




Private Water Supply A Pennsylvania Perspective Birchwood Lakes Community Association





Groundwater Resource Management



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Project Sponsors

- **Pocono Northeast Resource Conservation & Development Council**
<http://www.pnercd.org>
- **C-SAW Program - Consortium for Scientific Assistance to Watersheds Program**
<http://pa.water.usgs.gov/csaw/>
- **PA Association of Environmental Professionals**
<http://www.paep.org>

Center for Environmental Quality



Non-profit/ equal opportunity employer, is operated and managed, within the Department of Environmental Engineering and Earth Sciences at Wilkes University

Outreach Programs

- Environmental and Professional Education and Training
- Applied Research
- Community and Business Outreach Programs

Website: <http://www.water-research.net>

Presentation Sponsors

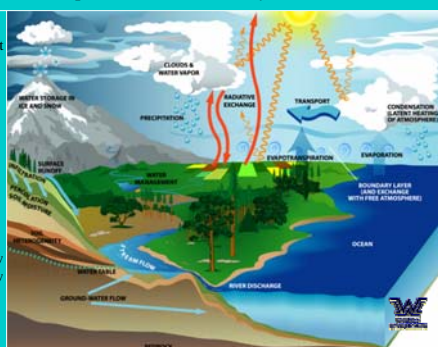


- Carbon County Groundwater Guardians
<http://www.carbonwaters.org>
- Wilkes University
<http://www.wilkes.edu>
- Pocono Northeast Research Conservation and Development Council
<http://www.pnercd.org/>
- Constorium for Scientific Assistance to Watersheds
<http://pa.water.usgs.gov/csaw/>

Components of the Water Cycle

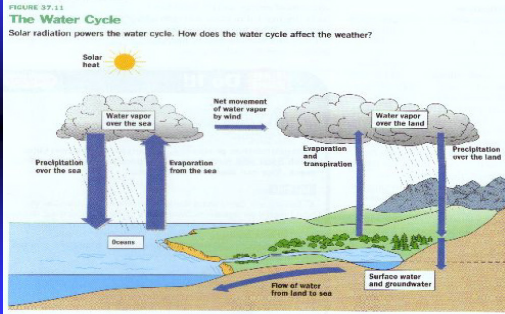
First The Ins
Solar Energy Input
Precipitation
Condensation
Well Injection
Irrigation

The Outs
Evaporation
Transpiration
Infiltration
Percolation
Runoff
Groundwater Flow
Surfacewater Flow
Well Pumping



water cycle

The Water Cycle Powered by the Sun: Solar Power



Precipitation



Types of Precipitation

- Natural**
 - Rain
 - Snow
 - Ice
 - Hail
 - Condensation/ Dew
- Man-Made**
 - Irrigation
 - Wastewater Applications



Interception Infiltration / Percolation




Canopy Interception




Infiltration- Movement Water Into Soil


Percolation - Water Movement Through the Soil

Evaporation / Transpiration Evapotranspiration






Credit: Kidzone Fun Facts




Stomata


Evaporation- Driven by Thermal Gradient and Moisture Difference

Runoff / Overland Flow






Uncontrolled Runoff
Causes Erosion

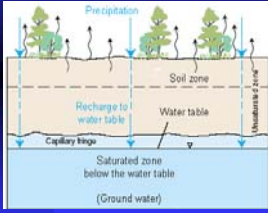


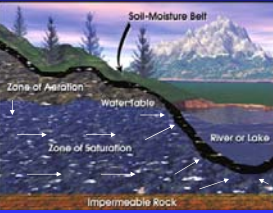
Low Infiltration
Causes - Overland Flow- Loss
Organic Material

When Rainfall Rate Exceeds Infiltration Runoff is Generated

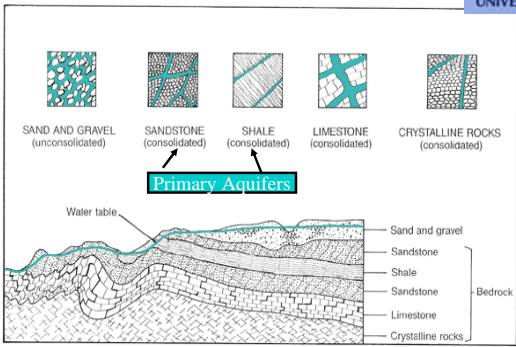
Groundwater Zone of Saturation



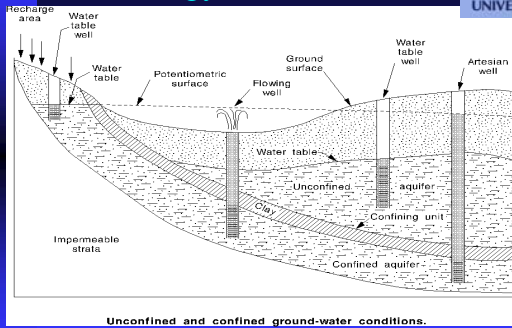




Primary Aquifers in PA

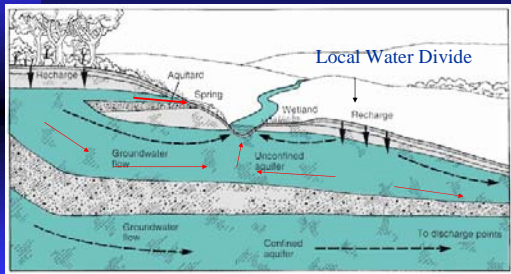


Well Geology

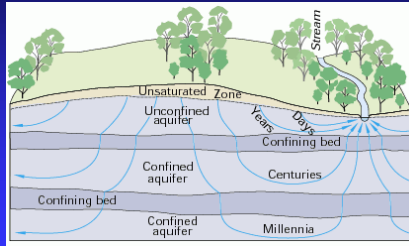


Unconfined and confined ground-water conditions.

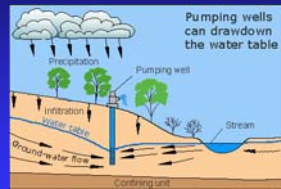
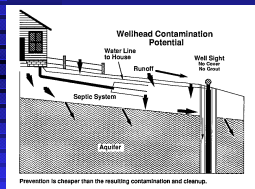
Surfacewater & Groundwater They Are Related and Connected !



Groundwater Moves - Slowly feet per year



Induced Recharge or Artificial Discharge




Artificial Recharge- Septic Systems Pumping Well - Artificial Discharge

County	# of homes served by private water systems			Avg. Change in homes served by private water systems per year	% of all homes served by public water	% of all homes served by private water system
	1980	1990	2000			
Bradford	13,443	16,865	20,287	+342	37	63
Carbon	6,594	12,235	17,876	+564	55	45
Lackawanna	9,952	12,745	15,538	+279	86	14
Luzerne	19,994	24,662	29,330	+467	82	18
Monroe	21,129	37,246	53,363	+1612	32	68
Pike	3,441	16,875	24,309	+748	43	55
Sullivan	2,147	4,727	7,307	+258	13	87
Susquehanna	9,423	15,212	21,001	+579	25	75
Tioga	9,126	11,888	14,650	+276	35	65
Wayne	9,913	19,097	28,281	+918	33	67
Wyoming	7,236	8,657	10,078	+142	27	73
Region	118,398	180,209	242,020	+562	43	57




Keys to Safe Drinking Water

- The Sanitary Survey- Proper Site Location
- **State Federal and Local Regulations**
- **Types of Well Water Sources**
- **Well Drilling and Construction**
- **Initial Water Testing- Common Water Quality Problems**
- Well Water Conditioning or Treatment
- Well Maintenance



State and Federal Regulation

- Currently No Federal Or Pennsylvania State Regulations Related to Private Water Well Construction.
- Pennsylvania has over 1 million households on Private Wells.
 - ◆ Pennsylvania one of 2 states that has no state-wide private water well construction standards, via regulation.
 - ◆ PA does not really have a comprehensive certification program for drilling contractors and operators.



Local Agency

The Pennsylvania State Association of Township Supervisors Surveyed second class townships across the state regarding water well ordinances and water well related problems. Of the 1,457 township across the state:

- 601 townships responded to the survey
- 39 of 601 townships maintain water well construction ordinances
- 21 townships were considering and ordinance

Protect Your Water Source

Things You or Your Community Can Do

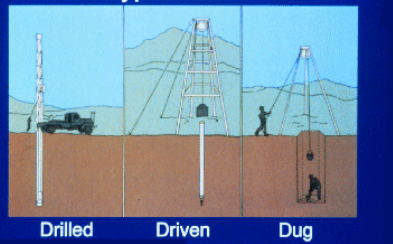


- Periodically Inspect
- Drain Surfacewater and Runoff Away
- Install Sanitary Seal
- Annual Testing
- Maintain Records
- Start a Community Based Groundwater Education Program
- Carbon County Groundwater Guardians
<http://www.carbonwaters.org/>
- Proper Abandonment
- Chemical Storage, Disposal and Use
- Keep Wellhead Above Grade
- Proper Well Location
- Septic System Maintenance
- Recycle used Oil and Participate in Hazardous Chemical Disposal Programs
- Well Ordinance

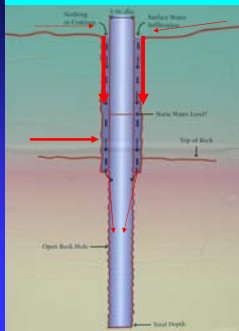
Private Water Sources Wells



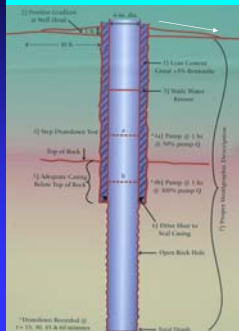
Types of wells



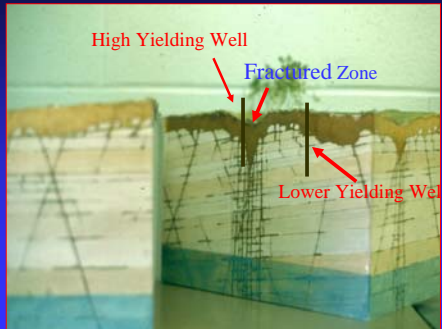
An UngROUTED Residential Well



A Properly Grouted Well



Bedrock Fractures and Fractured Zones



Well Isolation Distances

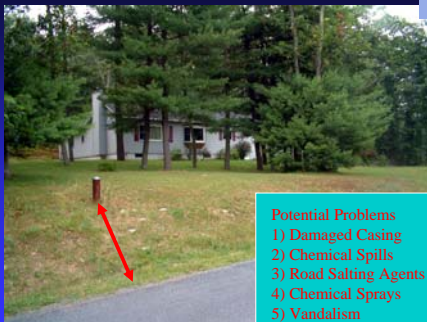


MONTGOMERY COUNTY HEALTH DEPARTMENT INDIVIDUAL WATER SUPPLY WELL CONSTRUCTION SPECIFICATIONS (partial listing)

- Delineated wetlands or floodplains (25 feet)
- Surface waters (25 feet) Storm water Systems (25 feet)
- Spray Irrigation/ Septage Disposal (100 feet)
- Farm silos / manure storage (200 feet) Septic Systems (100 feet)
- Septic Tanks/Holding Tanks (50 feet)
- Chemical Storage/Preparation Area (300 feet)

More Information at
<http://www.h2otest.com/regs/pa/montgomery/>

Too Close to the Road



Well Cap Not Secure



Well Construction Options for Private Wells

Standard Well Cap



Allow entry for insects, small animals

Sanitary Well Cap



Sealed to prevent contamination

Unsanitary Well Cap

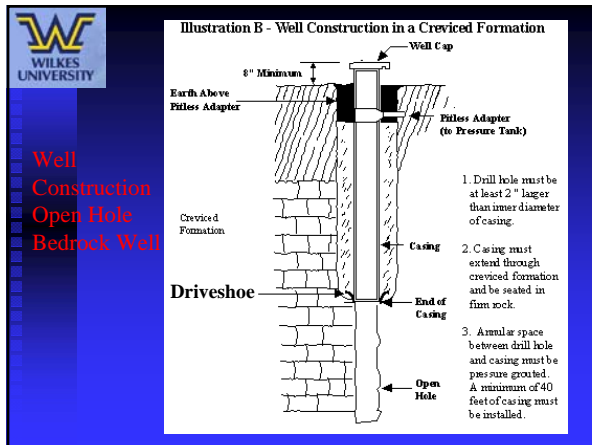


- Insects, Larvae and Nests / Egg Masses
- Mouse Colonies
- Snakes
- Beehives
- Mud - when casing to close to ground

Types of Contamination - Bacteria, Pathogens, Sediment
Subject to Vandalism, Salts, and Flooding

Why Care About Well Construction ?

- Poor construction can affect drinking water quality
- Poor construction can contribute, promote, and facilitate pollution and contamination of the groundwater aquifer
- Proper construction can prolong the life and yield of the well



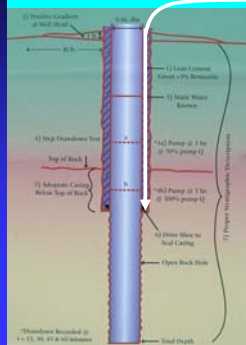
Well
Construction
Open Hole
Bedrock Well



Welding the Steel Casing



A Properly Grouted Well



Tremie Pipe

Installing the Tremie Pipe



Pumping in the Bentonite Grout





Why Test My Water ?



A USGS survey found that 70% of private wells were contaminated. This contamination could result in acute or chronic health concerns.

In general, there are no regulations related to well construction, placement, or required testing. It is up to you to determine the safety of your water.

EPA recommends, at minimum, an annual water test for private wells.

Primary Standards (NPDWR)



National Primary Drinking Water Regulations

Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water. They take the form of Maximum Contaminant Levels or Treatment Techniques.

There are over 100 chemical and biological primary drinking water standards, which include: trace metals, disinfection agents, disinfection by-products, radiological, microbiological agents, and organic chemicals.

Examples: Arsenic, Lead, MTBE, total coliform, *Giardia*, Trihalomethanes, Asbestos, Copper, Benzene, Trichloroethane, etc.

Secondary Standards



National Secondary Drinking Water Regulations

These standards were established more for cosmetic Effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor or color) in drinking water.

These are not regulated standards, but recommended limits.

The secondary standards include: aluminum, chloride, color, corrosivity, fluoride, foaming agents, iron, manganese, odor, pH, silver, sulfate, total dissolved solids, and zinc.



What Should I Test

The Selection of the Appropriate Testing Parameters Depends on YOUR Water


- How does it taste?
 - Do you have odor problems ?
 - Are there any aesthetic problems, such as: color, turbidity, grittiness, or staining ?
 - Where are you located ?
 - How much do you want to spend ?
- Comprehensive testing can cost over \$2500.00

Taste Problems



- | | |
|----------------------------|--|
| ■ Salty or Brackish Taste | ■ High Sodium |
| ■ Alkali Taste | ■ Elevated Hardness or alkalinity |
| ■ Metallic or Bitter Taste | Corrosion, Low pH, high metallic content (Cu, Fe, Mn, Pb,Al, Zn) |


Odors



- Rotten Egg / Musty Odor
- Oily
- Methane Like-Smell
- Chemical/ Solvent
- Sulfate, Sulfur, Nuisance Bacteria
- Gasoline, Oil Contamination or Nuisance Bacteria
- Organic Material or Natural Gas
- Industrial Chemicals

Note: Methane gas has no odor.

Sediments and Stains



Milky or Cloudy

Precipitation of carbonates / sulfates, excessive air, suspended solids, aquifer material

Bluish Green – Green Precipitates

Copper, hardness, aggressive water and corrosion by-products, nuisance bacteria


Blackish Tint or Black Slimes

Reactions with manganese and possibly iron, nuisance bacteria

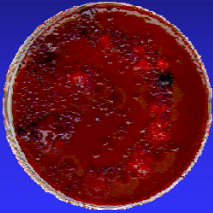
Yellowish or Reddish Tint or Slimes

Humic material, dissolved or precipitated iron, nuisance bacteria

Groundwater Pocono's Region: Pike County





Based on the geology of the Pocono's region, the **common** water quality problems are as follows:



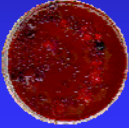
- Corrosive Water
- Low pH
- Soft Water (low hardness) to Moderate Hardness
- Iron and Manganese
- Discolored Water – Reddish to Brown Tints
- Total Coliform Bacteria
- Sulfur Odors and Elevated Sulfates

Coliform Bacteria


Coliform Bacteria
Absent or < 1 colony/100 ml

Testing Purpose
Used as an Indicator of Sanitary Condition of Water Source



Sources
Natural Soil Bacteria
Human and Animal Waste
Insect Waste

Less Common Problems



These water quality are not common to Groundwater in Pike County.


Elevated Nitrate- Nitrite Levels (local problems)

Radon or Radiological (local issues)

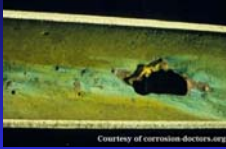
Arsenic (local issues)

Organic Contamination
Elevated Trace Metals
(except corrosion by-products like Copper, Lead, Aluminum, Zinc)
Salty or Brackish Water (very deep wells)
Trihalomethanes
Pathogenic Organisms

Corrosive Water



- Chemical or Biochemical Reaction between the water and metal surfaces.
- The corrosion process is an oxidation/reduction reaction that returns refined or processed metal to their more stable ore state.
- Corrosion can also be accelerated by:
 - 1) low pH and high pH;
 - 2) high flow rate within the piping;
 - 3) high water temperature;
 - 4) chemistry of the water; and
 - 4) presence of suspended solids, such as sand.



Courtesy of corrosion-doctors.org

Copper – Typically Blue or Blue-Green Staining

May also have elevated levels of Lead and Zinc.

pH



pH < 7 acidic
 a pH > 7 basic
 NSDWR – 6.5 – 8.5





Problems

- Bitter or Alkali Taste
- Corrosion
- Scale Formation
- Leaching Metals- Copper, Lead, Zinc, and Aluminum


Water Hardness, Iron, Manganese

- The hardness of a water is a measure of the concentration of the multivalent cations (Ca, Mg, Fe, Mn, etc) associated with carbonates (CO₃) .
- Hardness is typically reported as mg /L as CaCO₃ (calcium carbonate)
- Grains per gallon (1 gpg (US) = 17.12 mg CaCO₃/L .)
- Hardness Classification:
 - ◆ Soft: 0 to 17 mg CaCO₃/L
 - ◆ Slightly Hard: 17 to 60 mg/L;
 - ◆ Moderately Hard 60 to 120 mg/L
 - ◆ Hard 120 to 180 mg/L
 - ◆ Very Hard > 180 mg/L



Secondary Drinking Water Standard
 Iron – 0.30 mg/L (red or black)
 Manganese – 0.05 mg/L (black)

Sulfates in Water



Sulfates are a combination of sulfur and oxygen and are a part of naturally occurring minerals in some soil and rock formations that contain groundwater. The mineral dissolves over time and is released into groundwater.

Hydrogen sulfide gas also occurs naturally in some groundwater. The gas is formed from decomposition of organic compounds contained within the bedrock. Problems are typically found in aquifers that are shale, siltstone, peat related, or near surface sources of organic material.

Sulfur-reducing bacteria, use sulfur as an energy source and are the Primary producers of large quantities of hydrogen sulfide. These bacteria chemically change natural sulfates in water to hydrogen sulfide



Problems with Sulfates

- Laxative Effect- MCL 250 mg/L
- Form Precipitates on Piping and Fixtures
- Rotten Egg Odors
- Sewage Gas Odors
- Corrosion
- Water Heater Failure/Odors



Radon (In Air)- Pike County, PA



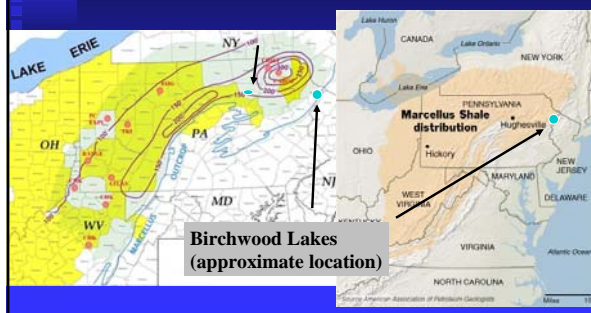
Pike County in the Orange Zone –
Suggests indoor air radon levels are less than 4 pCi/L

Zip Code	Number of Tests	Min Result pCi/L	Maximum Result pCi/L	Avg Result pCi/L
18328	1214	0.1	70.7	4.7

http://www.dep.state.pa.us/RadiationProtection_Apps/Radon/



Marcellus Shale- Natural Gas Play 50 to 200 trillion cubic feet





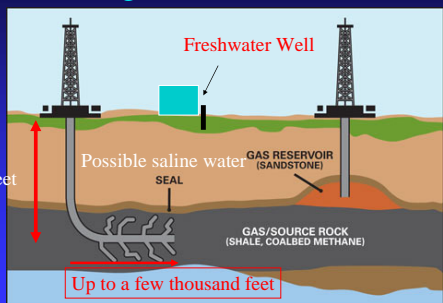
Marcellus Shale Photo



Outcrops Along the Southeastern Border of Pike County Along Route 209



Getting to The Natural Gas





Marcellus Shale Drilling Site



Pads can be 5+ acres – but one pad may support drilling multiple horizontal wells.



Concerns Related to Marcellus Shale

- Based on Community Location – this should not be a major concern or impact.
- In general, the concerns are related to the following:
 - ◆ Erosion and Sedimentation
 - ◆ Volume of Water Used In Hydrofracturing- 2 to 9 million gallons per well.
 - ◆ Loss of Freshwater Aquifer or contamination by brine water and drilling fluids.
 - ◆ Drilling fluids may contain environmental contaminations (metals and organics).
 - ◆ Impacts to Roadways, Tourism, and Ecology



Active Marcellus Production Site



Site Located in Chemung County, NY.



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Summary



Keys to Safe Drinking Water (Private Well)

- Proper Handling of Chemicals and Waste
- Development of Local Standards
- Understand Your Source
- Annual Water Testing
- Public Education





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