commission should encourage cooperative efforts to promote the development of reliable water supplies related to active and abandoned mining operations, for public drinking water, commercial operations, and industrial supplies.</p> <p>The area of influence and capture area for the mine withdrawal should be delineated, and the impacts identified. This is best accomplished through a study, which may incorporate a water budget analysis, field mapping of aquifer permeability features and water levels, and groundwater modeling. Once identified, the impacts may be mitigated through a variety of methods, including redirection/redistribution of the mine pumpage and modification or replacement of impacted sources. Where exceedence of sustainable yield is occurring, mine pumpage can be reduced through the grouting of water inflow points, or other methods as appropriate, if economically and technically feasible.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
A. ACTIONS TO ADDRESS GROUNDWATER RESOURCE ISSUES AND PROBLEMS (Continued)		
8. Impacts of Mining (Continued)	Exceedance of sustainable yield.	Where mining withdrawals of groundwater exceed sustainable yield, mine pumpage can be reduced through the grouting of water inflow points if technically and economically feasible, or other methods, as appropriate. In cases where the aquifer is otherwise unused, the effects of exceedance of sustainable yield may be mitigated by various means as appropriate. These mitigation procedures should be coordinated through the appropriate state and federal agencies, in concert with the project's engineering and hydrogeological staff and consultants. Mine pumpage may reach or exceed the sustainable groundwater yield of a basin, and thus effectively limit the potential for other withdrawals to be approved.
9. Flow Compensation for Consumptive Water Uses (see Section 2.9 in main report)	Need for additional low flow augmentation to compensate for consumptive water uses.	The Commission should bring together key stakeholders to help promote the use of groundwater stored in "artificial" aquifers created by mining or flooded quarries to offset consumptive water uses and support instream flow needs during droughts.
B. ACTIONS TO ADDRESS MANAGEMENT ISSUES		
1. Multi-Agency Coordination (see Section 3.1 in main report)	Coordination among water resource agencies can be ineffective or incomplete.	The Commission's water resource data collection, planning, monitoring, and management procedures should be closely coordinated through multi-agency committees, and the Commission and all appropriate agencies should closely communicate on the Project Review Program to avoid conflicting actions.
2. Changes to Water Resource Utilization Over Time (see Section 3.2 in main report)	<p>Water resource management programs can become less efficient with changes in technology and water use.</p> <p>Water supply sustainability and stream low flow conditions can be adversely impacted by lack of the best and most efficient use of groundwater resources.</p>	<p>To effectively manage changes in the utilization of the basin's water resources, the Commission must assess water resources utilization periodically through updated water budget analyses, preferably for watersheds at a scale of between 15 and 25 square miles focusing on PSAs of the basin, and make appropriate changes in its policies, procedures, and project review process.</p> <p>The Commission, in cooperation with member jurisdictions and other organizations, should strengthen requirements for water conservation and encourage reuse of treated wastewater and conjunctive use of groundwater and surface water.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
B. ACTIONS TO ADDRESS MANAGEMENT ISSUES (Continued)		
3. Regulatory Duplication (see Section 3.3 in main report)	Change in the regulatory programs of the member jurisdictions may make some of the Commission's regulatory program redundant, inefficient, or inappropriate.	Close and effective coordination, including the use of formal arrangements such as memorandum of understanding, should be maintained among the Commission, its member jurisdictions, and key agencies to ensure that implementation of this plan's recommendations is effective, current groundwater information and technology are shared, consistency is maintained, and redundancy is minimized.
4. Increased Knowledge About Groundwater as a Resource (see Section 3.4 in main report)	Useful information about groundwater occurrence, availability, transmissivity, and yield is collected by various government permitting agencies and others, but is not compiled and shared among agencies nor disseminated to the professional community, developers of policy, or local decision-makers.	Capture and compile groundwater data submitted to the Commission by project sponsors to allow its use by the Commission and others.

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
B. ACTIONS TO ADDRESS MANAGEMENT ISSUES (Continued)		
4. Increased Knowledge About Groundwater as a Resource (Continued)	<p>Lack of fundamental knowledge of groundwater resources by many policy/decision-makers at the local, municipality level and by their constituents, and at the corporate level of private businesses, has hindered the understanding of sound groundwater management practices.</p> <p>Lack of consideration of factors important to groundwater protection and sustainability within the municipal planning process, resulting from limited knowledge of groundwater resources, has hindered the implementation of sound groundwater management practices.</p>	<p>Identify the various constituents that would benefit from a multifaceted outreach and educational program, including local governments; regulated community and related associations; consultants; environmental, conservation and citizen organizations; and possibly colleges and high schools. Develop tools these groups can use to make informed decisions.</p> <p>Encourage and assist local governments to include groundwater management concepts in planning and land-use control. Use the various tools identified below, including video, information sheets, informational meetings, etc.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
B. ACTIONS TO ADDRESS MANAGEMENT ISSUES (Continued)		
4. Increased Knowledge About Groundwater as a Resource (Continued)	There is the absence of an educational framework needed to present groundwater concepts and issues to a variety of audiences through several forms of media.	<p>Incorporate the following methods into the multifaceted outreach and education program:</p> <p><u>Publications</u>: Periodically publish articles in the Commission quarterly newsletter; draft and submit articles to be published in the various constituents' publications; produce related information sheets, etc.</p> <p><u>Conferences, workshops, and informational meetings</u>: Identify the various constituents' conferences and determine their schedules; create new exhibits/displays on the topic; exhibit and/or speak at the conferences, workshops and information meetings; conduct Commission-sponsored conferences, workshops, and informational meetings, as the need arises.</p> <p><u>Speakers' Bureau</u>: Update and enhance the Commission's existing groundwater management presentation and publicize its availability.</p> <p><u>Web Site</u>: Establish a new link and announce the availability of the plan on CD-Rom, any related information sheets or related links, and short video clips (see below).</p> <p><u>Video</u>: Obtain funds to produce a video targeted particularly to local governments (short clips of the video can be included in the web site).</p> <p><u>Media Relations</u>: Issue a press release on the new plan, pointing out key benefits and uses; periodically submit articles on the benefits of groundwater planning and management; and periodically participate in radio and television talk shows.</p>
5. Plan Performance and Accountability (see Section 3.5 in main report)	The management plan will not be productive unless the tasks identified are performed and accountability for accomplishing the tasks is established.	Periodic reporting on implementation of the plan's recommendations by the accountable agencies and groups and any new and significant groundwater management issues should be made by Commission staff to WRMAC.
6. Review and Update of the Plan (see Section 3.6 in main report)	This management plan needs to be reviewed and updated on a recurring basis in order to be current and of continuing value.	While the overall planning process should be continuous, a more comprehensive review and revision of this plan by WRMAC should occur at intervals not to exceed 10 years.

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
B. ACTIONS TO ADDRESS MANAGEMENT ISSUES (Continued)		
7. Funding to Implement the Plan (see Section 3.7 in main report)	Adequate long-term funding needs to be made available to implement the actions recommended in the plan.	Funding to implement the plan's recommended actions should be made available and/or proactively sought by the lead jurisdiction(s) for each action.
C. GROUNDWATER MANAGEMENT SUPPORT PROGRAMS (Continued)		
1. Protection of Groundwater Sources of Supply and Aquifers (see Section 4.1 in main report)	<p>Contamination of groundwater resources from the affects of improper land use planning and zoning.</p> <p>Lack of comprehensive groundwater quality datasets showing the extent and severity of nonpoint source pollution affecting groundwater resources basinwide, and the lack of management plans necessary for improving conditions.</p> <p>Degradation of water quality conditions in aquifers from point source discharges.</p>	<p>Encourage the states and local jurisdictions to develop regulations and programs designed to protect critical aquifers from contamination because wellhead protection programs do not provide for protecting future public supply wells, domestic wells, and other uses of wells.</p> <p>Continue and expand monitoring and research, in cooperation with member jurisdictions, related to nonpoint source contamination, including agricultural and other sources of groundwater. In addition, the Commission has in the past used private/existing wells to collect monitoring data, and plans to continue such efforts when appropriate. The Commission recommends encouraging such cooperative efforts both for Commission initiatives, and those initiated by other agencies and local jurisdictions. The information obtained can be used to assess the severity of the problem and the need for management initiatives. Several programs support the assessment and implementation of such actions and include TMDLs, USEPA's 319 Nonpoint Source Program, and United States Department of Agriculture/Natural Resource Conservation Service (USDA/NRCS) water programs.</p> <p>Support the member jurisdictions in their efforts to consider the affect of wastewater discharges on groundwater, including sensitive recharge areas, when issuing NPDES or SPDES permits. This should potentially include the installation of monitoring wells in particularly vulnerable aquifers.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
C. GROUNDWATER MANAGEMENT SUPPORT PROGRAMS (Continued)		
1. Protection of Groundwater Sources of Supply and Aquifers (Continued)	Limited support for local development of source water protection plans.	Assist communities with groundwater source protection by utilizing existing source-water assessment data and aquifer test data to provide educational and technical assistance in formulation of protection plans. The overwhelming need for education on this subject far exceeds the resource capabilities of any one agency or organization. The success of source water education and protection activities resides with building broad partnerships among both public and private partners, based on the need for the protection of water supplies to span a number of issues/areas (i.e., land use planning, hazardous material handling, municipal ordinances, water quality monitoring).
2. Water Use and Availability Information (see Section 4.2 in main report)	<p>Not all large volume withdrawals (>10,000 gpd) are registered (documented).</p> <p>Data on large volume users needs to be available for management use.</p> <p>Well information (water use) is not available to all agencies and local managers.</p> <p>Groundwater managers, planners, and decision-makers often do not have ready access to fundamentally important, basinwide information on groundwater.</p>	<p>Require large volume users of groundwater (>10,000 gpd) to register (document) their use. In addition, require all registered (documented) withdrawals to be reregistered (updated) periodically. Coordinate with member states and others to maintain a vibrant data set.</p> <p>Maintain a centralized database containing information on large users, and make these data available to planners and managers throughout the basin. Access and use of the information would be subject to security considerations.</p> <p>Maintain a centralized database containing well location information, and make these data available to planners and managers throughout the basin. Access and use of the information would be subject to security considerations.</p> <p>The Commission should partner with the appropriate agencies to develop the required information for the entire basin, and make it available on-line at an appropriate web location.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
C. GROUNDWATER MANAGEMENT SUPPORT PROGRAMS (Continued)		
<p>3. Well Requirements (see Section 4.3 in main report)</p>	<p>Improper well construction and abandonment procedures can cause aquifer contamination.</p> <p>Lack of certification program for drillers in Pennsylvania and the need for improving existing licensing/certification programs and well driller training in other basin states.</p> <p>The observation well network does not have the capability to monitor the dynamic response of aquifers in the basin to changes in precipitation.</p>	<p>Support state and local programs for well construction and abandonment standards and improved controls to prevent pollution. Several towns and municipalities in the basin have established successful ordinances to protect groundwater quality through controls on well abandonment and construction procedures. Examples are available from the state or respective state rural water associations. The Commission will continue to support state/local efforts for developing construction standards, as outlined in the Commission's Annual Water Resources Program document.</p> <p>Support legislation that works toward the development of a well driller's certification program in Pennsylvania, and support the improvement of programs that provide training and licensing/certification for all well drillers.</p> <p>The Commission should support effective maintenance of the observation well network by the USGS, and work toward improving the network, through cooperative agreements between USGS and the member jurisdictions. The goal is to provide a useful observation well with real-time monitoring capability in each county in the basin. Well OG-23 should be replaced with a well located in an aquifer that is commonly used for water supply and constructed to provide accurate monitoring of the water table or aquifer head.</p>

Table E1. Summary of Current Recommendations for the 2005 Groundwater Management Plan (Continued)

Issues	Problems	Recommendations
C. GROUNDWATER MANAGEMENT SUPPORT PROGRAMS (Continued)		
4. Assessment of State/Federal Groundwater Programs and Program Coordination (see Section 2.4 in main report)	State and federal agencies need to ensure their groundwater programs are current and responsive. In addition, these programs need to coordinate management activities to enhance program effectiveness and efficiency.	The Commission's member jurisdictions should continue periodic assessments of their groundwater programs to identify needed improvements and plan for their implementation.

Table E2. Implemented or Deleted Recommendations from the Susquehanna River Basin Commission's 1993 Groundwater Management Plan

Topic	Page in 1993 Report	Recommendations	Actions Taken to Date and Comments
RESOURCE EVALUATION AND PROTECTION			
1. Groundwater Use	16 16 17	<p>The Commission should:</p> <ul style="list-style-type: none"> • Issue withdrawal permits based on long-term conservation management (the resource must be managed as a replenishable resource such that withdrawals do not exceed long-term recharge). • Determine that the proposed withdrawal is needed for a reasonable and beneficial use (reasonable and beneficial use means the use of groundwater in the requested quantity is necessary for an economic, social, or environmental purpose within the public interest, including, but not limited to, domestic, agricultural, industrial, mining, power, municipal, fish and wildlife, and recreational uses). • Insure that the proposed use will not cause unavoidable or unreasonable adverse environmental impacts. 	<p>The Commission is doing this for each water use request.</p> <p>The Commission determines if the requested quantity is reasonable. Beneficial use is accepted at face value.</p> <p>The Commission does this for each water use request for localized impacts.</p>
2. Balancing of Competing Users	18	<p>The Commission should:</p> <ul style="list-style-type: none"> • Verify that identified impacts are mitigated prior to issuing a permit; and require monitoring to assure there are no unforeseen impacts. 	<p>The Commission is verifying impact mitigation for local area only. Compliance and enforcement issues need to be addressed and are now part of a new recommendation in the current plan.</p>

Table E2. Implemented or Deleted Recommendations from the Susquehanna River Basin Commission's 1993 Groundwater Management Plan (Continued)

Topic	Page in 1993 Report	Recommendations	Actions Taken to Date and Comments
RESOURCE EVALUATION AND PROTECTION (Continued)			
3. Monitoring and Research	25	The Commission should: <ul style="list-style-type: none"> • Continue and expand research related to nonpoint source contamination of groundwater. 	The Commission has done some limited work on this. This action has been incorporated into a new recommendation in the current plan.
	25	<ul style="list-style-type: none"> • Support and promote consistency in the pollution source and public water supply monitoring efforts of the member states. 	No actions to date by the Commission. This is not a proactive action.
	25	<ul style="list-style-type: none"> • Encourage ambient-quality monitoring efforts that focus on random sampling of wells and the sampling of surface streams under base flow conditions. 	No actions to date by the Commission. Limited monitoring efforts are done by state agencies, as required by USEPA.
MANAGEMENT AND REGULATORY			
1. Water Use Registration	15	The Commission should: <ul style="list-style-type: none"> • Develop indirect methods to estimate the use by small-volume users in the basin 	No actions taken to date. Work unlikely to be funded and results would be of limited value.

Table E2. Implemented or Deleted Recommendations from the Susquehanna River Basin Commission's 1993 Groundwater Management Plan (Continued)

Topic	Page in 1993 Report	Recommendations	Actions Taken to Date and Comments
MANAGEMENT AND REGULATORY (Continued)			
2. Groundwater Use	16 17	<p>The Commission should:</p> <ul style="list-style-type: none"> • Require permits of all users of groundwater in excess of 100,000 gallons per day. This permit should be in the form of a water allocation that provides some level of protection to the applicant. • Issue permits for a specific period to provide for the recovery of investments made in developing a particular project. Modifications to an allocation during this period could only be made on an emergency basis, or as a result of conflicting water uses. In general, the 12-year duration for permits used by Maryland should be adequate. 	<p>The Commission is doing this. However, “permit” and “allocations” are incorrect terms and should be referred to as approvals.</p> <p>The Commission is issuing approvals based on a 25-year duration.</p>
3. Protection of Sources of Supply	20	<p>The Commission should:</p> <ul style="list-style-type: none"> • Support the states' efforts in establishing wellhead protection programs. 	<p>NY— Wellhead protection programs, which complement the baseline program implemented through state agency programs (NYSDOH and NYSDEC) are developed and adopted voluntarily by county and local governments and water suppliers.</p>

Table E2. Implemented or Deleted Recommendations from the Susquehanna River Basin Commission's 1993 Groundwater Management Plan (Continued)

Topic	Page in 1993 Report	Recommendations	Actions Taken to Date and Comments
MANAGEMENT AND REGULATORY (Continued)			
3. Protection of Sources of Supply (Continued)	20	<p>The Commission should:</p> <ul style="list-style-type: none"> • Support the states' efforts in establishing wellhead protection programs. 	<p>PA—Wellhead Protection Plans are voluntary, but the water supplier is required to own or control the Zone One Wellhead Protection Area (having a 100-400 foot radius depending on source and aquifer characteristics). Also, source water assessments are required for new public water supply sources serving populations of 3300 or more.</p> <p>MD—WHP Plans voluntary at state level. Some local communities require them through ordinance. MDE provides funding and technical assistance and a model ordinance.</p>
4. Minimum Testing Requirements for Domestic Wells	23	<p>The Commission should promote the development of programs in Pennsylvania and New York:</p> <ul style="list-style-type: none"> ▪ For subdivisions using individual wells, establish minimum lot sizes and establish minimum offset distances for wells. Review subdivision plans for impacts on groundwater. 	<p>States have programs in place and local jurisdictions are doing subdivision reviews.</p>

Table E2. Implemented or Deleted Recommendations from the Susquehanna River Basin Commission's 1993 Groundwater Management Plan (Continued)

Topic	Page in 1993 Report	Recommendations	Actions Taken to Date and Comments
PUBLIC OUTREACH AND EDUCATION			
5. Monitoring and Research	25	<p>The Commission should:</p> <ul style="list-style-type: none"> • Establish a basinwide well registration program for all wells withdrawing more than 10,000 gallons per day. 	<p>No actions taken to date. This was duplicative of another 1993 recommendation and has been incorporated into a new recommendation in the current plan.</p>
	25	<ul style="list-style-type: none"> • Develop better estimates of present and projected self-supplied use of groundwater, including agricultural use. 	<p>No actions taken to date. Water source is domestic wells that are not large water suppliers.</p>
	26	<p>The Commission should:</p> <ul style="list-style-type: none"> • Actively participate in informational meetings and seminars on groundwater. 	<p>The Commission has been and will continue to do this</p>
	26	<ul style="list-style-type: none"> • Develop a public information “hot line” via a computerized bulletin board system. 	<p>No action taken specifically on a “hot line”, but the Commission's web site is a vehicle for public information.</p>
	26	<ul style="list-style-type: none"> • Insure that any agency publications and newsletters containing information related to groundwater reach the appropriate local governments. 	<p>The Commission has been and will continue to do this.</p>
	26	<ul style="list-style-type: none"> • When appropriate, review and comment on local management plans and ordinances related to groundwater. 	<p>The Commission does reviews of plans and ordinances as needed during normal work processes.</p>

Table E2. Implemented or Deleted Recommendations from the Susquehanna River Basin Commission's 1993 Groundwater Management Plan (Continued)

Topic	Page in 1993 Report	Recommendations	Actions Taken to Date and Comments
PUBLIC OUTREACH AND EDUCATION (Continued)			
	27	<p>The Commission should:</p> <ul style="list-style-type: none"> • Develop a handbook for the development and operation of individual water supply systems in the basin. 	No action to date by the Commission. USGS has developed a handbook.
	27	<ul style="list-style-type: none"> • Encourage and participate in the development and presentation of educational programs, including scholastic programs. 	The Commission has and will continue to participate in educational programs.
	27	<ul style="list-style-type: none"> • Develop educational materials (i.e., brochures, pamphlets, and handbooks) targeted for private well owners. 	No actions to date by the Commission. Material is being prepared by states and USGS.
MAINTENANCE OF MANAGEMENT PLAN			
	29	<ul style="list-style-type: none"> • A committee should be established with the agencies of the signatory parties to provide ongoing review and to recommend modifications to this plan. 	WRMAC has continued to serve as the review body for the plan. There is no need to establish a separate committee
	29	<ul style="list-style-type: none"> • Assessments of the reliable yield of aquifers and larger regions during periods of drought should be attached to this plan as they become available. 	Work done for assessments is discussed under another recommendation in the current plan. The Commission does not believe there is a significant value added by attaching this potentially voluminous information to the plan.

APPENDIX F
PUBLIC REVIEW COMMENTS AND RESPONSES

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APPENDIX F

PUBLIC REVIEW COMMENTS AND RESPONSES

Appendix F presents a summary of public review comments on the June 2004 draft Groundwater Management Plan and responses to the comments. The review of the plan was conducted during a 90-day period that began on June 9, 2004. Three public workshops were held in July 2004 to present the draft plan and provide the opportunity for approximately 175 attendees to make oral comments. A record of all comments from the workshops was made. More formal written comments (by letter and/or e-mail) were also received by the Commission from 21 interested parties during the review period. Over 400 comments were received from the workshops and written submittals.

All comments were reviewed and addressed. The final plan has incorporated additional or revised information, as needed, to reflect changes in response to the comments. The review comments were organized by major topics for effective presentation in this appendix and a response is provided for each topic. Also noted for the written review comments is the list of interested parties who provided input on each major topic. A concerted effort was made to include representative and significant comments while accounting for numerous similarities in input received from multiple sources at workshops or in written form.

The list of interested parties that provided written comments is provided below. Acronyms or shortened names are noted and were used in the topic-by-topic responses which follow.

1. EPA = Environmental Protection Agency
2. PADEP = PA Department of Environmental Protection (3 offices provided comments)
3. PAFBC = PA Fish and Boat Commission
4. MDE = MD Department of the Environment (2 offices provided comments)
5. DCDWA = Delaware County, NY Department of Watershed Affairs
6. CCPC = Centre County, PA Planning Commission
7. SCWA and CTWA = State College, PA and College Township, PA Water Authorities (provided consolidated set of comments)
8. YCPC = York County, PA Planning Commission
9. STCRPDB = Southern Tier, NY Central Regional Planning and Development Board (2 sets of comments provided)
10. PCBI = Pennsylvania Chamber of Business and Industry
11. P&G = Procter and Gamble
12. Exelon = Exelon Corp.
13. PAGWA = Pennsylvania Ground Water Association
14. PAACA = Pennsylvania Aggregate and Concrete Association
15. SCCTU = Spring Creek, PA Chapter of Trout Unlimited
16. SCWC = Spring Creek, PA Watershed Community
17. Parizek = Richard R. Parizek and Associates
18. ARM = ARM Group, Inc.
19. Giddings = Todd Giddings and Associates
20. Converse = Converse Consultants
21. PSU = Pennsylvania State University

TOPIC 1: SCOPE OF THE PLAN

A. Workshop Comments. The document does not present a plan since it does not include a collection of data with specific recommendations. The recommendations that are in the draft plan are generic

and should be specific to the Susquehanna Basin. The draft plan is more a statement of policies and guidelines rather than a real plan.

- B. Written Comments.** The draft plan is more of a policy statement and provides no goals, objectives or means to measure accomplishments. The Commission should focus on a few key items over which it has control, and can make a positive and substantial impact, with actions prioritized to do this. Emphasis should be placed on the need to balance groundwater management, through preservation and/or sustainable use of the resource as a long term goal, with economic growth and public needs. Conjunctive use management of groundwater and surface water merits greater consideration and promotion. More extensive data gathering efforts are required prior to finalizing the plan.

Sources of comments: PADEP, MDE, PCBI, P&G, Exelon, PAACA, ARM, PSU.

- C. Response.** The scope of the plan was purposely set to be a framework that will guide the Commission and other responsible entities in effectively managing groundwater resources in the basin. Major problems, all of which are applicable to the Susquehanna Basin and 39 proactive recommended actions to address them were developed. Although broad based, the plan goes well beyond policy statements and identifies issues, problems, actions, roles, responsibilities, priorities and schedules. There are a number of actions that can be taken in the near term. Twelve continuing actions are identified in Section 6.2 and are defined to be those actions that should be initiated and/or implemented relatively easily and quickly under existing programs, although full implementation of some initiated actions may take years. The remaining actions are defined to be short-term (initiate within two years) or long-term (two to five years) and will require implementation measures such as development of new guidelines or regulations, provision of adequate resources, and interagency coordination. The discussion of goals and objectives has been expanded in Section 1.1 to be more complete. A means to measure and assess accomplishments is discussed in Section 3.5 and calls for an annual progress report.

Additional emphasis has been placed on the need to balance environmental needs, related to preservation of groundwater resources, with sustainable use of the resource to foster economic growth and meet public needs. See Sections 1.1 and 9. In a related matter, discussion of conjunctive water use management has been added in Section 1.6.3, and is part of a new recommendation discussed in Section 3.2.

The Commission recognizes the merits of focusing resources on the most critical items, but strongly believes all recommended actions are important and need to be addressed in the long term view. By assessing each action under a prioritization rating system, focus can be placed on those that are most critical. See Section 6.2 for further discussion of the prioritization of actions.

A purpose of the plan was not to conduct extensive data collection and assessment efforts, but rather outline needs based on existing data gaps as discussed in Sections 4.1 and 4.2. Significantly, several recommended actions relate to improved data collection.

TOPIC 2: WATER QUALITY

- A. Workshop Comments.** The plan should be expanded to more fully discuss water quality. There is a noted lack of water quality components and any in depth discussion of water quality issues and concerns. Water quality needs to be balanced in the plan.
- B. Written Comments.** Discuss and consider nutrient and/or pesticide loading, storm water run off impacts, non-AMD water quality issues, and degradation of groundwater quality by agricultural

practices. Address other agencies that manage water quality. Include actions to protect groundwater from pollution from gas drilling activities. There are serious concerns with restricting use of groundwater in areas upstream of AMD-impacted streams and thereby denying legitimate water use. The prohibition of consumptive use in TMDL-affected watersheds is unnecessarily broad. Consider water quality impacts in approval of projects.

Sources of comments: EPA, CCPC, STCRPDB, PCBI, P&G, Converse.

- C. Response.** The importance of water quality in effective groundwater management is recognized. Discussion has been added to the plan on water quality issues, data, and current programs (e.g., by states); see Section 1.4 and Appendix A of the plan. The role of the Commission is to provide effective coordination since it does not have a primacy in a water quality mission; see Section 4 of the plan for further discussion. Implementation of new or revised actions to address specific groundwater quality issues (e.g., pollution protection from gas drilling activities) is beyond the scope of the plan. The plan proposes possible restricted groundwater use in high quality, non-AMD-impacted areas based on an evaluation of downstream water quality impacts; see Section 2.4. Many types of activities that use water are possible in these watersheds with minimal impact to water quality and existing water uses will be grandfathered. Potential prohibition of consumptive use of groundwater is limited to those areas impacted by AMD and is not meant to broadly apply to other areas with TMDL issues. The plan proposes the Commission review individual consumptive use projects with respect to sustainability recognizing that the loss of water quantity is generally accompanied by a related reduction in water quality.

TOPIC 3: POTENTIAL STRESSED AREAS AND CARA'S

- A. Workshop Comments.** Plan should include standards and guidelines for identifying groundwater stressed areas. Concerned about statement describing State College as a groundwater stressed area. Identification of State College as a groundwater stressed area is a very positive point. Will there be regulatory controls to stop development in identified groundwater stressed areas? Has the Commission considered mapping of recharge areas?
- B. Written Comments.** State College (PA) was identified as a potential groundwater stressed area with no substantive documentation provided. We question both the identification of State College as a potential groundwater stressed area and the criteria used for this assessment. SCTU strongly supports the conclusion that the Spring Creek watershed (State College area) is a potentially groundwater stressed area. More than 43 years of study and personal observations indicate that the sustained yield of carbonate aquifers in Nittany and Penns Valleys (State College area) has not been exceeded. CARA's need to be identified and made available to land use planners. As a recharge and basin headwater area, Delaware County (NY) is targeted for "preservation" for the benefit of downstream communities.

Sources of comments: PADEP, DCDWA, SCWA and CTWA, SCCTU, Parizek.

- C. Response.** Information has been added in Section 2.1 of the plan on the criteria and assessments used to identify potential stressed areas. The Commission will review proposed projects in these areas with a greater degree of scrutiny and may invoke special conditions for any approved projects. Regulatory control of new development will be at the local level. Issues particular to the State College, PA area were thoroughly discussed at meetings requested by local interests and held in October 2004. Protection of groundwater recharge in headwater areas is important for sustaining water supplies and streamflow both locally (e.g., in Delaware County, NY) and in areas further downstream. Critical recharge areas (CARA's) will be identified for locations not included in the

currently identified potentially stressed areas during Commission project reviews, if sufficient information is available, or if/when funding is made available to do this work as a special study for a certain area. CARA results will be made available to interested parties.

TOPIC 4: PRISTINE AREAS

- A. Workshop Comments.** Protecting pristine watersheds sounds like anti-degradation and could be a land use issue. Need to clarify this is not a regulatory action, but land preservation and conservation management. The Commission should not generally prohibit consumptive use in headwater areas, but work out solutions.
- B. Written Comments.** Water preserves suggest that the Commission become involved in a broad land use management program which goes far beyond the purpose of the Compact's protected area program. Water preserves need to be identified and made available to land use planners.

Source of comments: PADEP, PCBI.

- C. Response.** After further consideration, the recommendation calling for the Commission to develop a long term protection program for pristine areas has been dropped. The protection of areas with pristine water quantity and quality is intended to be accomplished by (1) thorough Commission review of all impacts by proposed water use projects and (2) public outreach and education on the high value of pristine areas. The Commission will not be responsible for land use controls or land management which is a local prerogative. Local land use planners should be closely involved in actions to preserve/conservate lands in pristine areas.

TOPIC 5: FUNDING OF GROUNDWATER MANAGEMENT PROGRAMS

- A. Workshop Comments.** Need to specifically state in the plan that funding is paramount. The plan should tell decision-makers how much money is needed to implement the plan. The Commission should recommend funding for the Act 220 Program.
- B. Written Comments.** Apply a major effort to seek long-term sustained funding from state, federal, and other sources.

Source of comment: ARM.

- C. Response.** Long term, sustained funding at all levels is paramount to implementing the actions identified in the management plan and, accordingly, a new recommendation has been added to address this. See Section 3.7 for further discussion. The total implementation cost of all recommended actions is beyond the scope of the plan, but a limited discussion of costs is included in Section 6.3.

TOPIC 6: EFFECTIVE COORDINATION

- A. Workshop Comments.** The Commission should not work in a vacuum – need to ensure coordination with other agencies and ensure coordination with the Act 220 Program. Need to partner with the business community to avoid surprises on environmental protection and regulation.
- B. Written Comments.** The plan does not acknowledge the importance of engaging local communities. Local public perception is that the Commission is only interested in perpetuating its existence and regulatory authority through its fee structure. The plan and any implementing requirements must be

very closely integrated with state level program development (e.g., Act 220). Division of Drinking Water Management (PADEP) offers to take a co-lead on 12 recommendations and work with the Commission to create a workable program.

Sources of comments: PADEP, DCDWA, P&G.

- C. Response.** Several plan recommendations call for enhanced coordination as part of the Commission's Project Review Program, possibly including formal arrangements (e.g. MOU's); see Section 3 of the plan for further discussion. Improved coordination with business and environmental interests will be considered. The Commission is actively involved with Pennsylvania's Act 220 Program and has included the Groundwater Management Plan in coordination and meeting discussions. The importance of engaging local communities is recognized by the Commission and is reflected in Section 3.4, Increased Knowledge About Groundwater as a Resource, which targets local jurisdiction, among other groups, for public outreach and education. The assistance of PADEP's Division of Drinking Water Management will be considered during the implementation phase of identified actions.

TOPIC 7: AGRICULTURAL WATER USE

- A. Workshop Comments.** The whole issue of agricultural impact on water quality and quantity does not show up in the plan. Will the temporary suspension of consumptive use requirements for agriculture be addressed in the plan? How will the Commission bring agriculture into the management picture concerning nonpoint pollution?
- B. Written Comments.** Ag use should be exempt from groundwater restrictions, if not, who will conduct analyses and pay for water use?

Source of comment: DCDWA

- C. Response.** The issue of the quantity of agricultural water use is part of the topic of unknown and unregulated groundwater use discussed in Section 2.5. Water quality impacts are discussed in Section 1.4 and Appendix A. The suspension of consumptive use requirements has been added in Appendix B. The Commission does not have a lead in regulating or managing water quality efforts, including those related to agriculture. The impacts of agricultural water use can be significant and should not be permanently exempted from regulatory control. In the absence of a temporary suspension, the costs for water use applications, including analyses required, would be paid by the water user.

TOPIC 8: MINING

- A. Workshop Comments.** The plan needs more discussion on the issue of finding reliable water sources for municipalities in the lower basin where noncoal mining activities are significant users of groundwater. Are groundwater withdrawals in AMD-impacted areas looked at more critically than those in other areas? Do existing mining regulations achieve what the plan's recommendations for impacts of mining contain?
- B. Written Comments.** If there are major concerns on mining sand and gravel aquifers, recommendations would be welcome. The Groundwater Management Plan should also note the positive contributions of aggregate mining to groundwater management.

Source of comment: STCRPDB, PAACA

- C. Response.** The discussion of increasing and possibly conflicting groundwater demands in areas of both significant growth and mining activities has been expanded in Section 2.8. Withdrawals in AMD areas are critically reviewed and this has been clarified in Section 2.4 and 2.6 of the plan. The mining recommendations are meant to supplement existing regulations by providing additional analyses (e.g., water budgets). Section 2.8 discusses issues, problems, and recommendations related to groundwater mining and impacts to aquifers. Bedrock quarries present a unique set of both challenges and potential opportunities (i.e., positive contributions). The plan proposes that these be carefully evaluated and an approach to their review be developed.

TOPIC 9: PUBLIC OUTREACH AND EDUCATION

- A. Workshop Comments.** A key role for the Commission is to educate planners, local governments, the agricultural community, etc. Outreach should be relevant and targeted. It is important to keep water resource managers informed through outreach and education with possible use of electronic newsletters and bulletin boards. Consider increased coordination with agencies and organizations doing education and outreach to identify education needs.
- B. Written Comments.** Increase the emphasis on the technical information and assistance that can be provided to local decision-makers. Include more data and information that can be used for local planning efforts by including a reference list of all the water budget, groundwater modeling, and water quality monitoring projects that have been done over the years. Focus specifically on development and sharing of practical tools and implementation techniques for effective groundwater management.

Source of comment: STCRPDB, P&G

- C. Response.** The Commission agrees with the workshop comments and has addressed them in the plan; see Section 3.4. Several of the plan's recommendations in Section 3.4 call for outreach and education actions to include identifying constituencies, assisting local governments, and using a variety of methods. Additional emphasis has been added in Section 3.4 on providing technical information and assistance to local decision-makers. The research effort needed to document all water budgets, modeling, and water quality monitoring done in an area the size of the Susquehanna River Basin is outside of the scope of the plan.

TOPIC 10: REORGANIZATION AND REFORMATTING OF PLAN

- A. Workshop Comments.** The report should be reorganized to reduce redundancies, place emphasis on charts and group like items together. Charts should be placed up front followed by text that supports the charts.
- B. Written Comments.** Start with Table A-1 and reorganize verbiage portion of report. Organization needs improvement and length of document distracts from content.

Source of comment: PADEP, MDE

- C. Response.** The plan has been reorganized by grouping the discussion and recommendations for resource issues and problems, management issues, and support programs in their separate sections (Sections 2, 3, and 4, respectively). Charts and tables are placed immediately after discussion of their purpose and content for clarity and effective understanding. The main portion of the plan has been further reduced in length by placing much of the detailed information on existing conditions and

management principles and tools in appendices. A short summary report has been prepared for general distribution with the full and detailed plan prepared for more limited distribution. A summary of the recommended actions contained in Table E1 (which was Table A1 in the June 2004 draft plan) is included in the first portion of the plan, the Executive Summary. Improved organization of the plan should enhance its content despite the length.

TOPIC 11: STATE COLLEGE, PENNSYLVANIA, AREA ISSUES

- A. Workshop Comments.** Concerned about the strong statement in the draft plan describing State College as a potentially groundwater stressed area and the map identifying stressed areas. Is this identification based on Commission data? Is this map intended to be a complete map? If a community is identified as such by the Commission, and a community disagrees, what's their recourse? Does this mean that Commission's regulatory decisions related will be impacted (i.e., will it be harder to get approvals)? Maybe the Commission should make public notifications when decisions involving these areas are taking place.

What are the limits in these potentially stressed areas...are we talking about safe yields? We need to take into account aquifer storage capacity factors, not just look at drought-year factors, i.e., the 1-in-10-year drought factor.

Some feel the stressed area identification is a positive point, not negative, and unless we work at the municipal levels, we are never going to protect those areas. This information should be kept in the report.

- B. Written Comments.** State College was identified as a potential groundwater stressed area with no substantial documentation provided. The Commission plan portrays that the region's water suppliers are not managing the groundwater supplies in a sustainable manner. We (i.e., certain local jurisdictions) question both the identification of State College as a potential groundwater stressed area and the criteria used for this assessment, and believe the groundwater resource is being managed in a very sustainable manner. More than 43 years of study and personal observations indicate that the sustained yield of carbonate aquifers in Nittany and Penns Valleys has not been exceeded. SCTU (Spring Creek Chapter of Trout Unlimited) strongly supports the conclusion that the Spring Creek watershed is a potentially groundwater stressed area.

Source of comment: CCPC, SCWA, CTWA, SCWC, Parizek, PSU

- C. Response.** The high degree of interest and concern in the State College area resulted in a large number of comments and local interests requested a meeting with Commission staff. On October 18 and 19, 2004, two meetings were held in the State College area. Representatives of the following groups participated in discussions with Commission staff at one or both meetings.

Centre Regional Planning Agency	Pennsylvania State University
Centre County Planning Commission	Meiser and Earl, Inc.
State College Borough Water Authority	North American Water Systems
Spring Creek Watershed Community	

All significant issues raised in the comments were thoroughly discussed and the Commission's positions explained. The major issue concerned the identification of the State College area as a potentially stressed area and Commission staff discussed its criteria and data used to establish the identification. Section 2.1 of the final plan has been expanded to include the information (on both data and criteria used by the Commission) and site-specific conditions which led to the identification

of several locations in the Susquehanna River Basin, including State College, as potentially stressed areas. One particular criteria that is very important to understand is the use of existing plus additional approved groundwater withdrawal amounts, not just current withdrawals, by the Commission in assessing potentially stressed areas. Thus, the Commission's identification of potentially stressed areas is based on existing withdrawals and approved increases in withdrawal quantities. The plan has been clarified in Section 2.1 to explain the Commission's use of this criteria in assessing an area's problems and issues.

TOPIC 12: PRIORITIES

- A. Workshop Comments.** Seems like the Commission prioritized by feasibility.
- B. Written Comments.** Start with actions the Commission has regulatory control/authority over. Prioritize actions where the Commission can make a positive and substantial impact. Education is critical. Top Priorities: Maintain centralized database for well information and assist communities by utilizing existing source water assessment data.

Source of comment: PADEP, PCBI, STCRPDB

- C. Response.** The prioritization rating system considered four factors as discussed in Section 6.2 of the plan. The feasibility of the recommended actions is part of two of the rating factors in terms of development time, related actions required, technological and staffing requirements, and legal or policy constraints. Therefore, feasibility of the recommended actions was part of the prioritization rating process, but not the sole basis for setting priorities. The Commission's regulatory control/authority is an element considered in three factors (coverage under existing programs, timing and sequencing, and ease/difficulty of implementation). From a broader perspective, the Commission believes the full range of selected actions needs to be addressed and prioritized on an equal basis. Prioritizing by selecting only actions that the Commission can make a positive and substantial impact on limits the scope of the plan. It is believed the prioritization rating system used is a reasonable and balanced approach for assessing all actions.

Education is critical and the related recommended actions are included as either top or high priorities in Table 6.3. Maintaining a centralized database for well information is rated as a high priority, rather than top priority, due to implementation issues with a new program. Assisting communities by utilizing existing data has been changed from a priority to high priority action; see Table 6.3.

TOPIC 13: TECHNICAL EVALUATIONS

A. Workshop Comments.

1. Referencing a groundwater model in recommendation A1 can mean anything; need to describe a "standard" model. How will the model be applied?
2. Could the Commission and PADEP develop uniform procedures for doing water budget analyses? Will Penn State's Living Filter and proposed beneficial re-use project be factored into a water budget?
3. How satisfied is the Commission with the 48-hour pump test and the methodologies and data that come from the 48-hour tests? Are there any changes planned?
4. You need to recognize and clarify the time lag between taking of groundwater and the impacts. How restrictive should the Commission be? When will you hold a user to a lower level?
5. Has the Commission considered doing any kind of mapping to look at how much recharge might be needed for different aquifers – to use as a planning tool to guide future development?

B. Written Comments. The Commission needs to develop standard guidelines for preparing groundwater availability analysis. More work is needed on the evaluation of location, magnitude, and duration of groundwater pumping on surface water flows. When to apply groundwater modeling verses analytical solutions should be well defined.

Source of comment: PADEP, PFBC.

C. Response.

1. A model would use computerized mathematical simulations to predict groundwater flow. A standard model is not envisioned since the choice of the specific code or program to be used will be based on the conditions and technical needs for a particular area. A groundwater model would be used only if other less expensive analytical solutions are not adequate. (responds to third written comment also)
2. During scoping and conduct of future groundwater availability analyses, consideration will be given to developing uniform procedures. Elements such as beneficial reuse projects can be included in the analyses if they would have an impact on study results. (responds to first written comment also)
3. Pump tests required by the Commission have proven to be generally satisfactory and no significant changes are planned. However, staff agrees that in many cases, the 48-hour pumping test is of insufficient duration to allow documentation of the interaction of groundwater withdrawals with surface water bodies. Even so, the more intensive monitoring of surface water bodies required in the Commission's "Pumping Test Guidance" has resulted in many more such interactions being detected. Much more work in this area is needed, but until such time as this information becomes available, staff will interpret most fractured bedrock aquifer flow systems as being predominantly local, with minimal flow lost to regional flow systems. Site-specific data indicating the presence of a quantitatively significant regional flow system will be considered when available. (responds to second written comment also)
4. The issue of time lag between the taking of groundwater and surface water impacts is recognized, but the identification of specific time lags and impacts is difficult to quantify. The Commission will strive to identify this information for proposed projects if conditions, such as large withdrawals near high quality streams, warrant this effort. Restricted groundwater use will be an option available if significant impacts are identified.
5. The Commission can provide available aquifer recharge data and mapping to local jurisdictions for their planning purposes. This information will be limited to the areas where sufficient project related groundwater analyses have been done.

TOPIC 14: BALANCE BETWEEN ECONOMIC DEVELOPMENT AND ENVIRONMENTAL PROTECTION

A. Workshop Comments. The draft plan does not go far enough in putting it all together, including recommendations, policy issues regarding the balance between economic development and environmental protection. Suggest that the draft plan recognize that groundwater is a dynamic resource and that the Commission's purpose in managing groundwater is twofold, i.e., an impacts balancing approach, not one of preserve and protect. Caution against a "1-size fits all" approach. Noted the lack of discussion on conjunctive water use and management (as reflected in recommendation A1).

- B. Written Comments.** Such a balancing requires that the Commission develop a plan and administer regulations that do not promote one type of use over another (such as rules that elevate fish over people, or visa versa). The plan needs to provide for a balancing of the shortfalls to minimize economic dislocation and avoid serious environmental harm.

Source of comment: PCBI

- C. Response.** Additional emphasis has been placed on the need to balance environmental needs, related to preservation of groundwater resources, with sustainable use of the resource to foster economic growth and meet public needs. See Sections 1.1 and 9. Information has been added in Section 1.4 on the economics of groundwater use in the basin and to provide a more balanced view of economic development and environmental protection. Discussion has been added on the subject of conjunctive use in Section 1.6.3, and a recommendation has been added in Section 3.2 dealing with conjunctive use.

TOPIC 15: REGULATORY ISSUES

A. Workshop Comments.

1. Will this plan result in changes to Commission regulations and impact upcoming groundwater withdrawal applications (e.g., Shrewsbury's)?
2. Suggest that local governments perhaps should have water allocation powers. Would the Commission consider delegating any regulatory review responsibilities to the counties? It is nice to know the Commission is looking at the “big picture” and would not want any delegation process to result in the loss of that bigger-picture look.
3. There will be problems/issues if the Commission attempts to adjust approved withdrawal amounts for public water suppliers as referenced in the groundwater mining section of the draft groundwater plan.
4. Will the Commission's Pumping Test Guidelines include enforcement? In the recommendation that references the Pumping Test Guidelines, perhaps the Commission should indicate that there are regulatory requirements backing up the guidelines.
5. Does the Commission have any model well head protection ordinances for municipalities to use? Is the Commission tied into NYSDEC's water well drillers registration program, and has the Commission looked at the data?
6. What are the results of the Commission's registration program (referenced on page 118 of the draft plan)?

B. Written Comments.

1. The regulators and regulated community need standard definitions for stressed areas, critical areas, impact, and significant impact.
2. If other solutions to water supply problems are not forthcoming, consider invoking the Commission's protected area program authority to adjust regulatory standards (such as project review triggers) and focus other actions as necessary to assure a balanced sharing of water among all legitimate users.

Source of comment: PADEP, PCBI

- C. Response.** For A1-A6 comments:

- A1. It is not anticipated that the plan will directly result in changes to Commission regulations, but implementation of the plan's recommended actions over the long term could require some changes in regulations.
- A2. The Commission's mission is based on the authority and responsibility to ensure water resource management from a basinwide perspective, irregardless of political boundaries. Maintaining this "big-picture" view is important and regulatory responsibilities should not be delegated.
- A3. If groundwater availability has or is expected to become a critical issue in a certain area, then the Commission must consider all prudent alternatives. Any action will be carefully considered, particularly if they could impact existing water users, and the public will have the opportunity to comment. It is expected that reductions in approved withdrawals would be rare if they do occur.
- A4. The pumping test guidelines are provided to applicants for information and guidance in preparing project proposals. If an applicant does not meet or exceed the pumping test information required by the Commission, the proposed project will not be approved.
- A5. The Commission does not have model well head ordinances, but can provide technical information upon request. We are aware of NYSDEC's water well drillers registration program, but have not reviewed the data.
- A6. The referenced action calls for a new registration of groundwater uses that exceed 10,000 gpd. This requirement would supplement the current registration level of use exceeding 100,000 gpd. Results of the new registration program will be known only after a period of time following its implementation.

For B1 and B2 comments:

- B1. Establishing standard definitions is not practical in view of varying site conditions and the number of agencies with regulatory responsibilities. Each agency must determine and clearly communicate the definitions and/or criteria they apply based on project information and site-specific conditions.
- B2. In the rare event that issues and/or conflicts cannot be resolved, the Commission has the authority to take actions to assure an equitable use of groundwater resources among competing legitimate users. Before taking this step, the Commission will provide available technical information to project proponents for their use in the preparation of project material and in scoping a sound project. Commission staff can attend stakeholder meetings, if requested, to help identify potential solutions to groundwater use problems. If hydrogeological conditions warrant, Commission manpower can be made available, and if funding is provided to the Commission, staff can develop water budget analyses for a local jurisdiction(s).

TOPIC 16: LAND USE PLANNING AND DEVELOPMENT

- A. Workshop Comments.** Suggest that the Commission encourage and assist local groundwater concepts in planning and land use control. How does the Commission plan to address land use decisions and manage growth as referenced on page 54? Suggest that the Commission's plan identify where growth should occur. This plan needs to address the differences in land use requirements among the states, i.e. Maryland land use law is different from Pennsylvania. Suggest getting water addressed in local plan/ordinances via regional plans such as the one developed in northeast Pennsylvania. Do human activity and economic development culminate in an ultimate limit on water? What are the limits?
- B. Written Comments.** Critical aquifer recharge areas and water preserves need to be defined and made available to land use planners. The plan seems to discount the role of local governments who have control over land use decisions. Zoning and subdivision regulations, as well as establishment of

critical environmental areas, are handled at the local level; therefore recommendation C1 (develop regulations and programs to protect groundwater from contamination) should show the states and others (local jurisdictions) as co-leads for implementation.

Source of comment: PADEP, DCDWA

- C. Response.** The Commission does not regulate land use planning, as such, it does not engage in activities that are administered by other entities (i.e. planning commissions, local zoning boards). However, the Commission, through its outreach and education efforts, may make recommendations as to how groundwater resources may be affected by land use activities. When applicable, the Commission also coordinates its activities with other agencies with responsibilities relevant to the issues. The statement on page 54 of the draft plan, the Commission must “effectively manage changing land use and growth” was in error and has been corrected in the final plan. Concerning the limit of groundwater resources to support human activity and development, additional information has been added to Section 2.1 on potential groundwater stressed areas. The identification of CARA's and water preserves will be a long-term effort that will require substantial resources and support of interested parties; information will be made available as the work progresses. Implementation of the initial element of recommendation C1 has been revised to show the states and local jurisdictions as co-leads with the Commission in a support role; see Table 6.1.

TOPIC 17: RELATIONSHIP TO PENNSYLVANIA ACT 220

- A. Workshop Comments.** How does this plan relate to the Act 220 critical areas water planning? Need to ensure coordination. There is an opportunity to actively show how Commission activities fit into Act 220 requirements as a short-term solution, particularly the critical areas planning. The procedures for coming up with critical areas are being developed now to include scale under the Act 220 implementation process. The Commission's scale should not be different from DEP's pending scale.
- B. Written Comments.** We also believe strongly that the plan and any implementing requirements must be very closely integrated with State-level program development, especially in Pennsylvania as actions required to implement the Water Resources Planning Act (Act 220) are formulated. We support maintaining and strengthening this integration as a top priority in the Commission's Groundwater Management Plan. As a member of the Upper/Middle Susquehanna Regional Committee, I believe that your plan will be of great assistance to our committee in developing our regional component of the new State Water Plan under Act 220.

Source of comment: Giddings, P&G

- C. Response.** The Commission is coordinating very closely with PADEP concerning implementation of Act 220 activities, including critical areas planning, procedures, and designations. Funding has been provided by the Commonwealth for the Commission to assist in this effort. Discussion has been added in Section 6.1 explaining that the Commission's Groundwater Management Program is complimentary to and aligned with the state programs. As an example, Pennsylvania is actively pursuing groundwater planning and management improvements under their Act 220 Program. This effort includes water budget analyses which are recognized in this plan as being critical to sound groundwater management in areas of high demand in relation to sustainable water supply.

TOPIC 18: MEASURING PROGRESS UNDER THE PLAN

- A. Workshop Comments.** Need a way to measure/assess accomplishments, such as including goals and objectives. There are no outcomes identified so who will ensure that anything gets carried out? The Commission needs to figure out what to measure and develop models. What will the Commission do about the recommendations in the draft groundwater plan?
- B. Written Comments.** The plan as written provides no goals and objectives nor a way to measure/assess accomplishments. Without objectives and clear measures, it is difficult to measure progress.

Source of comment: PADEP

- C. Response.** Accomplishments will be measured by periodic assessments by the Commission of progress made toward implementation of the recommended actions. An annual progress report will be made to the Commission's Water Resources Management Advisory Committee. In addition issues related to plan implementation will be identified and resolved on an on going basis. A comprehensive review and revision of the plan will be made at intervals not to exceed ten years in order to ensure its continuing relevancy. It is believed the periodic assessments discussed above will help ensure recommended actions are being addressed. If significant issues of plan implementation arise the Commission will take steps to lead or support resolution of the issues.

TOPIC 19: MISCELLANEOUS**A. Workshop Comments.**

1. Is there a trend of increased groundwater use in the basin?
2. Does the Commission have concerns about using 1995 water use data and is this the best available data?
3. The importance of sustainability was mentioned. Regarding the fact that we are dealing with the 13 inches of rain left for management, are we orders of magnitude away to achieving sustainability (supply versus demand)?
4. Under the Intense Growth Areas section, there does not seem to be anything related to conservation (pg 115). Recommend that we strengthen conservation elements.
5. Suggest that the Commission attempt to do cost/benefit analysis to determine which recommendations should be prioritized for implementation. This approach would get the most bang for the buck.

B. Written Comments.

1. We recommend a "Definitions" section be added to the document. Adding a glossary to the plan would enable local elected and appointed officials to better understand the concepts, data, and recommendations.
2. An issue that as not mentioned in the plan was the ever present need for new stream gages as well as the continuation of existing gages.
3. One way to allay concerns about costs to the Commission is to allocate funds to local municipalities who can do projects much more cost-effectively than the Commission.
4. It would be helpful to list the members of WRMAC and the groups or agencies that they represent.

Source of comments: PADEP, DCDWA, EPA

C. Response. For A1 to A5 comments:

- A1. Any trends concerning increasing/decreasing water use are difficult to discern based on the lack of a consistent, uniform approach for any data collected on a basinwide scale. The Commission has been able to make determinations concerning trends in use within particular areas of the basin, and only using data collected as part of its regulatory program. The recommendations in this plan outline potential efforts to initiate a more comprehensive approach to collecting data for trends analysis, and also hopes to develop partnerships with other agencies/groups in order to create a more accurate and reliable database.
- A2. Yes, the Commission does have concerns with using data from 1995, particularly considering growth in certain parts of the basin. It was the best available dataset for comparing groundwater use throughout the basin, especially concerning uniformity/consistency in collection methods. The lack of current data available for this particular type of water use reinforces the importance of implementing the recommendations outlining the need for a comprehensive, basinwide groundwater database, increased groundwater monitoring, water budgets, cumulative impact analysis, etc.
- A3. On a basinwide basis (27,500 square miles) as well as for the major subbasins, demand is far less than supply. However, on a local watershed or groundwater basin basis several areas are nearing sustainability limits, as covered in Section 2.1.
- A4. In Section 2.1 of the final document, the importance of using BMPs (best management practices) in areas of intensive development to minimize loss of recharge is recognized. Although conservation is not explicitly listed as a solution, the referenced BMP guidance developed by the Commission's member jurisdictions details conservation elements, as well as many other BMPs, used for improving stormwater management and increasing groundwater recharge.
- A5. The concept of cost/benefit comparisons is sound, but requires economic analyses which are beyond the scope of this plan. It is believed the four factor priority rating system, discussed in Section 6.2, provides a reasonable basis for deciding which recommended actions are top priority, high priority, or priority.

For B1 to B4 comments:

- B1. Agree. A Glossary of Terms has been added at the end of the main report.
- B2. Agree. Statements were added to Appendix B (USGS information) to emphasize the need for existing and new gages.
- B3. The Commission's lead role for groundwater management actions is based on broad regulatory and water resources responsibilities for the 27,500 square mile Susquehanna Basin which includes hundreds of municipalities. Funding for the Commission's broad based programs is not meant to implement local municipal projects. In addition, local governments do not have the regional water resource regulatory authority required to implement many of the Commission actions.
- B4. Agree. The composition of WRMAC, including agencies represented, has been added to Section 1.3.