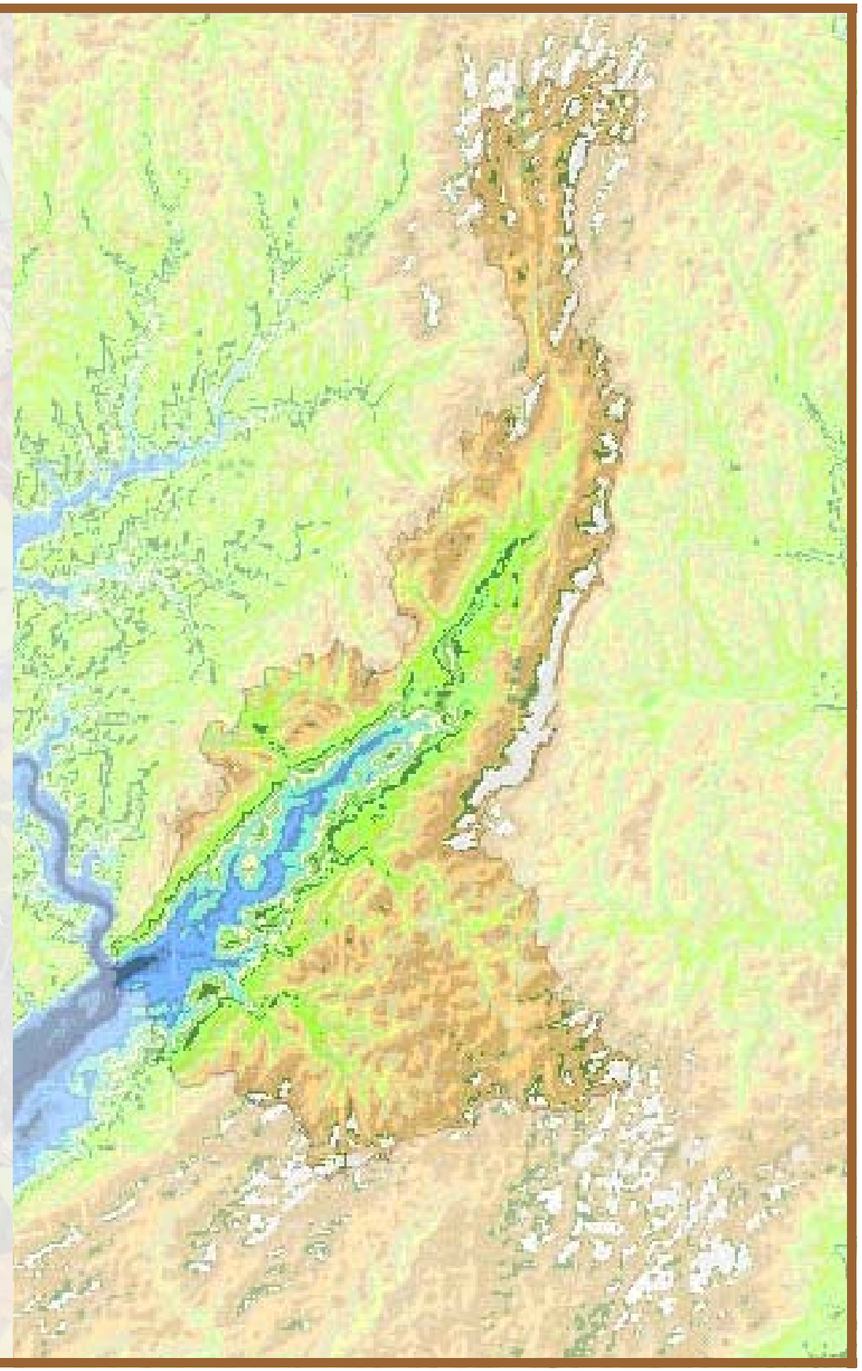
# Lackawanna River

# Watershed Atlas

A publication of the Lackawanna River Corridor Association



# Lackawanna River Watershed Atlas

Geographic Information Systems mapping in the watershed area of northeastern Pennsylvania
in Lackawanna, Luzerne, Susquehanna, and Wayne counties.

A publication of the Lackawanna River Corridor Association

First Edition

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*This publication made possible by a grant from the Margaret Briggs Foundation
and by support from the membership of the Lackawanna River Corridor Association.*

Map and atlas design: Alexandra Serio Younica

# Acknowledgements

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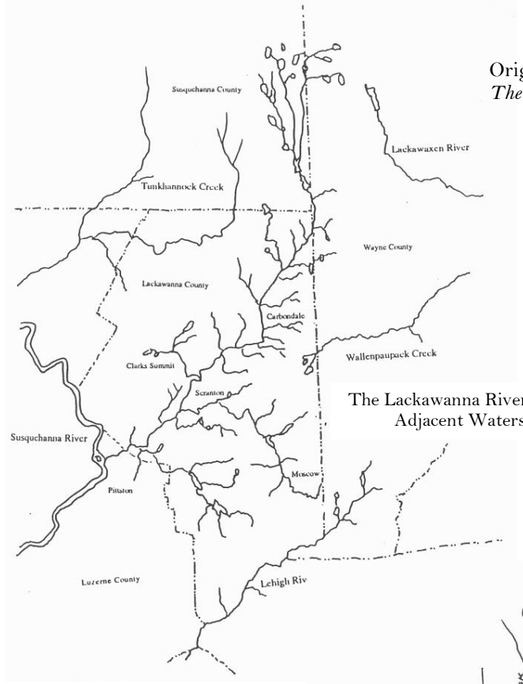
Concurrent Technologies Corporation
King's College
Lackawanna County Conservation District
Lackawanna County GIS
Luzerne County GIS
Wayne County GIS

## Cover Graphic

The watershed graphic is derived from a mosaic of the 10 meter digital elevation model United States Geological Survey

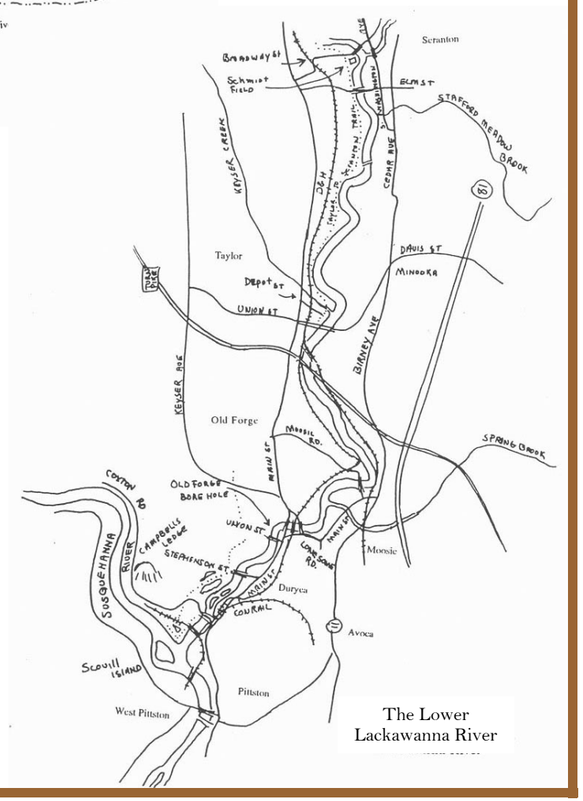
# Table of Contents






Original drawings by Bernie McGurl
*The Lackawanna River Guide*, 1994

The Lackawanna River Basin and Adjacent Watersheds

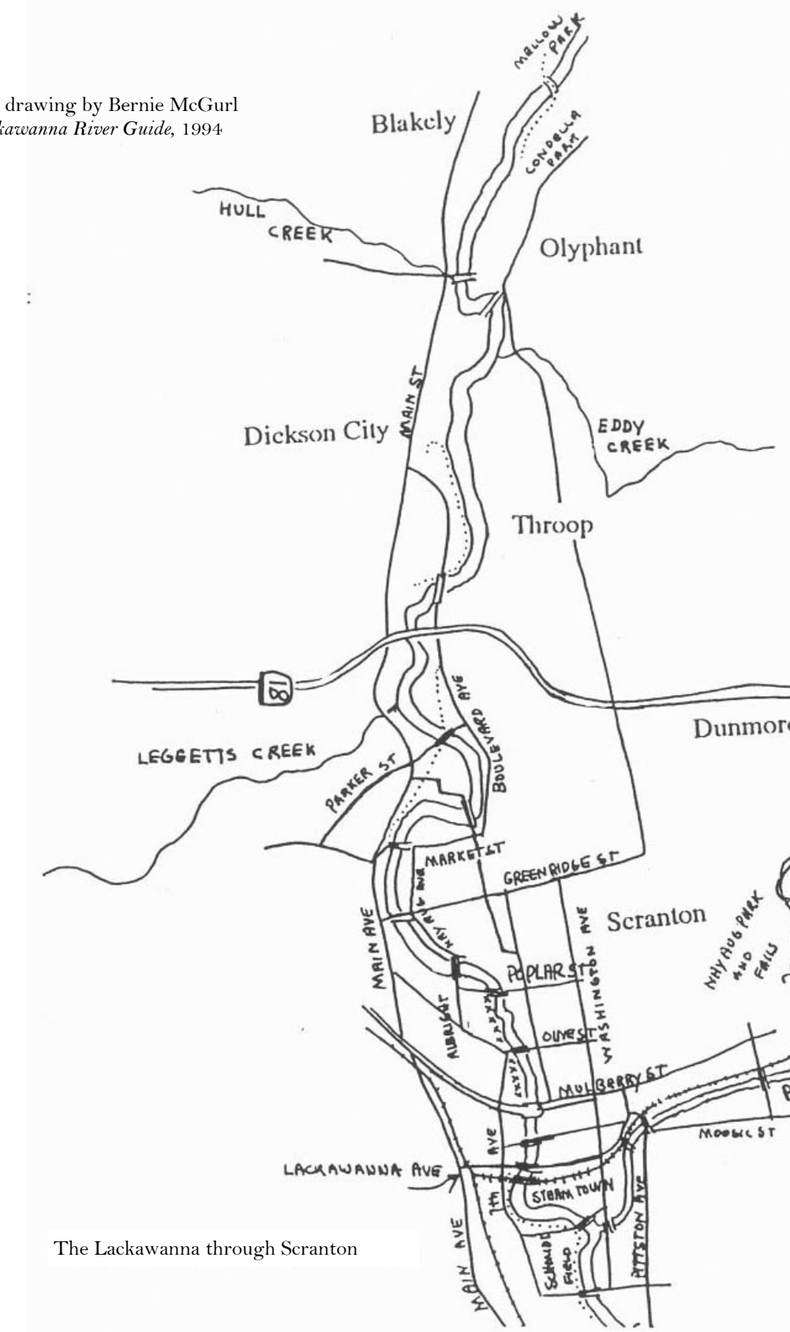



The Lower Lackawanna River

# Acronyms

| | |
|---|---|
| AMD | Acid Mine Drainage |
| AML | Acid Mine Lands |
| DNR | Pennsylvania Department of Natural Resources |
| EPA | Environmental Protection Agency |
| EPCAMR | Eastern Pennsylvania Coalition for Abandoned Mine Reclamation |
| ESRI | Environmental Systems Research Institute |
| GIS | Geographic Information Systems |
| LRCA | Lackawanna River Corridor Association |
| LHVA | Lackawanna Heritage Valley Authority |
| PASDA | Pennsylvania Spatial Data Access |
| USGS | United States Geological Survey |

Original drawing by Bernie McGurl
*The Lackawanna River Guide*, 1994




The Lackawanna through Scranton

# Mapping Details

All watershed maps were created at a 1:250,000 scale, where 1 inch equals approximately 4 miles. The Pennsylvania watershed map on page 11 was created at a scale of 1:2,500,000. Due to adjustments for publication, the maps stray from this absolute scale. Watershed maps are more accurately represented as 1 inch equals approximately 4.75 miles.

Map projection information can be found with each map.

A list of data sources can be found with each map. Associated dates reference the most recent date of publication, review, or access. All data accessed between February 2007 and July 2008.

Major data credits include:

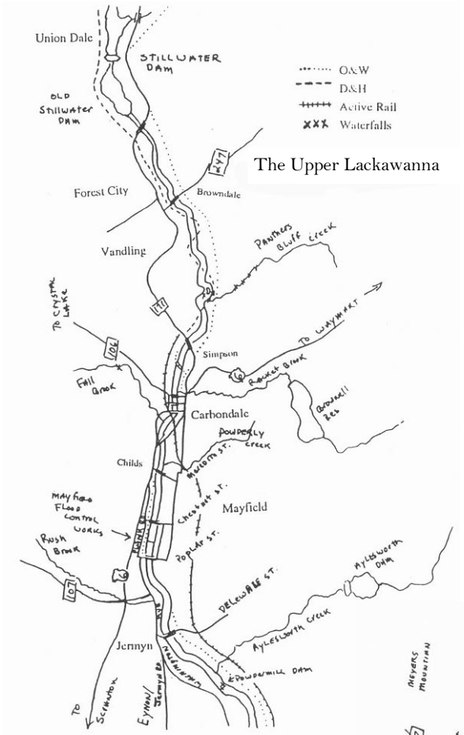
EPA, EPCAMR, LRCA, PASDA, USGS

Data processing and map products produced with Environmental Systems Research Institute's ArcGIS 9.2 suite of GIS software.

All maps are positioned to match the compass indicated.

Digital datasets complete with available metadata are available at:

www.lrca.org/atlas




Original drawings by Bernie McGurl
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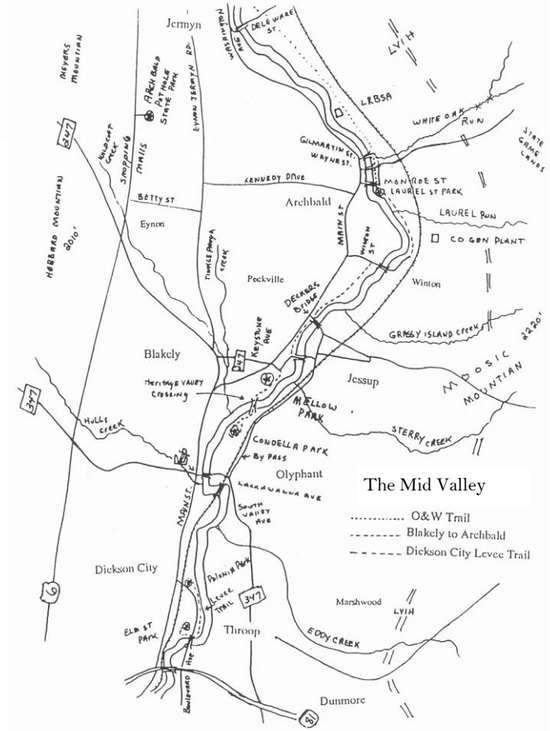
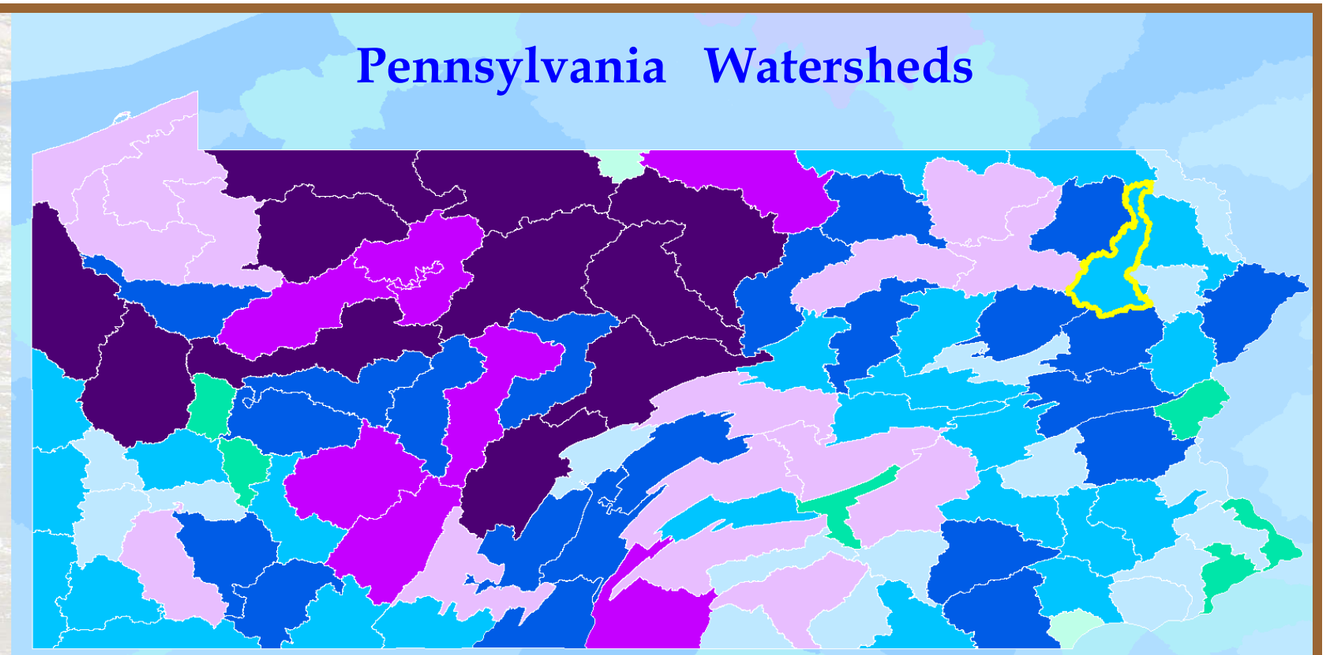



# Introductory Overview

The Lackawanna River Watershed comprises a mere 350 square miles of its mother watershed, the 64,000 square mile (over 40 million acres) Chesapeake Bay watershed. That equates to about half of one percent (.5%). Situated on an angle stretching from northeast to southwest, the watershed is primarily defined by the higher elevations of the West and Moosic mountain ranges.

The Lackawanna River rises in springs and waterways on the Allegheny Plateau between Elk Mountain and Mt. Ararat, along the border of Susquehanna and Wayne counties north of Forest City. The River flows through the Stillwater Gap and flows forty miles through the Lackawanna Valley to its confluence with the Susquehanna River near Pittston. Commonly known as an Indian derivative, *Lackawanna* refers to the meeting of two streams. The river lends its name to the county which holds its primary, but not total, drainage area and is the home to the city of Scranton. The watershed includes portions of Luzerne, Susquehanna, and Wayne counties.




The Lackawanna River's drainage area, or watershed, continuously collects waters flowing off the land as well as the waters rising from beneath the surface. Rain, snowmelt, agricultural runoff, treated sewage, untreated combined sewer overflow, and all other outfalls offer a positive and negative contribution to the river. Both the natural and unnatural inputs affect the health of the water and the encompassing lands.

In monitoring the current health of the river, a balance of the good and implicit evils can be discovered. The river tells a story of the region's interconnectivity of people, geology, and geography. The story features an unfortunate sidebar of the legacy of industry, still living in the river today.

Life in the Lackawanna River Watershed has rapidly changed in the short span of time but the river today continues it course. Once a convenient conduit for dumping household sewage, the river now offers stretches of Class A trout fishing as well as inspiration for reviving an entire city's downtown persona.

The following pages explore this unique watershed as a story told by maps, covering a history millions of years in the making, capturing a snapshot of present day life, and examining a few of the trends which perhaps forecast the future.

# What is a Watershed?

When the raindrop falls on the mountain peak, which direction down the hillside does the water flow in search of the ultimate fate: reaching the vast oceans? While not every drop of precipitation's life is simplified as surface runoff like this, the overarching concept of directional water flow is important to what a watershed represents.

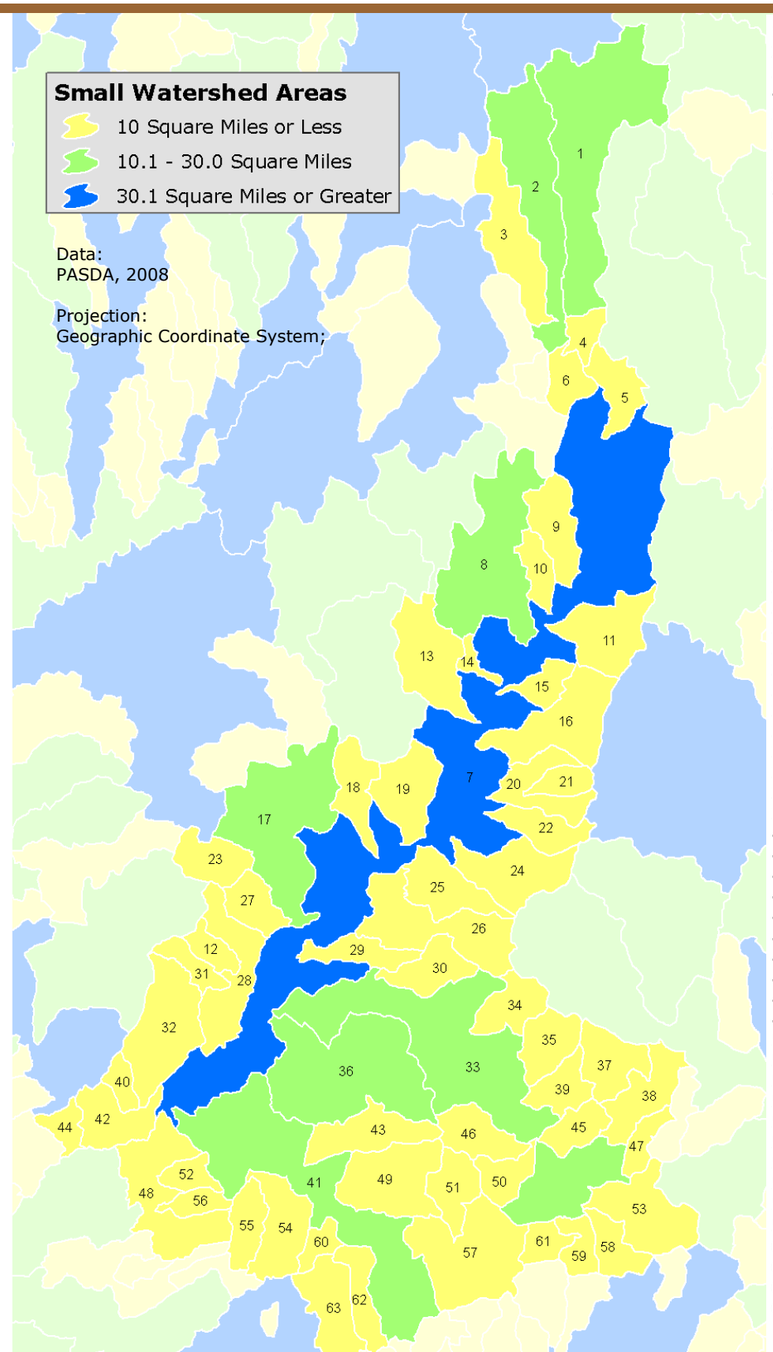
Visualize a watershed as a basin, or bowl, collecting rain, streams, pollution, people, and other life forms.

The World Resources Institute (2003) designates 114 major watersheds worldwide. The Susquehanna River basin comprises one of these large drainage areas and drains over 27,000 square miles according to the Susquehanna River Basin Commission (2008). The major basin's forest cover still resides on well over half its land area.

Within these larger watersheds exist smaller watersheds and within the smaller watersheds reside even smaller watersheds. The Upper Susquehanna-Lackawanna River watershed is an 1800 square mile portion of the world-class Susquehanna basin. The Lackawanna River watershed is a 350 square mile piece of this larger classification.

Even the Lackawanna River watershed contains smaller watersheds which are drainage areas for the tributaries eventually feeding the main river. Some pale in drainage area and volume of water drained yet these small units of contribution have the ability to indicate the health of the water and watershed as well as the origins of problems if they exist.

A long journey awaits water leaving the Lackawanna River watershed in search of the Atlantic Ocean. Nonetheless, the state in which it passes through and departs the watershed can provide insight to what is happening upstream.




| | |
|---|---|
| 1 | EAST BRANCH LACKAWANNA RIVER |
| 2 | WEST BRANCH LACKAWANNA RIVER |
| 3 | FIDDLE LAKE CREEK |
| 4 | EAST BRANCH LACKAWANNA RIVER |
| 5 | BRACE BROOK |
| 6 | LACKAWANNA RIVER |
| 7 | LACKAWANNA RIVER |
| 8 | FALL BROOK |
| 9 | WILSON CREEK |
| 10 | COAL BROOK |
| 11 | RACKET BROOK |
| 12 | LINDY CREEK |
| 13 | RUSH BROOK |
| 14 | LEES CREEK |
| 15 | POWDERLY CREEK |
| 16 | AYLESWORTH CREEK |
| 17 | LEGGETTS CREEK |
| 18 | HULL CREEK |
| 19 | WILDCAT CREEK |
| 20 | WHITE OAK RUN |
| 21 | INDIAN CAVE CREEK |
| 22 | LAUREL RUN |
| 23 | SUMMIT LAKE CREEK |
| 24 | GRASSY ISLAND CREEK |
| 25 | STERRY CREEK |
| 26 | EDDY CREEK |
| 27 | LEACH CREEK |
| 28 | KEYSER CREEK |
| 29 | MEADOW BROOK |
| 30 | LITTLE ROARING BROOK |
| 31 | LUCKY RUN |
| 32 | ST JOHNS CREEK |
| 33 | ROARING BROOK |
| 34 | ROCK BOTTOM CREEK |
| 35 | WHITE OAK RUN |
| 36 | STAFFORD MEADOW BROOK |
| 37 | POTTER CREEK |
| 38 | WILCOX CREEK |
| 39 | KELLUM CREEK |
| 40 | RED SPRING RUN |
| 41 | SPRING BROOK |
| 42 | LACKAWANNA RIVER |
| 43 | GREEN RUN |
| 44 | SUSQUEHANNA RIVER |
| 45 | BEAR BROOK |
| 46 | VAN BRUNT CREEK |
| 47 | WEBSTER CREEK |
| 48 | MILL CREEK |
| 49 | RATTLESNAKE CREEK |
| 50 | LANGAN CREEK |
| 51 | SIX SPRINGS CREEK |
| 52 | LIDY CREEK |
| 53 | EAST BRANCH ROARING BROOK |
| 54 | TROUT CREEK |
| 55 | MONUMENT CREEK |
| 56 | COLLINS CREEK |
| 57 | SPRING BROOK |
| 58 | ROARING BROOK |
| 59 | LAKE RUN |
| 60 | PLANK BRIDGE CREEK |
| 61 | EMERSON RUN |
| 62 | PANTHER CREEK |
| 63 | PAINTER CREEK |

# Places

Atop the watershed's surface, many lines can be drawn to describe where it exists and what exists in, on, and below its landscape. Perhaps the first to be drawn would be the almost 1,700 linear miles of roads crisscrossing the highlands and lowlands. Often the lines we cannot visualize on the landscape constitute the most crucial of all. An example of this would be the lines chopping the area into the governing local municipalities. Consider all the larger boundaries, of distance from the region but still important, such as Pennsylvania's state boundary and the outer boundary of the United States.

Many boundaries divide the watershed into unique segments, describing these places of human interest as well as the surrounding geography, hydrology, and geology.

A watershed boundary defines a physical geographic feature. Unlike it's political counterpart, physical features ignore those designed by humans and tend not to be limited to a single governing agency. Another example of this, shown on the adjacent map, are the geological regions in the watershed which follow elevation patterns.

The municipal boundaries control localized rules and regulations. This complex governing arrangement across the watershed encourages and necessitates cooperation of the participating agencies when it comes to management. Each municipality (boroughs, cities, townships) carries its own protocols for land use, zoning, and conservation at the local level. To maintain consistency in management, the state and federal governments also apply their regulations. The local level of management represents an important part of overall management as this is where the smallest changes can make the largest difference.

These municipal extents also allow us to measure the watershed's resident population and monitor trends in movement of people. The colored dots associated with each of the 53 municipal areas in the adjacent map point to the changes in population numbers. These numbers are based on the US Census of 2000 and population estimates for the subsequent years through 2007.

Examination of the map reveals trends in where we have been, how we live, and where we are migrating, and how fast we are changing.

**Population Change 2000-2007**

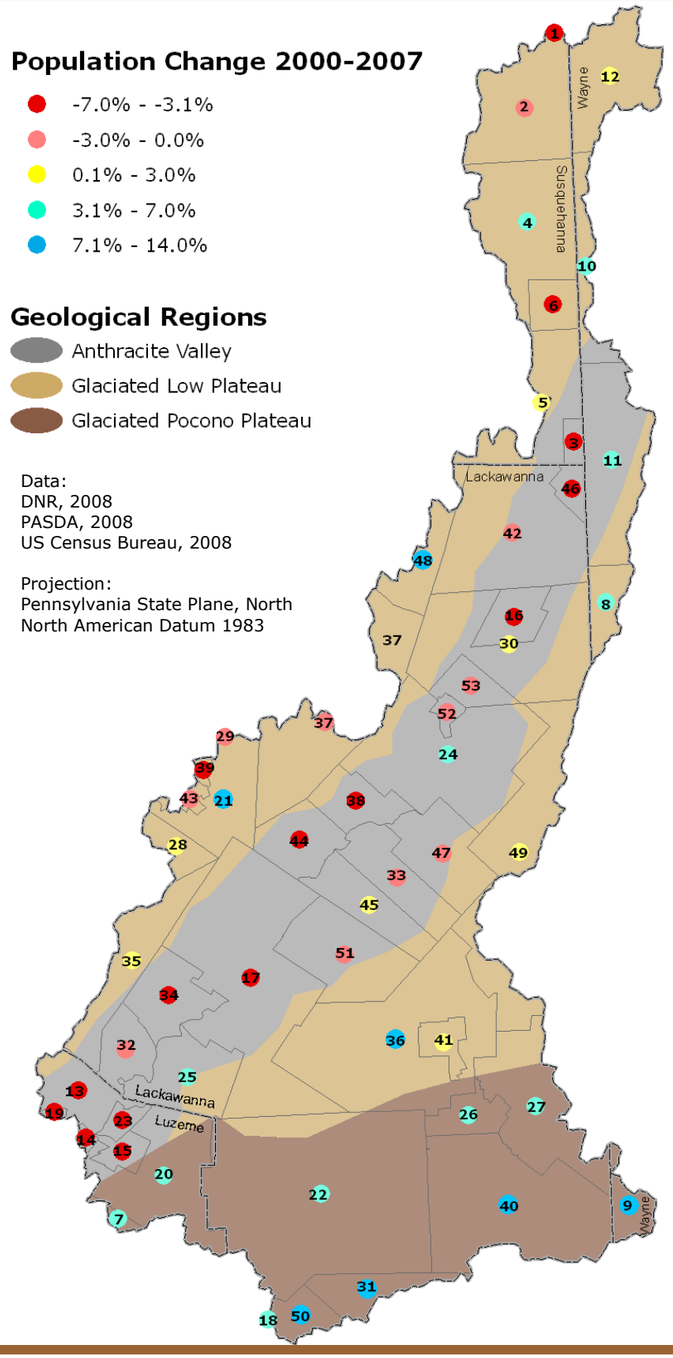
- -7.0% - -3.1%
- -3.0% - 0.0%
- 0.1% - 3.0%
- 3.1% - 7.0%
- 7.1% - 14.0%

**Geological Regions**

- Anthracite Valley
- Glaciated Low Plateau
- Glaciated Pocono Plateau

Data:
DNR, 2008
PASDA, 2008
US Census Bureau, 2008

Projection:
Pennsylvania State Plane, North
North American Datum 1983




| | |
|---|---|
| 1 | THOMPSON |
| 2 | ARARAT |
| 3 | FOREST CITY |
| 4 | HERRICK |
| 5 | CLIFFORD |
| 6 | UNIONDALE |
| 7 | JENKINS |
| 8 | CANAAN |
| 9 | STERLING |
| 10 | MOUNT PLEASANT |
| 11 | CLINTON |
| 12 | PRESTON |
| 13 | DURYEA |
| 14 | HUGHESTOWN |
| 15 | DUPONT |
| 16 | CARBONDALE CITY |
| 17 | SCRANTON |
| 18 | BEAR CREEK |
| 19 | PITTSTON CITY |
| 20 | PITTSTON TWP |
| 21 | SOUTH ABINGTON |
| 22 | SPRINGBROOK |
| 23 | AVOCA |
| 24 | ARCHBALD |
| 25 | MOOSIC |
| 26 | MOSCOW |
| 27 | MADISON |
| 28 | NEWTON |
| 29 | ABINGTON |
| 30 | CARBONDALE TWP |
| 31 | CLIFTON |
| 32 | OLD FORGE |
| 33 | OLYPHANT |
| 34 | TAYLOR |
| 35 | RANSOM |
| 36 | ROARING BROOK |
| 37 | SCOTT |
| 38 | BLAKELY |
| 39 | CLARKS GREEN |
| 40 | COVINGTON |
| 41 | ELMHURST |
| 42 | FELL |
| 43 | CLARKS SUMMIT |
| 44 | DICKSON CITY |
| 45 | THROOP |
| 46 | VANDLING |
| 47 | JESSUP |
| 48 | GREENFIELD |
| 49 | JEFFERSON |
| 50 | THORNHURST |
| 51 | DUNMORE |
| 52 | JERMYN |
| 53 | MAYFIELD |

# Geology & Industry

The geological formations in the watershed span segments of the Paleozoic Era, the period following the extensive Precambrian. The Paleozoic brought about the rise of vertebrates, seed and land plants, and the coal forming primitive tropical forests. The watershed's geology falls into the Devonian Period (410-360 million years ago) and two Carboniferous Periods: the Mississippian (360-320 million years ago) and Pennsylvanian (320-290 million years ago). These ancient times and processes yielded the sought after fossil products we still find today.

Geology lends itself crucial in explaining the anthropogenic interest in this region. Anthracite coal formed over the ages and is found in the Llewellyn Formation through the watershed, resting up to 700 feet below the surface. The Industrial Age of the nineteenth century hungered for energy and anthracite coal answered the call. Mining in Pennsylvania's northeast was born.

As tons of material in the form of coal and waste were extracted, the mined areas were left to fill with natural sources of groundwater. Today, one of the more interesting, yet disquieting, factors concerning water quality along the Lackawanna River in the watershed is not what is atop the surface but what lies beneath the interior. The cavernous and vacant underground mines became a series of basins below the Lackawanna Valley creating a unique subterranean hydrology, often stealing from the natural surface drainage. Pooled beneath the surface and exposed to various elements, the chemistry of the water becomes altered. When finally released back into the river, high iron concentrations yield an unsightly orange deposit around the surrounding riverbed, sometimes carrying the stain for miles from the place of origin. This is known as acid mine drainage (AMD) due to the higher pH of the discharge.

To alleviate hydraulic pressure from Mine Pool which sought relief in the basements of homes and the valley hillsides, features known as bore holes were established to reduce the problems. Most recognizable locally, the infamous Old Forge Bore Hole spews approximately 80 million gallons each day in the river. While the concentration of iron carried has decreased from 1960 when the borehole was installed, over a ton of dissolved iron flows from the Old Forge Bore Hole every day.

**Mining Operations and Outfalls**

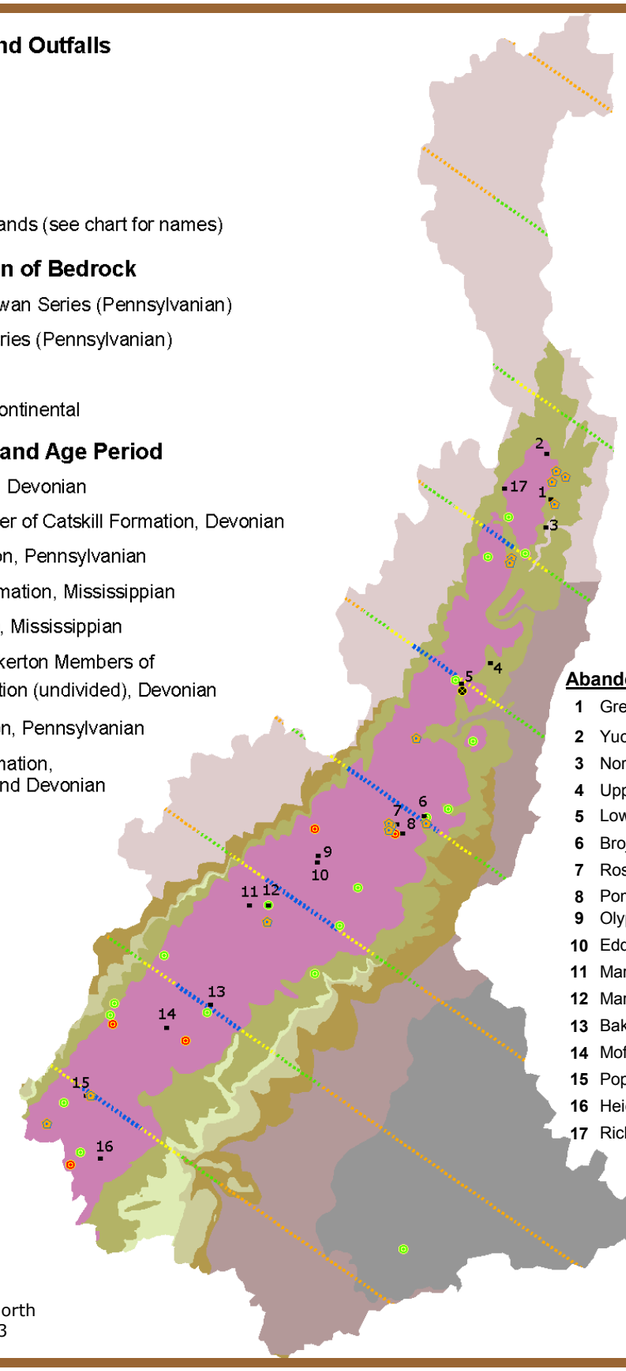
- Outfall Locations
- Abandoned Mines
- Active Mines
- Inactive Mines
- Abandoned Mine Lands (see chart for names)

**Temporal Description of Bedrock**

- Atokan and Morrowan Series (Pennsylvanian)
- Des Moinesian Series (Pennsylvanian)
- Mississippian
- Upper Devonian continental

**Geological Regions and Age Period**

- Catskill Formation, Devonian
- Duncannon Member of Catskill Formation, Devonian
- Llewellyn Formation, Pennsylvanian
- Mauch Chunk Formation, Mississippian
- Pocono Formation, Mississippian
- Poplar Gap & Packerton Members of Catskill Formation (undivided), Devonian
- Pottsville Formation, Pennsylvanian
- Spechty Kopf Formation, Mississippian and Devonian




**Abandoned Mine Lands**

1 Grey Slope Pile
2 Yucca Flats
3 Northwest Pile
4 Upper Powderly Basin
5 Lower Powderly Basin
6 Brojack Pile
7 Rose Pile
8 Pompey Colliery
9 Olyphant Colliery
10 Eddy Colliery
11 Marvine Colliery #6
12 Marvine Colliery
13 Baker Colliery
14 Moffat Colliery
15 Poppel Colliery
16 Heidelberg Colliery
17 Richmondale Pile

Data:
EPCAMR, 2006
LRCA, 2006
USGS, 1993

Projection:
Pennsylvania State Plane, North
North American Datum 1983

# GIS for the Watershed

The distance across the Lackawanna River's channel does not prohibit a stone or coin from easily being tossed from one bank and reaching the other. With such a small river area the management would seem simple.

Numerous factors add to the uniqueness of the river and its watershed, including the web of governing entities, legacy and modern pollution sources, and natural habitat. In order to manage these facets of the watershed's characteristics, computerized mapping systems effectively simplify such tasks.

Geographic information systems, or digital data management and mapping, provide a means to store all sorts of information from river levels to point-source pollution sites in individual data layers which can easily be compared. Traditional methods of mapping focused on printed maps, often overlaid with transparent sheets for analysis. Today, a GIS reduces the printed efforts in exchange for digital capabilities.

The maps within this atlas coordinate a variety of data from a variety of sources. As different agencies collect and maintain differing datasets, sometimes the most interesting extrapolations come from unusual pairings of layers. An example of this might include EPA's air quality data with local economic development plan datasets. This type of comparison could model future concerns for pollution based on the type of business or industrial site allowed with employment numbers indicating increased traffic flow.

Whether monitoring the present or modeling the past and future, GIS allows a glimpse of what is occurring around us.

## GIS Land Use Analysis

Description
Organizing data as layers proves paramount for GIS mapping. Dissecting the land use map on page 11, it is easy to see just how the map is made. Due to variations in the sophistication of GIS systems at the local level, the land use map prioritizes local land parcel datasets where possible and the remainder utilizes the USGS land use land cover format.. The list below details the contribution of each layer to the final map.

Lackawanna River Watershed
(PASDA, 2001)
Created from the federal and state delineations of watershed areas, this polygon feature recognizes the extent over four counties where drainage leads to the river.

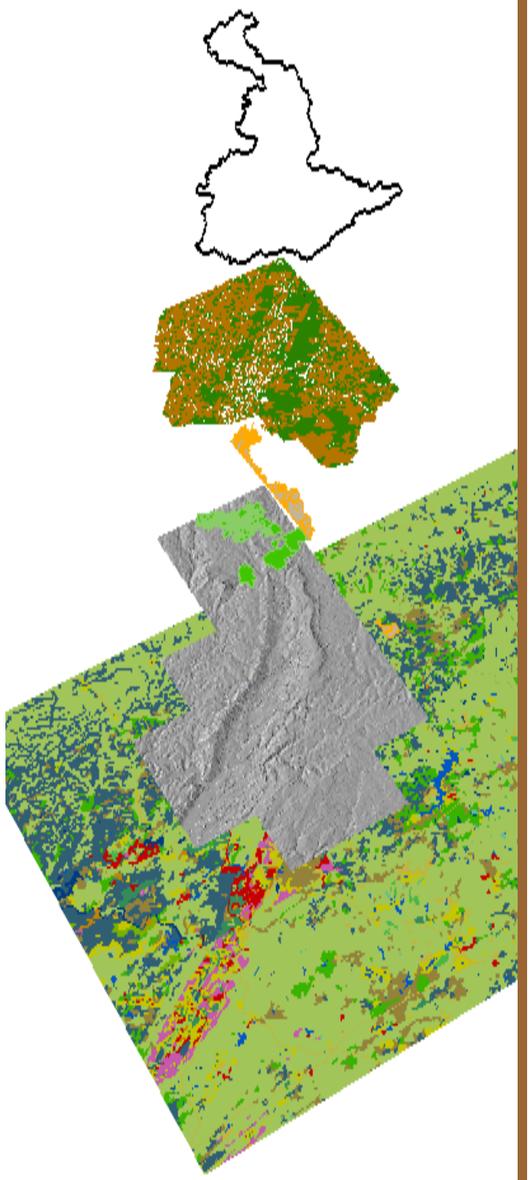
Wayne County Tax Parcels
(Wayne County 2008)
Contains data, by parcel, indicating use of and existing structures on parcel.

Lackawanna County Tax Parcels
(Lackawanna County, 2005)
Contains data, by parcel, indicating use of and existing structures on parcel.

Luzerne County Tax Parcels
(Luzerne County, 2008)
Contains data, by parcel, indicating use of and existing structures on parcel.

Digital Elevation Model
(USGS, 1993)
Hillshade created from elevation data for topographic effect.

Scranton Land Use Land Cover
(USGS, 1991)
Contains land use data (at a larger scale) to provide for portions of study area lacking data.



# Land Use

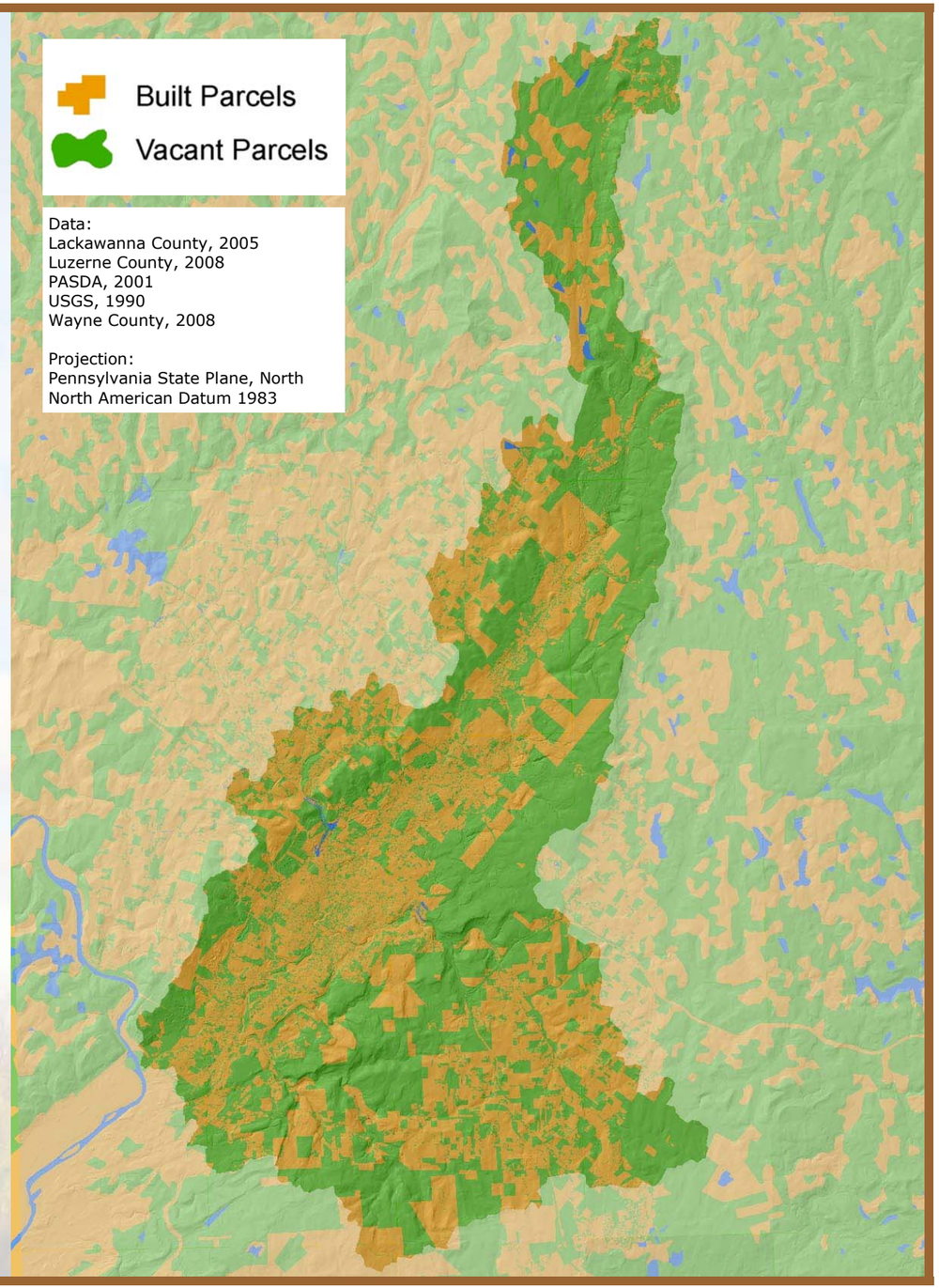
One simple way to determine how much of our watershed we have truly left untouched is to look at the way we are using the land around us. Whether for our home, our grocery store, vineyards, golf courses or grazing lands for livestock, these human uses have an unnatural impact on the environment. Human intervention on the landscape does not always constitute a threat. Ironically, such intervention proactively prevents future misuse of sensitive lands. Examples of this include conservation easements and land banking.

What is designed and built upon the landscape determines the level of impact a change will have on its proximity. While seemingly benign, any permeable (penetrable by water) surface which gets covered with a surface which is impervious forces rain water to seek other avenues of drainage or absorption. The watershed's sloping terrain lends itself to flooding following heavy precipitation events. As we loose land to development, more naturally absorbent surfaces get paved and the likelihood of flooding increases.

Land use also harbors clues about the patterns in which people move about the region. Over time, the change in tax parcel usage can indicate what types of activities are taking place as well as where growth has stagnated, stabilized, or blossomed. Land use is an important topic for local and regional planners as it controls what activities are compatible and those which are not. Such general classifications usually include residential, commercial, industrial, and conservation.

The adjacent map looks at the watershed's land parcels from a *used versus unused* perspective. Only the areas which exist without buildings or for natural use are represented in green. The orange areas included a structure and serve various uses for human purposes. Certain features can easily be seen such as dense urban areas and the higher elevations.

Conserving parcels favors environmentally significant lands but often includes lands which are: likely un-developable due to a large slope, known existence of sensitive species, riparian zones, and lands prone to erosion and flooding. By assessing land use, determinations can be made as to how well the resources have been allocated.



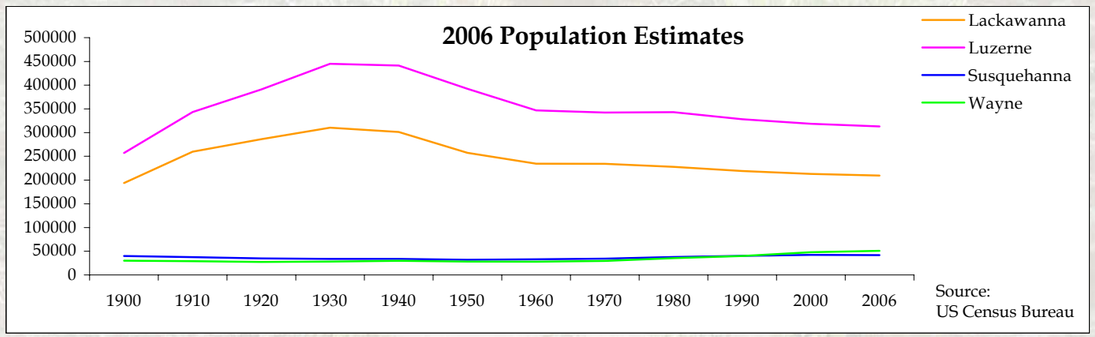
# People

Industry's effect on the Lackawanna River valley directly impacted the local population. The boom and bust of coal mining, manufacturing, and other regionally important economic activities lead to a dramatic decline of residents. Over the past century, the City of Scranton's population waxed into the mid 1900's, exceeding 140,000 by the 1940 census, but then decline followed the exiting mining and manufacturing industries. More recent population numbers show stabilization with the slight declines in Lackawanna , Luzerne, and Susquehanna counterbalanced by the increase in Wayne County's residents.

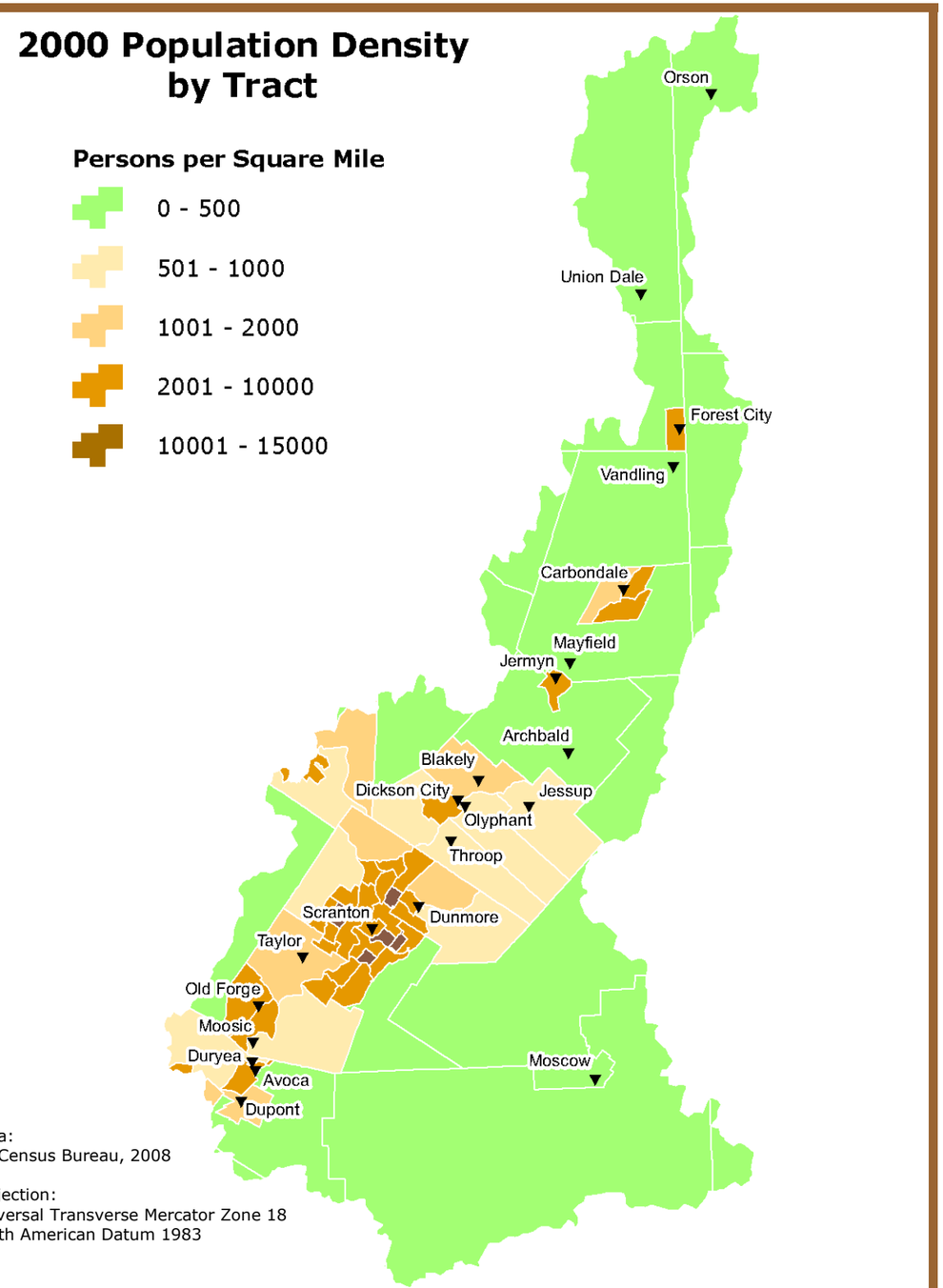
*Total Populations in 2006 (per chart) with Population Change*

*Lackawanna: 209,728 -2.0%*
*Luzerne: 313,020 -2.7%*
*Susquehanna: 41,889 -0.8%*
*Wayne: 50,929 +6.7%*

In the watershed, the concentration of residents inhabit the traditional urban portions, notably found in the valley. Suburbanization still leaves its modern paradigm signature on the landscape, especially in outlying rural areas with proximity access to the interstates connecting other local and regional metropolitan areas.




***Census Tract*** (Definition from the United States Census Bureau - www.census.gov)
A small, relatively permanent statistical subdivision of a county or statistically equivalent entity, delineated for data presentation purposes by a local group of census data users or the geographic staff of a regional census center in accordance with Census Bureau guidelines. Designed to be relatively homogeneous units with respect to population characteristics, economic status, and living conditions at the time they are established, census tracts generally contain between 1,000 and 8,000 people, with an optimum size of 4,000 people. Census tract boundaries are delineated with the intention of being stable over many decades, so they generally follow relatively permanent visible features. However, they may follow governmental unit boundaries and other invisible features in some instances; the boundary of a state or county (or statistically equivalent entity) is always a census tract boundary.



# The Water

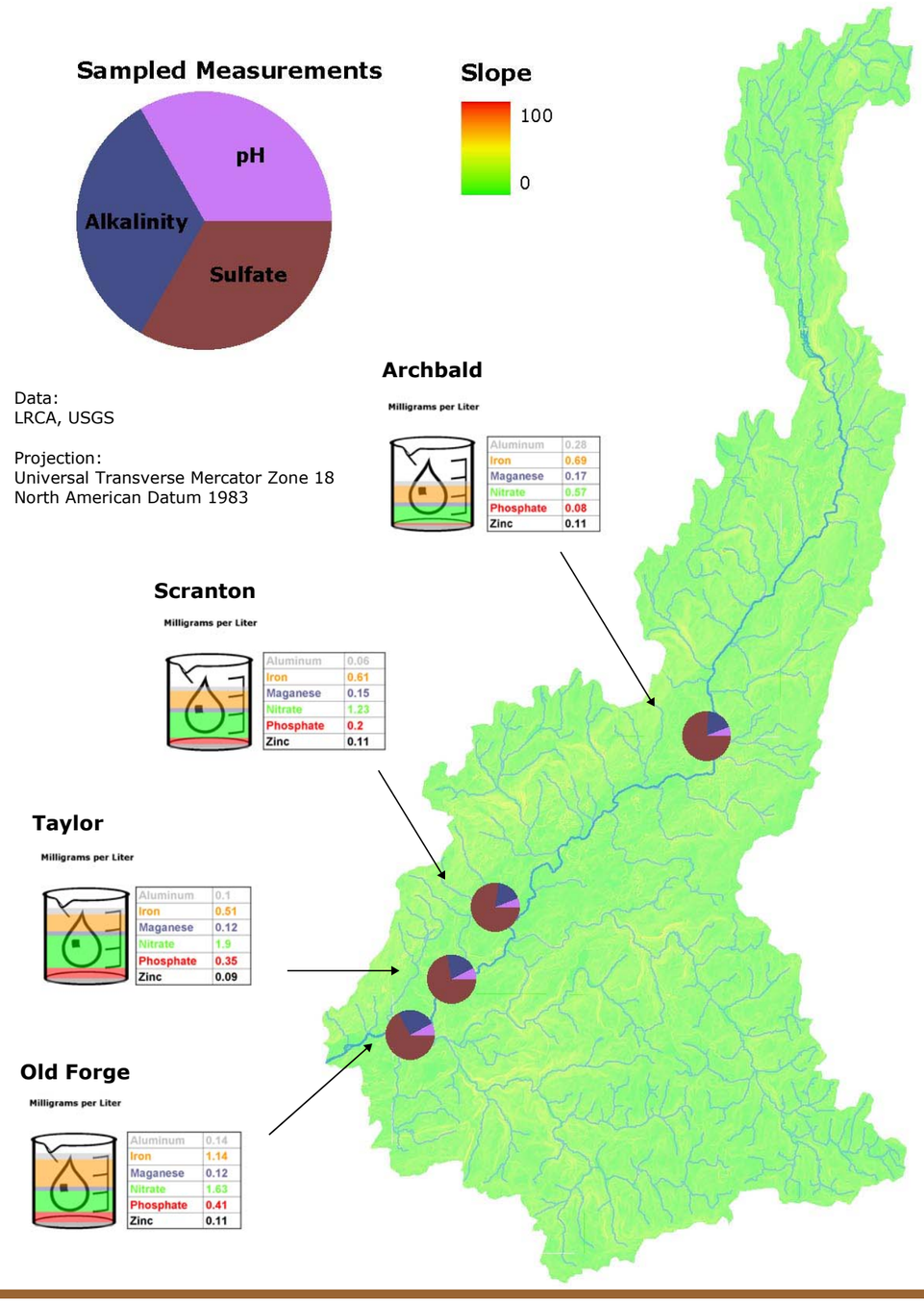
Indifferent to the passage of time, the Lackawanna River and its tributaries drain the watershed's surface and subsurface. Natural change comes slowly to its patterns through the landscape. Engineered changes, such a channelization, force the river to conform with modern land use needs.

Biological and chemical variables are evident with the waters passage and offer indicators of the environmental conditions affecting the river. While the clear water often hides its polluted content, portions of the river express its ills with the tainted hues of orange. This feature is most prominent below outfalls from the mine pool, such as the Old Forge Bore Hole. Over 80 million gallons of contaminated water known as Acid Mine Drainage (AMD) flows into the River from the Old Forge Bore Hole every day.

From a biological standpoint, both flora and fauna struggle to survive in the chemical ridden waters. Low dissolved oxygen levels and high levels of dissolved mineral content render the river useless as habitat. These chemical considerations determine both the quality and quantity of life forms in the water itself.

Aluminum, calcium, cobalt, iron, lithium, magnesium, manganese, nickel, strontium, zinc, and sulfate commonly appear concentrated in the AMD of anthracite coal fields according to the USGS. While many of these minerals occur naturally, the concentrated occurrences lead to contaminated waters which are unfit for exposure or consumption.

The adjoining map illustrates average chemical compositions taken in water samples from 1999-2004. Each year the majority of the sampling was performed three times, once in May, July and September. For each liter of water, the selected minerals get measured as milligrams. These measurements can verify what we do see in the water as well provide insight into the water's content when the naked eye cannot detect such contents.



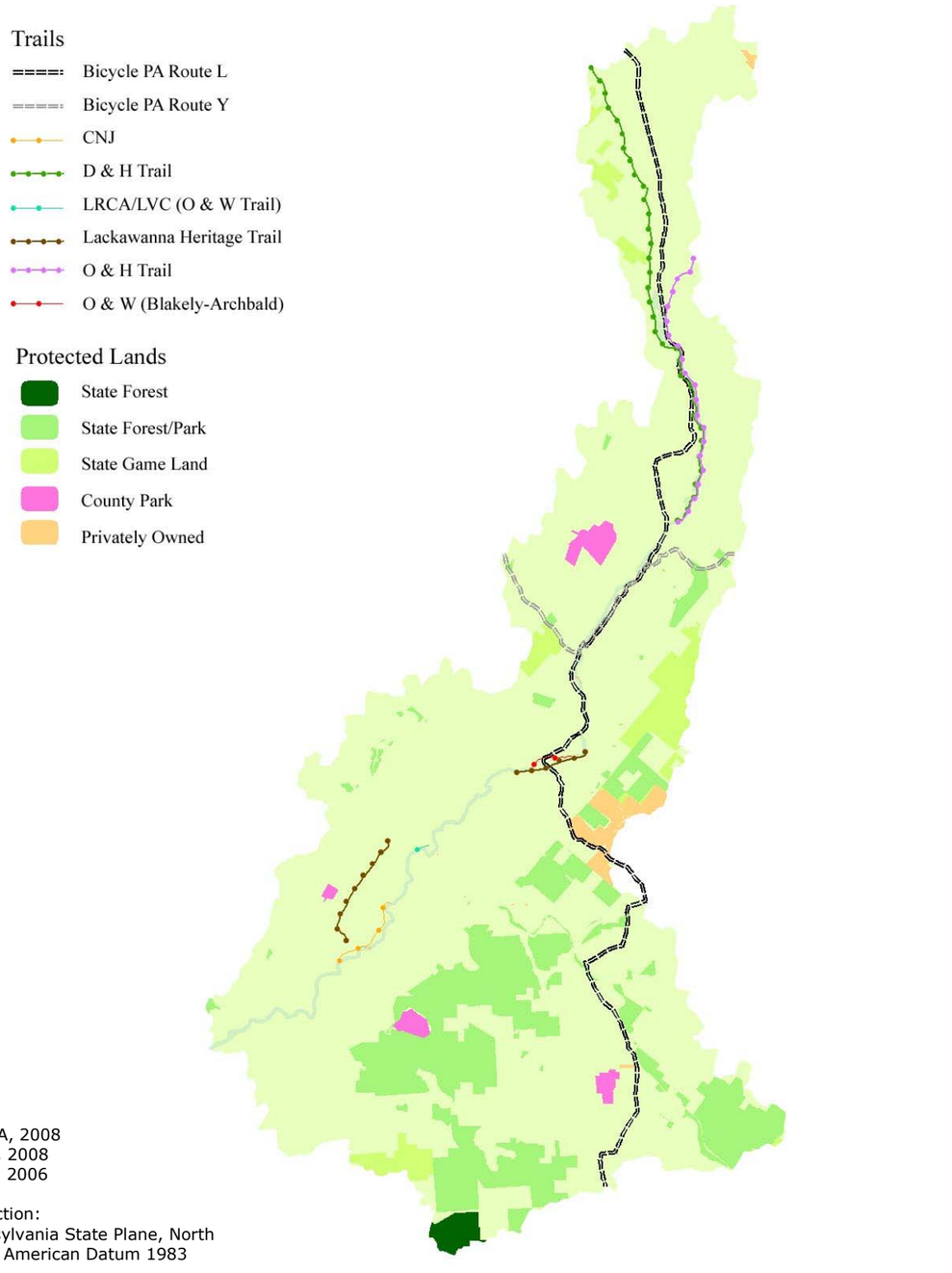
# Preserving the Watershed

The manner in which we regard our watershed today determines its quality tomorrow. Residents and visitors who pass through the region impact this quality.

The watershed continues to struggle to overcome its industrial history and improve. As the times have changed, so has the way in which we regard the river and its tributaries. There will always be issues with illegal dumping, stormwater runoff, and many other problems but mitigation efforts to minimize these effects can be made by all individuals. Understanding the limits of what burdens the river and its hinterland can tolerate are important to realize.

Dedicated lands such as parks, forests, and other protected lands establish boundaries for the continued expansion of urban and suburban growth. Protected areas help to counter-balance development activities which often include vegetative clearing, wetland destruction and application of impervious surfaces.

An awareness of the values that our watershed provides to enhance our Quality of Life is the basis of preserving and protecting the unique natural character of the Lackawanna River and its landscape. Fortunately, the region offers numerous means to see many of the interesting geological, hydrological and historical features present. The River is becoming more accessible for fishing and paddling. The watershed offers more opportunities for experiencing the best of outdoor activities from hiking and biking to hunting, fossil collecting, or birding. Networks of trails and public lands allow individuals to explore the watershed's offerings. While the stoic, aging hills imply the region's strength, be mindful of the river's fragileness and the watershed's susceptibility to the impacts of daily life here.




Data:
PASDA, 2008
LHVA, 2008
LRCA, 2006

Projection:
Pennsylvania State Plane, North
North American Datum 1983

## Further Investigations

The Lackawanna River Watershed Atlas publication is part of a larger digital project which is accessible online at:

www.lrca.org/atlas

Please visit the website to obtain up to date information on the river and surrounding watershed, from scientific data to recreational information.

Additional websites with related content:

www.lrca.org

www.lackawannawatershed.com

www.lhva.org

www.orangewaternetwork.org

www.epa.gov

www.usgs.gov