Natural Resources Profile

The Natural Resources Profile is designed to identify and analyze the vast assortment of natural resources that are found within or have an influence on Lebanon County. These resources and features include the physical geography; topography; soils; geologic formations and physiographic provinces; water resources; wellhead protection; woodlands; and wildlife and their value to economic pursuits, such as agriculture and forestry, and to the county's overall environmental quality.

The purpose of the profile is to help local, regional, and state government officials and decision-makers, developers, and citizens make more informed planning decisions. Sensitive environmental resources, threats to resource existence and function, development impacts, and types of protection techniques are of specific interest, as they aid in the identification of natural resources in need of remediation, features that impose development constraints, areas to be preserved, and places that are well-suited for development.

Physical Geography

Lebanon County is located in the Lebanon Valley between South Mountain, which rises to an elevation of 800 to 1,000 feet, and the Blue Mountain Chain to the north, which reaches peaks of 1,300 to 1,500 feet. The Lebanon Valley is divided into several smaller valleys by lines of hills parallel to the ensconcing mountains. The valley lies on the northern edge of the Southeast Piedmont Climatological Division which also includes Dauphin, Berks, Lancaster, Chester, Bucks, Montgomery, Delaware, and Philadelphia Counties and is more or less a transition zone from the piedmont region to the East Central Mountain and Middle Susquehanna Climatic Divisions.[1]

Climate

The climate of Lebanon County is best described as humid continental. Most of the weather systems that affect the county develop in the Central United States and are modified considerably after traversing the Northern Plains and the Midwest and crossing the Appalachian Mountains. The climate is also influenced by the Atlantic Ocean. The proximity to the ocean, combined with modifying influences on frontal systems approaching from the west results in a climate where extremes only occur under the influence of unusually powerful weather systems.

During the summer, highs typically reach into the mid 80s and lows dip into the 60s at night. Extended periods of hot and humid conditions do occur, and 90 degree plus readings are recorded on an average of 25 days a year. The warmest month is usually July. During the winter, colder temperatures seep in through the Canadian air masses. Daytime highs average in the upper 30s, and nighttime lows drop into the lower 20s. On average, the coldest month is January.

Precipitation is distributed throughout the year though slightly less precipitation falls in the winter months. Total average annual rainfall is roughly 44 inches.

Table 6-1 Average Temperatures and Precipitation (Regional)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
East Central Mountains												
Temperature	25.5°	27.9°	37.8°	48.3°	58.9°	67.4°	72.3°	70.4°	63.0°	51.9°	41.9°	30.7°
Precipitation	3.12"	2.80"	3.27"	4.01"	4.54"	4.07"	4.42"	4.21"	4.12"	3.29"	3.95"	3.49"
Middle Susquehanna												
Temperature	25.2°	27.7°	37.8°	48.7°	58.9°	67.4°	71.9°	70.2°	62.9°	51.6°	41.5°	30.5°
Precipitation	2.46"	2.58"	3.08"	3.16"	4.00"	4.25"	3.89"	3.46"	3.60"	3.17"	3.56"	2.97"

Source: USDA, National Agricultural Statistics Service – PA Office

Topography and Steep Slopes

The topography of Lebanon County can be described as a fertile valley nestled between two ridges to the north (the Blue Mountains) and one ridge to the south (South Mountain). The steepest slopes (greater than 25%) are found along the ridges in the northernmost part of the county, but local areas of precautionary slope (15% to 25%) and steep slopes (greater than 25%) can be found throughout the county. Steep slopes can also be seen along the ridge in the southern portion of the county, most

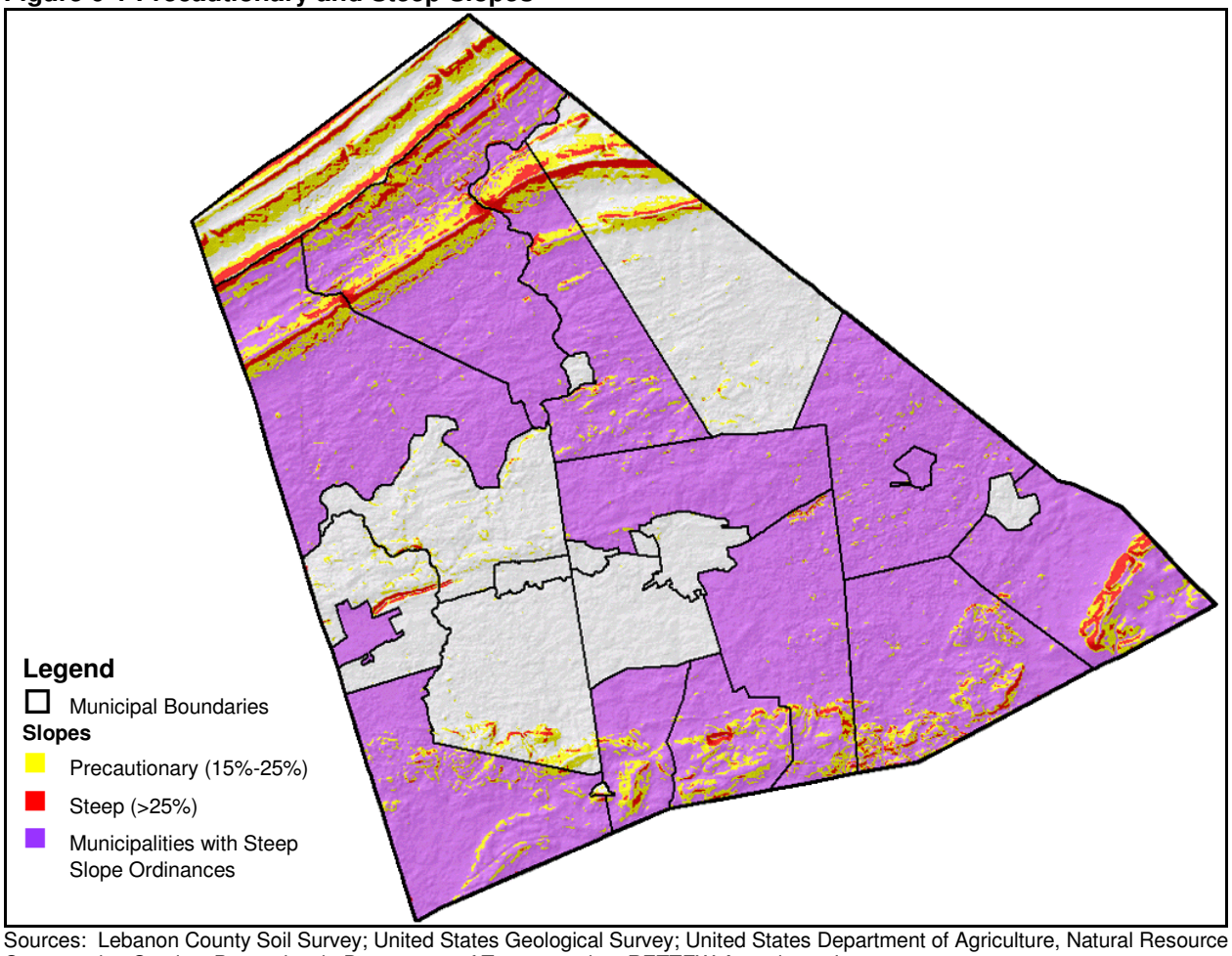
[1] Earth and Mineral Sciences, the Pennsylvania State University.

noticeably in Millcreek Township. Throughout the county, there are over 23,300 acres consisting of precautionary slopes of 15% to 25% grade. This amounts to 10.0% of all of the land in the county. Areas of steep slope (> 25%) are found in 4.0% of the county, over 9,200 acres. The topography of Lebanon County can be seen in Figure 6-1.

The topography of a landscape greatly affects the degree of development that is possible. Areas of steeper slope are more susceptible to erosion than shallow slopes and flatlands. As such, erosion concerns need to be considered prior to development approval and may result in limits to site disturbance. Additionally, it is often more difficult to install public utilities, such as sewer and water lines, in areas of steep slopes, limiting development to densities serviceable by on-lot systems. In addition, soils on steep slopes are often slightly to severely rocky. These constraints typically discourage agricultural uses and more intensive development from locating in these areas, leaving them naturally covered with woodlands and forests.

Municipal regulations have been implemented to formally address land use and development in these areas of steep or precautionary slope. These regulations are addressed at the end of this profile.

Figure 6-1 Precautionary and Steep Slopes



Sources: Lebanon County Soil Survey; United States Geological Survey; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Blue Mountain - Kittatinny Ridge Conservation Project

The Kittatinny Ridge Project, led by Audubon Pennsylvania, is a collaborative effort of local, regional, and state organizations and agencies to focus public attention on the importance of the 185-mile long forested Ridge through Pennsylvania; and to promote conservation activities to protect the Ridge from further habitat loss, fragmentation, and inappropriate land use.

The Kittatinny Ridge (also known as Blue Mountain) is a long mountain ridge that winds 185 miles through eastern and central Pennsylvania, to the Maryland line. The Ridge is a globally-significant fall migration flyway used annually by tens of thousands of raptors and vultures and millions of songbirds, and has been designated by Audubon Pennsylvania, as the largest of the state's "Important Bird Areas." The many rock outcroppings along the ridge also make it an excellent place to watch migrating hawks, eagles and vultures. Hawk Mountain Sanctuary and Audubon's Hawk Watch at Waggoner's Gap are located along the Ridge. Locally, an excellent migratory bird watching location is Second Mountain Hawk Watch, just off Cold Spring Road at the northern edge of Fort Indiantown Gap Military Reservation.

Kittatinny Ridge Conservation Corridor includes 160 miles of the Appalachian Trail; and serves as a vital link in the Appalachian Forest that stretches the length of the East Coast, providing critical, high quality interior-forest habitat for dozens of species of songbirds, mammals, reptiles and amphibians. The Ridge also protects important drinking water supplies and stream habitat.

Currently, the project is working on implementation of the following goals for the Blue Mountain - Kittatinny Ridge Project

- Develop a long-term vision for the Ridge as a unique natural corridor through an open, public-input process
- Develop tools and programs to help empower citizens, local governments, landowners, and civic groups to implement the vision at the local level[2]

The Highlands

The northeast-to-southwest orientation of the Highlands is apparent across New York and New Jersey, where lakes and reservoirs speckle the mostly forested region. In Pennsylvania, the Highlands form a chain of ridges and hills that culminate in the dramatic heights above the city of Reading. Pennsylvania's Highlands region expands to include the forested hills south and west of the Reading extension. Within Lebanon County, the Highlands extend across the southern portion of the county following the South Mountains.

The region's rivers are often born in the Highlands; their courses conform to the region's corrugated structure. The major rivers of the four-state area, Hudson, Delaware, Schuylkill, and Susquehanna, slice through the Highlands' topography.

The majority of the region's timberland is privately owned, most of it in small lots of fifty acres or less. Large, unbroken tracts of forest are home to many species, especially large mammals such as black bear, bobcat, and river otter. The Highlands are a rich mosaic of habitats, the result of its many water bodies, rugged terrain, varied soils, and several forest types. Possessing wetlands, bogs, swamps, glades, ravines, ridges, and large tracts of forest interspersed with grassland, pasture and cropland, the Highlands support diverse plant communities and a large number of animal species; it is rich in biological diversity. Over 100 plants and almost 50 animals listed on Federal or State inventories of species that are endangered, threatened, or of concern find harbor in the Highlands. The Highlands are vital to neotropical birds, tiny songbirds which fly above the unbroken forest during their migration and shelter there during the day.

The Highlands Conservation Act of 2004, H.R. 1964, was passed by the 108th United States Congress and signed by President Bush. It is designed to assist the States of Connecticut, New Jersey, New York and Pennsylvania in conserving priority land and natural resources in the Highlands region.

The purposes of this Act are:

> To recognize the importance of the water, forest, agricultural, wildlife, recreational, and cultural resources of the Highlands region, and the national significance of the Highlands region to the United States.
>
> To authorize the Secretary of the Interior to work in partnership with the Secretary of Agriculture to provide financial assistance to the Highlands states to preserve and protect high priority conservation land in the Highlands region.

[2] Kittatinny Ridge Project Study

To continue the ongoing Forest Service programs in the Highlands region to assist the Highlands states, local units of government, and private forest and farm landowners in the conservation of land and natural resources in the Highlands region.

USDA Forest Service has begun the Pennsylvania and Connecticut Update study in cooperation with the Pennsylvania Department of Conservation and Natural Resources, and the Connecticut Department of Environmental Protection. The first stage of the study has focused on: public involvement to identify issues, opportunities and concerns; resource data collection; and resource assessment with the aim of identifying land having high conservation value. Within Lebanon County, the lands associated with and around the Middle Creek Wildlife Preserve have been identified by the public as a "hot spot" for protection.[3] The second stage of this study, which is schedule for completion in 2007, will analyze the pattern and rate of land use change, its implications for the region's resources, and the adaptations required for a sustainable future.

Soils

The qualities of soils determine a soil's capability of supporting various types and intensities of land uses. For example, agriculture typically requires soils that are level, well-drained and fertile. Residential development in general is adaptable to a wider range of conditions, though the intensity of residential development can be limited by the soil's suitability for on-lot disposal systems and the cost of excavation. Industrial uses favor soils that are sturdy enough to withstand the heavy weights associated with the construction and operation of large industrial plants. These qualities of soils are inventoried in this section to inform the land use portion of the comprehensive plan with areas of suitability, sensitivity and hazard to future development.

The Soil Conservation Service of the U.S. Department of Agriculture, in conjunction with the Pennsylvania Department of Agriculture and the Pennsylvania State University, has compiled a detailed soil survey of Lebanon County. The survey distinguishes soil types and determines their suitability according to their properties: texture; drainage conditions; chemistry; structure, color, depth to bedrock; and maturity. The texture of a soil indicates the stability, strength, and drainage of that soil, which are important characteristics to know before farming the land, constructing buildings and roads, or installing waste disposal systems. Soils that are poorly drained have low strength and cannot support structures well. Wet soils also do not allow plant roots to obtain the oxygen they need and thus, plants do not grow well. Chemistry refers to the complex chemical reactions that take place in the soils, measured by the acidity of the soil. All of these characteristics contribute to the identification of soils and their uses.[4]

Within this section, Lebanon County soils will be described in terms of their types and properties and the abundance in the county; their agricultural suitability; their on-lot disposal system suitability. Table 6-2 provides an overview of these characteristics and conditions.

Table 6-2 Characteristics of Lebanon County Soils

Agricultural Soil Status	Acres	Percent of County
Prime farmland soils	86,087	37.1%
Farmland soils of statewide importance	46,612	20.1%
Soils developed or not ideal for farmland	99,309	42.8%
Ability of Soil to Absorb Septic Drainage	**Acres**	**Percent of County**
Somewhat limited	70,067	30.2%
Very limited	150,736	65.0%
Not rated	11,206	4.8%
Hydric Soil Inclusions	**Acres**	**Percent of County**
Yes	61,215	26.4%
No	170,794	73.6%

Sources: United States Department of Agriculture, Natural Resource Conservation Service; RETTEW Associates, Inc.

[3] Highlands of Connecticut, New York, New Jersey, Pennsylvania/ Study Update
[4] Penn State University, College of Agricultural Sciences, Cooperative Extension

Prime Farmland Soils and Farmlands of Statewide Importance

The Pennsylvania Municipalities Planning Code (PAMPC) states that a county comprehensive plan must, "identify a plan for the preservation and enhancement of prime agricultural land and encourage the compatibility of land use regulations with existing agricultural operations." "Prime agricultural land" is defined as, "land used for agricultural purposes that contains soils of the first, second or third class as defined by the United States Department of Agriculture, Natural Resource and Conservation Services county soil survey." An "agricultural operation," is defined in the PAMPC as, "an enterprise that is actively and continuously engaged in the commercial production and preparation for market of crops, livestock and livestock products and in the production, harvesting and preparation for market or use of agricultural, agronomic, horticultural, silvicultural and aquacultural crops and commodities. The term includes an enterprise that implements changes in production practices and procedures or types of crops, livestock, livestock products or commodities produced consistent with practices and procedures that are normally engaged by farmers or are consistent with technological development within the agricultural industry." [5]

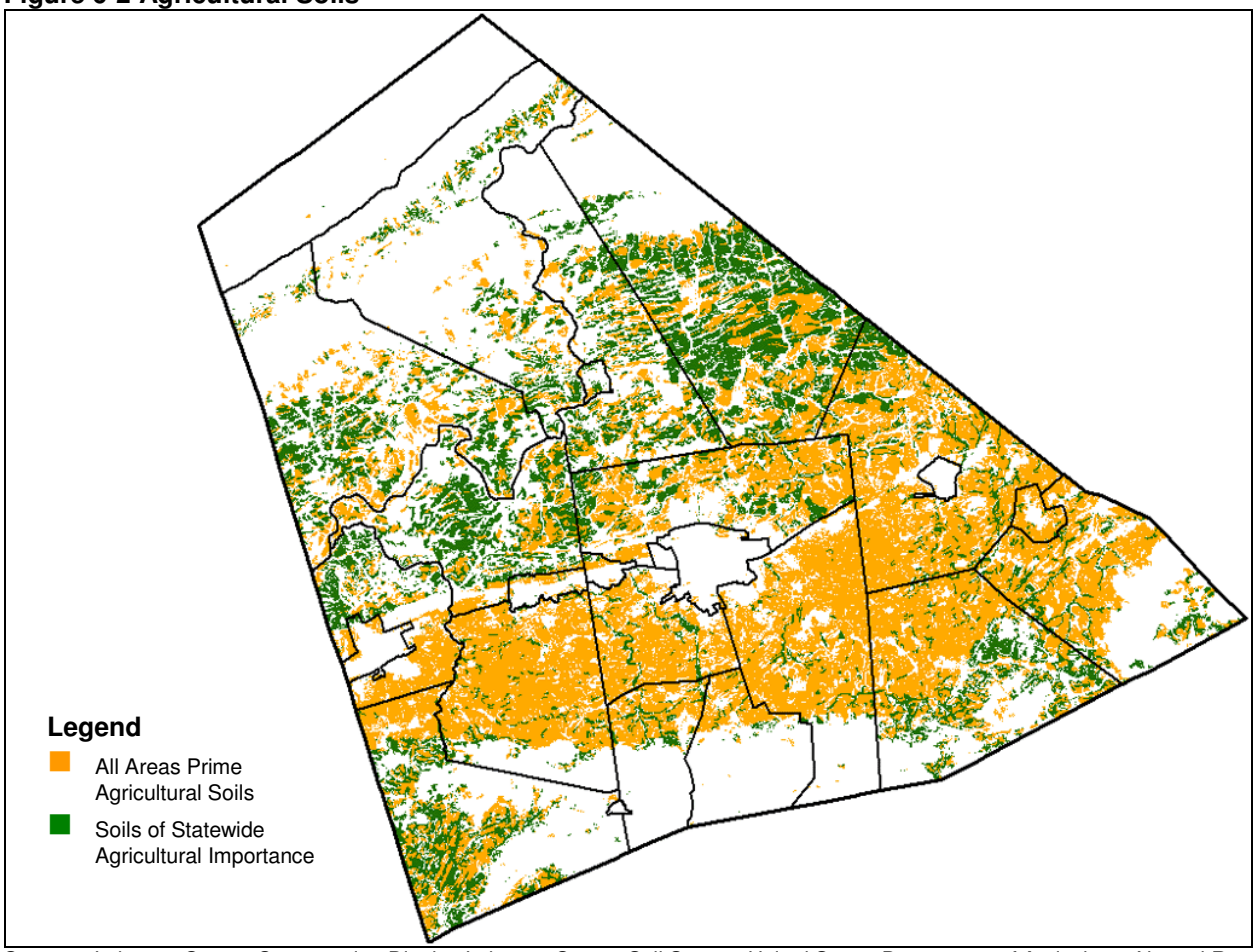
The U.S. Department of Agriculture's Natural Resource and Conservation Service classifies certain soils as Prime Farmland soils based on the following definition:

> "Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, and few or no rocks. They are permeable to water and air. Prime farmlands are not easily eroded or saturated with water for a long period of time; these soils either do not flood frequently or are protected from flooding."[6]

In addition to the Class I and II Prime Farmland soils, Class III soils are designated as additional farmland of statewide importance. Part 667 of the National Environmental Policy Act identifies additional farmland of statewide importance as, "land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, fiber, forage, and oilseed crops. Criteria for defining and delineating this land are to be determined by the appropriate State agency or agencies. Generally, additional farmlands of statewide importance include those that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some may produce as high a yield as prime farmlands if conditions are favorable. In some states, additional farmlands of statewide importance may include tracts of land that have been designated for agriculture by state law."

[5] Pennsylvania Municipalities Planning Code
[6] SSM, U.S.D.A. No. 18, 1993

Figure 6-2 Agricultural Soils



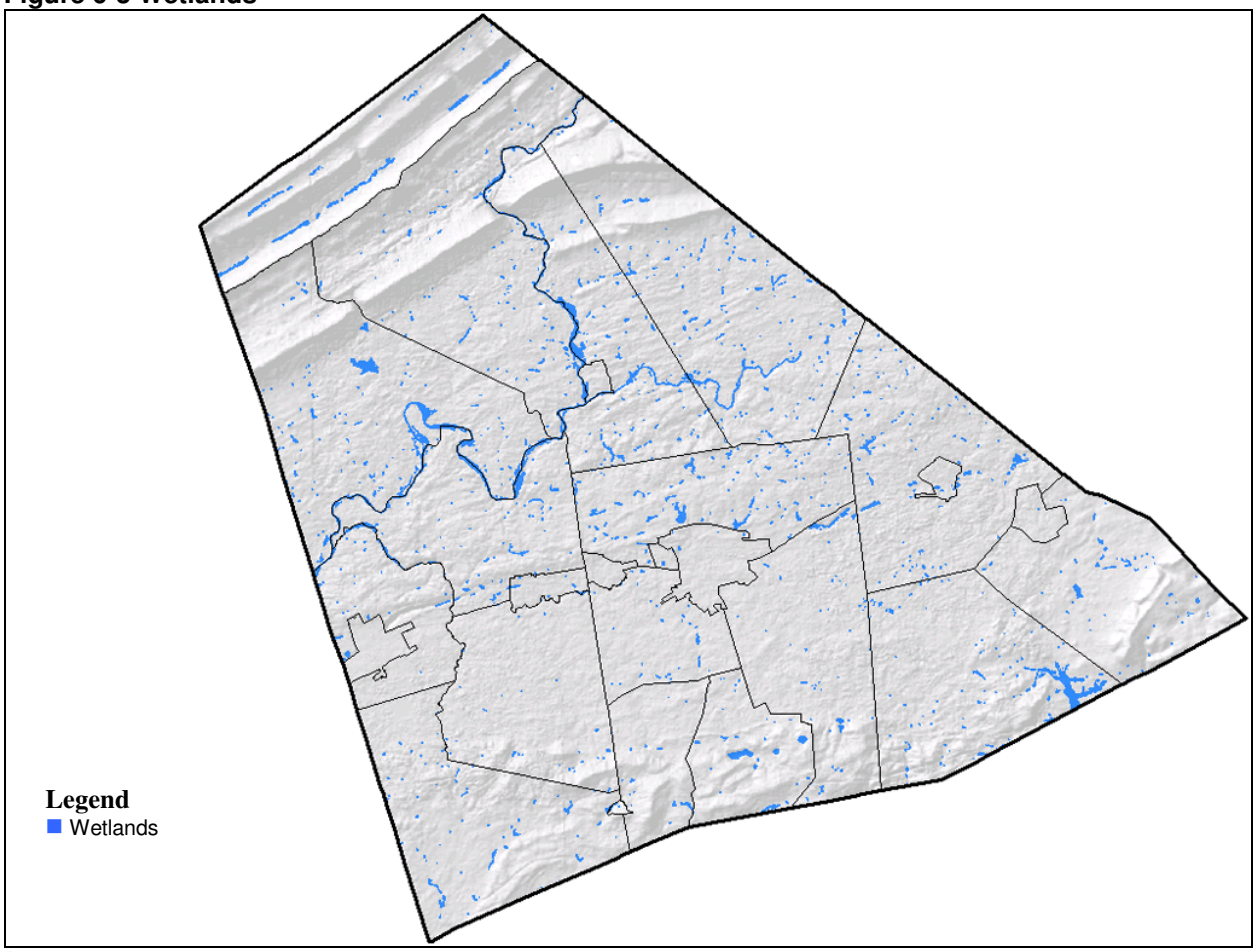
Sources: Lebanon County Conservation District; Lebanon County Soil Survey; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Areas of Lebanon County containing Prime Farmland soils and farmland of statewide importance are shown in Figure 6-2. Approximately 86,000 acres, 37% of the county's soils are considered to be Prime Farmland Soils and 46,600 acres, roughly 20% are considered to be additional farmland of statewide importance. The bulk of County's prime farmland occupies an area bounded by US-422 to the north, and US-322/PA-419 to the south. These lands are a delicate resource that should be protected. Farmland preservation in Lebanon County occurs in the form of Agricultural Security Areas and Agricultural Easements. These will be discussed further in the "Agriculture" section of this profile. Municipal regulations relating to the protection of prime agricultural soils are included in the "Municipal Regulations" Section.

Hydric Soils

In recent years, wetlands have been given increased attention as a valuable resource. One of the decisive indicators of wetlands is the presence of hydric soils. Wetlands are further discussed in the "Water Resources" section of this profile.

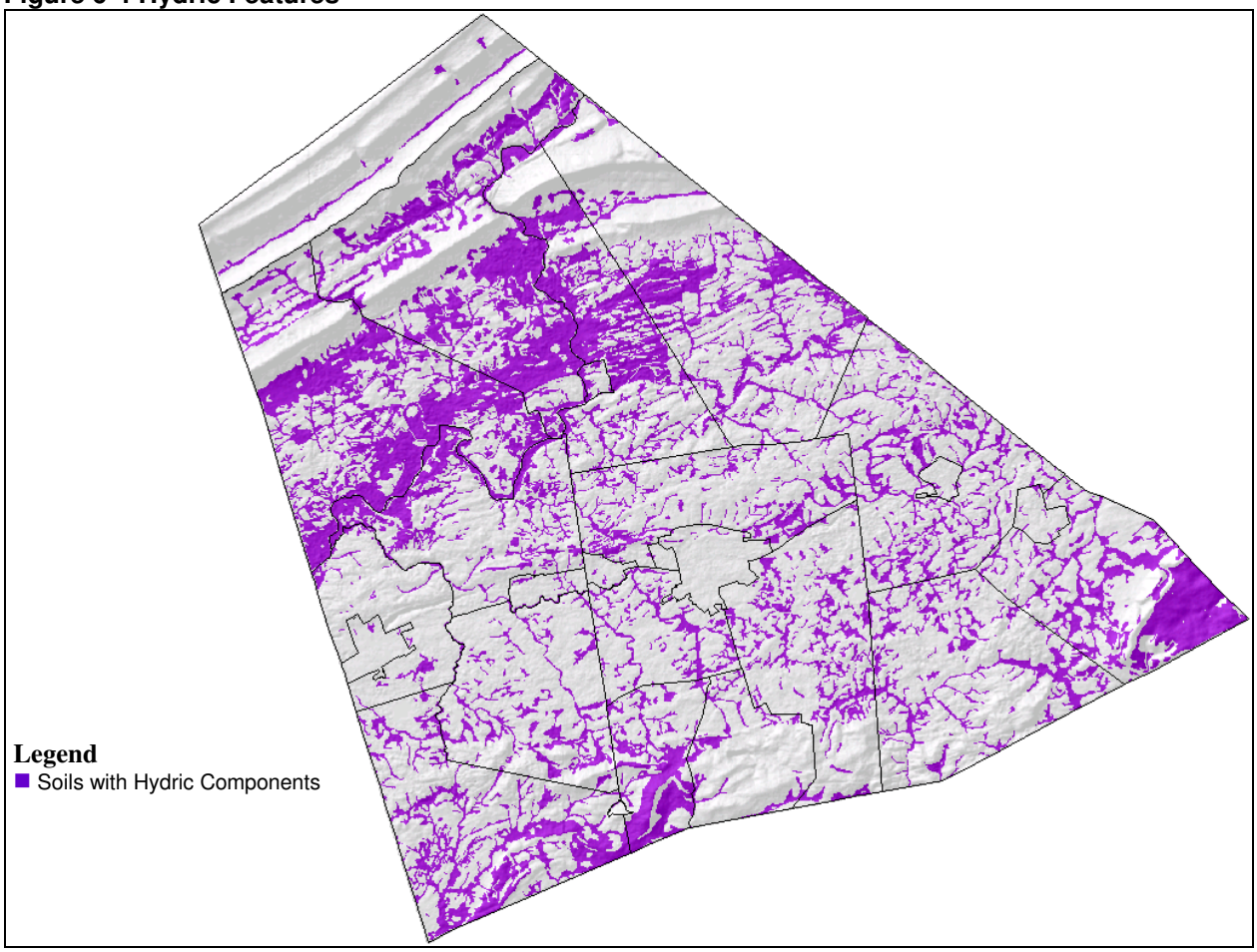
Figure 6-3 Wetlands



Sources: Pennsylvania Department of Environmental Protection; Environmental Resources Research Institute, Water Resources Division; FEMA; US Fish & Wildlife Services; Lebanon County Soil Survey; USGS; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

The USDA Natural Resources Conservation Service (NRCS) defines hydric soils as, "soils that form under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part. The concept of hydric soils includes soils developed under sufficiently wet conditions to support growth and regeneration of hydrophytic vegetation. Soils that are sufficiently wet because of artificial measures are included in the concept of hydric soils. Also, soils in which the hydrology has been artificially modified are hydric if the soil, in an unaltered state, was hydric. Some series, designated as hydric, have phases that are not hydric depending on the water table, flooding, and ponding characteristics."

Figure 6-4 Hydric Features



Sources: USGS; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

When describing hydric soils, it is helpful to know the drainage conditions of the soil. The NRCS considers soils to be *somewhat poorly drained* if water is removed slowly enough that the soil is wet for significant periods during the growing season. A soil is *poorly drained* if water is removed from the soil so slowly that the soil is saturated periodically during the growing season or remains wet for long periods of time. A soil is considered *very poorly drained* if water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season.[7]

In Lebanon County, over 61,200 acres, 26% of the county is covered with soils containing hydric components/inclusions. Areas where these soils are found are shown in Figure 6-4. It is important to recognize these locations as potential wetlands. Onsite investigation is recommended for site development planning to determine the actual field presence or absence of hydric soils, soils with inclusions, and/or wetlands. Precautions should be taken to avoid, or if necessary to mitigate, disturbance of wetlands. Municipal regulations, as well as state and federal laws, pertaining to wetlands are discussed in a latter portion of this profile.

Soil Suitability for On-Lot Sewage Disposal Systems

Soil properties also help to determine the suitability of certain lands for development and the use of on-lot sewage systems. The system facilities with specific soil requirements are septic systems with absorption fields and sewage lagoons. Septic systems with absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid waste. The lagoon floor and sides require soil material that is nearly impervious to minimize seepage and contamination of groundwater.

[7] USDA, NRCS

Table 6-2 shows the degree and kind of soil limitations that affect septic systems with absorption fields and sewage lagoons. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. The first classification (not found in Lebanon County), "not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.[8] In addition, some of soils in Lebanon County were not tested for septic potential, and are listed as "not rated."

For septic systems with absorption fields, only that part of the soil to a depth of 72 inches or a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. Saturated hydraulic conductivity (Ksat), depth to a water table, ponding, depth to bedrock or a cemented pan, and flooding affect absorption of the effluent. Stones, boulders, and bedrock or a cemented pan interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the distribution lines. In these soils the absorption field may not adequately filter the effluent, particularly when the system is new. As a result, the groundwater may become contaminated.

The main limiting factors and features of soils used in determining soils suitable for a standard on-lot disposal system (OLDS) are:

- Restricted permeability – which could limit absorption rates
- Steep slopes – which could decrease absorption and increase subsurface flow toward points of concentration
- Presence of cobbles, stones, or boulders – which could increase absorption rates
- Insufficient depth to bedrock – physical limitations to system installation
- Flooding – which could facilitate ground or surface water contamination
- The presence of high water table – which could facilitate water contamination
- Underlying cavernous limestone – which could facilitate groundwater contamination
- Hydric Soils – which are difficult to build upon and an indicator of wetlands, which are protected from development by state and federal regulations.

As discussed earlier, "Sewage lagoons" are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of groundwater. Considered in the ratings are slope, saturated hydraulic conductivity (Ksat), depth to a water table, ponding, depth to bedrock or a cemented pan, flooding, large stones, and content of organic matter.

Saturated hydraulic conductivity (Ksat) is a critical property affecting the suitability for sewage lagoons. Most porous soils eventually become sealed when they are used as sites for sewage lagoons. Until sealing occurs, however, the hazard of pollution is severe. Soils that have a Ksat rate of more than 14 micrometers per second are too porous for the proper functioning of sewage lagoons. In these soils, seepage of the effluent can result in contamination of the groundwater. Ground-water contamination is also a hazard if fractured bedrock is within a depth of 40 inches, if the water table is high enough to raise the level of sewage in the lagoon, or if floodwater overtops the lagoon.

A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor. If the lagoon is to be uniformly deep throughout, the slope must be gentle enough and the soil material must be thick enough over bedrock or a cemented pan to make land smoothing practical.

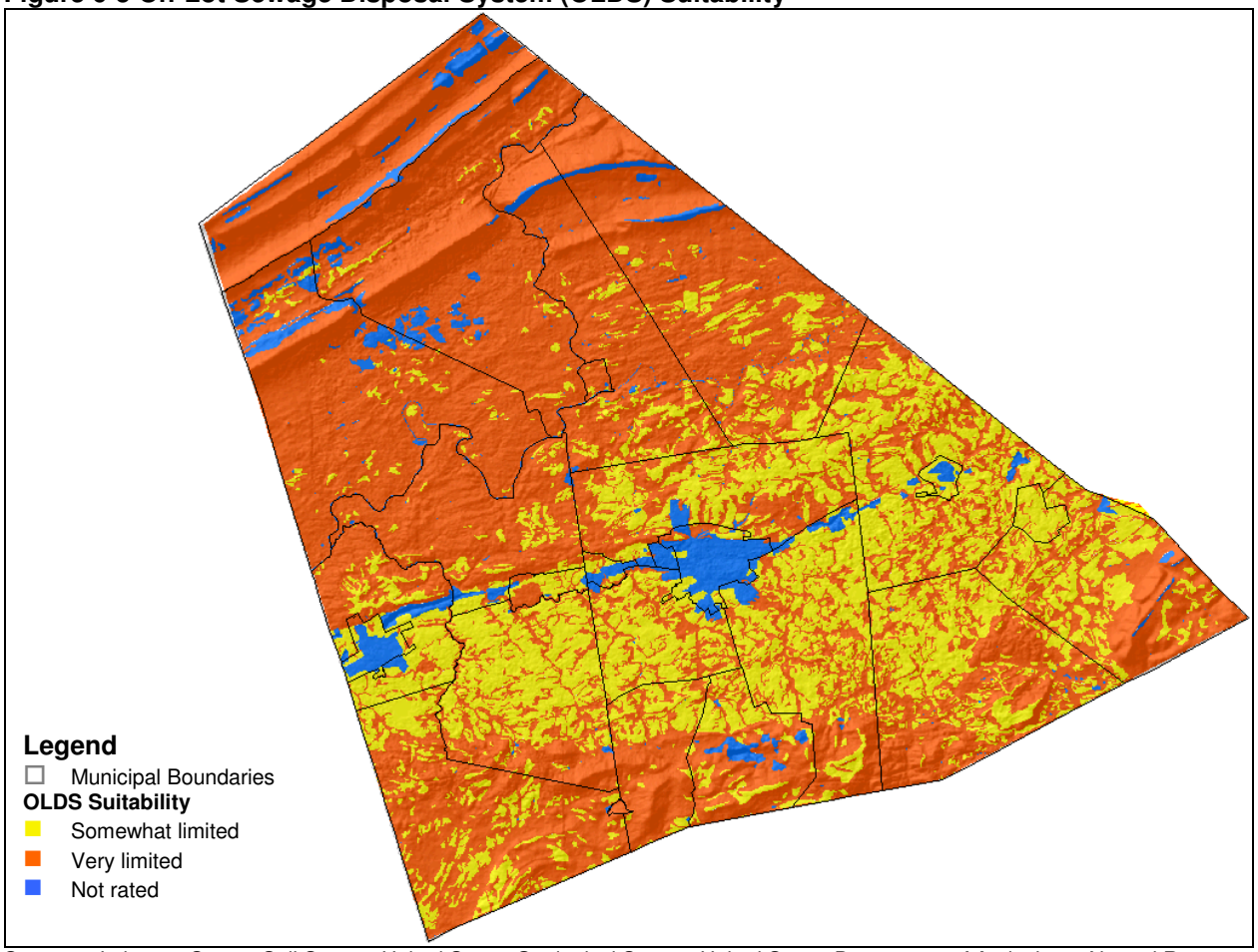
[8] United States Department of Agriculture, Natural Resource Conservation Service

Information in Table 6-4 is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil between the surface and a depth of 5 to 7 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil. The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works. More detailed information can be found in the current digital Lebanon County Soil Survey.

In Lebanon County, approximately 65%, or 150,736 acres of the county are considered "very limited" for the application of on-lot sewage disposal systems. The degree of suitability of the Lebanon County soils for an on-lot disposal system is described in Table 6-2 and depicted graphically in Figure 6-5.

There are several alternative methods to standard septic system designs that reduce the effects of limiting soil types. Alternatives include elevated sand mounds, oversized drain fields, individual spray irrigation systems, and system management. These techniques are designed to compensate for soil characteristics such as permeability which is too slow or too rapid and shallow depth to bedrock or high water table. Technology advances have allowed the Pennsylvania Department of Environmental Resources (DEP) to expand the authorized on-lot sewage system designs permitted in Pennsylvania to a matrix of conventional, alternate, and experimental sewage systems.

Figure 6-5 On-Lot Sewage Disposal System (OLDS) Suitability



Sources: Lebanon County Soil Survey; United States Geological Survey; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Table 6-3 Major Soils Groups of Lebanon County (>1% of County)

Soil Group	Acres	Percent of County
Bedington	16,077.9	6.9%
Berks	28,264.2	12.2%
Brinkerton	4,136.9	1.8%
Buchanan	2,939.4	1.3%
Clarksburg	9,120.3	3.9%
Comly	5,430.8	2.3%
Duffield	21,171.5	9.1%
Hagerstown	29,523.1	12.7%
Hazleton	9,728.0	4.2%
Hazleton and Laidig	2,922.9	1.3%
Holly	8,150.8	3.5%
Joanna	2,280.5	1.0%
Klinesville	4,042.4	1.7%
Laidig	14,191.4	6.1%
Leck Kill	4,429.7	1.9%
Neshaminy	8,754.0	3.8%
Quarries	2,396.2	1.0%
Ungers	13,968.8	6.0%
Weikert	11,636.5	5.0%

Sources: Lebanon County Soil Survey; United States Geological Survey; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Table 6-4 Major Soils of Lebanon County (>1% of County)

Symbol	Name and Description	Hydric Components	Agricultural Soil Status	On-Lot Sewage Disposal Suitability	Acres	Percent of Lebanon County
BeB	*Bedington shaly silt loam, 3 to 8 percent slopes*					
	Gently sloping, deep, well drained soil on dissected uplands with moderate permeability and moderate available water capacity.	No	All areas are prime farmland soil	Somewhat limited	11,792.7	5.08%
BkB	*Berks shaly silt loam, 3 to 8 percent slopes*					
	Gently sloping, moderately deep, well drained soil on dissected uplands with moderate to rapid permeability and very low available water capacity.	No	Farmland soil of statewide importance	Very limited	14,895.6	6.42%
BkC	*Berks shaly silt loam, 8 to 15 percent slopes*					
	Sloping, moderately deep, well drained soil on dissected uplands with moderate to rapid permeability and very low available water capacity.	No	Farmland soil of statewide importance	Very limited	8,890.4	3.83%
BkD	*Berks shaly silt loam, 15 to 25 percent slopes*					
	Moderately steep, moderately deep, well drained soil on dissected uplands with moderate to rapid permeability, very low available water capacity and rapid surface runoff.	No	Non-prime farmland soil	Very limited	2,511.5	1.08%
CkA	*Clarksburg silt loam, 0 to 3 percent slopes*					
	Nearly level, moderately well drained soil on concave areas on the uplands in the limestone valley. This soil has slow permeability and available water capacity is moderate.	Yes	All areas are prime farmland soil	Very limited	4,184.3	1.80%
CkB	*Clarksburg silt loam, 3 to 8 percent slopes*					
	Gently sloping, moderately well drained soil on concave areas on the uplands in the limestone valley. This soil has slow permeability and the available water capacity is moderate.	Yes	All areas are prime farmland soil	Very limited	4,936.0	2.13%
CmB	*Comly silt loam, 3 to 8 percent slopes*					
	Gently sloping, deep, moderately well drained and somewhat poorly drained soil on broad upland flats, in drainageways, and within areas having spring seeps. This soil has moderate permeability in the surface layer and upper part of the subsoil and moderately slow permeability in the lower part of the subsoil. Available water capacity is moderate.	Yes	All areas are prime farmland soil	Very limited	4,184.6	1.80%
DfA	*Duffield silt loam, 0 to 3 percent slopes*					
	Nearly level, deep, well drained soil on uplands in the limestone valley. This soil has moderate permeability and high available water capacity.	No	All areas are prime farmland soil	Somewhat limited	2,596.4	1.12%
DfB	*Duffield silt loam, 3 to 8 percent slopes*					
	Gently sloping, deep, well drained soil on undulating uplands in the limestone valley. This soil has moderate permeability and high available water capacity.	No	All areas are prime farmland soil	Somewhat limited	17,150.1	7.39%
HaB	*Hagerstown silt loam, 3 to 8 percent slopes*					
	Gently sloping, deep, well drained soil on undulating uplands. This soil has moderate permeability and a high available water capacity.	No	All areas are prime farmland soil	Somewhat limited	17,222.0	7.42%

Symbol	Name and Description	Hydric Components	Agricultural Soil Status	On-Lot Sewage Disposal Suitability	Acres	Percent of Lebanon County
HeC	*Hagerstown-Rock outcrop complex, 8 to 25 percent slopes*					
	Sloping and moderately steep complex on undulating uplands with moderate permeability and high available water capacity.	No	Non-prime farmland soil	Very limited	3,519.0	1.52%
HHE	*Hazleton extremely stony sandy loam, steep*					
	Steep and very steep, deep, well drained soil on ridges of mountains with moderately rapid to rapid permeability, low available water capacity, and rapid surface runoff.	No	Non-prime farmland soil	Very limited	5,948.4	2.56%
HLD	*Hazleton-Laidig association, moderately steep*					
	Extremely stony, sloping and moderately steep, deep, well drained soils on side slopes and near the ridge tops. These soils have moderately rapid to rapid permeability in the surface layer and upper part of the subsoil and moderately slow permeability in the lower part of the subsoil.	No	Non-prime farmland soil	Very limited	2,922.9	1.26%
Ho	*Holly silt loam*					
	Nearly level, deep, very poorly drained soil on floodplains of the larger, prominent creeks and narrow streams that dissect upland areas and is formed in sediment washed from uplands. This soil has moderately slow and moderate permeability and high available water capacity.	Yes	Non-prime farmland soil	Very limited	8,150.8	3.51%
LdC	*Laidig extremely stony loam, 8 to 25 percent slopes*					
	Sloping to moderately steep, deep, well drained soil on mountainsides and near ridge tops with moderate to moderately rapid permeability in the surface layer and upper part of the subsoil and moderately slow permeability in the fragipan and medium to rapid surface runoff.	No	Non-prime farmland soil	Very limited	7,844.2	3.38%
LdgD	*Laidig gravelly loam, 8 to 25 percent slopes, extremely stony*					
	No description available.	No	Non-prime farmland soil	Very limited	3,880.1	1.67%
NhC	*Neshaminy extremely stony silt loam, 8 to 25 percent slopes*					
	Sloping and moderately steep, deep, well drained soil on ridges with moderately slow permeability, moderate available water capacity, and medium to rapid surface runoff.	No	Non-prime farmland soil	Very limited	2,856.3	1.23%
Qu	*Quarries*					
	Miscellaneous area on uplands covered by surface mines from which the underlying rock has been removed. The quarry consists of the open pit and the spoil bank. The rock material mined may be limestone, coal, iron ore, quartzite, or quartzitic sandstone.	No	Non-prime farmland soil	Not rated	2,396.2	1.03%
UnB	*Ungers loam, 3 to 8 percent slopes*					
	Gently sloping, deep, well drained soil on uplands with moderate permeability and high available water capacity.	No	All areas are prime farmland soil	Somewhat limited	2,383.6	1.03%
UnC	*Ungers loam, 8 to 15 percent slopes*					

Symbol	Name and Description	Hydric Components	Agricultural Soil Status	On-Lot Sewage Disposal Suitability	Acres	Percent of Lebanon County
	Sloping, deep, well drained soil on uplands with moderate permeability and high available water capacity.	No	Farmland soil of statewide importance	Very limited	2,899.2	1.25%
UoC	*Ungers extremely stony loam, 8 to 25 percent slopes*					
	Sloping and moderately steep, well drained soil on mid and upper side slopes of ridges with moderate permeability, high available water capacity, and medium surface runoff.	No	Non-prime farmland soil	Very limited	6,604.1	2.85%
US	*Urban land-Hagerstown complex*					
	Nearly level to moderately steep complex within the limestone valley. The complex is used for houses, schools, factories, shopping centers, hospitals, other urban developments, and woods. The soils have been cut and filled, mixed, and mostly covered with asphalt or concrete to an extent that separation of soils is impossible at the scale of the soil map.	No	I Urban Land	Not rated	3,754.6	1.62%
WeB	*Weikert shaly silt loam, 3 to 8 percent slopes*					
	Gently sloping, shallow, well drained soil on tops of convex, dissected ridges and hills with moderately rapid permeability and very low available water capacity.	Yes	Non-prime farmland soil	Very limited	2,511.8	1.08%
WeD	*Weikert shaly silt loam, 15 to 25 percent slopes*					
	Moderately steep, shallow, well drained soil on convex side slopes of dissected ridges and hills with moderately rapid permeability, very low available water capacity, and rapid to very rapid surface runoff.	No	Non-prime farmland soil	Very limited	3,107.5	1.34%
WeE	*Weikert shaly silt loam, 25 to 50 percent slopes*					
	Steep and very steep, shallow, well drained soil on steeper side slopes of dissected ridges with moderately rapid permeability, very low available water capacity, and rapid to very rapid surface runoff.	No	Non-prime farmland soil	Very limited	2,416.5	1.04%

Sources: Lebanon County Soil Survey; United States Geological Survey; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Physiographic Regions and Geological Formations

Lebanon County straddles three physiographic provinces. Almost all of Lebanon County lies in sections of the Ridge and Valley Physiographic Province. The southern most part of the county is in the Gettysburg-Newark Lowland Section of the Piedmont Province. The southeastern portion of the county is in the Reading Prong Section of the New England Province.[9] The Pennsylvania Department of Conservation and Natural Resources provides descriptions of the various sections of the different physiographic provinces.

Three sections of the Ridge and Valley Province can be found in Lebanon County.

- The northern most part of the county, in and around Cold Spring Township, lies in the Anthracite Upland Section. This section consists of an upland that has low, linear to rounded hills, many of which contain strip mines, and mining waste holes. The upland is surrounded by an escarpment, a valley, and a mountain rim. The dominant rock types are sandstone, siltstone, conglomerate, and anthracite coal in narrow folds with steep limbs. The local relief ranges from low to high; elevation in this section ranges from 320 feet to 2,094 feet.

- The Blue Mountain Section of the Ridge and Valley Province is a linear ridge to the south of the Anthracite Upland Section. The Blue Mountain Section is a south limb of a broad fold formed on sandstone, siltstone, and shale, and some limestone and conglomerate. Very resistant sandstones occur at the crests of the Blue Mountain. Shales and siltstones occur on the slopes and valleys. Local relief is moderate to high. The highest elevation is 1,680 feet.

- The Great Valley Section comprises the largest portion of Lebanon County. This section lies to the south of the Blue Mountain Section. The lowland has gently undulating hills eroded into shales and siltstones on the north side of the valley and a lower elevation and flatter landscape developed on limestones and dolomites on the south side. Local relief is generally less than 100 feet, particularly in the carbonate area, but may be up to 300 feet in the shale area.

The Gettysburg-Newark Lowland Section of the Piedmont Province traverses the southern portion of the county. This section consists mainly of rolling low hills and valleys developed on red sedimentary rock. Almost all of the underlying sedimentary rock dips to the north or northwest. Many of the smaller drainageways are oriented in the direction of dip. This section is made up of sediments that were deposited in a long, narrow island basin that formed when the continents of North America and Africa separated more than 200 million years ago. Relief generally ranges from 100 to 200 feet.

The Reading Prong Section of the New England Province consists of circular to linear rounded low hills or ridges that project upward in significant contrast to the surrounding lowlands. The hills and ridges are made up of granitic gneiss, granodiorite, and quartzite. These rocks are very resistant to erosion and thus the hills and streams are steep and have a very well defined change in slope where they meet the lower and gentler slopes of adjacent sections. Elevations range from 140 to 1,364 feet.[10]

Geology

The geology of Lebanon County is varied. The youngest formations are in the northwest portion of the county, where thin bands of formations from the Pennsylvanian, Mississippian, Devonian, and Silurian Periods are present. Geologic materials from these periods are comprised of red and grey sandstone, shale, limestone, and conglomerate. Chert, flagstone, and clay are also found in at least one of these portions, and coal is found in the extreme northwestern part of the county, from the Pennsylvanian Period.

The middle part of the county contains geologic material from the Ordovician Period. This comprises the largest land area in the county. Material from this period consists of shale, limestone, dolomite, and sandstone.

The southeastern portion of the county contains rocks from the Cambrian Period and the Precambrian. Rocks from the Cambrian Period include limestone, dolomite, sandstone, shale, quartzite, and phyllite. Precambrian material includes gneiss, granite, anorthocite, metadiabase, metabasalt, metarhyolite, and marble. Precambrian material is found in the extreme southeastern corner. Also evidenced in the southern portion of the county is a small outcropping of rocks from the Ordovician and a wider band of formations from the Jurassic and Triassic Periods. Material from the Jurassic and Triassic Periods includes red sandstone, shale and conglomerate, intruded by diabase.

[9] Pennsylvania Department of Conservation and Natural Resources
[10] Ibid.

Table 6-5 Geology of Lebanon County

Symbol	Name	Carbonate	Dominant Lithology	Secondary Lithology	Acres in County	Percent
Cbs	Buffalo Springs Formation	YES	Limestone	Dolomite	8,208.69	3.5%
Cha	Hardyston Formation	NO	Quartzite	Feldspathic sandstone	1,026.60	0.4%
Clv	Leithsville Formation	YES	Dolomite	Shaly dolomite	995.38	0.4%
Cms	Millbach and Schaefferstown Formations, undivided	YES	Limestone	Dolomite	7,665.81	3.3%
Cr	Richland Formation	YES	Dolomite	Limestone	12,681.17	5.5%
Csc	Snitz Creek Formation	YES	Dolomite	Limestone	6,506.26	2.8%
Dccf	Clarks Ferry Member of Catskill Formation	NO	Sandstone	Siltstone	843.81	0.4%
Dcd	Duncannon Member of Catskill Formation	NO	Sandstone	Siltstone	964.50	0.4%
Dciv	Irish Valley Member of Catskill Formation	NO	Siltstone	Mudstone	1,762.26	0.8%
Dcsc	Sherman Creek Member of Catskill Formation	NO	Mudstone	Siltstone	3,968.43	1.7%
Dh	Hamilton Group	NO	Shale	Siltstone	2,505.95	1.1%
DSop	Onondaga Formation through Poxono Island Formation, undivided	NO	Shale	Sandstone	483.24	0.2%
Dtr	Trimmers Rock Formation	NO	Siltstone	Shale	2,455.02	1.1%
gg	Graphitic felsic gneiss	NO	Graphitic gneiss	Felsic gneiss	49.35	0.0%
gn	Felsic to mafic gneiss	NO	Felsic gneiss	Intermediate gneiss	1,723.38	0.7%
hg	Hornblende gneiss	NO	Mafic gneiss		1,335.53	0.6%
Jd	Diabase	NO	Diabase		7,131.73	3.1%
MDsk	Spechty Kopf Formation	NO	Sandstone	Siltstone	920.32	0.4%
Mmc	Mauch Chunk Formation	NO	Shale	Siltstone	5,352.67	2.3%
Mp	Pocono Formation	NO	Sandstone	Siltstone	1,417.92	0.6%
Oan	Annville Formation	YES	High-calcium limestone		1,517.64	0.7%
Oe	Epler Formation	YES	Limestone	Dolomite	9,738.08	4.2%
Oh	Hamburg sequence rocks	NO	Shale	Siltstone	68,693.80	29.6%
Ohg	Graywacke of Hamburg sequence	NO	Graywacke		9,799.46	4.2%
Ohjv	Jonestown Volcanic Suite	NO	Andesite	Metadiabase	2,268.53	1.0%
Ohl	Limestone of Hamburg sequence	YES	Limestone		3,133.92	1.3%
Ohm	Hershey and Myerstown Formations, undivided	YES	Argillaceous limestone	Limestone	5,411.72	2.3%
Ohsg	Shale and graywacke of Hamburg sequence	NO	Shale	Graywacke	2,339.23	1.0%
Om	Martinsburg Formation	NO	Shale	Siltstone	5,389.11	2.3%
Oo	Ontelaunee Formation	YES	Dolomite	Limestone	5,185.53	2.2%
Ori	Rickenbach Formation	YES	Dolomite	Chert	2,334.88	1.0%
Os	Stonehenge Formation	YES	Limestone	Conglomeratic, siliceous limestone	9,669.60	4.2%
Pl	Llewellyn Formation	NO	Sandstone	Siltstone	3,103.92	1.3%
Pp	Pottsville Formation	NO	Sandstone	Conglomerate	3,140.83	1.4%
Sb	Bloomsburg Formation	NO	Shale	Siltstone	2,429.79	1.0%
Sc	Clinton Group	NO	Shale	Limestone	1,155.75	0.5%
Ss	Shawangunk Formation	NO	Sandstone	Conglomerate	1,045.69	0.5%
St	Tuscarora Formation	NO	Quartzite	Quartzitic sandstone	837.22	0.4%
Trfl	Limestone fanglomerate	YES	Limestone congl.		717.61	0.3%
Trg	Gettysburg Formation	NO	Silty mudstone	Shale	3,051.80	1.3%
Trh	Hammer Creek Formation	NO	Sandstone	Siltstone	17,177.74	7.4%
Trhc	Hammer Creek conglomerate	NO	Quartz congl.	Sandstone	6,004.23	2.6%
Trn	New Oxford Formation	NO	Arkosic sandstone	Shale	156.14	0.1%

Source: Pennsylvania Bureau of Topographic and Geologic Survey; Department of Conservation and Natural Resources

The Influences of Physiography and Geology

The geology and physiography of Lebanon County have had an incredible influence on development patterns. The great Lebanon Valley that traverses the middle portion of the county in an east-west fashion is bound by two ridges; one to the north and one to the south. The two ridges are often barriers to development or agriculture. Steeper slopes are often more susceptible to erosion and the soils tend to become rockier as elevation increases. Land cover in these areas often includes forests and rock outcroppings. Limited mining of bituminous coal has taken place in the northernmost part of the county and the Cornwall Mine extracted iron ore in the southern portion of the county.

The valley offers better opportunities for agriculture as the soils in this area tend to be deeper and more fertile with better drainage and less rock material. The valley is also more conducive to development and more susceptible to development pressures as it is easier to build on a flatter landscape. It is often difficult to balance agriculture and development on a landscape such as this. When considering development, the location of prime agricultural soils should be considered as well as the underlying bedrock.

The Lebanon Valley is largely comprised of limestone and dolomite carbonate rock formations, as shown in Table 6-5. In Lebanon County, over 73,700 acres are underlain by carbonate rock. This accounts for over 31% of the total acreage in the county. Both of these rock types are easily eroded by groundwater and as a result, landscapes comprised of these rock types are known for having karst topography and for subsidence occurrences (See next section for definitions and further details). Formations with carbonate components cover much of the Lebanon Valley, as illustrated in Figure 6-6 in yellow shaded regions. Development in areas of karst topography and especially in areas that have experienced subsidence in the past should be discouraged and avoided if possible. Sinkhole locations and subsidence are further discussed below.

Sinkholes and Subsidence

The geology of Lebanon County lends itself to a Karst landscape. Karst features form as the limestone and dolomite rock layers are eroded by groundwater underneath, creating a void in the landscape. Common features of a karst landscape include: a presence of underground caves, a lack of surface streams and an abundance of springs and swallets or underground streams. Also prominent is evidence of sinkholes and areas of subsidence on the landscape.

In geologic terms, a sinkhole refers to a surface collapse feature on the surface of the earth. These areas are prone to flooding and require stormwater management systems, especially if the area is developed for residential, commercial or industrial purposes, to reduce the concentration of stormwater on the landscape surface. Subsidence is a term used for downward movement of surface material. Subsidence occurs where carbonate bedrock, such as limestone or dolomite, is present. Subsidence occurs when there is a drop in the water table, and thus a void to be filled in, when water is channeled from its natural course and concentrated in a single area such as downspouts that are often found on residential housing units.

Locations of sinkhole, subsidence, and closed topographic features in Lebanon County include various locations in Palmyra Borough, and along Route 422 in the Lebanon Valley. Figure 6-6 shows the location of known sinkhole subsidence that has occurred in Lebanon County as of 1995.

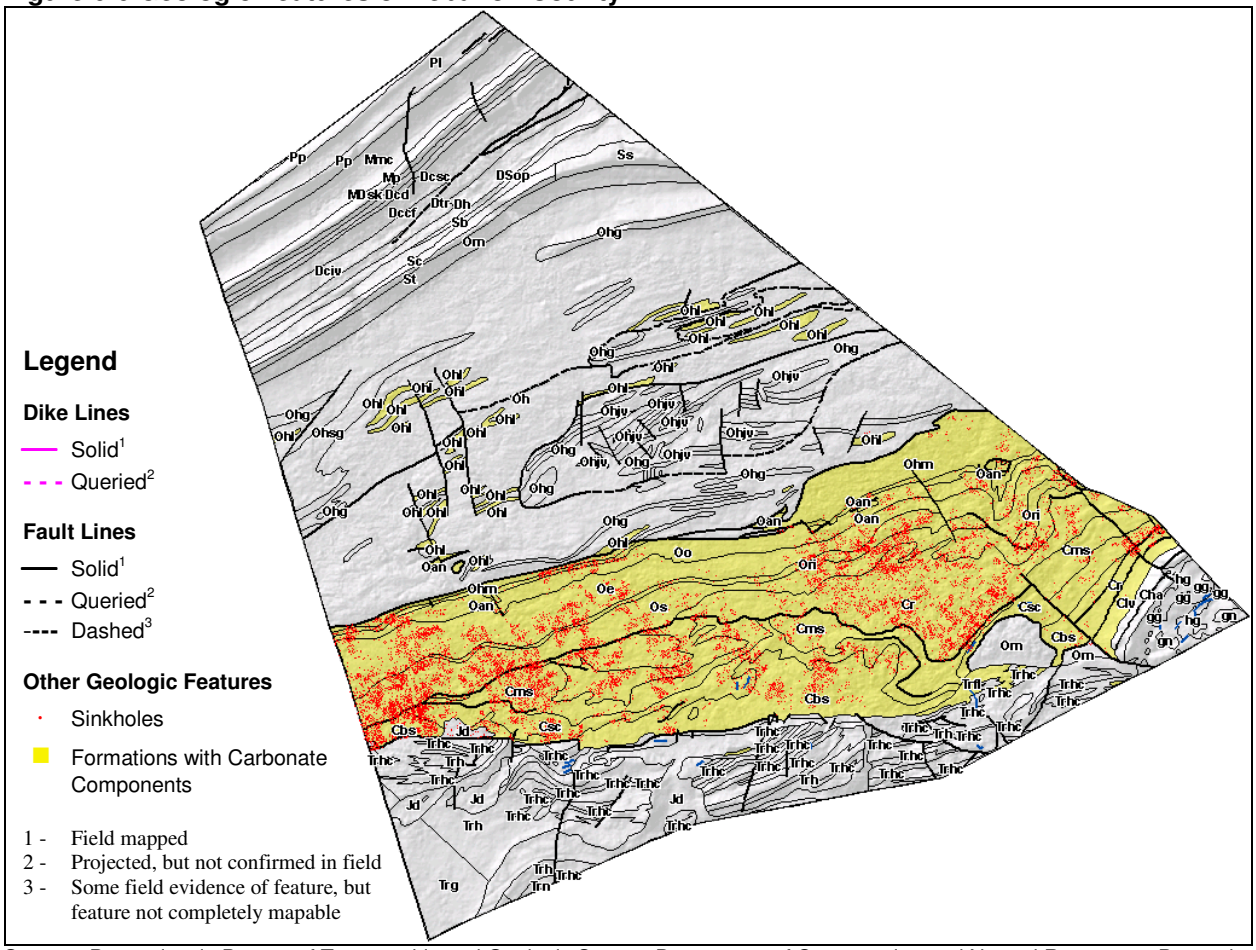
Sinkholes can be remediated to reduce the risk of sinkhole expansion. Best practices suggest that the void be filled with a tiered system of rock sizes, with large boulders at the bottom and smaller gravel toward the top covered with top soil or other surface material. This pyramid of rock soils allows the water to percolate through rather than being channeled in one area. Channeling water increases the chance for subsidence to reoccur. Locations where subsidence has occurred should be documented to ensure future uses of the land do not include residential, commercial, or industrial development.

Fault Lines

Pennsylvania has experienced earthquakes since European settlement, and as recently as the past decade. In the Commonwealth, the southeastern portion of the state has the greatest potential for seismic hazard, although this hazard is slight. Earthquakes often occur at faults, or fractures dividing rocks into two sections that have moved visibly relative to each other. Faults that are present in Lebanon County include the Sweet Arrow fault, which trends northeast to southwest. The Sweet Arrow fault extends to the eastern edge of the National Guard Training Center at Fort Indiantown Gap; however, the fault direction after that point is unknown. The Yellow Breeches thrust plate and associated faults are located along the south side of the Cantonment Area. Two other northeast-southwest trending, strike-slip faults are located south of Fort Indiantown Gap. One of these faults extends across the western end of Memorial Lake. Fault trends indicate that the faults could

potentially extend beneath Fort Indiantown Gap, and movement along these faults is possible.[11] Fault lines as well as dike lines (discordant, intrusive rock, as distinguished from the preexisting rock that surrounds it, that is substantially wider than it is thick) in Lebanon County can be seen in Figure 6-6.

Figure 6-6 Geologic Features of Lebanon County



Source: Pennsylvania Bureau of Topographic and Geologic Survey; Department of Conservation and Natural Resources; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Aquifers

The Pennsylvania Department of Environmental Protection defines an aquifer as a formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs. Hydrogeologists have identified four principle types of aquifers in the state: sand and gravel, sandstone and shale, carbonate rock, and crystalline rock. Two of these, sandstone and shale and carbonate rock aquifers can be found in Lebanon County. The carbonate rock aquifers consist of limestone and dolomite and traverse the middle portion of the county in an east-west direction. Caves, solution channels, subsidence and sinkholes are caused by water dissolving portions of the carbonate rock. Water in carbonate rock aquifers can be very hard and contain relatively large amounts of dissolved solids.[12] More detail on groundwater is presented in the following section.

[11] Draft Environmental Impact Statement for Fort Indiantown Gap; Schultz, 1999
[12] Pennsylvania League of Women Voters, *Groundwater: A Primer for Pennsylvanians*.

Water Resources

An understanding of a community's natural water resources is critical to planning for future land use and community facilities and services. Water resources provide on-lot and public water systems with domestic and commercial/industrial water supplies and recreation opportunities; support fire protection services; and have inherent value to the environment. Due to our extensive dependence on water, water is a valuable and essential resource that must be understood and managed in order to protect the health, safety and general welfare of the community. Protecting water supplies by strategically directing development to suitable areas, promoting safe use and disposal of pollutants, such as fertilizers, industrial wastes, sewage effluent from septic systems, and minimizing excessive erosion, is crucial in municipal planning. This section will present the classifications and conditions of groundwater and the impacts to groundwater from mineral extraction and agriculture; surface water and its protection status; related wetlands and floodplains; stormwater management planning; and watershed planning.

Water resources can generally be described as groundwater or surface water. Groundwater is water contained in the soils and rock formations. Groundwater is derived from precipitation that has infiltrated and percolated through the soil. After reaching the water table, groundwater slowly moves toward points of discharge, such as surface waters, springs, and man-made wells. The pumping of wells draws water from all directions, changing the natural groundwater flow. These areas of modified groundwater flow are called discharge areas. Surface water is water on the surface of the ground and consists of perennial and intermittent streams, lakes, reservoirs, ponds, wetlands, springs, natural seeps and estuaries, excluding water at facilities approved for wastewater treatment and constructed wetlands used as part of a wastewater treatment process.

Groundwater and Wellhead Protection

The Department of Environmental Protection defines groundwater as, "water beneath the surface of the ground within a zone of saturation, whether or not flowing through known and definite channels or percolating through underground geologic formations, and regardless of whether the result of natural or artificial recharge. The term includes water contained in aquifers, artesian and nonartesian basins, underground watercourses and other bodies of water below the surface of the earth." Groundwater is an extremely valuable resource and needs to be monitored closely.

Pennsylvanians ultimately depend on groundwater for drinking water. Public water companies use wells and springs to supply residents with water; residential homes, primarily in rural areas, use private wells and springs; and almost half of all Pennsylvanians get at least part of their water directly from the groundwater. In 1990, 77% of the total water used for domestic and commercial/industrial uses in Lebanon County came from groundwater.[13] Groundwater is a vital resource, and it is essential that measures are taken to ensure that it is kept clean from pollution and wisely used.

If groundwater becomes contaminated, the rate at which the substance reaches groundwater and the rate and extent at which the plume of contamination will travel and disperse depends on the thickness of the unsaturated zone and the nature of the rock itself. Groundwater can become polluted from a variety of human activities including mismanagement of on-lot sewage disposal systems, mineral extraction activities, leakage from underground tanks, and commercial agricultural production. In rural areas, nitrates and bacteria from household sewage and wastewater chemicals that are dumped into septic systems can contaminate groundwater when systems are not properly installed or maintained. Any water resource may also be threatened from a site specific hazardous materials spill or incident.

In areas of karst topography, such as exist in Lebanon County, the majority of water does not occur as surface water, but exists underground. Dissolution of the carbonate bedrock develops a subsurface drainage network along widened cracks or fractures within bedrock layers; the more interconnected and larger spaces or fractures lead to more permeable rock which water can generally pass through more quickly. Problems arise in that in any given area, it is difficult to determine exactly where this water travels underground or the rate at which it travels or what unknowingly might be added to it along the way.

Key to maintaining high-quality groundwater is wellhead protection. The Wellhead Protection Program (WHPP) is a proactive approach towards securing quality groundwater, to safeguard public health and limit the need for costly water treatment. Under the Federal Safe Drinking Water Act (SDWA), states are required to submit plans detailing their efforts to protect groundwater. In Pennsylvania, the implementation of these programs happens at the state, county and municipal levels, as well as with a variety of private stakeholders such as landowners and water suppliers.

[13] Pennsylvania Department of Conservation and Natural Resources

In Lebanon County, the implementation of a local wellhead protection program has potential for many benefits, both to public health and financially. Several components would be key to a local program, including creating a steering committee, creating an avenue for public participation, delineating wellhead protection areas (WHPAs), identifying key contaminant sources, developing management approaches, and contingency planning, including identifying future water supply sources. These programs have the potential to be implemented at the local level, though a countywide program would allow for greater resource protection across municipal lines. Water flow does not stop at township, borough and city boundaries, and as such, a comprehensive approach would have many benefits to the citizens of Lebanon County.

Wellhead protection areas can also play a key role in planning future development. The delineation of wellhead protection areas involves the considerations of many factors, such as geology, groundwater flows, and infiltration potential. As such, proper land planning, to assess both groundwater impacts and increased consumption needs, are critical to proper wellhead protection. By keeping land uses with potential negative impacts out of susceptible wellhead protection areas, and requiring best management practices in construction, industry and agriculture, the benefits can extend beyond just groundwater, and impact greater land use goals in the county.[14]

Impacts Associated with Mineral Extraction

Groundwater is essential to mining activities for product washing, sorting and refining, dust control and a variety of other activities. There are various ways in which mineral extraction pose a threat to groundwater. From a groundwater quality standpoint, removing the natural protection of the overlying strata in a working area, the groundwater is more susceptible to pollution as stormwater runoff will have less of a filtering period. This contamination may be transported by the groundwater and impact surface waters and points downstream. Large mineral extraction activities also impact the quantity of groundwater available to adjacent land uses and water filled quarries provide an opportunity for direct contamination of the groundwater.

The short and long term impacts of mineral extraction on groundwater and surface water have been so severe that the term acid mine drainage (AMD) has been defined. The Pennsylvania Department of Environmental Protection defines acid mine drainage as, “drainage flowing from or caused by surface mining, deep mining, or coal refuse piles that is typically highly acidic with elevated levels of dissolved metals.” Acid mine drainage is formed by a series of complex geo-chemical and microbial reactions that occur when water comes in contact with pyrite in coal, refuse or the overburden of a mine operation. The resulting water is usually high in acidity and dissolved metals. The metals remain in solution until the pH rises to a level where they precipitate or fall out of the water solution. The precipitates form the red, yellow, and orange sediments found on the bottom of streams containing mine drainage. The acid mine drainage can further dissolve heavy metals such as copper, lead, and mercury from adjacent soils into the ground and surface water resulting in additional contamination.[15]

Impacts Associated with Commercial Agricultural Activities

Commercial agricultural activities can also have an adverse impact on the quality of groundwater in an area. The incorrect or excessive application of fertilizers, manure, and pesticides has degraded the quality of streams and shallow groundwater in agricultural areas across the country. The United States Geological Survey’s National Water-Quality Assessment Program is assessing the sources, transport and fate of chemicals applied to crops in agricultural basins. Chemicals selected for study are nutrients, including nitrogen and phosphorus, and approximately fifty commonly used pesticides and their transformation products. The program divides its studies by drainage basin, with Lebanon County having land in the Delaware River and Lower Susquehanna studies. The Delaware River study began in 1997 and was completed in 2002, with a revised study to take place between 2008 and 2010. The Lower Susquehanna study was conducted between 1991 and 1994, and went into a low intensity phase in 1997 which continues today.

Nutrients are often elevated in agricultural areas. High levels of nitrate in drinking water can be harmful to humans and especially harmful to infants and pregnant women. Nitrates interfere with the blood’s ability to transport oxygen which causes suffocation, known as methemoglobinemia (“blue-baby” syndrome) in infants. Extreme concentrations of phosphorus promote excessive plant growth in streams with physical and chemical implications: lower levels of dissolved oxygen in the water and subsequently harm to fish and other aquatic life; clog water-intake pipes and filters; cause a foul water smell and taste from decaying plant material; and interfere with fishing, swimming, and boating.[16]

[14] Pennsylvania Department of Environmental Protection
[15] Ibid., Scottish Executive Environmental Group
[16] Unites States Geologic Survey, PA League of Women Voters

Pesticides are widely used in the agricultural industry, and commonly available in combination mixes. Across the state, it was found that pesticide concentrations are generally below United States Environmental Protection Agency drinking-water standards; however, the risk to humans and the environment from these low-level exposures is unclear, and standards do not exist for many pesticides or mixtures of pesticides. Furthermore, herbicides were found more frequently and at higher concentrations in streams and groundwater in agricultural areas than in urban areas. Insecticides that were used in the past, such as DDT, are still evidenced in streams and sediment.[17]

In considering the different kinds of contamination, it is important to note that different factors influence the contamination of ground or surface waters. Streams are most vulnerable to contamination from agricultural chemicals where poorly drained soils, agricultural practices, and topography encourage the rapid movement of water off fields, or where tile drains and ditches quickly transport agricultural runoff from fields to streams. Some chemicals readily dissolve in water bodies, while other chemicals attach to eroded soil particles carried by the water. Groundwater is typically less vulnerable to contamination by chemicals that strongly attach to soils. Chemical transport is also influenced by agricultural practices and chemical use. The use of drip irrigation rather than furrow irrigation decreases the amount of water lost to evaporation and allows more precise control of the amount and location of pesticide and nutrient applications.[18]

The water quality of the Lower Susquehanna River Basin was studied between 1992 and 1995. Major study issues and findings included the following:

- Water from wells in agricultural areas underlain by limestone and crystalline bedrock commonly exceeded the United States Environmental Protection Agency (USEPA) Maximum Containment Level (MCL) for nitrates in drinking water.
- Streams from agricultural areas underlain by limestone bedrock contributed large amounts of nitrate per unit area to the Lower Susquehanna River when compared to streams in areas with other land uses and bedrock types.
- Manure application rate may be the most important factor influencing nitrate concentrations in streams in agricultural basins underlain by limestone.
- It is unclear whether bacteriological contamination of well water is caused by inadequate protection of wells from surface runoff, septic system failure, the applying of animal manure to fields, or other causes.
- The presence of bacteria in water from rural wells is one of the most important water quality issues related to human health in the study unit.
- The fish population was influenced by agricultural activity in the agricultural settings, but the influence is related to habitat degradation rather than nutrients in the water.[19]

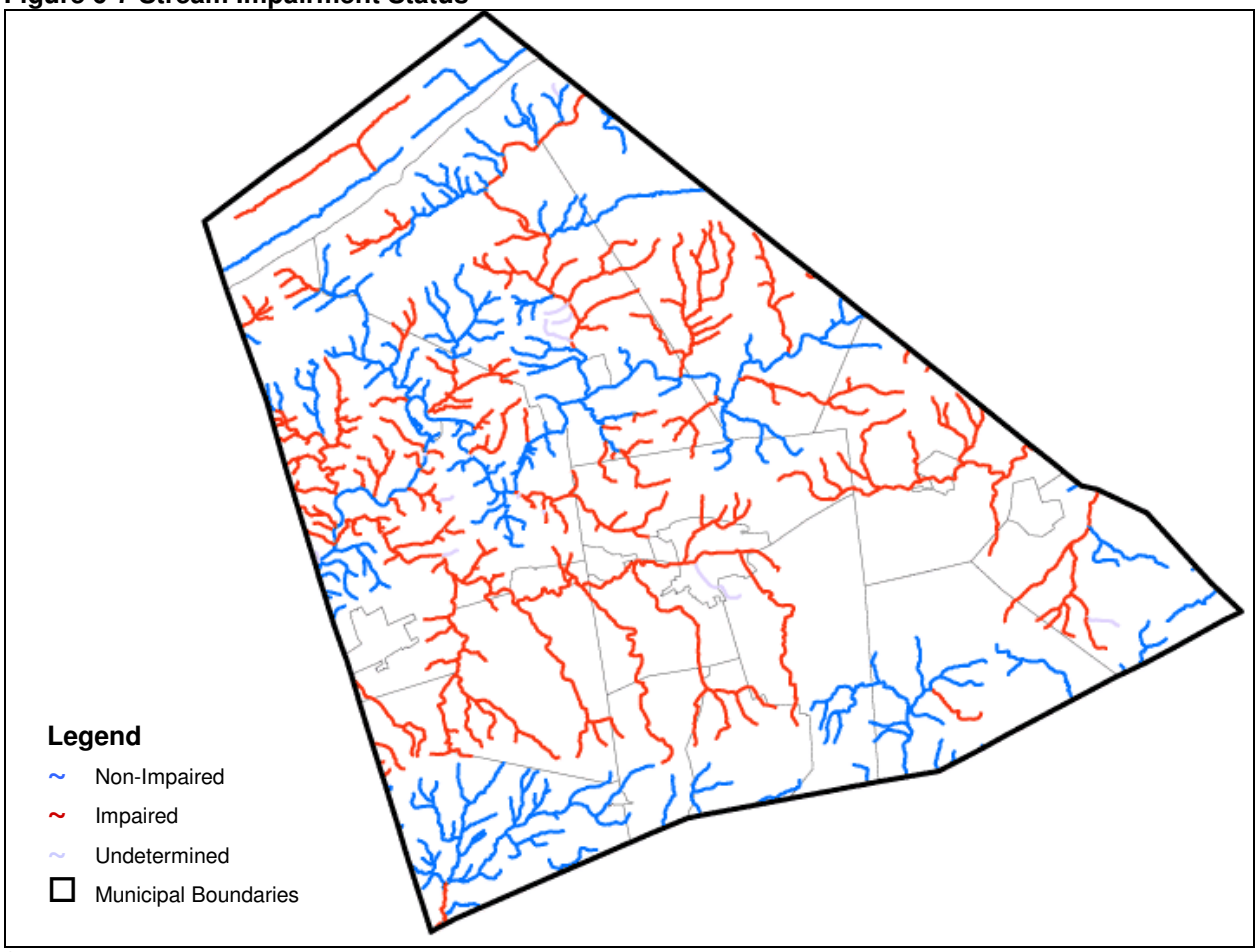
Surface Water

The Pennsylvania Department of Environmental Protection defines surface water as “water on the surface of the earth, including water in a perennial or intermittent watercourse, lake, reservoir, pond, spring, wetland, estuary, swamp or marsh, or diffused surface water, whether such body of water is natural or artificial. The term does not include recirculated process water or wastewater stored in an off-stream impoundment, pond, tank or other device unless such water or wastewater is withdrawn and used by a person other than the person who initially withdrew the water from a water resource or obtained such water from a public water supply agency.”

Surface water is also intricately connected to groundwater. The two “feed” one another, and also have the potential to contaminate one another. Run-off and ground-based pollutants often percolate into the water table, degrading groundwater. At the same time, contaminated groundwater, emerging from springs, wells and marshes can pose threats to surface water.

[17] United States Geologic Survey
[18] Ibid.
[19] Ibid.

Figure 6-7 Stream Impairment Status



Sources: Pennsylvania Department of Environmental Protection; Environmental Resources Research Institute, Water Resources Division; FEMA; US Fish & Wildlife Services; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

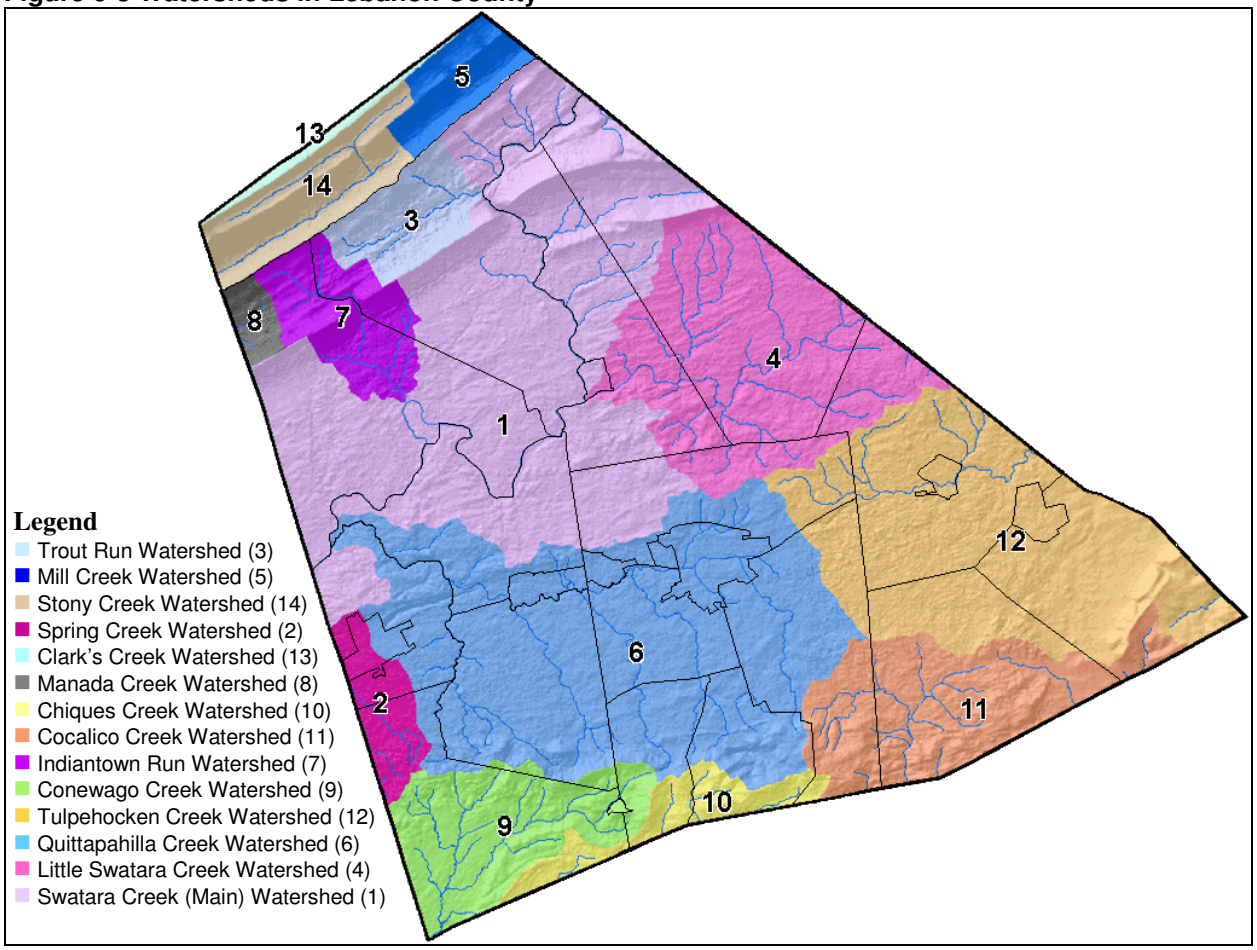
Table 6-6 Impaired Waterways in Lebanon County

Stream	Impairments
Aires Run	Agriculture/Flow Alterations, Agriculture/Siltation
Bachman Run	Agriculture/Nutrients
Beach Run	Urban Runoff/Storm Sewers/Siltation
Beck Creek	Agriculture/Nutrients
Bow Creek	Road Runoff/Siltation
Brandywine Creek	Urban Runoff/Storm Sewers/Flow Alterations
Buckholder Run	Agriculture/Flow Alterations, Agriculture/Siltation
Cocalico Creek	Crop Related Agric/Nutrients, Grazing Related Agric/Siltation, Urban Runoff/Storm Sewers/Cause Unknown
Conewago Creek	Agriculture/Nutrients
Coover Run	Crop Related Agric/Nutrients, Grazing Related Agric/Siltation
Crosskill Creek	Agriculture/Flow Alterations, Agriculture/Pathogens, Source Unknown/Pathogens
Deep Run	Agriculture/Nutrients, Agriculture/Suspended Solids, Agriculture/Siltation, Industrial Point Source/Cause Unknown, Industrial Point Source/Suspended Solids, Municipal Point Source/Nutrients
Earlakill Run	Agriculture/Nutrients
East Branch Rausch Creek	Abandoned Mine Drainage/pH
Elizabeth Run	Agriculture/Nutrients, Agriculture/Siltation, Industrial Point Source/Suspended Solids, Municipal Point Source/Nutrients, Source Unknown/Pathogens
Forge Creek	Agriculture/Flow Alterations, Agriculture/Siltation
Gingrich Run	Agriculture/Suspended Solids, Urban Runoff/Storm Sewers/Organic Enrichment/Low D.O.
Hoffer Creek	Agriculture/Nutrients, Agriculture/Siltation, Other/Other Habitat Alterations
Indiantown Run	Road Runoff/Siltation
Iron Run	Agriculture/Siltation
Killinger Creek	Agriculture/Flow Alterations, Agriculture/Siltation, Agriculture/Nutrients
Lynch Run	Agriculture/Siltation, Agriculture/Turbidity, Other/Cause Unknown
Manada Creek	Agriculture/Pathogens/Road Runoff/Siltation
Mill Creek	Agriculture/Nutrients, Agriculture/Organic Enrichment/Low D.O., Agriculture/Suspended Solids, Agriculture/Pathogens, Agriculture/Siltation, Erosion from Derelict Land/Siltation
Oil Creek	Crop Related Agric/Flow Alterations, Crop Related Agric/Siltation
Owl Creek	Agriculture/Nutrients, Agriculture/Siltation
Quittapahilla Creek	Agriculture/Flow Alterations, Agriculture/Siltation, Urban Runoff/Storm Sewers/Flow Alterations, Bank Modifications/Other Habitat Alterations, Urban Runoff/Storm Sewers/Flow Alterations
Rausch Creek	Abandoned Mine Drainage/pH
Red Run	Crop Related Agric/Flow Alterations, Crop Related Agric/Siltation
Reeds Creek	Agriculture/Flow Alterations, Agriculture/Siltation
Rife Run	Agriculture/Siltation
Snitz Creek	Agriculture/Nutrients
Spring Creek	Agriculture/Siltation, Natural Sources/Water/Flow Variability, Other/Suspended Solids, Urban Runoff/Storm Sewers/Suspended Solids
Swatara Creek	Abandoned Mine Drainage/Metals, Abandoned Mine Drainage/pH, Abandoned Mine Drainage/Suspended Solids, Agriculture/Pathogens
Trout Run	Agriculture/Nutrients, Agriculture/Siltation
Tulpehocken Creek	Agriculture/Siltation, Erosion from Derelict Land/Siltation, Urban Runoff/Storm Sewers/Siltation
Vesle Run	Road Runoff/Siltation

Sources: Pennsylvania Department of Environmental Protection

Surface water is organized into different watersheds and sub-watersheds by the topography of the landscape. The majority of Lebanon County is in the Lower Susquehanna River watershed, but a small portion of southeastern Lebanon County lies in the Delaware River watershed. The various sub-watersheds in Lebanon County can be seen in Figure 6-8; the streams that comprise them are listed in Table 6-7.

Figure 6-8 Watersheds in Lebanon County



Sources: Pennsylvania Department of Environmental Protection; Environmental Resources Research Institute, Water Resources Division; FEMA; US Fish & Wildlife Services; Lebanon County Soil Survey; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Table 6-7 Watersheds in Lebanon County

Watershed	Acres	Percent of County
Total	**232,300.1**	**100.0%**
Delaware River (Schuylkill River)	**34,112.9**	**14.7%**
Tulpehocken Creek	*34,112.9*	*14.7%*
Tulpehocken Creek (Main Branch)	20,365.4	8.8%
Furnace Creek	1,922.7	0.8%
Mill Creek	9,841.0	4.2%
Owl Creek	1,983.1	0.9%
Susquehanna River	**198,187.2**	**85.3%**
Cocalico Creek	*16,172.6*	*7.0%*
Cocalico Creek (Main Branch)	1,336.8	0.6%
Hammer Creek	9,544.3	4.1%
Walnut Run	862.7	0.4%
Middle Creek	3,087.4	1.3%
Furnace Run	634.6	0.3%
Segloch Run	683.8	0.3%
Harnish Run	23.0	0.0%
Chiques Creek	*4,828.2*	*2.1%*
Chiques Creek (Main Branch)	896.8	0.4%
Little Chiques Creek	1,460.7	0.6%
Shearer's Run	2,470.6	1.1%
Conewago Creek	*12,451.3*	*5.4%*
Conewago Creek (Main Branch)	8,417.6	3.6%
Little Conewago Creek	3,803.6	1.6%
Hoffer Creek	230.2	0.1%
Swatara Creek	*156,015.6*	*67.2%*
Swatara Creek (Main Branch)	57,761.5	24.9%
Mill Creek	4,218.7	1.8%
Spring Creek	4,240.2	1.8%
Manada Creek	1,622.0	0.7%
Indiantown Run	7,397.9	3.2%
Little Swatara Creek	25,773.1	11.1%
Quittapahilla Creek	49,472.2	21.3%
Trout Run	5,530.1	2.4%
Stony Creek	*7,465.0*	*3.2%*
Stony Creek (Main Branch)	4,816.5	2.1%
Rausch Creek	2,648.5	1.1%
Clark's Creek	*1,254.5*	*0.5%*
Clark's Creek	1,214.1	0.5%
Wiconisco Creek	40.4	0.0%

Sources: Pennsylvania Department of Environmental Protection; Environmental Resources Research Institute, Water Resources Division

Stream Gauges

Accurate and reliable gauging and bankfull discharge figures need to be developed for the various waterways in Lebanon County. Gauging is the measurement of the volume of water flowing in a stream channel. Bankfull discharge is the volume of stream flow when waters reach the top of the stream bank, i.e. the floodplain. How a stream contains its flow during high-water events has a very significant impact on the shape of the stream channel, the strata found in the stream bed, as well as the habitat and aquatic life found in the stream. This is especially important in determining the stability of the stream, and the volume of sediment that would be discharged at various times. When restoring streams, these figures help to determine the best ways to manage sediment flows and bank erosion and to identify areas where habitat is at risk or new habitats can be created.

The most reliable method for estimating bankfull discharge is an evaluation of flow records from stream gauges located in the watershed. However, when working in watersheds without stream gauges, regional regression equations that relate drainage area to bankfull discharge can be developed by conducting field calibration surveys at stream gauges in adjacent watersheds or other watersheds with the same physiographic characteristics.

A watershed and stream gauge survey was sent to the watershed associations in Lebanon County. The following stream gauge sites were identified:

Quittapahilla Creek Watershed

Bachman Run
Beck Creek
at Bellegrove Road and Snyder Road

Forge Creek Watershed

Christian Seigrist/Highbridge Reservoir
Indianhead Reclamation

Indiantown Run Watershed

Killinger Creek
Lebanon Highbridge Reservoir

Manada Creek Watershed

Quittapahilla Mouth

Querg Run Watershed

Snitz Creek
Middle Creek Stream Reclamation

Trout Run Watershed

WQN211 (Testing site at the mouth of Swatara Creek)

USGS Gauges (Pine Grove, Inwood, Harper's Tavern, Hershey)

Protected Status of Streams

Chapter 93 of the Pennsylvania Code provides stream classifications which include Trout Stocking Fisheries (TSF), Cold Water Fisheries (CWF), Warm Water Fisheries (WWF), High Quality Waters (HQ), and Exceptional Value Waters (EV). Trout Stocking, Warm Water Fishery, and Cold Water Fishery classifications are based on the maintenance or propagation of the fish species, or both, and the flora and fauna native to their habitat. The Special Protection Waters, High Quality and Exceptional Value classifications are to be maintained and protected based on the chemical and biological water quality standards established for these classifications. High Quality and Exceptional Value waters are surface waters having quality which exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water. The difference between the two is Exceptional Value waters are to be protected at their existing water quality because they have outstanding recreational or ecological values. High Quality waters are also to be protected, but their water quality can be lowered if a discharge is a result of necessary social and economic development and all in-stream uses are protected. In other words, Exceptional Value classification mandates a higher level of protection than the High Quality classification. The protected status of streams in Lebanon County is shown in Table 6-8.

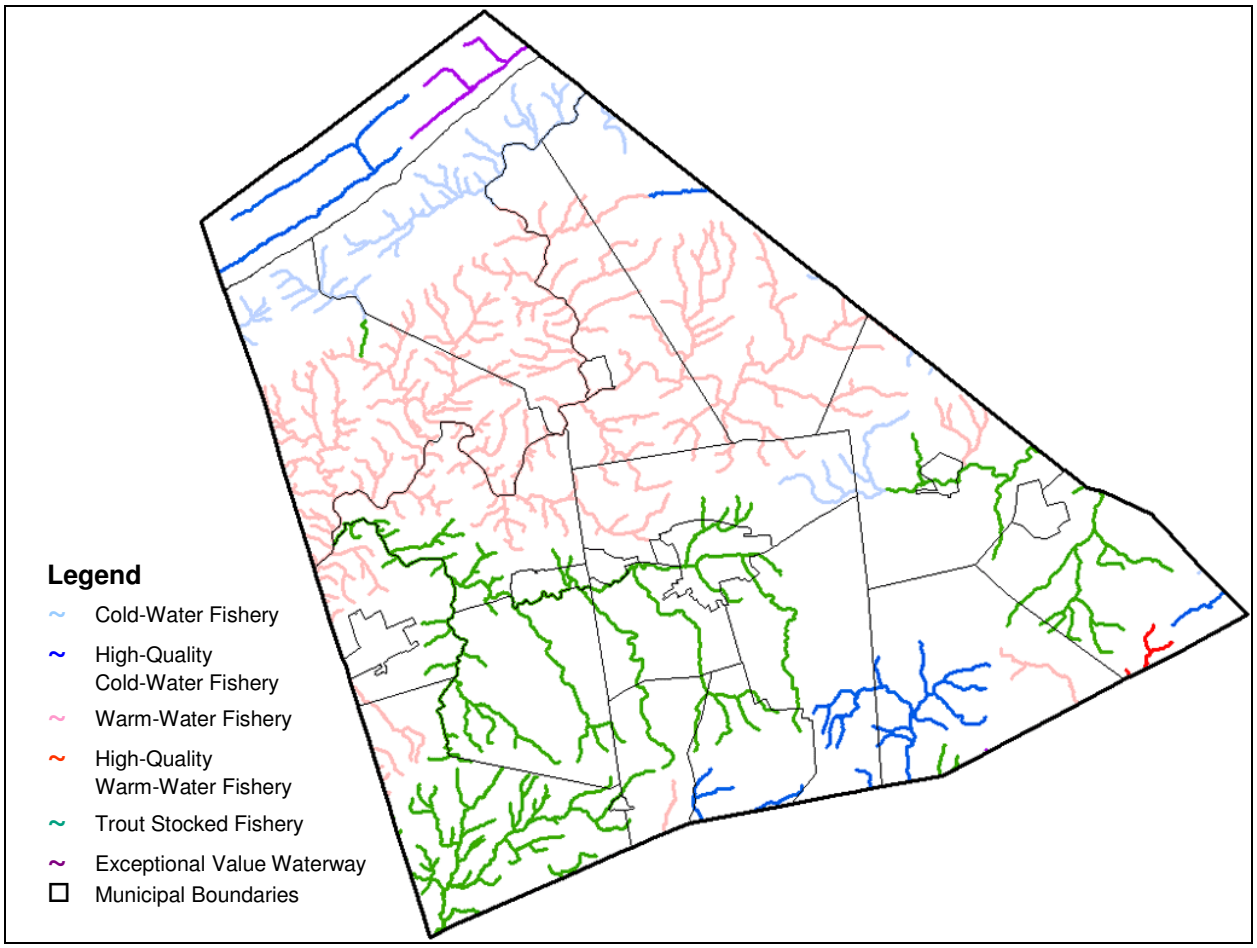
Table 6-8 Protected Status of Streams in Lebanon County

Name	Zone	Protected Water Uses
Cocalico Creek	Basin, source to Lancaster County	High-Quality Cold-Water Fishery
Furnace Creek	Basin, source to Berks/Lancaster County	High-Quality Cold-Water Fishery
Hammer Creek	Basin, source to Lancaster County	High-Quality Cold-Water Fishery
Indiantown Run	Source to Inlet of Marquette Lake	Cold-Water Fishery
Indiantown Run	Inlet of Marquette Lake to Inlet of Memorial Lake	Stocked Trout Fishery
Indiantown Run	Inlet of Memorial Lake to Mouth	Warm-Water Fishery
Little Swatara Creek	Source to Berks-Lebanon County Line	Cold-Water Fishery
Little Swatara Creek	Berks-Lebanon County Border to Mouth	Warm-Water Fishery
Mill Creek	Source to City of Lebanon Authority Dam (Schuylkill County)	Exceptional Value Waterway
Mill Creek	City of Lebanon Authority Dam to Mouth (Schuylkill County)	Cold-Water Fishery
Monroe Creek	Source to tailwaters of Lake Strause	High-Quality Cold-Water Fishery
Monroe Creek	Lake Strause Dam to Mouth	Warm-Water Fishery
Owl Creek	Basin	Warm-Water Fishery
Quittapahilla Creek	Basin	Stocked Trout Fishery
Segloch Run	Basin, source to Lancaster County	Exceptional Value Waterway
Shearers Creek	Basin, source to Lancaster County	High-Quality Cold-Water Fishery
Stony Creek	Basin, source to Dauphin County	High-Quality Cold-Water Fishery
Swatara Creek	Mill Creek to Proposed Swatara Gap Dam	Cold-Water Fishery
Swatara Creek	Main stem, proposed Swatara Gap Dam to mouth	Warm-Water Fishery
Unnamed Tributaries to Chiques Creek	Basins (Lebanon and Lancaster Counties)	Warm-Water Fishery
Unnamed Tributaries to Swatara Creek	Proposed Swatara Gap Dam to Mouth	Warm-Water Fishery

Source: Pennsylvania Code, Chapter 93

The Pennsylvania Fish and Boat Commission maintains a list of the state's Class A Wild Trout Streams. These are streams which "support a population of naturally produced trout of sufficient size and abundance to support a long-term and rewarding sport fishery." Shearers Run in Lebanon and Lancaster Counties is listed as a Class A Wild Trout Stream. Wild Brown Trout can be found from the headwaters downstream to the powerline near the county line, a total length of 1.7 miles.

Figure 6-9 Chapter 93 General Water Quality Criteria



Sources: Pennsylvania Department of Environmental Protection; Environmental Resources Research Institute, Water Resources Division; FEMA; US Fish & Wildlife Services; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Wetlands

The Pennsylvania Department of Environmental Protection, the United States Environmental Protection Agency, and the United States Army Corps of Engineers define wetlands as, "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas"[20]. Wetlands are identified by hydric soils, hydrophytic vegetation, and the presence of water during the growing season. Wetlands in Lebanon County can be seen in Figure 6-3.

Wetlands are important for a number of reasons. They provide habitat for most threatened and endangered species. Wetlands provide food for game fish and other animals, as well as nesting birds. They function to reduce flooding by absorbing additional waters and slowing the pace of water to neighboring creeks and streams. Wetlands also act to buffer creeks and streams from excessive erosion and sedimentation. The following listing outlines several other socioeconomic values and environmental functions of wetlands.

[20] Pennsylvania Code 93.1

Socioeconomic Values
- Flood Control
- Erosion Control
- Groundwater Recharge
- Recreation
- Aesthetics
- Education/Research

Environmental Quality Values
- Sediment Removal
- Oxygen Production
- Nutrient Recycling
- Chemical and Nutrient Absorption
- Aquatic Productivity

Wildlife Values
- Habitats or landscapes for fish, waterfowl, birds, mammals, plants, insects, and other forms of wildlife.

Forested Wetlands (approximately 1,082 acres within Lebanon County) are wetlands dominated by woody vegetation. Forested Wetland includes seasonally flooded bottomland hardwoods, and wooded swamps including those around bogs. Wooded swamps and floodplains contain primarily ash (*Fraxinus*), alder (*Alnus*), willow (*Salix),* tupelo (*Nyssa*), oaks (*Quercus)*, and red maple (*Acer rubrum*). These wetlands are of particular value to amphibian species, which depend on an interface between aquatic and land environments.

Nonforested/Emergent Wetlands (approximately 685 acres within Lebanon County) are dominated by wetland herbaceous vegetation or are nonvegetated. These wetlands are comprised of marshes and nonvegetated flats as well as flooded meadows, and open bogs. Both narrow-leaved emergents such as cattail (*Typha*), bulrush (*Scirpus*), sedges (*Carex*), sawgrass (*Cladium*) and other grasses (for example, *Panicum* and *Zizaniopsis miliacea*), and broad-leaved emergents such as waterlily (*Nuphar, Nymphea*), pickerelweed (*Pontederia*), arrow arum (*Peltandra*), arrowhead (*Sagittaria*), and water hyacinth (*Eichhornia crassipes*),can be found in nonforested/emergent wetlands. Additionally, flora such as mosses (*Sphagnum*) and sedges (*Carex*) may also be present.

Lebanon County's landscape encompasses a number of free-flowing watercourses which overflow their banks on occasion. Normally dry land subject to temporary inundation by water from these watercourses or the unusual and rapid accumulation or runoff of surface waters from any source is called a floodplain and is generally measured by the frequency of its occurrence (e.g. 100 year, 500 year, etc.). The Federal Emergency Management Agency (FEMA) is the agency responsible for floodplain designation and management and has chosen the 100 year flood as its base flood. FEMA also oversees the National Flood Insurance Program (NFIP), which provides subsidized flood insurance to property owners located in the floodplain.

Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage and preventing new development from occurring in flood prone areas. These measures take a variety of forms and generally include zoning, subdivision, or building requirements, and special-purpose floodplain ordinances at the municipal level. In Pennsylvania, the Department of Community and Economic Development (DCED) provides assistance to local municipalities in their floodplain management programs and compliance with the NFIP. In Lebanon County, the Planning Department has been instrumental in developing model regulations and assisting communities to adopt floodplain management regulations which meet NFIP guidelines.

Adequate floodplain management is crucial to municipalities that have extensive floodplain areas. Preserving floodplain areas from development disturbances minimizes potential damages to property and risk of injury due to extensive flooding. Allowing the floodplain areas to remain in their natural state will also minimize any major changes to the balance of the hydrologic system and provide a protective buffer to the waterways, thereby reducing pollutant levels which may reach the waterway. The unplanned encroachment of structures and land filling activities in floodplain areas has the potential of reducing the floodplain land area and water carrying capacity, thus increasing water heights, velocities, and flood hazards in areas beyond these encroachments. Incorporating conservation areas in the landscape along watercourses will be effective in preserving floodplain areas. A community's agreement to adopt and enforce floodplain management ordinances, particularly with respect to new construction, is an important element in making flood insurance available to home and businesses owners. Additionally, communities can mitigate risk by reclaiming floodplains as older homes deteriorate or are destroyed by flooding with substantial damage. Municipalities that enforce floodplain ordinances are listed in the Municipal Regulations section of this profile.

In Lebanon County, approximately 14,100 acres of land are considered to be in the 100-year floodplain or the floodway. This accounts for over 6% of the total land area in the county. Floodplains in Lebanon County can be seen in Figure 6-12 and appear in much more detail on FEMA maps and municipal zoning maps. The success of Lebanon County's floodplain management program has been evident after recent flood events as the county has not experienced significant flood damage because it has instituted floodproofing measures and restricted substantial improvements whenever possible in existing structures and has prohibited new development from occurring in flood prone areas.

MS4 Stormwater Management Areas

Stormwater runoff is often transported by municipal Separate Storm Sewer Systems (MS4s) and ultimately discharged into local rivers and streams without treatment. A municipal separate stormwater system is a conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains) that channels and discharges water from rain events to the natural waterways.

In 1990, the EPA established Phase I of the National Pollutant Discharge Elimination System (NPDES) stormwater program. The Phase I program for MS4s requires operators of "medium" and "large" MS4s, those that generally serve populations of 100,000 or greater, to implement a stormwater management program as a means to control polluted discharges from these MS4s. Phase II, initiated in 2003, extends coverage of the NPDES stormwater program to certain small MS4s. A small MS4 is any MS4 located within U.S. Census defined Urbanized Areas and not already covered by the Phase I program as well as selected MS4s located outside of urban areas.

Phase II Rule establishes an MS4 stormwater management program that is intended to improve the nation's waterways by reducing the quantity of pollutants that stormwater carries into storm sewer systems during storm events. Common pollutants include oil and grease from roadways, pesticides from lawns, sediment from construction sites, and litter. These pollutants can impair the waterways, discouraging recreational use of the resource, contaminating drinking water, and interfering with fish and wildlife habitat.

The County of Lebanon and nineteen of its municipalities are required to apply for NPDES permits and develop a plan for their small MS4s. The county does not contain any medium or large MS4 permit municipalities. Operators of regulated small MS4s are required to design their programs to:

- Reduce the discharge of pollutants to the "maximum extent practicable"
- Protect water quality
- Satisfy the appropriate water quality requirements of the Clean Water Act.

Federal regulations establish six categories of minimum control measures with specific annual goals and an implementation schedule:

- Public Education and Outreach
- Public Participation and Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post Construction Stormwater Management
- Pollution Prevention and Good Housekeeping for Municipal Operations and Maintenance.

The following municipalities in Lebanon County are required to implement MS4 management systems: Cleona Borough, Cornwall Borough, East Hanover Township, Jackson Township, Jonestown Borough, Lebanon City, Myerstown Borough, North Annville Township, North Cornwall Township, North Lebanon Township, North Londonderry Township, Palmyra Borough, South Annville Township, South Lebanon Township, South Londonderry Township, Swatara Township, Union Township, West Cornwall Township, and West Lebanon Township. The Lebanon County Planning Department has assisted county municipalities in implementing these regulations.

Municipalities within Lebanon County that are not required to implement an MS4 stormwater management program are: Annville Township, Bethel Township, Cold Spring Township, Heidelberg Township, Millcreek Township, Richland Borough and Mount Gretna Borough.

Watershed Planning

Several watershed groups and organizations, working at various watershed and sub-watershed levels, are active in Lebanon County. They have performed studies on their respective watersheds that analyze the environmental conditions and sustainability, as well as existing problems or remediation strategies that are currently taking place. The studies were reviewed in preparation for this profile and are described below. The watersheds of Lebanon County can be seen in Figure 6-8.

The Stormwater Management Act (No. 167) of 1978

The Stormwater Management Act (No. 167) of 1978 requires that the following policy and purpose be implemented by counties of the Commonwealth:

(1) Encourage planning and management of stormwater runoff in each watershed which is consistent with sound water and land use practices.
(2) Authorize a comprehensive program of stormwater management designated to preserve and restore the flood carrying capacity of Commonwealth streams; to preserve to the maximum extent practicable natural stormwater runoff regimes and natural course, current and cross-section of water of the Commonwealth; and to protect and conserve groundwater and groundwater recharge areas.
(3) Encourage local administration and management of stormwater consistent with the Commonwealth's duty as trustee of natural resources and the people's constitutional right to the preservation of natural, economic, scenic, aesthetic, recreational and historic values of the environment.
(4) Prepare and adopt watershed plans for each designated watershed. Each municipality within the watershed is to be represented on a plan preparation advisory committee.
(5) Within six months of the watershed plan adoption, all affected municipalities are required to amend local ordinances (zoning, subdivision, etc.) to comply with the watershed plan.
(6) The PADEP is to publish guidelines and model ordinances for county and municipal use during this process.
(7) State grants (up to 75%) are available from the PADEP for approved watershed planning activities.

The PADEP has designated eight watersheds within Lebanon County, as follows:
(1) Quittapahilla Creek
(2) Tulpehocken Creek
(3) Swatara Creek
(4) Spring Creek
(5) Cocalico Creek
(6) Conewago Creek
(7) Little Chiques Creek
(8) Stony Creek

According to Act 167, each county must prepare a stormwater management plan for each of its designated watersheds in consultation with the municipalities located within the boundaries of the watershed. The main objective of a stormwater management plan is to control stormwater runoff on a watershed-wide basis rather than on a site-by-site basis, taking into account how development in any part of the watershed will affect stormwater in all other parts of the watershed. Of the eight designated watersheds in Lebanon County, only two have approved Act 167 Stormwater Management Plans at the time of the Plan. The following provides a brief outline of these studies:

Tulpehocken Creek Watershed Act 167 Stormwater Management Plan

The Tulpehocken Creek watershed straddles Lebanon and Berks Counties. It lies in the southeast portion of Lebanon County in all or parts of the following municipalities: Heidelberg Township, Jackson Township, Millcreek Township, Myerstown Borough, North Lebanon Township, Richland Borough, and South Lebanon Township. The Lebanon County municipalities are principally within the headwaters of the watershed. The 23 municipalities within Berks and Lancaster Counties are primarily downstream, along the main watercourses and involve confluence areas. All of the municipalities within the watershed that administer their own subdivision/land development ordinances are required to adopt the Tulpehocken Creek Stormwater Management Plan as a regulatory document.

The plan is composed of three volumes. Volume I provides an overview of Act 167 with a summary of the standards and criteria. Volume II consists of the Plan Report (GIS maps and Model Ordinance). Volume III contains the background technical materials (supporting data, watershed modeling parameters and runs, as well as peak flows, release rates, the existing municipal ordinance matrix, and obstructions inventory). The plan preparers utilized the Penn State Runoff Model (PSRM), calibrated by streamflow, rain gauge and local data. Four watershed districts were identified with varying stormwater control criteria established for each, as well as exemptions for small scale projects.

In addition to these guidelines, five main objectives in addressing stream bank erosion, flooding, water quality, groundwater recharge, and stormwater management measures on development sites were created:

- Implement non-point source pollution removal methodologies;
- Maintain groundwater recharge;
- Reduce channel erosion;
- Manage overbank flood events; and
- Manage extreme flood events.

The affected municipalities within Lebanon County have revised their ordinances at the local and county level to comply with the Tulpehocken Creek Plan.[21]

Cocalico Creek Act 167 Stormwater Management Plan

The Cocalico Creek Watershed is located in the northern portion of Lancaster County, the southern part of Lebanon County, and parts of Berks County. The Cocalico Creek flows into the Conestoga River, draining a watershed area of approximately 140 total square miles; 25 sq. miles are in Lebanon County. Municipalities in Lebanon County that are in the Cocalico Creek Watershed include: Cornwall Borough, Heidelberg Township, Millcreek Township, and South Lebanon Township. Portions of the watershed are developed, but vast areas are still undeveloped with a potential for extensive growth under existing zoning. The effects of this potential growth and development on drainage, flooding, and erosion problems are a major concern for municipal officials and affected property owners. The watershed is acknowledged to be 32% underlain by carbonate rock (limestone and dolomite) which commonly facilitate sinkhole formation. This karst topography is hazardous for groundwater infiltration. The plan was prepared utilizing a calibrated version of the TR20 (SCS method) to model the watershed. A total of 107 subwatersheds were identified and modeled.

With implementation of the plan, the 100-year flood elevation at a particular site should be no higher nor wider in the future than it is now. This plan's effectiveness hinges on adherence to its proposed guidelines. These guidelines include certain performance standards for the control of stormwater runoff, listed here:

- *Match Pre-existing Hydrograph*: Developers and / or landowners are encouraged to provide infiltration facilities or utilize other techniques so that the post-development hydrograph will match the pre-existing hydrograph for the site. This option is most feasible for small subdivisions in areas of non-carbonate geology.
- *Groundwater Recharge Standard*: Stormwater management measures such as porous pavement with underground infiltration beds and infiltration/recharge structures or Best Management Practices (BMPs) can be designed to promote groundwater recharge. Minimum requirements for BMPs are listed.
- *Water Quality Standard*: Pollutants accumulate on impervious surfaces between rainfall events or during dry weather. Pollutant concentrations in runoff from developed land tend to be greatest at the beginning of the storm event, or the "first flush" of runoff. It has been found that 80% to 90% of rainfall events are 1.2 inches or less, and essentially simulate this "first flush." The majority of the nonpoint source pollutants, therefore, are being washed into streams during the smaller storms. Capturing this first flush and/or smaller storms will allow the stormwater to be detained and will allow pollutants to settle, thus allowing a cleaner outflow. Criteria are established to achieve this goal.
- *Description of the Performance Standard Districts*: It was found during the watershed study that a release rate of 50% of the pre-existing flow rates in all areas provided results which were not significantly different than any variable release rate scenario. The variable release rate scenarios evaluated for this basin indicated that most of the development potential of the basin exists around the edges of the watershed.

[21] Tulpehocken Creek Watershed Stormwater Management Plan.

- *Sub-Regional (Combined Site) Storage*: The goal should be the development and use of the most cost effective and environmentally-sensitive stormwater runoff controls which significantly improve the capability and flexibility of land developers and communities to control runoff consistent with the Cocalico Creek Management Plan.
- *No Harm Option*: For any proposed development, the developer has the option of using a less restrictive runoff control if the developer can prove that "no harm" would be caused by discharging at a higher runoff rate than that specified by the plan.

The four Lebanon County municipalities within the Cocalico Creek watershed have revised local and county ordinances to be consistent with the Plan requirements.

To summarize, Lebanon County Planning Department and local municipalities have amended their subdivision and land development ordinances to:

(1) Adopt required criteria for the Tulpehocken and Cocalico Creek watersheds; and
(2) Extend water quality standards, infiltration requirements, best management practices, and other PADEP stormwater management guidelines to the remainder of the county under the jurisdiction of the County ordinances.

Swatara Creek Watershed River Conservation Plan

The 571 square miles of the Swatara Creek Watershed originates in Schuylkill County and travels in a south – southwest direction through Schuylkill, Berks, Lebanon, and Dauphin Counties arriving at its confluence with the Susquehanna River in Middletown, Dauphin County. Just over 42% of the total watershed is found within Lebanon County or approximately 244 square miles.

The creek was a significant transportation route in the colonial period of North America up through the middle 19th century. The Union Canal, an early public works project conceived by William Penn in the 1690s and begun in 1792 to connect the Susquehanna and Delaware rivers, followed the lower course of the river below Quittapahilla Creek. The upper course above Quittapahilla Creek into the mountains provided the route of a feeder to the main canal, as well as providing a route to ship anthracite from the mountains to Philadelphia.

Water quality within the watershed has shown improvement over the last few decades, though there are many opportunities to better the Swatara's water quality. Much of the improvements have resulted from the mitigation of non-point pollution generated from anthracite coal mines to the north. While this is encouraging, significant growth of residential land use (up from 179,500 in 1960 to 252,300 in 1990) presents new challenges. In response to these the Swatara Creek Watershed Association was formed with the mission "to promote the conservation of the natural resources of the Swatara Creek Watershed by conducting scientific investigations and research, disseminating information, conducting educational programs, sponsoring conservation projects and all activities incidental thereto."

The Swatara Creek Watershed River Conservation Plan was designed to be a comprehensive document that outlines both natural and man-made resources of the watershed; identifies the challenges and problems of the watershed; and presents alternative solutions and strategies for preserving and protecting the watershed resources. The plan was completed in 2000 and determined management options to address the opportunities within the watershed and issues relating to water quality, population growth, land use within the watershed, Swatara Creek State Park, and the Swatara Greenway.

Much of the plan's goals involve state, county and municipal land use considerations in the watershed. At the state level, the plan encourages readers to show support for legislation to clean brownfield areas, limit point and non-point pollution, protect endangered species, support recycling efforts, and agricultural preservation. The plan encourages the comprehensive planning process at the local and county level to set proper goals for resource conservation and utilize environmentally conscious land use controls along the Swatara and its tributaries, especially floodplain management. The plan promotes effective sewer management through Act 537 planning, transportation and population impact studies, and forming partnerships with local school districts and universities for stream rehabilitation and education. At the grassroots level the plan seeks to hold watershed wide cleanup days, promote best management practices in local agriculture, conduct regular water quality testing, propagate riparian buffers, educate the public to the threats of non-native species, and make the stream corridor more user friendly.[22]

[22] Swatara Creek Watershed Association

Quittaphilla Watershed Association

The Quittaphilla Watershed Association was established in 1997 and became affiliated with the Swatara Creek Watershed Association in 1998. The entire Quittapahilla Watershed (77.3 square miles) is in Lebanon County. The creek's major tributaries include Killinger Creek, Bachman Run, Beck Creek and Snitz Creek. The Quittapahilla Creek flows into the Swatara Creek, which flows into the Susquehanna River and eventually into the Chesapeake Bay. Annville Township, Cleona Borough, Lebanon City, and West Lebanon Township lie completely within the Quittaphilla Watershed. North Annville, North Lebanon, South Lebanon, North Londonderry, North Cornwall, Heidelberg, South Annville, and West Cornwall Townships and Palmyra and Cornwall Boroughs are partially within the Quittapahilla Watershed.

The Quittapahilla Creek Watershed Assessment, completed in 2006, provided a detailed characterization and assessment of stream conditions for 18 miles of mainstem stream and 65 miles of tributaries within the 79 square mile watershed. The study examined and mapped in-stream conditions, inventoried land use conditions and impacts, determined bankfull dimensions and analyzed morphological (stream shape/type) stability, determined floodplain delineation, , and conducted biological assessment for aquatic habitat. Where poor, problematic or declining conditions were found, the study identified restoration and management strategies to address these conditions. By modeling streambank erosion rates and nutrient and sediment loading per various land uses, the study was also able to project future problems and recommend appropriate mitigation strategies. These projections can later be used to analyze the impact of restoration and mitigation strategies once implemented.

Overall, the study concluded that the Quittie suffers most significantly from heavy sedimentation, shallow water, low flow, and a lack of riparian cover. Its water quality is fair to poor water quality impacted predominantly by suspended solids, turbidity, and heavy metals (lead, zinc, copper), which exceed EPA standards. These conditions are more severe downstream from wastewater treatment plants. Urban impacts from channel alterations designed for flood mitigation in the early 1980s and non-point source pollution are heaviest downstream. Flow diversions (ponds for livestock, irrigation supply, etc.) have typically not caused problems except in drought years. The stream's biological community is in good and improving condition given a poor history. Tributaries are in better condition than main stem, though the mainstem has better forest cover. Snitz Creek has the best conditions, indicated by the highest fish diversity. Killinger Creek has the heaviest sediment loads but still supports a diverse biological community. Fish barriers and habitat enhancement structures have had mixed effects.

The study reports that best management practices that have been installed or implemented are working. Stream bank fencing is working to restrict grazing of riparian buffers and manage livestock access to the stream channel. Natural buffers within fenced areas are regenerating forested vegetation and will likely narrow and deepen channels naturally. Timbering, mining and quarrying operations continue to impact conditions but are making strides to mitigate them.

The preliminary report indicates that stream conditions can be made better through restoration and management strategies. However, it would be unreasonable to expect restoration of pristine (undeveloped) stream conditions given the current development pattern.

Tri-County Conewago Creek Association

The Tri-County Conewago Creek Association (TCCCA) began in November, 2001, as a group of concerned citizens in Dauphin, Lancaster, and Lebanon Counties. In 2002, the group incorporated and gained 501(c)(3) tax exempt status. TCCCA's activities in its first year of existence were many and varied, and focused on achieving the goals set forth in its mission statement. TCCCA developed an assessment and restoration plan in 2003. The plan outlines that TCCCA will seek to continue to work with landowners throughout the watershed to make stream improvements on their property by stabilizing eroded stream banks, fencing and planting trees along the creek, and conducting educational and public outreach initiatives.

In Lebanon County, the watershed includes portions of West Cornwall Township, Mt. Gretna Borough, South Londonderry Township, and South Annville Township; it encompasses a 53.2 square mile area in the rolling farm hills and woodlands. Its headwaters are just northeast of Mt. Gretna, in the western portion of West Cornwall Township, Lebanon County. It empties into the Susquehanna River just north of the village of Falmouth in Lancaster County. The upper portion of the Conewago flows through Lebanon County, while the middle and lower sections form the boundary between Dauphin and Lancaster Counties. The Conewago's main tributaries include the Little Conewago Creek, Hoffer Creek, Brills Run and Lynch Run.

TMDL Statutory and Regulatory Requirements –§ 303(d) Clean Water Act and 40 C.F.R. § 130.7

Clean Water Act Section 303(d) establishes the Total Maximum Daily Load (TMDL) program. The purpose of the TMDL program is to identify sources of pollution and allocate pollutant loads in places where water quality goals are not being achieved.

The Commonwealth manages many different water quality programs that have traditionally regulated well-defined sources of water pollution, such as discharges from sewage treatment plants and industrial facilities. Over the past several years, the Department of Environmental Protection (DEP) has focused on watershed management techniques and processes that take a comprehensive approach to water pollution control to address polluted runoff or nonpoint source pollution, as well as point sources of pollution. Using the watershed approach requires selection or definition of watershed size, and begins with a comprehensive assessment of water quality problems in the watershed. Pennsylvania has already begun this effort with its Unassessed Waters Initiative, which will assess over 83,000 miles of surface waters. After water quality problems are identified, a planning process occurs to develop strategies that can successfully address and correct water pollution problems in the watershed. Pennsylvania is using this process, in conjunction with federal Clean Water Act requirements, for establishing total maximum pollutant loadings, or TMDLs, to clean up polluted streams so that they meet water quality standards. Water quality standards are the combination of water uses, such as water supply, recreation and aquatic life, to be protected and the water quality criteria necessary to protect them. TMDLs can be considered to be a watershed budget for pollutants, representing the total amount of pollutants that can be assimilated by a stream without causing impairment or water standards to be exceeded. The maximum allowable amount of a specific pollutant is allocated to all sources in the watershed, including point source discharges from sewage treatment plants and industrial wastewater facilities (wasteload allocations) and polluted runoff from the land (load allocation). A margin of safety is also provided to account for uncertainty in the loading calculations. The TMDL process allocates the amount of pollutants that can be discharged into a waterway from each category of pollutant source. The TMDL does not specify how discharges must attain particular load reduction.[23]

Within Lebanon County TMDL levels have been identified and a threshold plan has been developed for the following streams: Conewago Creek Watershed, CrossKill Creek, Deep Run Watershed, Deep Run/Beach Run, and Elizabeth Run, Earlakill Run, Owl Creek, Quittapahilla Creek Watershed, and Unnamed Tributary of Swatara Creek. Additionally, Cocalico Creek Watershed, Hammer Creek and Middle Creek have identified the need to develop a threshold plan. At this point, Conewago Creek Watershed is the only TMDL that has begun developing a TMDL implementation plan.

Pennsylvania State Water Plan (Act 220)

The 2002 Pennsylvania Water Resource Planning Act, in its broadest sense, calls for:

- An update of the State Water Plan within 5 years
- Registration and reporting of high volume water withdrawals (averaging over 10,000 gallons per day)
- Identification of critical water planning areas
- Creation of critical area resource plans in watersheds identified as critical water planning areas
- Establishment of a voluntary water conservation program.

These tasks will result in more complete and more integrated water resource management at the state and regional levels and are intended to sustain the quality of our water resources, maintain our natural environment, boost our economy and enhance our recreational opportunities.

The technical tasks required to prepare the 2008 State Water plan have been classified into four tiers that direct the committees. Tier one is data collection and analysis water supplies and water demand; high volume withdrawals reports; discharge monitoring reports; and population projections. Tier two is mapping and description of major basins. Results from tiers one and two will be compiled by region and presented in a regional atlas and series of GIS maps. Tier three is marketing and engaging the public on the importance of water resource issues, and tier four is the creation of a State Water Plan and statewide action agenda for the period 2008-2013. As of 2006, all four tiers are underway, with the State Water Plan due in 2008.

To carry out the planning provisions of the law, a Statewide Water Resources Committee was formed to help guide the development of the State Water Plan through a collaborative process. Representing Pennsylvania's geographic diversity, six

[23] Pennsylvania Department of Environmental Protection Fact Sheet

regional water resources committees were also created to facilitate the development of the regional components of the State Water Plan. The six planning regions include:

- Delaware Regional Water Resource Committee
- Upper/Middle Susquehanna Regional Water Resource Committee
- Lower Susquehanna Regional Water Resource Committee
- Ohio Regional Water Resource Committee
- Great Lakes Regional Water Resource Committee
- Potomac Regional Water Resource Committee

Lebanon County is part of the Lower Susquehanna Regional Water Resource Committee, which is one of the six statewide regional committees for the Water Resource Planning Act. This committee has discussed county and regional issues and identified four priorities for the region:

- An inventory of water resource supply (sources, geologic influences, and quantity and quality issues) and demand (current and projected consumption rates by use, critical water planning areas, impacts of flood and drought conditions on demand); development of a water budget for each watershed
- Promotion of water resource conservation, including wise and efficient use, water re-use practices, and protection of critical water bodies and functions
- Minimize land use impacts, i.e. reduce or eliminate point and non-point sources of water pollution; protect, restore and reclaim floodplains, wetlands, and waterway corridors
- Unification of water resource management initiatives via intergovernmental coordination (communication, data collection and sharing, and regulatory linkages), regional planning and advancement of priorities, and promotion of water resource stewardship.

Lebanon County submitted several county-specific issues for consideration at the regional level. In Lebanon County, the following issues were raised:

- Fredericksburg and Spring Creek near Hershey areas of Lebanon County were identified as “potentially stressed” due to rapidly expanding commercial industrial and residential development.
- Public education about water resources is needed throughout the county.
- There is a lack of forested buffers and agricultural best management practices in use, e.g. lack of conservation tillage, cover crops, livestock and human waste management, proper carcass disposal, etc., as well as lack of funding for education and implementation of best practices
- Lebanon City’s water supply facilities are projected to reach capacity by 2010.
- Need for review of local ordinances for appropriate permitting on commercial water bottling enterprises
- Determination of water uses requiring statewide priority, fee structure for non-priority uses, on-site storage options during drought and flooding crises.
- Viable options for soil improvement, e.g. addition of organic matter
- Evaluation of sediment removal behind dams
- Need for septic system maintenance regulations and possible inspections

Each of the county-specific issues raised by the committee is addressed in whole or in part by these regional priorities.

Other concerns noted by the Lower Susquehanna Regional Water Resource Committee though not thoroughly addressed by the regional priorities include:

- The need for consistency between plans for expansion of water supply service areas and local comprehensive planning
- The lack of funding for mandated water supply planning
- Lack of regulation of private wells; while on-lot septic receives attention, on-lot wells receive little attention
- Lax enforcement of Act 167 Storm water Planning requirements
- The complexity of water quality protection when pollution comes from multiple sources.

The 2008 State water Plan will benchmark water resource planning and management in Pennsylvania. It will compile regional priorities and include a gap analysis for water resources planning in the Commonwealth and present action plans to direct the future planning and management of water resources across the state where change is needed. The State Water plan will be updated every five years with a planning horizon of 2030.

Susquehanna River Basin Commission

The Susquehanna River is the nation's 16th largest river and extends from New York through Pennsylvania into Maryland, where it empties into the Chesapeake Bay. The river basin borders the major population centers of the east coast, and although relatively undeveloped, the river basin has experienced problems of water pollution and overusage. Because the Susquehanna River flows through three states and is classified as a navigable waterway by the federal government, state, regional, and national interests are involved. The need to coordinate the efforts of three states and the agencies of the federal government, as well as to establish a management system to oversee the use of the water and related natural resources of the Susquehanna River, resulted in the drafting of the Susquehanna River Basin Compact. This compact was signed into law on December 24, 1970 and adopted by the Congress of the United States and the state legislatures of New York, Pennsylvania, and Maryland, creating the Susquehanna River Basin Commission (SRBC).[24]

The mission of the Susquehanna River Basin Commission is to enhance public welfare through comprehensive planning, water supply allocation, and management of the water resources of the Susquehanna River Basin. To accomplish this, the SRBC works to reduce damages caused by floods; provide for the reasonable and sustained development and use of surface water and groundwater for municipal, agricultural, recreational, commercial and industrial purposes; protect and restore fisheries, wetlands and aquatic habitat; protect water quality and instream uses; and ensure future availability of flows to the Chesapeake Bay.[25]

The Susquehanna River Basin Commission Compact states that, "the Commission will annually adopt a water resources program, based upon the comprehensive plan, consisting of the projects and facilities which the Commission proposes to be undertaken by the Commission and by other authorized governmental and private agencies, organizations, and persons during the ensuing six years or such other reasonably foreseeable period as the Commission may determine." The 2005 Annual Water Resources Program identifies various programs and projects of the Commission and other water resource management agencies to meet the water resource needs. These include:

- Coordinate the planning and management of the water resources of the basin in accordance with the requirements of the Compact and the Comprehensive Plan; communicate with and listen to the concerns of the water use stakeholders and their elected representatives; educate the public about the water resources of the basin.
- Prevent the loss of life and significantly reduce future damages from floods within the basin through an integrated system of structural and nonstructural flood damage reduction measures.
- Mitigate the adverse impacts of drought conditions on water users and the environment.
- Control water pollution and excess nutrient runoff sufficiently to maintain and establish water quality capable of supporting multiple purpose uses for public water supply, recreation, fish and wildlife, agriculture, industry and other such uses. Protection also will be given to the receiving waters of the Chesapeake Bay.
- Restore native migratory fishes to the Susquehanna River System. Remove obstacles to the movement of migratory and indigenous fishes.
- Insure an adequate supply of water for all users, including instream users and the Chesapeake Bay.
- Inventory and store relevant water resource management data in a readily retrievable and usable form.

In addition to recognizing these needs, the Commission has established a Draft Groundwater Management Plan for the Susquehanna River Basin that is to be completed in 2006 and released for public information prior to final approval and implementation.

Chesapeake Bay Foundation

The Chesapeake Bay Foundation (CBF) is the largest conservation organization dedicated solely to the Chesapeake Bay watershed. The motto, Save the Bay, defines the organization's mission and commitment to reducing pollution, improving fisheries, and protecting and restoring natural resources such as wetlands, forests, and underwater grasses. CBF headquarters are in Annapolis, MD, and it has state offices in Maryland, Virginia and Pennsylvania. CBF operates 15 environmental education programs. In 2000, the Governors of Pennsylvania, Maryland, and Virginia; the Administrator of the United States

[24] Susquehanna River Basin Commission
[25] Ibid.

Environmental Protection Agency; and the Mayor of Washington D.C. signed the Chesapeake 2000 Agreement, pledging to improve water quality to remove the Chesapeake Bay from EPA's list of "impaired waters" by 2010.[26]

The Groundwater Foundation

The Groundwater Foundation was started so that citizens could learn, in ways that were scientifically accurate but also user-friendly, about groundwater impacts on a community. The Groundwater Foundation works to make groundwater science accessible and understandable to citizens everywhere, so that educated citizens can be involved in protecting the environmental and economic vitality of their communities.

The Foundation has always valued its role as an incubator for local groundwater champions. As a result, they began a national program in 1994 entitled Groundwater Guardian, which supports, recognizes, and connects communities taking proactive, voluntary steps to protect groundwater. Today, the Foundation is proud to work with hundreds of communities in over 40 states that concentrate efforts on comprehensive protection of local groundwater supplies.

Since 1996, Lebanon County has been identified as a Groundwater Guardian Community by The Groundwater Foundation. Lebanon County uses the Groundwater Guardian program to educate farmers, landowners, watershed groups, municipalities, water suppliers, and the public about non-point source pollution and groundwater protection. The Lebanon County Groundwater Education Team, a diverse group comprised of representatives from citizen groups, local government, educational institutions, business and agriculture, works to provide information and resources demonstrating best practices and encouraging and assisting in the implementation of groundwater protection programs.

Result Oriented Activities:

- Continued to facilitate the installation of best management practices on dairy and livestock farms in county watersheds.
- Working with state agencies to complete the Lebanon County Comprehensive Plan which will address all aspects of community planning.
- Served as a liaison to various local watershed protection organizations, coordinating efforts for watershed education and outreach.
- Implemented public education and outreach efforts, combined with storm drain marking, as best practices to comply with state storm sewer system requirements. [27]

Pennsylvania Water Resources Education Network (WREN)

The Pennsylvania Water Resources Education Network (WREN) is a nonpartisan informal collaboration among organizations and public officials working for the protection and management of Pennsylvania's water resources, both surface and groundwater, through education and informed policy making.

WREN's goals are:

- To foster and support local stakeholder communities which will educate themselves, other citizens, and local officials about their water resources and the public policies necessary to protect them.
- To make water resources protection a priority at the state and local level in Pennsylvania.
- To facilitate water resources education in schools.
- To exchange information among WREN members about activities and information relating to water resources in Pennsylvania.
- To enhance coordination and cooperation between WREN members.
- To make recommendations about meeting water resources education needs in schools and communities.

[26] Chesapeake Bay Foundation Website
[27] The Groundwater Foundation Web Site

Lebanon County has been recognized as a Groundwater Guardian Community since 1996. The role of the Groundwater Guardian Team is to gather information about local groundwater resources; to raise public awareness of the need for protection, conservation and pollution prevention; and to encourage intergovernmental cooperation and the development of policies for protecting groundwater resources. Within Lebanon County programs on wellhead protection and drinking water protection and non-point source pollution prevention has been organized.[28]

Capital Region Water Board

The Capital Region Water Board is a non-profit corporation under the laws of the Commonwealth of Pennsylvania and is incorporated for the purposes of improving public water management in the Capital Region of Pennsylvania and enhancing regional cooperation.

The Capital Region Water Board of South Central Pennsylvania was formed to study and evaluate the water supply situation of the region. The Board is attempting to address the problem of viability of small systems by searching for regional solutions. It may now expand its scope to do more comprehensive planning for a larger region in order to represent the Region's interests in facing competition for out-of-basin diversions. [29]

Woodlands

Pennsylvania has over 17 million acres of forestland, covering more than 60% of the state. Pennsylvania's forests are primarily hardwoods and include species such as black cherry, northern red oak, white oak, sugar maple, red maple, walnut, poplar and ash. In Lebanon County, these forests are comprised of roughly 70,000 acres of deciduous forest, 2,300 acres of coniferous forest, 5,200 acres of mixed deciduous-coniferous forest, and 1,100 acres of wooded wetlands.[30] This is approximately 34% of the county's total area, and a significant land resource.

Pennsylvania's forests provide multiple benefits to the citizens of the Commonwealth. These include:

- Improving air quality
- Helping improve water quality
- Providing habitat for a variety of plant and animal species
- Providing recreation and scenic opportunities
- Supporting a dynamic forest products industry that supports many rural communities and is an economic driving force in the Commonwealth[31]

Blue Mountain, also known as the Kittatinny Ridge, forms the northern rim of the Great Valley and hosts the largest uninterrupted forest area in central and eastern Pennsylvania. The forests of the ridge are tremendous assets to communities along the Ridge, such as Lebanon County, for timber production, water supply, wildlife habitat and outdoor recreation. The historic Appalachian Trail follows Blue Mountain for 85 miles from the Pennsylvania-Maryland state line to the Delaware Water Gap, traveling through Lebanon County and providing a unique recreation opportunity and greenway asset.

The Kittatinny Ridge Project, led by Audubon Pennsylvania, is a collaborative effort of local, regional, and state organizations and agencies to focus public attention on the importance of forested ridge through Pennsylvania; and to promote conservation activities to protect the ridge from further habitat loss, fragmentation, and inappropriate land use. Lebanon County is an active participant in the project.

South Mountain is the Great Valley's natural southern boundary. While smaller in scale than Blue Mountain, South Mountain has played a larger role in the development of Lebanon County. The mountain's iron and red sandstone formations were heavily mined in the 1800s and 1900s. More recently, growing residential development has impacted the forested South Mountains.

[28] Pennsylvania Water Resources Education Network (WREN) Web Site
[29] Capital Region Water Board Web Site
[30] Pennsylvania Department of Conservation and Natural Resources
[31] Ibid.

USDA Forest Service, as part of the Highlands Study, has begun the Pennsylvania and Connecticut Update study in cooperation with the Pennsylvania Department of Conservation and Natural Resources, and the Connecticut Department of Environmental Protection. The first stage of the study (currently underway) will focus on: public involvement to identify issues, opportunities and concerns; resource data collection; and resource assessment with the aim of identifying land having high conservation value. The study will include a scientific resource assessment; its principle product will be a map showing high conservation values in the highlands, a necessary component of land conservation partnership projects. An analysis of land use change will provide the basis to model future water quality and to examine the implications of change for other resources. The study will explore strategies for conserving forest resources and their ecological services in a region of rapid and extensive land use change.

Public woodland areas in Lebanon County include: Memorial Lake State Park, Swatara State Park, Middle Creek Wildlife Management Area, Stoever's Dam Park, Clarence Schock Memorial Park at Governor Dick and numerous state game land tracts.[32]

The Lebanon County Conservation District (LCCD) employs a forester/naturalist to conduct forestry and educational programs throughout the county. A few specifics include:

- Urban Forestry – Assistance is available to local municipalities in obtaining funding for tree planting, writing tree ordinances, and starting a Shade Tree Commission. Routine inspection and evaluation for disease and insect problems can be provided to local municipalities.

- Gypsy Moth – Inspections for gypsy moth infestations are conducted and reported to the state for possible control. Often confused with "webworms", gypsy moths hatch from small, tan egg cases no bigger than your thumb. The red and blue dots on the back of the caterpillar aid in proper identification. Formal complaints of heavy infestations are reported to the LCCD office in order to include properties in the county spraying program.

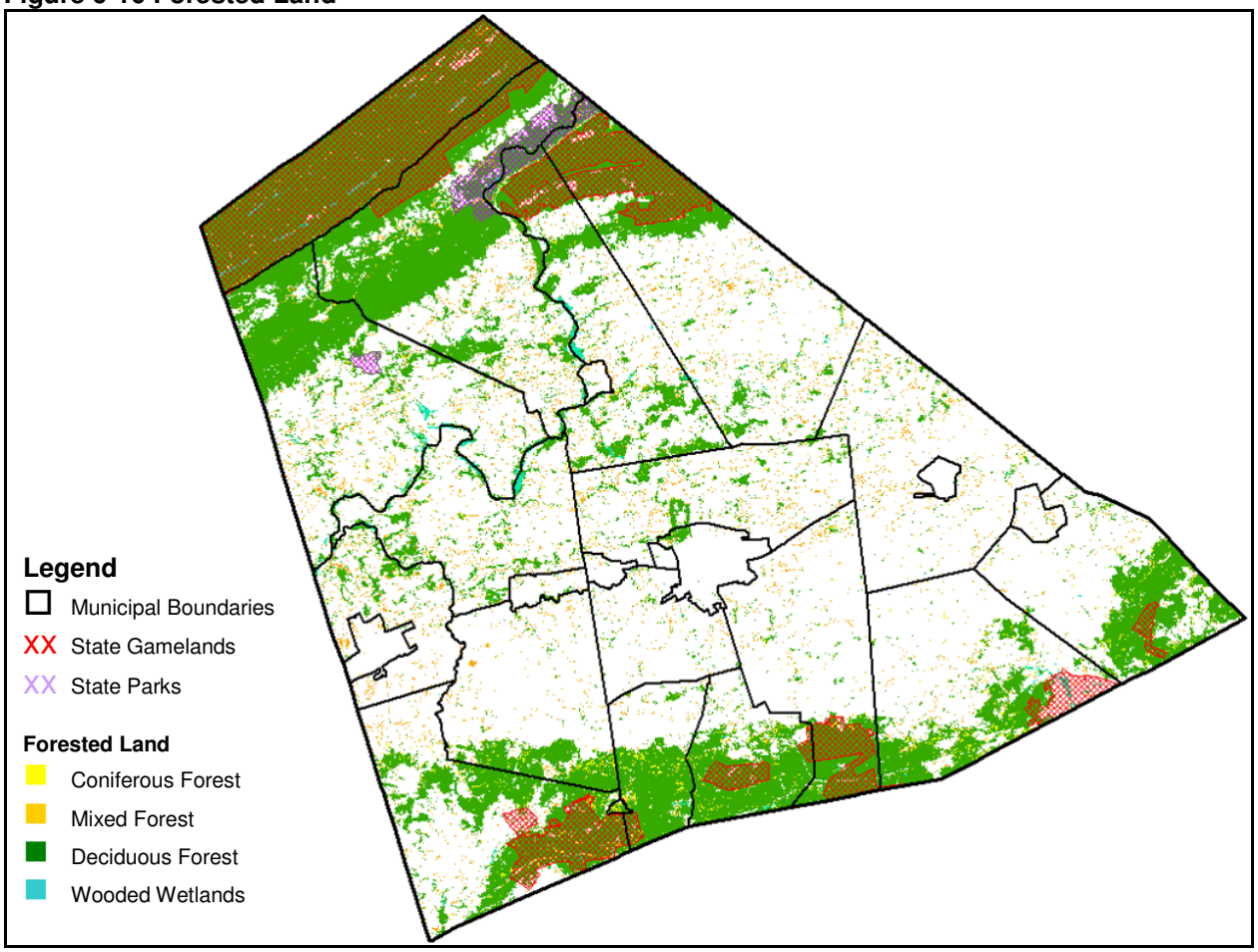
- Hemlock Woolly Adelgid - In Pennsylvania, this non-native insect continues to severely damage our state tree. The LCCD provides information for the public and municipalities on dealing with the pest species.

- Seedling Sale – The LCCD has an annual seedling sale in April offering a variety of evergreens and hardwoods, including Sugar Maple, Red Oak, Black Cherry, Common Lilac, Fruit trees, groundcover and others.

Another forest land preservation program being used in Lebanon County is the Forest Legacy Program (FLP), a federal and state partnership which encourages conservation of important, privately owned forest lands. FLP is a voluntary program that focuses on the permanent acquisition of conservation easements to prevent the conversion of forests to non-forest uses. These easements are purchased from the landowner, based on an appraised market value of the development rights. The state or federal government holds title to the easement, while the landowner retains ownership of the land and continues existing uses provided they meet the terms of the easement. The easement remains in place forever, even if the property is sold.

[32] PennLive.com

Figure 6-10 Forested Land



Source: Office of Remote Sensing of Earth Resources, Penn State University; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Upland Forest Communities

The American Chestnut once dominated many of the Eastern North American Hardwood Forests from Maine to Michigan to Alabama. However, around 1904, blight spread from the Bronx Zoo northward and southward, and by 1960, there were basically no mature chestnuts left standing. Today, young sprouts and shoots still remain, but very few will ever reach maturity due to the blight. Efforts to develop and establish a blight resistant strain of the American Chestnut show promise. This invaluable species provides important mast crops for wildlife and, more importantly, produces commercially valuable hardwood products at roughly 2½ times the growth rate of oaks. The loss of the Chestnut from the canopy left huge breaks all across the eastern United States. These holes have since filled with many of the Chestnut's associate species, including species of oak. These oak species comprise the Appalachian Oak Forest, which is the dominant vegetation type in the uplands of Lebanon County. White Oak, Northern Red Oak, and Chestnut Oak dominate the upland forest communities along with an array of other hardwood species. Hardwood associates such as Scarlet Oak, Black Birch, Red Maple, Black Gum, Hickory, American Beech, and Tulip Poplar are major associates within an Appalachian Oak Forest. The understory of Appalachian Oak Forests typically consists of Mountain Laurel, Early-Low Blueberry, Hillside Blueberry, Black Huckleberry, Witch Hazel, and other species. The best examples of an Appalachian Oak Forest in Lebanon County include State Game Lands #211, Fort Indiantown Gap, and the Governor Dick property in Mount Gretna.[33]

[33] The Nature Conservancy

Wildlife

The Pennsylvania Science Office of the Nature Conservancy compiled a Natural Areas Inventory of Lebanon County in 2003. The natural areas in Lebanon County were evaluated by botanists, wildlife biologists and ecologists and ranked in order of importance for conservation of biodiversity at a statewide level. The size and quality, condition, landscape context, and rarity of the species or natural community were factors used to assign ranks for each site. Generally speaking, sites are dispersed throughout the county with the majority located in those regions that have been untouched by development.

The Natural Areas Inventory recognizes two primary levels of significance for the protection of biodiversity: sites of statewide importance and sites of local significance. Sites of statewide importance support species of special concern, or have exemplary natural communities. Locally significant sites provide locally significant habitat and may be suitable for environmental education, parks or preserves. No species of special concern or exemplary communities have been identified at the locally significant sites, but the absence of species of concern cannot be proven in these potential habitats.

Sites of Statewide Significance

Sites of statewide significance for the protection of biological diversity in Lebanon County are listed in the approximate order of priority from the most important rank (Rank =1) to the least important (Rank =5). The most important sites of statewide significance in Lebanon County are described below.

Fort Indiantown Gap Macrosite (Union Township, East Hanover Township)
This area makes up the majority of the Fort Indiantown Gap Military Reservation (FIGMR) and contains the largest viable population in the United States of Regal Fritillary Butterfly, a Pennsylvania-Endangered butterfly species. Approximately 200 acres of land have been identified as a designated habitat for this species. A biological inventory of this site produced many additional Pennsylvania species of concern. Additionally, this site is in proximity to Second Mountain, an Important Bird Area (IBA) and raptor migration location in Pennsylvania. Despite the military training that occurs on this land, it remains a vital conservation site in Lebanon County.

Indiantown Run Woods (Union Township)
This area is part of the FIGMR and contains important habitat for the Regal Fritillary Butterfly, a Pennsylvania endangered animal species. The Black Dash Butterfly, Black-waved Flannel Moth, and Spiny Oakworm Moth, all animal species of concern, were found at this site along with two plant species of special concern, the American Holly and Netted Chainfern.

Walnut Run Watershed, State Game Lands #156 (South Lebanon Township)
This area consists of mesic hardwoods in the lowlands and additional xeric species in the uplands. A marginal to good-quality population of Puttyroot, a Pennsylvania-rare plant species, and a small population of Bog Bluegrass, a Pennsylvania-Threatened plant species were found at this site at the headwaters of Walnut Run. In addition, a good to excellent quality population of Nodding Trillium, a plant species of concern was found at this site.

Table 6-9 Sites of Statewide Significance

Site Rank	Site Name	Municipality
1	Fort Indiantown Gap Macro site	Union Township, East Hanover Township
1	Indiantown Run Woods	Union Township
1	Walnut Run Watershed, SGL #156	South Lebanon Township and Lancaster County
2	Sharp Mountain	Cold Spring Township and Schuylkill County
2	Chiques Creek Headwaters	West Cornwall Township and South Londonderry Township
2	Middle Creek Wildlife Management Area (SGL # 46)	Heidelberg Township
2	Millbach Wetlands	Millcreek Township
2	Monroe Creek, SGL #80	Bethel Township
2	Penryn Park Seep / Shand Kiwanis Camp	Cornwall Borough
2	Shearers Creek Swamp	Cornwall Borough
2	Stony Creek Valley, part of SGL #211	Cold Spring Township
2	Swatara Hillside Forest	Union Township
2	Swope Valley Run	Bethel Township and Schuylkill County
2	Trout Run Meadow	Union Township
3	Cold Spring / Stony Creek at Dresden Lake	Cold Spring Township
3	Furnace Creek Spring Run	Millcreek Township and Berks County
3	Gold Mine Run Vernal Pool and Seeps	Cold Spring Township
3	Gold Mine Wetlands, part of SGL #211	Cold Spring Township
3	Lebanon Reservoir Seeps	South Lebanon Township, Cornwall Borough, Heidelberg Township
3	Swatara Creek Floodplain	Bethel Township and Schuylkill County
3	Rausch Creek Ridge, part of SGL #211	Cold Spring Township
3	Rausch Gap, Rausch Creek	Cold Spring Township
3	State Game Lands #145 at Mount Gretna	South Londonderry Township
4	East Blue Mountain Spring	East Hanover Township
4	Gold Mine Seeps	Cold Spring Township
4	Route 322 Powerline Site	Cornwall Borough
4	St. Joseph Spring	East Hanover Township
4	Toineeta Farm Meadow	Swatara Township
5	Colebrook Meadow	South Londonderry Township
5	Dinosaur Rock Woods, SGL #145	South Londonderry Township
5	Swatara Gap Fossil Site	Union Township
5	Valley Glenn Floodplain	North Annville Township, North Londonderry Township

Source: The Nature Conservancy

Sites of Local Significance

Sites of local significance for the protection of biological diversity in Lebanon County are listed in the approximate order of priority from high to low. The most important sites of local significance in Lebanon County are described below.

Dogtown Wetlands (Heidelberg Township and Lancaster County)
This site is considered locally significant because it contains a diverse wetland and has potential habitat that exists for a Pennsylvania-Endangered animal species of concern. It is recommended by the Nature Conservancy that this site continue to be surveyed for this animal species of concern and steps taken to manage and protect the habitat. It is also recommended that exotic species be controlled if such species threaten the integrity of the wetland.

Lake Conewago at Mount Gretna (South Londonderry Township)
This locally significant area contains a recreation-altered lake but has a known historical record and potential habitat for a Pennsylvania-Endangered animal species of concern in a creek leading from the lake. This site is considered locally significant due to the potential habitat for a Pennsylvania-Endangered animal species of concern and for the extensiveness of

the creek and the wetland feeding into the lake. It is recommended by the Nature Conservancy that future surveying for this species be conducted to determine the presence / absence on the property.

Swatara Creek at Route 78 (Swatara Township)
This locally significant area contains a very diverse shrub swamp and sedge wetland openings and some surrounding forested wetlands. Despite the exotic plant species documented at this site, this area is significant due to the large wetland that provides habitat for animals and plants and also for the possibility of rare species. The major threat to this area is the spread of exotic plant species in the wetland. With the exception of invasive species control, this wetland should be left as is.

Evening Branch Wetlands (Cold Spring Township)
This section of wetlands in State Gamelands 211 lies parallel to the railroad grade transecting the gamelands, upstream of Evening Branch's confluence with Gold Mine Run in Cold Spring Township. The wetland has significance in its filtration role, upstream of the Lebanon Reservoir, as well as it's accessible for nature watching by the general public. The wetland enjoys a significant degree of protection, particularly from threats of development and subsequent run-off, due to state ownership.

Swatara Floodplain and Union Canal (East Hanover Township)
This locally significant site consists of an extensive deciduous floodplain between the Swatara Creek and Union Canal with a buttonbush-swamp rose thicket and a swamp rose thicket. Due to the extensiveness of the wetland, and the lack of such wetlands in this area, this site is considered locally significant. A recommendation for this site is the control of the spread of Multiflora Rose throughout this property.

Table 6-10 Sites of Local Significance

County Rank	Site Name	Municipality
High	Dogtown Wetlands	Heidelberg Township and Lancaster County
Medium	Lake Conewago at Mount Gretna	South Londonderry Township
Medium	Izaak Walton League Land	Heidelberg Township
Medium	Swatara Creek at Route 78	Swatara Township
Medium	State Game Lands #211, Evening Branch Wetlands	Cold Spring Township
Medium	Swatara Floodplain and Union Canal	East Hanover Township
Low	Lake Duffy, SGL #145	South Londonderry Township
Low	Quittie Creek Nature Park	Annville Township

Source: The Nature Conservancy

Agriculture

Agriculture has been and continues to be a thriving industry in Lebanon County. This is due in large part to the climate, prevalence of high quality soils, strong cultural heritage, and proximity to transportation access to major market areas within the east coast.

The Lebanon County Conservation District (LCCD) works with local farmers, the Lebanon County Commissioners, and the Pennsylvania Department of Agriculture's Bureau of Farmland Preservation to help protect farmland in Lebanon County. The LCCD's services include farmland preservation efforts, erosion and sedimentation pollution control, conservation planning, national pollution discharge elimination system, nutrient management, biosolids, and watershed education, all contributing towards greater support of the agricultural community and the county at large.
These programs support the continued economic viability of the agricultural community, help assure affordable and accessible food supplies to the general public, and help to reduce public services needed and taxes on agribusiness. These efforts also encourage soil and water conservation, improve and/or protect water and air quality, preserve farm culture, and retain open space, aesthetics and quality of life in the county.

Agricultural Security Areas

The Agricultural Security Area (ASA) program began in 1981 as a tool for strengthening and protecting agriculture in Pennsylvania. These ASAs are intended to promote more permanent and viable farming operations over the long term by strengthening the farming community's sense of security in land use and the right to farm. ASAs are created by local

municipalities in cooperation with individual landowners who agree to collectively place at least 250 acres in an ASA. It should be noted, that ASA designation is not a permanent designation but rather a seven year program. The land to be included must have soils conducive to agriculture and be used for the production of crops, livestock, livestock products, horticultural specialties, and/or timber. Specific regulations applying to the eligibility of property are as follows:

- Noncontiguous farm parcels must be at least 10 acres in size. The farm tracts needed to create a new 250 acre or larger agricultural security area do not have to be under the same ownership or even be located in the same municipality. The Agricultural Area Security Law (Act 43 of 1981) allows for the creation of multi-municipal ASAs.
- The property should be viable agricultural land. Cropland, pasture, and woodland can all be included in an ASA.
- At least 50% of the land should be in soil capability classes I-IV, as defined by the county soil survey.
- The property must be zoned to permit agricultural uses.
- Subdivision or development, however, is not prohibited

Setting up an Agricultural Security Area is a simple process with five basic steps.

1. The process of establishing an ASA is initiated by petition of owners of productive farmland totaling at least 250 acres. The land to be included must have soils conducive to agriculture and be used for the production of crops, livestock and livestock products. The petition is submitted to the local government unit with a description and boundaries of the proposed Area. Non-adjacent parcels of at least 10 acres may be included. A proposed ASA located in more than one government unit is submitted for approval to each governing body.
2. The governing body gives public notice of the proposal to create an ASA. Basic information is printed in a newspaper and posted in five locations, with an invitation for objections and modifications to be submitted to the governing body and planning commission within 15 days.
3. After the comment period the proposal, with objections and modifications, is referred to the local planning commission and a specially formed Agricultural Security Area Advisory Committee. The Advisory Committee is made up of three active local farmers, one citizen and a member of the local governing body. Both groups have up to 45 days to review the proposal and make recommendations to the governing body.
4. A public hearing on the proposed area must be held by the governing body. Modifications to the ASA may be made up to 7 days before the public hearing is advertised.
5. Following a public hearing the governing body may decide to adopt or reject the proposal, or any modifications to it. The ASA, if created, has a 7 year lifetime after which it is reviewed. The governing body must act within 180 days from the date the petition was submitted. If the governing body fails to decide in 180 days, the Agricultural Security Area is automatically adopted as originally petitioned. Within 10 days of its creation a description of the Area must be filed with the recorder of deeds and both the local Planning Commission and the Lebanon County Planning Department.

All of the municipalities in Lebanon County have ASAs within their respective jurisdictions with the exceptions being: Cold Spring Township, Union Township, Palmyra Borough, Annville Township, Cleona Borough, Lebanon City, Cornwall Borough, Richland Borough, Myerstown Borough, and Jonestown Borough. Agriculture is not a predominant land use in these communities, except for Union Township.

Preserved Farms

The Pennsylvania Agricultural Conservation Easement Purchase Program was developed in 1988 to help slow the loss of prime farmland to non-agricultural uses. The program enables state, county and local governments to purchase conservation easements from owners of quality farmland. Counties participating in the program, including Lebanon County, have appointed Agricultural Land Preservation Boards. A state board oversees the program, and provides $750 of the $1,500 dollars offered per acre, with the remaining $750 provided by local sources.

By voluntarily selling or donating agricultural conservation easements, the landowner is preventing development of the land for purposes other than agricultural production, while retaining ownership and other property rights. In order to qualify for a conservation easement, the following conditions must be met:

- The farmland tract must be located in an Agricultural Security Area. Parcels located outside of an Agricultural Security Area will be considered on a case-by-case basis with regards to the other conditions listed here and municipal zoning and land development plans.
- The property must contain at least 50% of soils which are available for agricultural production and are of soil capability classes I-IV.
- The property must contain at least 50% harvested crop land, pasture lands or grazing lands.
- The property must be at least 50 contiguous acres in size unless a minimum of 10 acres is of a unique crop or adjoining an attached perpetual agricultural conservation easement.
- The landowner must have a conservation plan meeting Resource Management System (RMS) standards, and approved by the Lebanon County Conservation District, including an "Act 6 level" of nutrient management plan review by the Conservation District by the time of closing.
- The land use must be compatible with municipal land development plans.
- The landowner must be willing to accept $1500 per acre.
- Not more than 50% of the property may be enrolled in a reserve program such as CRP.

Farmers may choose to receive the proceeds from the easement sales in a lump sum payment, installments up to five years, or on a long-term installment basis. Many farmers use the proceeds from easement sales to reduce debt loads, expand operations, and pass farms to the next generation.[34] The county reached a milestone mark of 10,000 acres of preserved farms early in 2006. Lebanon County's preserved farms can be seen in Figure 6-11. While certainly influential on its own, farmland preservation is most effective when combined with other land use controls, such as effective agricultural zoning and strict subdivision and land development ordinances.

Table 6-11 Agricultural Land Areas as of June 2006

Designation	Acres	Percent of Agricultural Land	Percent of County
Preserved Farms	10,996	11.8%	4.7%
Agricultural Security Areas	53,577	41.1%	23.1%
All Agricultural Land	130,496	100.0%	56.2%

Source: Office of Remote Sensing of Earth Resources, Penn State University; Pennsylvania Department of Transportation; Lebanon County Conservation District; RETTEW Associates, Inc.

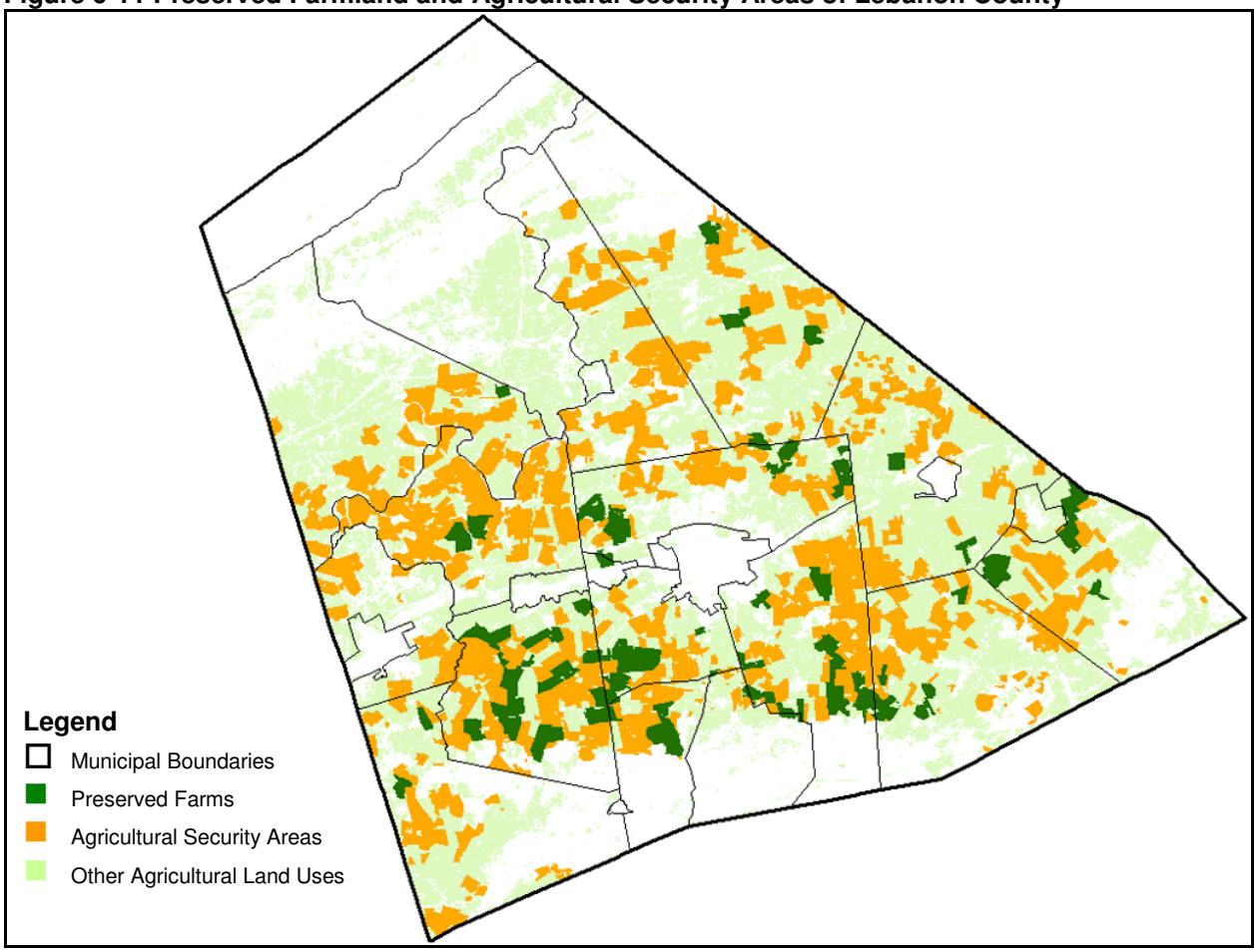
Table 6-12 Preserved Agriculture by Municipality as of June 2006

Municipality	Acres Preserved as of 06-28-06	Municipality	Acres Preserved as of 06-28-06
Cleona	77.27	North Cornwall	868.90
Bethel	711.7	North Lebanon	1,148.85
Cornwall	70.34	Richland	4.0
East Hanover	72.99	South Annville	2,745.55
Heidelberg	684.39	South Lebanon	1,597.56
Jackson	310.42	South Londonderry	199.06
Millcreek	1,052.90	Swatara	100.00
North Annville	787.75	Union	3.0
		West Cornwall	561.44

Sources: Lebanon County Conservation District; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

[34] Pennsylvania Department of Agriculture; Lebanon County Conservation District.

Figure 6-11 Preserved Farmland and Agricultural Security Areas of Lebanon County



Sources: Lebanon County Conservation District; Lebanon County Soil Survey; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Nutrient Management Act

As discussed previously in this profile, agricultural activities can have an adverse impact on the quality of groundwater in an area. This is mostly caused by pesticides and nutrients which pollute local streams or percolate through the soils into the groundwater system. Areas of carbonate bedrock geology, such as much of Lebanon County, are more susceptible to contamination of this sort. In 1993, Pennsylvania adopted Act 6, the Pennsylvania Nutrient Management Act, which addresses water quality protection through Best Management Practices. Regulations went into effect October 1, 1997 and are administered by the State Conservation Commission with the assistance of county conservation districts. The Nutrient Management Act Program is a non-point source pollution prevention program. The goal is to prevent nutrient pollution of water resources by planning the appropriate application and management of manures and other plant nutrients, in conjunction with other water quality protection best management practices. This has become critical with the increase of concentrated animal operations and a decrease in available lands for nutrient application.[35]

For livestock and poultry operations, an approved Pennsylvania Nutrient Management Plan is required based on the operation's ratio of animals to land available for the appropriate application of manure. If there are more than 2,000 pounds of live weight of livestock per acre of land suitable for manure application, a nutrient management plan is required. These farming operations are defined as Concentrated Animal Operations (CAOs) under the law. Operations which are not considered to be CAOs are encouraged to plan on a voluntary basis. Volunteer planning provides eligibility for technical and financial assistance, limited liability protection, as well as other benefits.[36]

[35] Pennsylvania State Conservation Commission
[36] Ibid.

The quality of nutrient management plans written in Pennsylvania is ensured by a nutrient management plan writing and review certification program administered by the Pennsylvania Department of Agriculture. The certification program is designed to train and certify nutrient management planners to assist the farm community in developing plans, and plan reviewers who assure plan completeness and compliance. Planners are also required to attend continuing education training to help them keep informed of emerging issues relating to nutrient management. Each county conservation district maintains a listing of state-certified commercial nutrient management specialists available to write nutrient management plans. Farmers can be certified to write their own plans.

Three financial assistance programs are available to assist livestock operators to adopt sound nutrient management practices. The Plan Development Incentive Program helps to cover the cost of plan development. The Plan Implementation Grant Program helps to cover the cost of installing Best Management Practices included in an approved plan. The Agriculture-Linked Investment Program (AgriLink) provides low interest loans to help cover the cost of installing best management practices included in an approved plan.[37]

ACRE Legislation

Agriculture Communities and Rural Environments (ACRE) legislation is intended to respond to the concerns of both the agricultural and environmental communities. The legislation allows the Office of the Attorney General to review both existing and proposed local ordinances to see that they do not contradict state law or exceed the authority granted to local governments. If infringements are found in existing ordinances, the Office of the Attorney General is to bring any actions to the Commonwealth Court in a timely manner. The Pennsylvania Office of the Governor stated that "the bill also requires that any disputes between farmers and the local community be sent directly to Commonwealth Court to ensure that the precedents established are applicable statewide, preventing a variety of county legal standards."[38] Silvicultural (forestry) operations are also protected from restrictive ordinances by this legislation.

The ACRE legislation establishes a 100 foot buffer from surface waters for the application of manure, compared to the 150 foot buffer that the Department of Environmental Protection has been trying to establish. The bill also requires concentrated animal feeding operations (CAFOs) to develop and implement an odor management plan for new and expanding operations.[39]

Municipal Regulations

Many of the municipalities in Lebanon County have taken actions to conserve and protect important natural resources. The ways in which municipalities have incorporated natural resources such as floodplains, agriculture, erosion and sedimentation, and steep slopes, into their local ordinances are varied.

Cornwall Borough has by far the most extensive environmental regulations of the municipalities in Lebanon County. Article 20 of the zoning ordinance, as amended January 14, 2002, creates an Environmental Protection Overlay District (EP) to supplement the underlying district provisions. The regulations of the Environmental Overlay District are designed to protect environmentally sensitive areas and resources. The regulations address the following features: floodplains; streams, watercourses, wetlands, seeps, springs, lakes and ponds; stormwater, soil erosion and sedimentation; seasonal high water table areas; prime agricultural soils; conservation of woodlands and other vegetation; open space and critical habitat; Natural Diversity Impact Areas; and areas of steep slopes. The ordinance is set up such that any person proposing an activity that disturbs or impacts any of these natural features must submit a Conservation Plan for review to the Borough Engineer, Borough Planning and Zoning Commission, and Borough Council and must obtain approval of this plan by Borough Council. Minor Conservation Plans are associated with Building Permit Applications and Major Conservation Plans are filed with an application for Subdivision and /or Land Development. Additional regulations exist where certain environmental concerns are present.

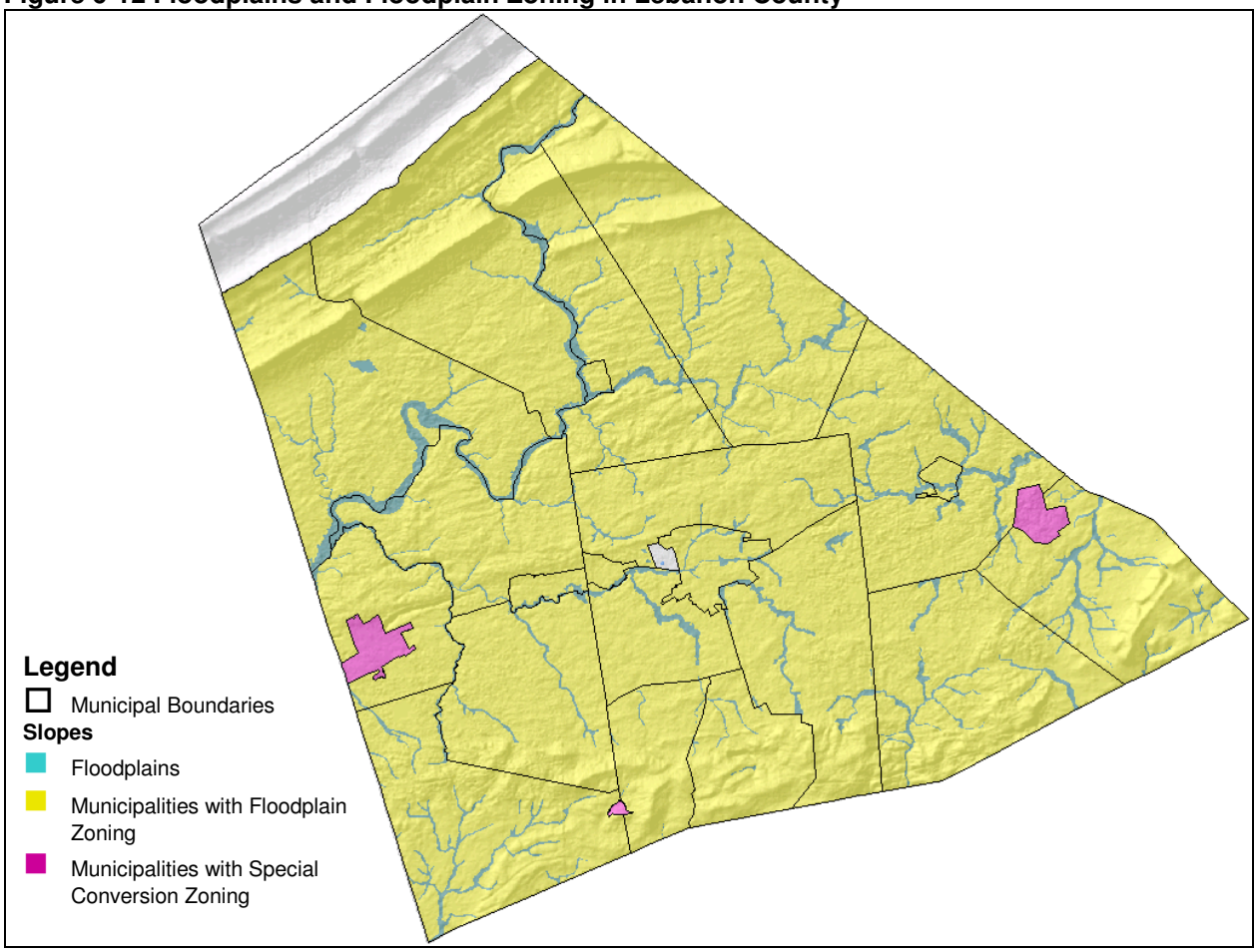
[37] Ibid.
[38] Pennsylvania Office of the Governor,
[39] Sierra Club, Pennsylvania Chapter.

Table 6-13 Municipal Regulations

	Zoning Ordinance	Agriculture	Steep Slopes	Floodplain
Annville-Cleona SD				
Annville	X	N/A		X
Cleona	X	N/A		X
North Annville	X	None		X
South Annville	X	RD		X
Cornwall-Lebanon SD				
Cornwall	X	RD	X	X
Mount Gretna		NA		Sp. Conv.
North Cornwall	X	LL	X	X
North Lebanon	X	RD	X	X
South Lebanon	X	RD	X	X
West Cornwall	X		X	X
ELCO SD				
Heidelberg	X	LL	X	X
Jackson	X	RD	X	X
Millcreek	X	LL	X	X
Myerstown	X	N/A	X	X
Richland	X	N/A		Sp. Conv.
Lebanon SD				
Lebanon City	X	N/A		X
West Lebanon	X	N/A		X
Northern Lebanon SD				
Bethel	X	RD		X
Cold Spring		None		
East Hanover	X	RD	X	X
Jonestown	X	N/A		X
Swatara	X	RD	X	X
Union	X	None	X	X
Palmyra Area SD				
North Londonderry	X	None		X
Palmyra	X	N/A	X	Sp. Conv.
South Londonderry	X	RD	X	X

Source: Municipal Comprehensive Plans, Lebanon County
Agriculture Key: LL- Large Lot agricultural preservation provisions; None - No agricultural protection provisions enacted; N/A - Urbanized area with no agricultural lands; RD - Residential Density agricultural preservation provision (Sliding Scale Zoning)
Floodplain Key: Sp. Conv.- Special Conversion

Figure 6-12 Floodplains and Floodplain Zoning in Lebanon County



Sources: Pennsylvania Department of Environmental Protection; Environmental Resources Research Institute, Water Resources Division; FEMA; US Fish & Wildlife Services; Lebanon County Soil Survey; United States Department of Agriculture, Natural Resource Conservation Service; Pennsylvania Department of Transportation; RETTEW Associates, Inc.

Agriculture

Like much of southcentral Pennsylvania, Lebanon County is blessed with large contiguous areas of prime agricultural lands and productive farming communities. Due to the physical ease of construction, these areas are often the most vulnerable to development pressures. Consequently, municipalities that wish to preserve their agricultural lands and farming communities should incorporate agricultural preservation provisions into zoning ordinances. Two agricultural techniques are predominately used within the county: large lot zoning and residential density control zoning (sliding scale zoning). Both of these agricultural techniques permit agriculture to occur by right with other uses described below:

Large lot provisions are defined by residential uses permitted to occur only on lots of 5 acres or more in size. No commercial or industrial uses would be permitted.

Residential density control can be described where residential uses would be permitted in the agricultural zones on a very low density basis; however, dwelling units could be located on a minimum lot size of one to two acres. No commercial or industrial uses would be permitted. This technique is often called "sliding scale zoning." Sliding scale zoning limits the number of times that a parent tract (a parcel existing on the date of ordinance adoption) can be split, based on its size, i.e. the larger the parcel the more splits that may occur, up to a maximum number established. A larger minimum parcel size is also typically established.

Steep Slopes

Several of the municipalities in Lebanon County that have incorporated steep slope protection provisions into their zoning ordinances have done so through a section entitled, "Environmental Improvements and Energy Conservation Requirements,"

with very similar regulations. These municipalities include South Lebanon, East Hanover, Jackson and Swatara Townships, and Cornwall and Palmyra Boroughs. These regulations General Standards include a restriction on the removal of total vegetative cover permissible on slopes greater than a certain percentage. The South Lebanon Township Zoning Ordinance states, "Land areas with slopes in excess of twenty percent (20%) shall be restricted to the removal of not more than twenty-five percent (25%) of the total vegetative cover of the lot." In Palmyra Borough, the restriction applies to areas with slopes greater than 15%.

West Cornwall, North Lebanon, Millcreek, and Union Townships have a variation of restrictions that relate to the percentage of the lot which may be developed where slopes are in excess of a certain percentage than those listed above. The specific restrictions for slopes between 15% and 25% and those in excess of 25% vary West Cornwall and North Lebanon Townships' ordinances also include a provision that requires an increased minimum lot size in certain districts when steep slopes are present. Several ordinances also require the submission of an Erosion and Sedimentation Control Plan to either the Lebanon County Conservation District or the Zoning Officer of the municipality on lots with slopes in excess of a certain percentage.

Floodplains

Twenty-two (22) municipalities in the county have floodplain regulations which meet or exceed those required by the National Flood Insurance Program (NFIP); three (3) have had special conversions (no defined floodplain) by FEMA. Cold Spring Township, which has no governing body and is predominantly State Game Land, is the only municipality in the county which does not participate in the NFIP. The NFIP regulates construction and development in the 100-year flood plain. In municipalities where detailed studies have been done, zoning regulations specify two or three floodplain districts: the Floodway and the Flood Fringe Districts where base flood elevations have been determined, and the Approximate Floodplain District where no base flood elevations exist. Each district has different requirements relating to building and development, with the Approximated Floodplain and Floodway Districts imposing the most exacting regulations and the Flood Fringe District having the least restrictive requirements. In those municipalities where only approximated studies have been done, one floodplain district has been designated (General Floodplain District-GFP). GFP regulations are stringent since the location of the floodway has not been defined within this district.

Municipalities in the county participating in the NFIP have also adopted the Lebanon County Floodproofing Building Code. This code contains flood damage control regulations intended to prevent excessive damage to buildings and structures located in the floodplain. The restrictions apply to all new construction, development and substantial improvement occurring in the 100-year floodplain. Regulations in the code address: basements and first floor elevations; use of fill; placement of buildings and structures; anchoring; special mobile home anchoring and site requirements; construction requirements for floors, walls, and ceilings, electrical systems, plumbing; paints and adhesives; and storage. The code also specifies information which must be provided to the Zoning Officer and others reviewing permit applications for construction and development in the floodplain.

A third part of the county's floodplain management program includes subdivision and land development requirements. These requirements are supplemental to municipal zoning regulations, the Lebanon County Floodproofing Building Code, and other applicable ordinances and codes and deal with site development issues such as excavation, grading and use of fill; drainage facilities; streets; lot layout; and location and floodproofing of public utilities located in the floodplain.

Air Quality

Air pollution comes from many different sources such as factories, power plants, motor vehicles and equipment, and even windblown dust and wildfires. Air pollution can threaten the health of human beings through the more than 3,000 gallons of air adults breathe every day; even more per pound of body weight for children. Especially sensitive groups include: children, the elderly, people with heart and lung diseases such as asthma, emphysema, and chronic bronchitis, and adults who exercise or work outdoors. Air pollution can also threaten our economy and our environment through its effects on crops and native vegetation, water bodies, animals, and visibility as well as its damage to the ozone layer and the built environment.

Six Principal Pollutants

Currently, six principal pollutants are regularly monitored by regulatory, enforcement and research agencies, including the US Environmental Protection Agency (US EPA) and the Pennsylvania Department of Environmental Protection (DEP). Five are monitored for compliance with the Clean Air Act; lead is not a specified pollutant in the Clean Air Act.

1. Carbon monoxide (CO) is a colorless, odorless, poisonous gas that inhibits the delivery of oxygen to the body's tissue, thereby causing asphyxia or shortness of breath. Carbon monoxide is a byproduct of the incomplete burning of fuels. Industrial processes contribute to carbon monoxide pollution levels, but the principal source of carbon monoxide in most large urban areas is vehicle emissions. Peak carbon monoxide concentrations typically occur during the colder months of the year when automotive emissions are greater and nighttime inversion conditions are more frequent.

2. Lead is a highly toxic metal when ingested or inhaled. It is a suspected carcinogen of the lungs and kidneys and has adverse effects on the cardio, nervous and renal systems. Lead is emitted to the atmosphere by vehicles burning leaded fuel and from certain industrial processes, primarily metal processors, battery manufacturers and lead smelters.

3. Oxides of nitrogen (NOx) are formed when fuel is burned at a very high temperature (above 1200 °F). For air pollution purposes, it is composed primarily of nitric oxide (NO), nitrogen dioxide (NO_2) and other oxides of nitrogen. Nitrogen oxides come from burning fossil fuels at power plants, industrial boilers and motor vehicles. Although there is no air quality standard for NOx, it plays a major role in the formation of ground-level ozone in the atmosphere through a complex series of reactions with volatile organic compounds (VOC's). VOC's are emitted from a variety of sources, including motor vehicles, chemical plants, refineries and natural (biogenic) sources. Nitrogen oxides also contribute to deposition of nitrogen in soil and water through acid rain.

   Nitrogen dioxide (NO_2) is a highly toxic, reddish brown gas that is formed through the oxidation of nitric oxide (NO) emitted primarily from the combustion of fuels in stationary or transportation sources. It can cause an odorous, brown haze that irritates the eyes and nose, shuts out sunlight and reduces visibility. NO_2 acts as a precursor to acidic rain and plays a key role in nitrogen loading of forests and ecosystems. NO_2 has been associated with acute effects in sufferers of respiratory disease.

4. Ground-level ozone, or photochemical smog, is a secondary pollutant. It is not emitted directly to the atmosphere but rather is formed in the atmosphere by the reactions of other pollutants. Ground-level ozone forms during the summer months, when nitrogen oxides (NOx) and volatile organic compounds (VOC) combine and react in the presence of sunlight and warm temperatures. Changing weather patterns contribute to yearly differences in ozone concentrations. Ozone and the precursor pollutants that cause ozone also can be transported into an area from pollution sources located hundreds of miles away. In the short-term, exposure to high levels of ozone irritates the lung's airways and causes inflammation, much like sunburn. Other symptoms include coughing, wheezing, chest pain and headaches. It can aggravate chronic respiratory diseases such as asthma and bronchitis and can lead to increased emergency room visits and hospital admissions. Long-term, prolonged exposure to even low levels of ozone can cause asthma in children and lead to permanent lung damage. Ozone is also a strong irritant to the eyes and upper respiratory system. It hampers breathing and damages crops and man-made materials such as monuments and statues.

5. Particulate matter (PM) is the general term used for a mixture of solid particles and liquid droplets found in the air. These particles, which come in a wide range of sizes, may be emitted directly by a source or formed in the atmosphere. These fine particles are of health concern because they easily reach the deepest recesses of the lungs. Batteries of scientific studies have linked particulate matter, especially fine particles (alone or in combination with other air pollutants), with a series of significant health problems, including:

   - Premature death;
   - Respiratory related hospital admissions and emergency room visits;
   - Aggravated asthma;
   - Acute respiratory symptoms, including aggravated coughing and difficult or painful breathing;
   - Chronic bronchitis;
   - Decreased lung function that can be experienced as shortness of breath; and
   - Work and school absences.

Total suspended particulates (TSP) refers to the aggregate of solid or liquid matter in air. Particles vary in size (up to 45 micrometers in diameter) and may remain suspended in the air a few seconds to several months. Particulate emissions come from coal-burning power plants, industrial processes, mining operations, municipal waste incinerators and fuel combustion. They also are produced by natural sources such as forest fires and volcanoes. The federal ambient air quality standard for particulate matter was revised to reflect the adverse health effects of smaller particulate matter less than 10 microns in size (PM10), which can penetrate the lungs and have significant effects on health. PM10 appears to represent essentially all of the particulate emissions from transportation sources and most of the emissions in the other traditional categories.

Sulfate particulate matter in the atmosphere is composed of two types: primary sulfates from industrial processes and secondary sulfates formed from photochemical processes. Studies have shown significant correlation between high sulfate levels and increased absences from work and school because of illness. Sulfates are also of interest due to their effects of reducing visibility and contributing to acid rain.

Nitrates are particulate compounds that are usually formed in the atmosphere from the oxidation of oxides of nitrogen gases. They are of interest since they represent a significant portion of the finer particulates which can be inhaled into the lungs and which have a great impact on visibility. Nitrates are also being studied to determine their impact on acid precipitation.

Fine particles are those that are less than 2.5 micrometers in diameter (PM2.5). Fine particles can accumulate in the respiratory system and are associated with numerous adverse health effects including decreased lung function and increased respiratory symptoms and disease. Particulate matter also can cause adverse impacts to the environment. PM2.5 is the major cause of reduced sight visibility in parts of the United States. Other environmental impacts occur when particles deposit onto soil, plants, water, or man-made materials such as monuments or statues.

6. Sulfur dioxide is a gaseous pollutant that is emitted primarily by industrial furnaces or power plants burning coal or oil containing sulfur. The major health effects associated with high exposures to sulfur dioxide include effects on breathing and respiratory illness symptoms. The population most sensitive to sulfur dioxide includes asthmatics and individuals with chronic lung disease or cardiovascular disease. Sulfur dioxide damages trees, plants and agricultural crops and acts as a precursor to acid rain. Finally, sulfur dioxide can accelerate the corrosion of natural and man-made materials that are used in buildings and monuments, as well as paper, iron-containing metals, zinc and other protective coatings.

National Ambient Air Quality Standards

The U.S. Environmental Protection Agency (EPA) protects human health and the environment through the regulatory process and voluntary programs such as Energy Star and Commuter Choice. Under the Clean Air Act, EPA sets limits on how much of a pollutant is allowed in the air anywhere in the United States.

EPA has established national air quality standards to protect public health. Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country. These standards are shown in Table 6-14.

The Air Quality Index (AQI) is an index for reporting daily air quality. It tells how clean or polluted the air of a given area is, and what associated health effects might be a concern for citizens of that area. The AQI focuses on health effects citizens may experience within a few hours or days after breathing polluted air.

EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide.

The AQI values range from 0 to 500. An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy, at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Table 6-14 National Ambient Air Quality Standards

Pollutant	Primary Stds.	Averaging Times	Secondary Stds.
Carbon Monoxide	9 ppm (10 mg/m3)	8-hour (1)	None
	35 ppm (40 mg/m3)	1-hour (1)	None
Lead	1.5 µg/m3	Quarterly Average	Same as Primary
Nitrogen Dioxide	0.053 ppm (100 µg/m3)	Annual (Arithmetic Mean)	Same as Primary
Particulate Matter (PM10)	Revoked (2)	Annual (2) (Arithmetic Mean)	Revoked (2)
	150 µg/m3	24-hour (3)	Same as Primary
Particulate Matter (PM2.5)	15.0 µg/m3	Annual (4) (Arithmetic Mean)	Same as Primary
	35 µg/m3	24-hour (5)	Same as Primary
Ozone	0.075 ppm	8-hour (6)	Same as Primary
	0.12 ppm	1-hour (7)	Same as Primary
		(Applies only in limited areas)	
Sulfur Oxides	0.03 ppm	Annual (Arithmetic Mean)	-------
	0.14 ppm	24-hour (1)	-------
	-------	3-hour (1)	0.5 ppm (1300 µg/m3)

ppm = parts per million, ug/m3 = micrograms per cubic meter

(1) Not to be exceeded more than once per year.

(2) Due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution, the agency revoked the annual PM10 standard in 2006 (effective December 17, 2006).

(3) Not to be exceeded more than once per year on average over 3 years.

(4) To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m3.

(5) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).

(6) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.

(7) (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ 1, as determined by appendix H.
(b) As of June 15, 2005 EPA revoked the 1-hour ozone standard in all areas except the fourteen 8-hour ozone nonattainment Early Action Compact (EAC) Areas.

Table 6-15 Air Quality Index Values

Air Quality Index (AQI) Value	Level of Health Concern	Color	Meaning
0 to 50	Good	Green	Air quality is considered satisfactory; air pollution poses little or no risk.
51 to 100	Moderate	Yellow	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
101 to 150	Unhealthy for Sensitive Groups	Orange	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
151 to 200	Unhealthy	Red	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
201 to 300	Very Unhealthy	Purple	Health alert: everyone may experience more serious health effects.
301 to 500	Hazardous	Maroon	Health warnings of emergency conditions: everyone is even more likely to be affected.

Regional Ambient Air Quality Trends

DEP monitors air quality in areas having high population density, high levels of expected contaminants, or a combination of both factors. The majority of the monitoring takes place in the 13 designated air basins of the Commonwealth. Air basins are geographic areas, usually valleys, where air tends to stagnate. Harrisburg/Lebanon, Lancaster, and Reading are the nearest designated air basins. For transportation planning and air quality analyses, the Harrisburg and Lebanon urbanized areas share the same air basin or air shed. The Pennsylvania Air Quality Monitoring Annual Reports from 2005 to 2007 indicate improving trends for air quality as it relates to PM2.5; however the 2005-2007 mean (three year average) for ozone is 81 which is above the new standard of 75 parts per billion.

Additional Pennsylvania Ambient Air Quality Standards

The PA DEP has established additional standards for beryllium, fluorides, and hydrogen sulfide, as shown in Table 6-16.

Table 6-16 Other Pennsylvania Ambient Air Quality Standards

Pollutant	Average	Concentration
Beryllium	30-Day	0.01 ug/m3
Fluorides	24-Hour	5 ug/m3
Hydrogen Sulfide	24-Hour	0.005 ppm
	1-Hour	0.1 ppm

In addition to the principal pollutants listed above, DEP monitors acid rain, mercury content in rain and ragweed pollen for their impacts on the environment and public health.

PA DEP Permitting

One of the major initiatives Congress added to the Clean Air Act in 1990 was an operating permit program for larger industrial and commercial sources that release pollutants into the air. Operating permits include information on which pollutants are being released, how much may be released, and what kinds of steps the source's owner or operator is required to take to reduce the pollution. Permits must include plans to measure and report the air pollution emitted. In Pennsylvania, PA DEP issues operating permits. If state and tribal governments do not do a satisfactory job of carrying out the Clean Air Act permitting requirements, EPA can take over issuing permits.

Operating permits are especially useful for businesses covered by more than one part of the Clean Air Act and additional state or local requirements, since information about all of a source's air pollution is in one place. The permit program simplifies and clarifies businesses' obligations for cleaning up air pollution and can reduce paperwork. For instance, an electric power plant may be covered by the acid rain, toxic air pollutant, and smog (ground-level ozone) sections of the Clean Air Act. The detailed information required by those separate sections is consolidated into one place in an operating permit.

Businesses seeking permits have to pay permit fees, much like car owners paying for car registrations. These fees pay for the air pollution control activities related to operating permits. Thousands of operating permits that have been issued across the United States are available to the public. Contact PA DEP for information on access to those documents.

US EPA Enforcement

The Clean Air Act gives EPA important enforcement powers. In the past, it was difficult for EPA to penalize a company for violating the Clean Air Act-the Agency had to go to court for even minor violations. The 1990 Amendments strengthened EPA's power to enforce the Act, increasing the range of civil and criminal sanctions available. In general, when EPA finds that a violation has occurred, the agency can issue an order requiring the violator to comply, issue an administrative penalty order (use EPA administrative authority to force payment of a penalty), or bring a civil judicial action (sue the violator in court).

Air Quality Partnership

The Air Quality Partnership is a public/private coalition of volunteers dedicated to improving air quality in the four most populous areas of Pennsylvania. The Susquehanna Region encompasses Cumberland, Dauphin, Lancaster, Lebanon and York Counties.

The goals of the Air Quality Partnership are to increase the public's understanding of the impact of air pollution, provide alerts for days with high air pollution, provide health effects information and guidelines to prevent or reduce exposure, and finally encourage voluntary actions to reduce air pollution emissions, especially on “Action Days”.

The Partnership forecasts "Action Days," or days when the air is expected to be unhealthy to breathe. Using a color-coded scale, the forecast informs people about the predicted ozone and fine particulate matter (PM2.5) levels and any precautions that need to be taken.

Voluntary Citizen Action

There is plenty citizens can do to help improve air quality year round.

1. Consider transportation options:

    - Transit: take the bus, train, subway or trolley to work.
    - Ridesharing: join a carpool or vanpool.
    - Bicycling or walking: walk or bike to your destination. It's cheap and good for you!
    - Telecommuting: work from home and spend your extra commute hours with your family.

2. When traveling by car:

    - "Trip-link" by doing all errands at one time, avoiding unnecessary cold starts. An engine that's been sitting for an hour or more pollutes five times as much as a warm one.
    - Refuel at the end of the day. Ozone levels are usually at their highest in the mid- to late afternoon, and pumping gas emits roughly five tons a day of pollution into the air. So, save your pumping until evening.
    - Don't "top off" your fuel tank. This is never a good idea, no matter what time of day. Spillage adds about two tons of pollution a day to our air.
    - Turn off your engine when you stop your car for a minute or more.
    - Keep tires properly inflated and aligned.
    - Use an energy-conserving (EC) grade motor oil.
    - Get regular engine tune-ups and car maintenance checks.
    - Choose efficient, low-polluting models of vehicles.

3. When maintaining and operating a business or household,

    - Postpone mowing the lawn until late in the day or use a manual or electric mower instead. (And remember to refuel mowers and other gasoline-powered tools after dusk too).
    - Start your barbecue with an electric probe or use a gas grill. Charcoal lighter fluid vaporizes quickly and adds to air pollution.
    - Refrain from using household sprays and oil-based paints, or wait until early evening. These items contain gases which contribute to ozone pollution.
    - Use wood stoves and fire places wisely and sparingly. A well maintained stove or fireplace is safer and produces less particle pollution. Consider replacing old wood stoves with EPA-certified models.
    - Refrain from burning trash or yard waste. Burning your garbage outdoors can release toxic particles into the air harming the health of your family and neighbors.
    - Conserve energy at home by setting your thermostat lower. If we use less energy, power plants will not need to burn as much coal or oil. Weather stripping, fluorescent lights and programmable thermostats help to conserve energy and save you money.
    - Turn off appliances and lights when you leave the room.

- Choose products that have less packaging and are reusable.
- Recycle paper, plastic, glass bottles, cardboard, and aluminum cans. (This conserves energy and reduces production emissions.)
- Plant deciduous trees in locations around your home to provide shade in the summer, but to allow light in the winter.
- Buy green electricity-produced by low-or even zero-pollution facilities.
- Connect your outdoor lights to a timer or use solar lighting.
- Wash clothes with warm or cold water instead of hot.
- Lower the thermostat on your water heater to 120°F.
- Use low-VOC or water-based paints, stains, finishes, and paint strippers.
- Test your home for radon-a dangerous, radioactive gas that is odorless and tasteless. If the test shows elevated levels of radon, the problem can be fixed cost effectively.
- Choose not to smoke in your home, especially if you have children. If you or your visitors must smoke, then smoke outside.
- Buy ENERGY STAR products, including energy efficient lighting and appliances. They are environmentally friendly products.
- Shop with a canvas bag instead of using paper and plastic bags.
- Buy rechargeable batteries for devices used frequently.

Lebanon Valley Conservancy

The Lebanon Valley Conservancy is a local, non-profit membership organization, having as its mission the promotion of conservation of natural resources, open spaces and agricultural lands through public awareness, education and scientific research. In order to accomplish this mission, the Conservancy's efforts extend to the protection, preservation and proper use of:

- Farms and agricultural lands
- Streams and groundwater
- Open space
- Historic landmarks
- Scenic landscapes
- Bio-diversity of woodlands and wildlife habitat
- Recreational opportunities

The Lebanon Valley Conservancy draws together groups interested in responsible growth management to work in cooperation with neighboring conservancies and trusts and local and state governments to seek the preservation of unique cultural, historical and environmental heritage of Lebanon County for present and future generations. Local groups who work with the Conservancy include:

- Lebanon County Agricultural Land Preservation Board
- Lebanon Valley Rails-to-Trails
- Quittapahilla, Swatara, Little Swatara and other watershed associations
- Friends of the Union Canal
- Quittapahilla Audubon Society
- Lebanon County Historical Society
- Historic Preservation Trust of Lebanon County
- Lebanon Valley Chamber of Commerce
- Lebanon County Builder's Association

Conclusions

Land, water, vegetation and wildlife resources are dispersed throughout Lebanon County. As described and illustrated throughout this profile, the majority of lands in the county possess one or more natural attributes worthy of consideration in future community development and conservation planning. Each resource has its own unique pattern to its distribution, and

could be considered independently. Yet these resources interact with one another and their patterns overlap, creating the unique landscapes and ecology found within Lebanon County. As interrelated systems, they require more careful consideration of the impacts of resource use and management.

Lebanon County Landscapes

The county's mountain landscapes – the Highlands to the south and the Appalachians to the north – contain steep slopes, contiguous forest cover, high quality habitats, and generally the county's best surface water quality. The steep terrain naturally inhibits large scale development. The forests that drape these hills host large caches of flora and fauna unique to the Commonwealth and even the nation. While host to wildlife and recreational activities, they are also the source of valuable commercial timber products, and vital to the local economy.

Public land ownership provides some protection from development for resources on Blue Mountain, and municipal regulations in all but Bethel Township and South Annville Township afford some level of protection to scattered steep slopes throughout the valley. Land ownership is predominantly private in the county's Highlands region, which poses higher potential for development and associated impacts. Productive activities, such as forestry, need not be excluded from these areas, as timber harvesting with best management practices can result in little to no environmental degradation.

The Blue Mountain - Kittatinny Ridge Conservation Project and Highlands Project aim to preserve the natural condition through public and private efforts. These large landscape corridors, or mega-greenways as designated by PA DCNR, are priority projects at the state and, in the case of the Highlands, even federal levels. The Highlands is the more diverse and threatened landscape corridor due to the greater percentage and number of private land owners, as well as greater biological diversity, at least as documented to date. Within Lebanon County, the lands associated with and around the Middle Creek Wildlife Preserve have been identified as a "hot spot" for protection.[40]

The county's upland valley spans east-west between US 422 and Blue Mountain. This landscape is dominated by active agriculture and scattered woodlands, though it also includes the communities of Jonestown and Fredericksburg. Slopes here are not excessively steep but still require caution. Most municipalities in this region have slope regulations; such regulations are still needed in North Annville and North Londonderry Townships. Isolated wetlands are scattered in small depressions throughout this region.

The county's fertile lowland valley comprises lands primarily between US 422 and US 322 and PA 419. A low profile and good drainage make these lands suitable for a wide range of uses with the fewest limitations to development. Most of the county's population centers are located here, as well as a large share of its agricultural industry. Small woodlots are also found here. This region's agricultural soils are also the best in the county for on-lot sewage disposal systems, i.e. lower density development, even though they are still "somewhat limited". The presence and potential for sinkholes, and further potential for groundwater contamination, are limiting factors.

Challenges and Opportunities

These conditions present distinct challenges and opportunities for the future. Specific policy options will be addressed at greater depth in the natural features component of the plan, though generalized conclusions are apparent though the development of the natural features profile.

Many municipalities have recognized the impacts of topography on land use, and have some level of regulatory protection, particularly those with significant areas of steep slopes. However, provisions would be beneficial in Bethel and South Annville Townships, and perhaps in North Annville and North Londonderry Townships for precautionary slopes. Additional provisions such as best management practices for safe, sustainable timber harvesting in steep slope areas could retain the productive capacity of these lands and improve terrain stability throughout the county. These efforts would not completely eliminate threats such as bank erosion, subsidence, and viewshed obstructions but could have a substantial benefit.

Riparian buffers could bring significant benefits to water quality in Lebanon County. Even in areas where only narrow vegetated corridors can be created, the addition of non-invasive, filtering plants can have significant, positive impacts. In addition to streams and other channelized watercourses, these buffers serve to protect isolated wetlands from adjacent land

[40] Highlands of Connecticut, New York, New Jersey, Pennsylvania/ Study Update

uses and activities. Where applicable, they can also be used to expand unique habitats. In such instances where wetland remediation through new wetland construction is needed, consideration should be given to sites with hydric soils.

Agricultural land uses, while valued for their rural character, open vistas and overall contributions to quality of life, are impacting surface water quality across the county, but particularly in the valley. Riparian buffers would help mitigate these impacts, protect wetlands associated with stream corridors, increase wildlife habitat and migration corridors. Such may be designated as passive or natural greenways rather than active greenways for public recreation. Greenways, linear corridors of land that serve as the physical linkages between identified natural or manmade features, can maximize the impacts separate environmental habitats, as well as increase the benefits of separate recreational spaces. Where applicable, they can be created through public rights-of-way that include trails, recreation sites, and other public amenities, though established greenways in private ownership, managed through voluntary stewardship plans, can also accomplish resource goals.

Agricultural Security Areas (ASAs) are large and contiguous in the upland and lowland valley regions. The only municipality with active agriculture lacking ASAs is Union Township. This precludes agricultural preservation in the township, since ASA is a pre-requisite for the county agricultural pres program. All municipalities with significant agricultural soils, except North Annville, North Londonderry, and Union Townships, have municipal regulations managing the impact of development, and should be encouraged. Preserved agricultural lands are few in comparison to active farmland and ASAs and still not very contiguous; a future strategy to attempt to fill these gaps would help. By expanding ASAs, adopting municipal ordinances to protect agricultural areas from development, working towards creating contiguous agricultural spaces, and by increasing inter-municipal cooperation on planning for agriculture, farming in Lebanon County would be more viable. The agricultural industry is stronger and more resilient to development when a farmland is contiguous and development is discouraged or sited on lower quality soils amid the farmland. The county's criteria for agricultural preservation should strive to create larger more contiguous preserved areas, if agriculture is to be sustained as a significant part of the county's economy. Municipal regulations should guide development consistently in this manner, but currently do not.

The county would be well served to develop a comprehensive, countywide wellhead protection program. Water resource and watershed planning exists in various forms and stages of implementation across the county. Some efforts focus on stormwater, others on land use, and some areas have no plans at all. By unifying provisions under a single wellhead protection plan, municipalities could save costs in developing individual ordinances, and criteria could be based on specific geologic, watershed, and aquifer data. Where ventures are taken involving the cultivation or extraction of natural resources, it is essential that best management practices are employed to minimize their impacts, particularly on the county's waterways. Additionally, municipal land planning take into account potential impacts to groundwater, and direct those uses away from critical areas. Where these land uses are permitted, analysis of existing and potential groundwater impacts should be required. For example, mineral resources are suitable for commercial extraction, namely limestone, but extraction requires extensive uses of water and removes buffering soils and subsurface geology that filters waters en route to groundwater aquifers, and deserves consideration. In uses with high potential for negative impacts on water quality, planning should require groundwater impact assessment. With over 70% of the county's population relying on groundwater, these steps are crucial to ensuring a safe and sufficient water supply is available in the future.

The 83,000 acres of forest land in the county are concentrated on Blue and South Mountains. Half of forest lands are held in public ownership including Memorial Lake State Park, Swatara State Park, Middle Creek Wildlife Management Area, Stoever's Dam Park, Clarence Schock Memorial Park at Governor Dick and numerous state game land tracts. While protected from private development, these forest and woodlands may not be purposefully managed. There are no contiguous forest or woodland corridors connecting Blue and South Mountains. A county greenway plan, in coordination with those proposed for riparian areas, could connect these mega-greenways along streams, trails, and other preserved natural lands. Like stream corridor greenways, these could also be held under public or private ownership and management. Where applicable, specific greenways could be designated to mitigate impacts from conflicting adjacent land uses, and protect unique habitats. Strategic greenway designations have the potential to support redevelopment of brownfields or restoration of aquatic habitat in urbanized areas (for example, the greater Lebanon area along the Quittapahilla), or reclaim degraded rural land (such as forming mining areas in the northern portion of the county). In future and existing forested areas, stewardship plans may be needed, possibly in coordination with state agencies, to ensure such land is not just protected from development, but also healthy and lasting. As component of stewardship, the county should also explore programs to limit invasive or pest species (gypsy moth, borer beetle, emerald ash borer, multiflora rose, etc.) to provide additional protection to these resources. Combined, these efforts serve to protect the health and continuity of the native ecosystem so important to quality of life in the county.

Municipalities can and should conserve natural resources. Misuse and mismanagement of the natural environment can lead to unnecessary impacts on or costs to protecting public health, safety and welfare. Therefore regulations that reasonably restrict activities are appropriate. At present, Mount Gretna Borough is the only governed municipality without zoning. While small in size and unique in character, the Borough still contains valuable natural resources. Its location in the Highlands region further supports environmental protection policy, if not broader land use provisions. In contrast, Cornwall Borough has by far the most extensive environmental regulations of the municipalities in Lebanon County and could serve as a model for other communities to amend or replace existing provisions. Other municipalities have required ordinances, but lack key provisions to protect natural resources. For example, West Lebanon is the only governed municipality without floodplain protection in its zoning. In all of these concerns, consistency across ordinances regarding floodplains, groundwater, steep slopes, and riparian buffers would increase the efficacy of efforts to protect natural resources.

While natural features are critical for the ecological functions and economic benefits, it is not practical to preserve them all from development. More employment opportunities are desired and more housing will be needed to accommodate projected population growth. Convenient sites for new construction are often located on or within resources that cannot sustain development and impacts without negative impacts.

Impacts to the various natural features of the county carry multiple consequences that will literally and figuratively trickle down, and ultimately impact the county's land and water resources. This is why resource planning is necessary. Environmental policy is not an either-or proposition. The county's natural assets are of a value that demands consideration. At the same time, the county must view its planning holistically, addressing concerns that extend beyond environmental policy. Economic, social, fiscal, institutional, and legal constraints oblige the county to view natural resources as a key element, but not the only element of successful community planning. This requires a strategic approach to reap the greatest rewards in environmental protection.

If the proper actions are taken, Lebanon County can continue to utilize and benefit from its natural resources. From passive uses, such as recreation, to commercial production, proper management and application of resources will ensure that Lebanon County communities exist in harmony, not conflict, with the natural environment.