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/casaw/
- PA Association of Environmental Professionals
  http://www.paep.org
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
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

Condensation/Dew
Man-Made
Irrigation
Wastewater Applications

Canopy Interception
Infiltration - Movement Water Into Soil
Percolation - Water Movement Through the Soil
Evaporation / Transpiration
Evapotranspiration

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
Groundwater Moves - Slowly feet per year

Induced Recharge or Artificial Discharge

Artificial Recharge - Septic Systems  Pumping Well - Artificial Discharge

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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 statewide 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

Drilled Driven Dug

An Ungrooted Residential Well

A Properly Grouted Well
Bedrock Fractures and Fractured Zones

High Yielding Well

Fractured Zone

Lower Yielding Well

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)
- Septic Tanks/Holding Tanks (50 feet)
- Farm silos / manure storage (200 feet) Septic Systems (100 feet)
- Chemical Storage/Preparation Area (300 feet)


Too Close to the Road

Potential Problems:
1) Damaged Casing
2) Chemical Spills
3) Road Salting Agents
4) Chemical Sprays
5) Vandalism
Well Cap Not Secure

Well Cap is Off!

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 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.

Illustration B - Well Construction in a Crustal Formation

1. Drill holes must be at least 2" larger than inner diameter of casing.
2. Casing must extend through coarse formation and be sealed in fine rock.
3. A minimum space between drill holes and casing must be preserved.
4. Maximum of 50 feet of casing must be installed.

Casing With Driveshoe
Welding the Steel Casing

A Properly Grouted Well

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
- Alkali Taste
- Metallic or Bitter Taste
- High Sodium
- Elevated Hardness or alkalinity
  Corrosion, Low pH, high metallic content (Ca, Fe, Mn, Pb, Al, Zn)
**Odors**
- Rotten Egg / Musty Odor
- Oily
- Methane Like-Smell
- Chemical/ Solvent

**Sediments and Stains**
- Milky or Cloudy
  - Precipitation of carbonates / sulfates, excessive air, suspended solids, aquifer material
- Blackish 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

Note: Methane gas has no odor.
**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

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**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

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**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.

- **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

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**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 12 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)

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**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

<table>
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<tr>
<th>Zip Code</th>
<th>Number of Tests</th>
<th>Min Result pCi/L</th>
<th>Maximum Result pCi/L</th>
<th>Avg Result pCi/L</th>
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http://www.dep.state.pa.us/RadiationProtection_Apps/Radon/

Marcellus Shale - Natural Gas Play

- 50 to 200 trillion cubic feet
- Birchwood Lakes (approximate location)
Marcellus Shale Photo

Outcrops Along the Southeastern Border of Pike County Along Route 209

Getting to The Natural Gas

Freshwater Well

5000 to 7000 feet

Possible saline water

Gas reservoir (shale gas)

Up to a few thousand feet

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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- C-SAW Program: Consortium for Scientific Assistance to Watersheds Program
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- PA Association of Environmental Professionals
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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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