SUSQUEHANNA RIVER BASIN COMMISSION

This executive summary and the full report (SRBC Publication #235) are available on the web site at www.srbc.net/waterbudgetstudy.htm and by CD-Rom. For copies of the CD-Rom: e-mail at srbc@srbc.net or call (717) 238-0423, ext. 302.

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Northern Lancaster County Groundwater Study: A Resource Evaluation of the Manheim-Lititz and Ephrata Area Groundwater Basins

Executive Summary

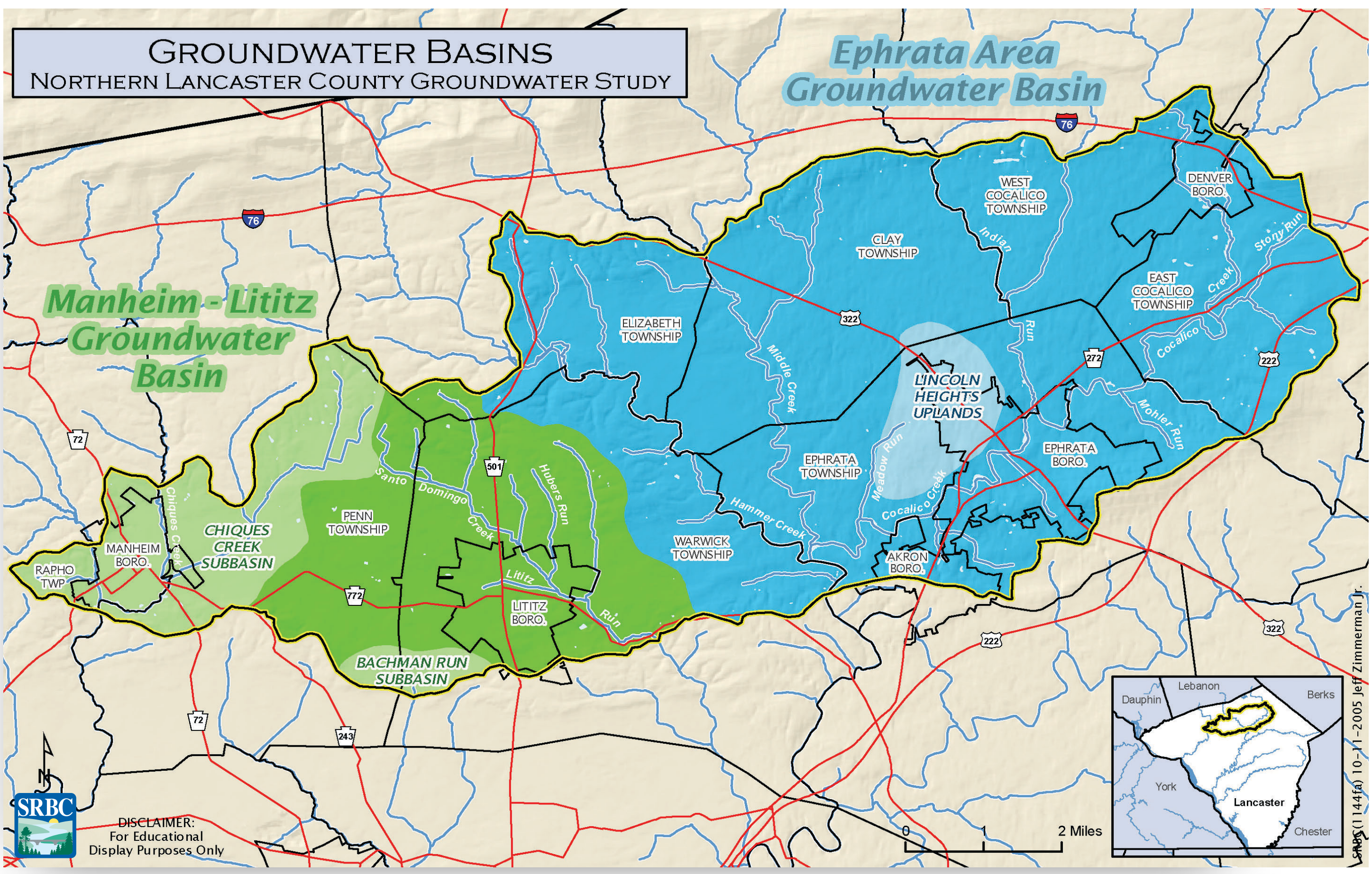
September 2005

J. Howe

John Hauenstein, SRBC Engineering Technician, checking the well at a farmhouse in Elizabeth Township.

Achieving a balance among environmental, human, and economic needs in the management of the basin's water resources is a critical mission of the Susquehanna River Basin Commission (Commission), as described in the 1971 Susquehanna River Basin Compact. The Commission carries out its water resource management responsibilities in a number of ways through its regulatory program, public education and information, and resource evaluation. In areas of intense water resource utilization, the Commission may conduct special studies, water budget analyses, and identify critical aquifer recharge areas (CARAs).

The Commission, in partnership with the Lancaster County Conservation District, performed a groundwater resources evaluation of a carbonate valley located in northern Lancaster County, Pennsylvania.



What is groundwater?

Groundwater is any water beneath the earth's surface that supplies wells and springs, and replenishes streamflow. For the purposes of this study, groundwater is the water that has reached the water table and the saturated zone, where all interconnected voids in unconsolidated (loose) sediments, and fractures and openings between layers in consolidated (hard) rock are filled.

Where does the water found in aquifers come from?

Water in aquifers primarily comes from precipitation – mostly rain. Replenishment or "recharge" occurs on most of the land surface, wherever water can soak into the ground. Exceptions include areas covered by impermeable materials like rooftops and paved areas, and areas where groundwater is upwelling, such as most perennial stream valleys.

Precipitation landing on the ground surface must be absorbed by the soil in order to become recharge. If the soil is frozen or precipitation is delivered at a rate that exceeds the ability of the soil to absorb it, then some of the precipitation is "rejected" and becomes surface runoff to streams and wetlands. Surface runoff moves downslope and becomes channelized flow.

Some of the precipitation absorbed by the ground is taken up by plant roots and transpired; the remaining water filters downward through the pores and fractures in the soil in the unsaturated zone. Eventually, this water reaches the water table, the boundary below which all of the spaces and cracks in the soil or rock are filled with water. Water that filters through the ground to the water table recharges the aquifer.

Some water becomes "stranded" in depressions or as drops on leaf (and other) surfaces. Most of this water evaporates and is returned to the atmosphere. The water returned to the atmosphere by plants (transpiration) or by evaporation is grouped under the single term evapotranspiration.

The project was funded by the Pennsylvania Department of Environmental Protection (PADEP) through its Growing Greener Grant Program. The study area includes an isolated carbonate aquifer of 50 square miles and a surrounding siliciclastic contributing area of 20 square miles. Parts of 13 municipalities, including the Boroughs of Manheim, Lititz, Akron, Ephrata, and Denver, are located in the study area.

Groundwater is the primary source of water for municipal, domestic, industrial, and agricultural uses. As groundwater withdrawals increase to meet growing demands, stakeholders need information on the location and quantity of water resources available, and how to best develop, conserve, and protect them.


J. Howe

Hammer Creek

Removal of groundwater resources faster than the sustainable rate could lead to a growing water deficit, the gradual failure of water supplies, diminishing stream and spring flows, and degraded aquatic and riparian habitat.

Project participants involved the local public during the course of the study through a Water Budget Advisory Committee (WBAC) and educational workshops. Important resource areas are identified, and management recommendations for these areas are provided in this Executive Summary and the full report.

The study area has experienced rapid growth. From 1990 to 2000, several municipalities in the study area exceeded Lancaster County's growth rate of 11.3 percent. Warwick Township, located in the Manheim-Lititz groundwater basin, experienced the highest growth rate of 33.2 percent. Anticipated growth and development in the study area are expected to result in increased water demand. Population projections from 2000 through 2025 represent a 26 percent increase.

Historic changes in land use have led to increased impervious areas, increased stormwater runoff, and reduced infiltration. Impervious cover was 9 percent of the 70-square-mile study area. This potentially reduces average annual recharge by 1,575 million gallons in the study area. When one considers the carbonate areas of the Manheim-Lititz and Ephrata area groundwater basins, 12.6 percent and 8 percent of these areas are impervious, respectively.

The focus of the study is a valley approximately 50 square miles in area, underlain by a highly productive carbonate aquifer, and herein informally termed the "carbonate valley." The carbonate valley is surrounded almost entirely by hills underlain by aquifers of much lower permeability. The carbonate valley includes parts of the Chiques Creek, Cocalico Creek, and Lititz Run watersheds. Streams generally flow from north to south across the study area, with the exception of the largest stream, Cocalico Creek, which flows from northeast to southwest.

The study area includes parts of 8 townships and 5 boroughs, and had a population of approximately 61,000 in the year 2000. Water supply needs are met almost entirely by groundwater. The valley was once largely agricultural, but is rapidly changing to a mosaic of urban, suburban, and agricultural areas. The population in the carbonate valley is rapidly growing, as is the need for water. However, the amount of water available is limited. Most of the groundwater is derived from the carbonate aquifer that underlies the valley.

The presence of sinkholes, abundant closed depressions, large springs, and lack of streams in many areas suggests that dissolution of the carbonate bedrock, a condition known as karst, has substantially enhanced the ability of the aquifer to store and transmit water. Karst aquifers are known for their abundant water resources and extremely high well yields, as well as their hard water, enigmatic flow patterns, sinkholes, and high susceptibility to contamination.

FINDINGS

From June 2003 to June 2005, the Commission evaluated the groundwater resources to address water quantity issues in a 70-square-mile area underlying parts of Chiques Creek, Cocalico Creek, and Lititz Run watersheds. Normal annual precipitation was 43.5 inches, of which 14.4 inches was estimated to be groundwater recharge.

Two groundwater basins were delineated based on water table mapping, and two sets of water level measurements were made during this study.

The Manheim-Lititz groundwater basin is 21.8 square miles and contains the upper Lititz Run watershed and part of Chiques Creek watershed. The groundwater basin is in the area westward from Manheim to within a few thousand feet of the Cocalico Creek water gap, and includes parts of Rapho, Penn, Warwick, and Elizabeth Townships, and the Boroughs of Manheim and Lititz. Groundwater level measurements taken during the study indicate a water table that gradually declines from 400 to 340 feet in elevation.

East of the Manheim-Lititz groundwater basin, the water table rapidly falls 40 to 60 feet. This area is called the Ephrata area groundwater basin, and has a water table graded to the lower reaches of Cocalico Creek, where it crosses the Cocalico Formation through the Cocalico Creek water gap at an elevation of approximately 300 feet. The 48.4-square-mile Ephrata area groundwater basin contains parts of Elizabeth, Warwick, Clay, Ephrata, West Cocalico, and East Cocalico Townships, and parts of Akron, Ephrata, and Denver Boroughs within the Cocalico Creek drainage area.

The annual recharge for each groundwater basin, for the 2-, 10-, and 25-year recurrence intervals, was based on previous regional studies that employed extensive base flow separations, water table mapping, and groundwater modeling. The annual recharge of the Manheim-Lititz groundwater basin, for the 2-, 10-, and 25-year recurrence intervals, was estimated to be 5,822 million gallons, 3,531 million gallons, and 2,449 million gallons, respectively. The annual recharge of the Ephrata area groundwater basin, for the 2-, 10-, and 25-year recurrence intervals, was estimated to be 11,676 million gallons, 7,077 million gallons, and 4,917 million gallons, respectively.

Annual Recharge in Million Gallons for the Study Area and Groundwater Basins

	1-in-2	1-in-10	1-in-25	Area (sqmi)
Manheim-Lititz	5,822	3,531	2,449	21.8
Ephrata Area	11,676	7,077	4,917	48.4
Study Area	17,498	10,608	7,366	70.2

The Commission uses the 1-in-10-year recharge as the sustainable limit of groundwater development. This limit attempts to balance the amount of groundwater available for development, instream flow needs, and required reservoir or tank storage capacity. This would suggest a maximum sustainable limit for groundwater withdrawals of 3,531 million gallons per year (mgy) for the Manheim-Lititz basin and 7,077 mgy for the Ephrata area basin. However, passby flows can place further restrictions on availability.

> ***"The Commission uses the 1-in-10-year recharge as the sustainable limit of groundwater development."***

The Commission, in coordination with the Commonwealth of Pennsylvania, requires that regulated withdrawals negatively impacting streamflows must cease or streamflows be augmented when the flow in a stream classified as a warm water fishery falls below 20 percent of the average daily flow. Discharge of an equal amount of wastewater immediately upgradient or adjacent to the impacted stream reach would largely mitigate this impact.

Groundwater withdrawals in the Ephrata area groundwater basin have not exceeded 10 percent of the lowest flow for 7 consecutive days in 10 years (Q7-10) for Cocalico Creek as it leaves the carbonate valley. However, most of the existing groundwater withdrawals are located in the southern half of the basin, and are compensated for by the discharge from the Ephrata area wastewater treatment plant. However, future withdrawals could trigger the passby requirement in one of the subbasins. This can be avoided by locating wells in downstream areas where the Q7-10 flow is higher.

Streamflows in the study area will be below 20 percent of their average daily flow approximately 30 days per year. Groundwater withdrawals in the Manheim-Lititz groundwater basin have exceeded the Q7-10 for the surface water flow (combined flow from Chiques Creek and Lititz Run) as it leaves the carbonate valley. However, most of the existing groundwater withdrawals are located in the southern half of the basin, and are compensated for by the discharge from the Manheim and Lititz wastewater treatment plants. Future withdrawals located in the northern half of the basin could trigger the passby requirement. The passby requirement can be avoided by locating wells in downstream areas where the Q7-10 flow is higher.

Existing Conditions

Groundwater withdrawals were evaluated to determine the total amount of water currently approved for

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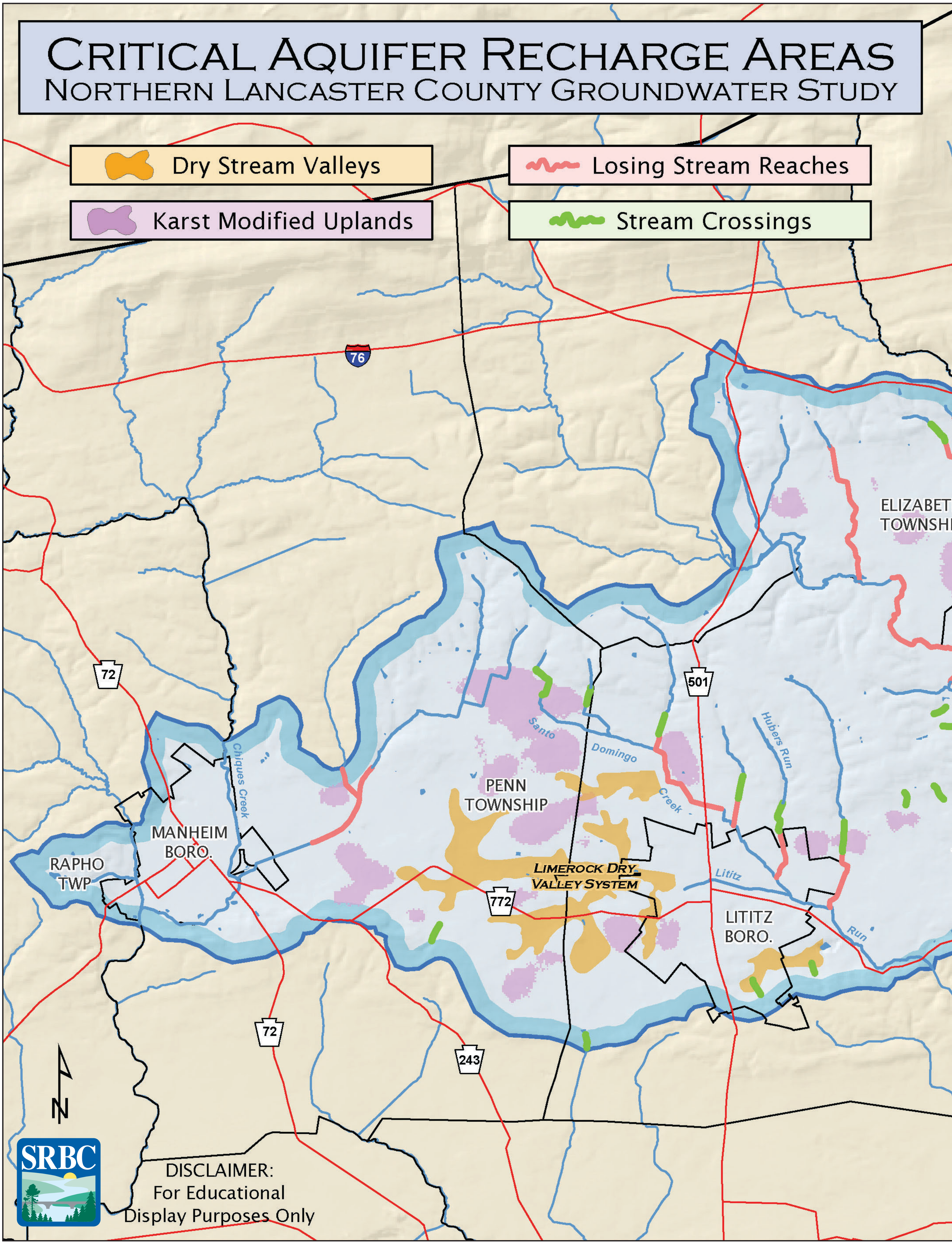
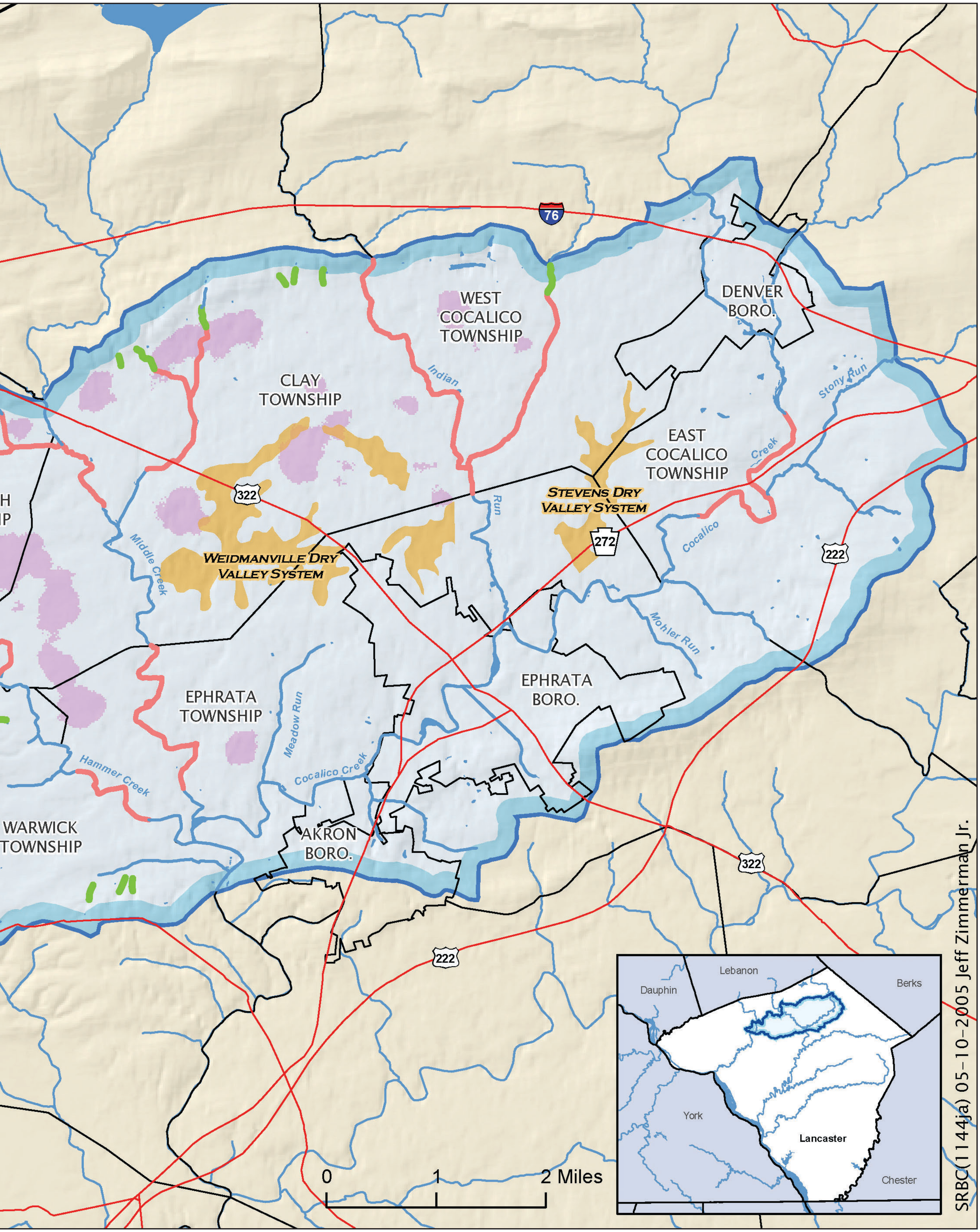
Plate 1 See descriptions of four critical aquifer recharge areas on page 6





WEST
COCALICO
TOWNSHIP
DENVER
BORO.
CLAY
TOWNSHIP
EAST
COCALICO
TOWNSHIP
STEVENS DRY
VALLEY SYSTEM
WEIDMANVILLE DRY
VALLEY SYSTEM
EPHRATA
BORO.
EPHRATA
TOWNSHIP
WARWICK
TOWNSHIP
AKRON
BORO.
Indian
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Stony Run
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Meadow Run
Cocalico Creek
Hammer Creek
76
322
272
222
0
1
2 Miles
Lebanon
Dauphin
Berks
York
Lancaster
Chester
SRBC(1144ja) 05-10-2005 Jeff Zimmerman Jr.

Critical Aquifer Recharge Areas

(see Plate 1 on pages 4 & 5)

Recharge occurs wherever the land surface is pervious and the water table is below the surface. However, some areas are characterized by features or attributes that provide an exceptional amount of replenishment (recharge) to the aquifer per unit area, and are herein termed critical aquifer recharge areas (CARAs). Four CARAs were identified in the course of this study.

Dry Valleys

Dry valleys occur throughout the carbonate valley. They consist of an integrated network (drainage net) of broad valleys that lack streamflow or even discrete stream channels, and resemble a surface drainage net. These valleys were abandoned (perennial streamflow ceased) when karst permeability in the underlying carbonate bedrock under-drained the valley, lowering the water table to the level of the solutional openings and leaving the surface streams deprived of base flow.

The valleys have been further modified by differential solution of the underlying carbonate bedrock, resulting in wider, subtly depressed areas over more soluble bedrock formations. During major precipitation and meltwater events, water floods the broad valley floor depressions and spills from pool to pool. As the amount of water delivered to the valley declines, continuous surface water flow breaks up into a series of shallow pools. The pooled water may be present for a period of days to weeks. The pools gradually diminish in area as the water evaporates and percolates to the water table. Use by plants (evapotranspiration) may be significant if the pooling occurs during the growing season, and the existing plants are adapted to saturated soil conditions.

The dry valleys are thought to contribute an exceptional amount of recharge because the underlying bedrock has greater karst permeability (more voids and conduits), the water table is below the land surface so that head conditions are favorable to recharge, and the surface runoff covers a large surface of absorption while pooled water is present. Although the rate of percolation for these soils is not exceptionally high (i.e., the soils are not well drained), percolation occurs over an extended period of time and over a large surface area due to the pooling of surface water. The pooling allows some of the rejected recharge (i.e., surface runoff) from surrounding uplands to percolate to the water table.

The larger dry valleys have been identified (Plate 1) and three major dry valley systems have been informally named: the Limerock Dry Valley System is located between Manheim and Lititz and has a surface water collection area of more than 3 square miles; the Weidmanville Dry Valley System is located northwest of Ephrata and has a surface water collection area of more than 2.5 square miles; and the Stevens Dry Valley System has a surface water collection area of more than 2 square miles.

Losing Stream Reaches

Streams flowing over an underdrained carbonate terrain are typically perched on low permeability carbonate residuum (orange-brown silty clay) over much of their length and have minimal flow loss to the aquifer. However, where the channel crosses a stratigraphic horizon with well-developed karst conduits and a hydraulically efficient connection between the stream and the aquifer is present, streamflow is lost to the aquifer. A number of losing stream reaches were bracketed by the streamflow measurement stations. The actual losses were only a small fraction of the total streamflow for larger streams, but were a substantial fraction of the total flow for smaller streams. Losses ranged from a few tenths of a cubic foot per second for small streams to several cubic feet per second for the larger streams.

Siliciclastic to Carbonate Stream Crossings

Stream water draining siliciclastic terrains is generally acidic due to the lack to soluble buffering compounds in the rock. When streams with acidic water emerge onto a carbonate terrain that is underdrained, the acidic water may percolate through the streambed and valley floor alluvium, past the root zone and into the underlying carbonate bedrock aquifer. The seasonal to continuous supply of acidic water produces enhanced karst permeability beneath the percolation area, which may extend for some distance downgradient from the siliciclastic to carbonate crossing. This represents an increase in the amount of water in the carbonate basin above that derived from the recharge of local precipitation. This same process occurs to some degree all along the non-carbonate-carbonate contact, where local groundwater flow from the higher, non-carbonate terrain flows into the carbonate valley. However, it is more important at perennial stream crossings where recharging streamflow substantially augments the local groundwater flow from the non-carbonates.

Karst Modified Uplands

The broad uplands between the major stream valleys (see Plate 1) are inferred to have solution-enhanced permeability based on the occurrence of numerous small, shallow depressions. These depressions have dimensions similar to active sinkholes in the study area and have been interpreted as dormant sinkholes. While some of these may be of non-karst origin (i.e., pseudo-karst), the abundant carbonate bedrock pinnacles in these areas strongly suggest the presence of solution-enhanced permeability. The upland setting provides aquifer porosity for the storage of recharging water that is higher in elevation than local groundwater discharge areas, an essential characteristic for a recharge area.

Existing Conditions continued from page 3

Allocated and Existing (Current Year 2000) Groundwater Withdrawals and Comparison to the 1-in-10-Year Recharge

	Allocated Withdrawal (mgy)	Existing Withdrawal (mgy)	Percent Allocated to the 1-in-10	Allocated Existing to the 1-in-10
Manheim-Lititz	2,478	1,493	70	42
Ephrata Area	2,418	1,497	34	21
Study Area	4,896	2,990	46	28

withdrawal (i.e., allocated withdrawals) and the portion of such allocations currently being withdrawn to meet present demands (i.e., existing withdrawals). The total allocated groundwater withdrawals in each basin includes both existing withdrawal amounts plus approved but unused amounts. Existing (actual, current) water withdrawals, plus currently allocated but unused quantities, were identified and totaled for each groundwater basin. These total allocated groundwater withdrawals were compared to the Commission's criterion for allocated withdrawals in potentially stressed areas (PSAs), which is 50 percent of the 1-in-10-year recharge.

Actual, current (year 2000) withdrawals for the Manheim-Lititz groundwater basin, the Ephrata area groundwater basin, and the entire study area do not exceed 50 percent of the 1-in-10-year recharge.

The total groundwater withdrawal in the Ephrata area groundwater basin of 1,497 mgy is approximately equal to that of the Manheim-Lititz groundwater basin (1,493 mgy). However, the area of the Manheim-Lititz groundwater basin (21.8 square miles) is less than half the area of the Ephrata area groundwater basin (48.4 square miles) that results in a groundwater yield of approximately 188,000 gallons per day (gpd) per square mile versus 85,000 gpd per square mile, respectively. The size of a groundwater basin (recharge catchment area) relative to the volume of total withdrawals is an important consideration in determining groundwater sustainability in a given area.

For the entire study area, allocated groundwater withdrawals were 46 percent of the 1-in-10-year recharge. For the Manheim-Lititz groundwater basin, allocated groundwater withdrawals were 70 percent of the 1-in-10-year recharge, which exceeds the Commission's PSA standard. Allocated groundwater withdrawals from the Ephrata area groundwater basin are 34 percent of the 1-in-10-year recharge.

Projected Conditions

Groundwater withdrawal for the study area has been projected for 2010 and 2025. The water demand projection is based on census data showing a population of 61,085 in 2000 and a per-capita water use of 116 gpd. Using data provided by Lancaster County Planning Commission, the projected population in 2010 and 2025 will be 67,400 and 76,905, respectively. Utilization in 2010 (3,753 mgy) is estimated to be 35 percent of the 1-in-10-year recharge and 51 percent of the 1-in-25-year recharge. Utilization in 2025 (4,337 mgy) is estimated to be 41 percent of the 1-in-10-year recharge and 59 percent of the 1-in-25-year recharge.

For the Ephrata area groundwater basin, water use in 2010 (2,070 mgy) is estimated to be 29 percent of the 1-in-10-year recharge and 42 percent of the 1-in-25-year recharge. Water use in 2025 (2,357 mgy) is estimated to be 33 percent of the 1-in-10-year recharge and 48 percent of the 1-in-25-year recharge. The projected population in 2010 and 2025 will be 41,329 and 47,174, respectively.

Study Area	2000	2010	2025
Total Population	61,085	67,400	76,905
Total Use mgy*	3,382*	3,753	4,337
Percent Utilization of 1-in-10	28	35	41
Percent Utilization of 1-in-25	41	51	59

**Includes surface withdrawals at Ephrata and Denver.*

Existing and Projected Total Use and Percent Utilization of 1-in-10 and 1-in-25-Year Recharge for the Study Area

Ephrata Area	2000	2010	2025
Total Population	37,449	41,329	47,174
Total Use mgy*	1,889	2,070	2,357
Percent Utilization of 1-in-10	27	29	33
Percent Utilization of 1-in-25	38	42	48

**Includes surface withdrawals at Ephrata and Denver.*

Existing and Projected Total Use and Percent Utilization of 1-in-10 and 1-in-25-Year Recharge for the Ephrata Area Groundwater Basin

Manheim-Lititz Area	2000	2010	2025
Total Population	23,636	26,071	29,732
Total Use mgy	1,493	1,677	2,007
Percent Utilization of 1-in-10	42	47	57
Percent Utilization of 1-in-25	61	68	82

Existing and Projected Total Use and Percent Utilization of 1-in-10 and 1-in-25-Year Recharge for the Manheim-Lititz Groundwater Basin

The projected population in the Manheim-Lititz groundwater basin in 2010 and 2025 will be 26,071 and 29,732, respectively. Water use in 2010 (1,677 mgy) is estimated to be 47 percent of the 1-in-10-year recharge and 68 percent of the 1-in-25-year recharge. Water use in 2025 (2,007 mgy) is estimated to be 57 percent of the 1-in-10-year recharge and 82 percent of the 1-in-25-year recharge.

The existing allocations for groundwater withdrawal are sufficient to meet these projected demands, assuming that the new demand is located on the systems with existing excess capacity or can be served through interconnections with water systems that have excess capacity.

RECOMMENDATIONS

The Commission developed a series of recommendations to address water resource problems in the study area, after consideration of the following: (1) a review of existing ordinances and regulations that impact water resources; (2) a review of related plans and water resource initiatives; (3) community input on issues and concerns through the WBAC and at a June 2004, workshop; and (4) the findings of this study. *The Water Resource Management Recommendations* section in the full report provides a detailed explanation of the issues, problems, and recommendations and description of the existing management tools available to the Commission, PADEP, and municipalities.

The recommendations address four major issues. Recommendations 1 through 5 address overall reduction of infiltration and groundwater recharge. Recommendations 6 and 7 address excess withdrawal of groundwater in PSAs. Recommendations 8 through 11 address overall increase in water use, and recommendation 12 addresses consistency among municipal ordinances.

1. ***Problem:*** *Loss of critical aquifer recharge areas (CARAs) from future growth and development is a concern.*

Recommendation: Municipalities should maintain or enhance the unique hydraulic characteristics of CARAs to maximize the amount of groundwater available for utilization within a groundwater basin. Mapping of these important water resource areas provides information that municipal governments can use to make informed decisions on planning for future growth (Plate 1).

2. ***Problem:*** *Increased areas of impervious cover will reduce the potential for recharge.*

Recommendation: Municipalities should encourage developers to reduce the effect of impervious cover by implementing technologies that increase the infiltration capability of that cover. Developers should consider using designs such as porous pavement in areas where natural recharge rates are higher than other land areas. Where the infiltration capability of the land cover cannot be increased, such as rooftops, the stormwater runoff can be directed to other areas and enhance groundwater recharge through distributed infiltration best management practices.

3. ***Problem:*** *Floodplain systems that were once areas of natural recharge are now filled with fine sediment and less permeable, thereby reducing recharge.*

Recommendation: Municipalities should consider floodplain restoration in a limited number of areas that historically contained meandering stream channels, thereby improving groundwater recharge along those reaches.

4. ***Problem:*** *Lack of stormwater plans in the study areas misses opportunities to address infiltration and recharge of stormwater runoff.*

Recommendation: County and local governments should complete Act 167 stormwater management plans for the remaining areas. They also should implement the PADEP's new comprehensive stormwater policy, which promotes the use of distributed infiltration best management practices to increase groundwater recharge.

5. ***Problem:*** *Certain carbonate areas, such as those identified as karst modified uplands, may not be suitable for on-site stormwater management best management practices.*

Recommendation: County and local governments should consider distribution of stormwater runoff to regional stormwater management facilities in restored floodplains and CARAs. They also should explore transfer of stormwater requirements to receiving areas (i.e., CARAs or stormwater management facilities) for the expansion of development rights in sending areas (i.e., areas in a development that would normally be set aside for stormwater best management practices).

6. ***Problem:*** *Water use in the Manheim-Lititz and Ephrata area groundwater basins is 70 percent and 34 percent, respectively, of the sustainable limit.*

Recommendation: The Commission should continue to require groundwater availability analyses for new water withdrawal projects and detailed water budgets in PSAs.

Regional and local planning agencies should evaluate the impacts of different post build-out scenarios on recharge and water demand.

7. ***Problem:*** *Intensive groundwater withdrawals in localized areas will diminish groundwater yields, base flows, and perennial streamflow.*

Recommendation: Project sponsors applying for new or increased withdrawals should utilize groundwater models in localized areas to evaluate the withdrawal impact and address sustainability. For localized areas where the sustainable yields have been exceeded, new wells should not be installed and additional withdrawals should be discouraged.

Since existing allocations for groundwater withdrawal are sufficient to meet projected demands, the Commission should encourage municipalities and water authorities to consider addressing new demand with systems that have existing excess capacity or through interconnections with water systems that have excess capacity.

8. ***Problem:*** *The public is not well educated about the limits of groundwater resources.*

Recommendation: Water resource management agencies should partner with schools to introduce material on water and the environment into the curricula for grades K through 12.

Water resource management agencies should continue to conduct basinwide or regional workshops to acquaint citizens with water management issues, problems, and solutions. The Commission should present the findings and recommendations of this study to watershed groups, civic organizations, and legislative leaders.

9. ***Problem:*** *Insufficient or incomplete beneficial reuse of process water or wastewater results in increased water demand.*

Recommendation: Industrial and commercial users should identify opportunities to reclaim water from one application for use in another application. Within the context of appropriate water quality limitations, agricultural sites near urban areas may provide opportunities to recycle industrial and commercial water for irrigation.

Reuse water is a sustainable water supply. Municipalities should be evaluating ways to take advantage of their wastewater plant effluent for reuse, thus lessening the demand on their potable water supplies. Municipalities can perform "Reuse Master Plans" that focus on reuse opportunities as a water resource for their community and surrounding area.

10. ***Problem:*** *Inefficient water use or lack of conservation measures wastes water.*

Recommendation: Water authorities and purveyors, in partnership with municipalities, should offer residential water surveys. Water surveyors check for leaking plumbing, provide water conservation tips, offer advice on retrofitting with water-efficient fixtures, and may distribute water-efficiency kits (containing, for example, faucet aerators and low flow showerheads).

When businesses apply for new or increased withdrawals in PSAs, water resource management agencies should encourage them to consult with qualified engineering firms that specialize in on-site water use evaluations and assist in replacement of water-inefficient equipment.

Watershed organizations should organize and conduct public information programs consisting of conservation brochures, displays, and classes dealing with outdoor use practices, such as landscaping alternatives and changing wasteful practices, to conserve water.

11. ***Problem:*** *Water discharged from mining operations is underutilized as a resource.*

Recommendation: The Commission should encourage cooperative efforts to promote alternative water supplies such as mining operations for public drinking water, commercial operations, and industrial supplies.

12. ***Problem:*** *Municipal ordinances that influence water supply availability are inconsistent across municipal boundaries.*

Recommendation: Local governments should continue to utilize the opportunities presented in the Pennsylvania Municipalities Planning Code to develop comprehensive land management ordinances that address groundwater resource protection and enhancement.