

## Private Homeowner Drinking Water Issues Pike County Presentation (Part II) - 2009

Presenter

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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/>
- **Carbon County Groundwater Guardians**  
<http://www.carbonwaters.org/>
- **PA Lake Management Society**  
<http://www.palakes.org>
- **B.F. Environmental Consultants Inc.**  
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## Center for Environmental Quality

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

### Outreach Programs

- Environmental and Professional Education and Training
  - Applied Research
  - Community and Business Outreach Programs
- Website: <http://www.water-research.net>

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## Updates New Websites and Announcements

- **Blogging Site**  
– <http://pennsylvania-solutions.blogspot.com/>
- **Announcing the Go- Green Program**  
– <http://www.bfenvironmental.com/workshops.php>
- **Pocono Northeast RC&D Council - Looking for Community Partners**  
– <http://www.pnercd.org>

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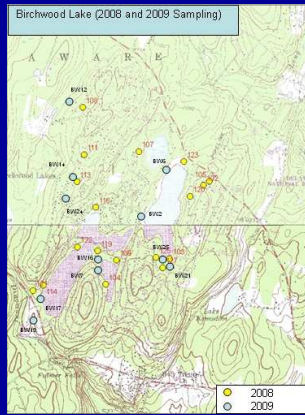
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## S a m p l i n g




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## R e s u l t s 2 0 0 9

Parameters	Tested	Standard or Guidance	# Exceeding	Percentage
Total Coliform	10	< 1 per 100 ml or Absent	5	50
E. Coli Positive	10	< 1 per 100 ml or Absent	2	40
Standard Plate Count	10	< 1 per 1 ml	1	10
pH	10	≥ 8.5	0	0
pH	10	< 6.5	4	40
Nitrate + Nitrite	7	> 10 mg NO3-N/L or > 1 mg NO2-N/L	1	10
Conductivity	10	no standard (< 600 µS/cm)	1	10
Sulfate	7	> 250 mg/L	0	0
Copper	7	> 1.0 mg/L	0	0
Iron	7	> 0.3 mg/L	3	43
Manganese	10	> 0.05 mg/L	4	57
T. Hardness	7	> 160 mg CaCO3/L or < 2 mg CaCO3/L	1	14
Saturation Index	7	+1 to -1	4	57
Lead	7	< 0.005 mg/L	1	14
Turbidity	10	< 1 ntu	7	70

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## Recommendations After the Water Has Been Tested

- Evaluate Existing Source
- Maintenance and Inspection
- Repair Existing Source
- Pollution Control Measures
- Treatment- POU, POE, or other

Explore all of them before taking action- FINAL ACTION!

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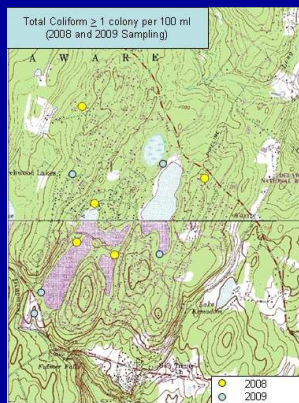
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## Bacteria T. Coliform



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## Shock Disinfect



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## Bacterial Issues, Odors, and Turbid Water: Inspect Well; Possibly Change Well Cap, Regrade Area, Divert Runoff

Loose-fitting vs. Sanitary  
Sealed Well Caps

CAP SEAL



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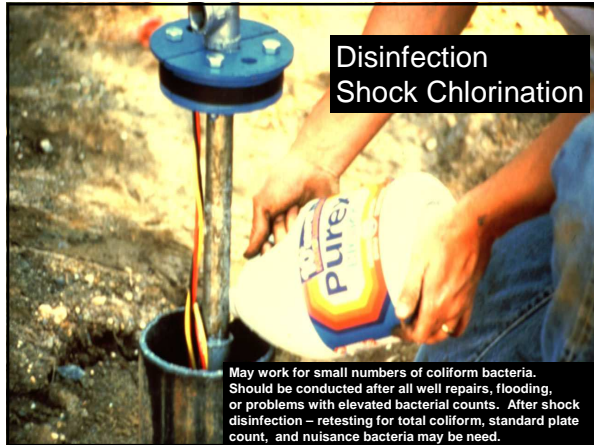
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Disinfection  
Shock Chlorination

May work for small numbers of coliform bacteria. Should be conducted after all well repairs, flooding, or problems with elevated bacterial counts. After shock disinfection – retesting for total coliform, standard plate count, and nuisance bacteria may be need.

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## Iron / Nuisance Bacteria



- Periodic shock well disinfections
- Drop tablets chlorinators
- Chlorine feed system
- Ozone treatment
- UV treatment – may be potential Class A or Class B Unit.

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## Hydrogen Sulfide

- Hot water only?
  - Adjust water heater to a temperature of 160 °F for 12 to 24 hours and then flush
  - remove or replace rod in heater (Warranty Issues)
- Carbon Filtration- *no bacterial problem*
- Chlorination/ Contact Tank / Filtration
- Aeration- *no bacterial problem*
- Oxidizing filter- manganese greensand

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## Whole House Treatment

Point of Entry (POE)

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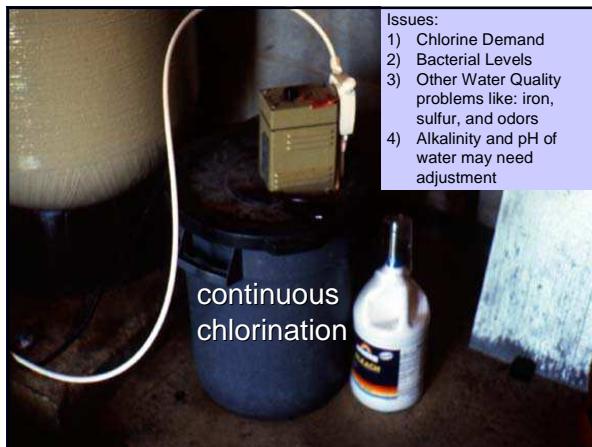
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- Issues:
- 1) Chlorine Demand
  - 2) Bacterial Levels
  - 3) Other Water Quality problems like: iron, sulfur, and odors
  - 4) Alkalinity and pH of water may need adjustment

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## U-V Sterilizer

The Selection of UV Unit system depends on the following:

- a) General Water Quality
- b) Turbidity
- c) Hardness
- d) Iron and Manganese
- e) Bacterial Levels
- f) Source Water Type and Overall Water Quality ?
- g) Class A or Class B Unit ?



<http://www.nsf.org>

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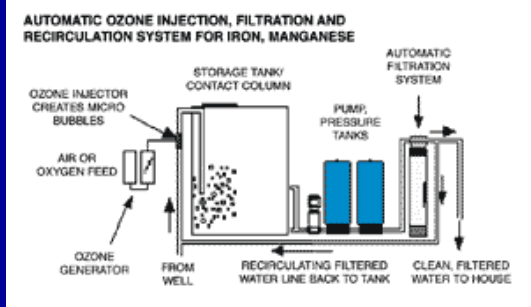
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## Ozone



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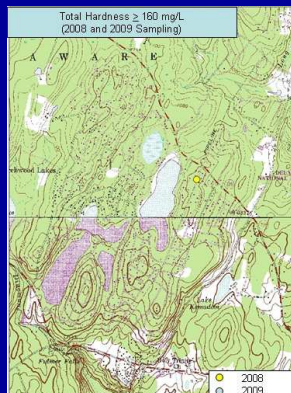
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## Hardness



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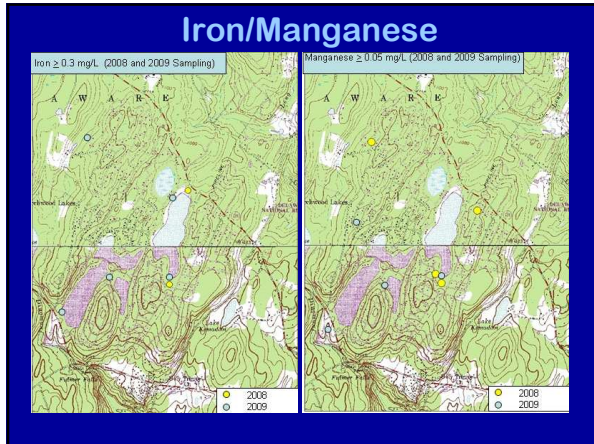
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### Iron and Manganese Removal

- Form and concentration is important
  - Oxidized = visible, orange or black stain
  - Reduced = colorless
- Removal Methods
  - Water Softener
  - Chlorination / Filtration
  - Oxidizing Filter
  - Ozone

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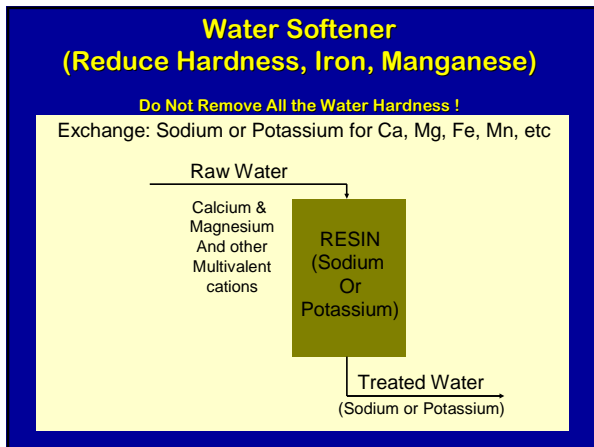
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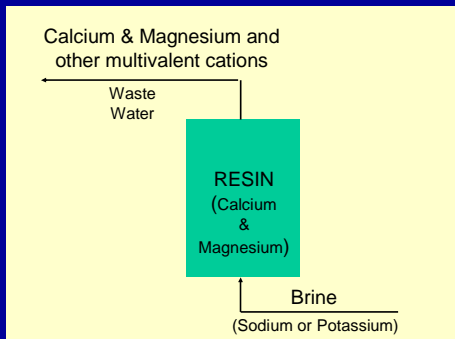
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## Recharge with Brine



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## Softener with Tank

Reaction Tank with  
Computerized Controller  
(adjustable)

Brine Tank Used to  
Backwash the Reaction  
Tank



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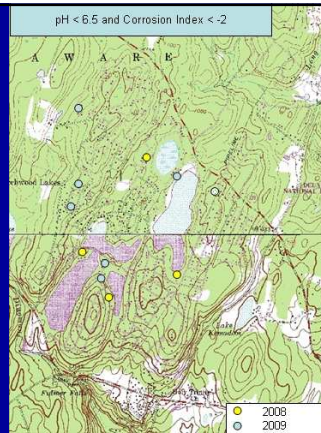
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## pH / Corrosion



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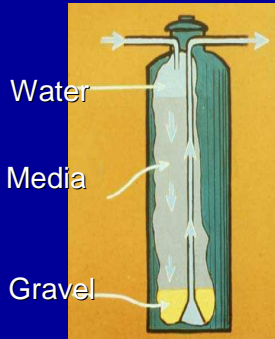
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## Acid (Corrosive Water) Control



Use this unit if existing pH is 6.0 or greater.

Target pH is 6.9 to 7.0 - use limestone.

Target pH is higher - use magnesia (magnesium oxide)

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## pH adjustment- Low pH



May require a reaction tank to provide contact time.

Use sodium carbonate (soda ash) when pH is  $\geq 4.0$  to 6.8

When  $< 4.0$ , use caustic soda (sodium hydroxide)

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## Carbon Filtration

- Uses
  - Remove man-made organic chemicals
  - Remove miscellaneous tastes and odor from water - assuming no bacterial problems
  - Remove radon gas from water
- Maintenance
  - Carbon must be replaced routinely



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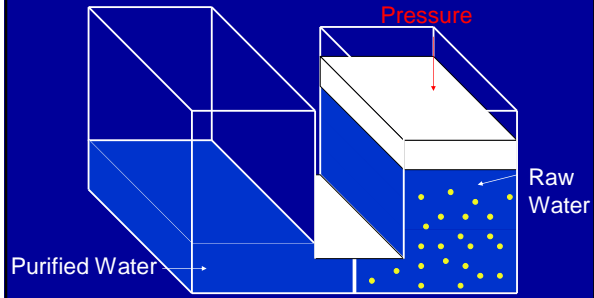
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## Reverse Osmosis

- force water through membrane
- removes many contaminants



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## Reverse Osmosis System

- Pretreatment
- 1) Softener
  - 2) Filtration
  - 3) Disinfection
  - 4) Fe / Mn Control



R/O Units

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## R/O Requires Storage

Size of Tank is a function of demand and water quality

Also, a percentage of the water is wasted. The recovery rate may be 20 to 30 % (70 to 80 % wasted)



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## At the Sink

Point of Use (POU)

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Units are rated for Water that meets Drinking Water Standards  
Not for Water with Levels above the Drinking Water Standard



Typically these are small carbon-block filters that will remove particles, reduce odors and taste problems, and have a limited exchange capacity for hardness and trace metals.

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## R/O at the Sink



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## Before You Buy Treatment Equipment Get the Facts- Not the Sales Pitch

- Have your water tested by a reputable accredited, approved, and/or certified lab
  - Don't rely on in-home water test results.
  - Don't rely on free water tests.
- Consult unbiased water quality experts and get multiple quotes for a system.
- Explore all alternatives
  - Well rehabilitation, New source, Local Pollution Control, Maintenance

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## Tips for Buying Treatment Equipment

- Seek reputable companies that have been around
- Ask for customer references
- Research company history
- Beware of hard sale techniques (scare tactics)
- Ask about maintenance requirements
- Get a detailed warranty
- Look for NSF and WQA certifications
- EPA certification means nothing
- Get everything in writing!
- If it sounds too good - it is!

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### Sample No. 1

Test	Result	Maximum Contaminant Level (MCL)
Coliform bacteria	2 /100 mL	<1 /100 mL
Nitrate-N	1 mg/L	10 mg/L
pH	6.7	6.5 to 8.5**
Hardness	100 mg/L 6 gpg	No MCL (7-10 gpg is very hard)
Iron	0 mg/L	0.3 mg/L **

gpg = grains per gallon (1 gpg = 17.1 mg/L), \*\* = Recommended standard (RMCL)

### Recommendation ?

Shock chlorination and retesting, possible continuous Disinfection: Chlorination, Ozone, UV disinfection

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**Sample No. 2**

Test	Result	Maximum Contaminant Level (MCL)
Coliform bacteria	150 /100 mL	<1 /100 mL
Nitrate-N	1 mg/L	10 mg/L
pH	6.7	6.5 to 8.5**
Hardness	100 mg/L 6 gpg	No MCL (7-10 gpg is very hard)
Iron	0 mg/L	0.3 mg/L **

gpg = grains per gallon (1 gpg = 17.1 mg/L),\*\* = Recommended standard (RMCL)

**Recommendation ?**

Shock Treatment and Retesting and Possibly Chlorination, UV Irradiation, or Ozone

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**Sample No. 3**

Test	Result	Maximum Contaminant Level (MCL)
Coliform bacteria	0 /100 mL	<1 /100 mL
Nitrate-N	1 mg/L	10 mg/L
pH	6.8	6.5 to 8.5**
Hardness	34 mg/L 2 gpg	No MCL (7-10 gpg is very hard)
Iron	7.0 mg/L	0.3 mg/L **

gpg = grains per gallon (1 gpg = 17.1 mg/L),\*\* = Recommended standard (RMCL)

**Recommendation ?**  
Oxidizing filter or Ozone

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**Sample No. 4**

Test	Result	Maximum Contaminant Level (MCL)
Coliform bacteria	0 /100 mL	<1 /100 mL
Nitrate-N	1 mg/L	10 mg/L
pH	7.0	6.5 to 8.5**
Hardness	154 mg/L 9 gpg	No MCL (7-10 gpg is very hard)
Iron	0.5 mg/L	0.3 mg/L **

gpg = grains per gallon (1 gpg = 17.1 mg/L),\*\* = Recommended standard (RMCL)

**Recommendation ?**  
Water softener

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**Sample No. 5**

Test	Result	Maximum Contaminant Level (MCL)
Coliform bacteria	0 /100 mL	<1 /100 mL
Nitrate-N	3 mg/L	10 mg/L
pH	5.1	6.5 to 8.5**
Hardness	17 mg/L 1 gpg	No MCL (7-10 gpg is very hard)
Iron	0 mg/L	0.3 mg/L **

gpg = grains per gallon (1 gpg = 17.1 mg/L),\*\* = Recommended standard (RMCL)

Recommendation ?  
Acid Neutralizing Filter

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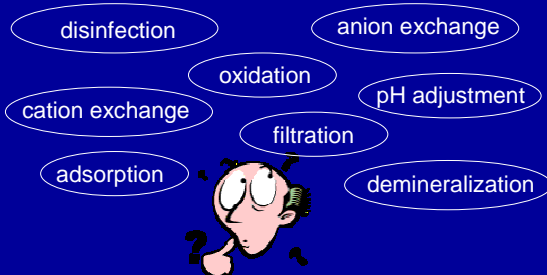
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**Water Treatment**



Now You Have the Answers or You  
Have Even More Questions!

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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/>  
(Or similar local organization)
- Proper Abandonment
- **Chemical Storage, Disposal and Use**
- Keep Wellhead Above Grade
- **Proper Well Location and Construction**
- **Septic System Maintenance**
- **Recycle used Oil and Participate in Hazardous Chemical Disposal Programs**
- Well Ordinance

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## Marcellus Shale Drilling Site



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

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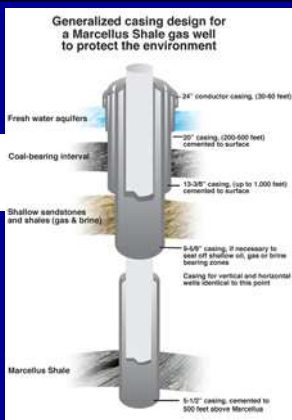
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## Multiple Grouted Casing Used in Drilling Process



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## Concerns Related to Marcellus Shale

- Based on Community Location – this could 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

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## Types of Fluids

- Top hole fluids – typically the water from the freshwater aquifer. This water from the first 600 to 800 feet.
- Bottom hole fluids – brine or connate water.
- Stimulation Fluids – fluid used to improve recovery (frac process)
- Production Fluids – water produced along the natural gas release – similar to bottom hole fluid.

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## Active Marcellus Production Site – Frac Fluid Chemistry

Typically Frac Water is comprised of clean water with a low probably for scale formation, but treated effluents and other sources being evaluated. The components include:

Friction Reducer – anionic polymer high molecular weight (hold frac sand and other particles)

Wetting Agent- nonionic surfactant – reduce surface tension and improve frac water flowback.

Biocides- control growth or regrowth of microorganisms.

Scale Inhibitor – phosphate based chemicals to inhibit precipitate formation and scale formation.

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## Available Frac Water Chemistry

Parameter	Units	Concentration	PWS	Multiple Above PWS Standard
Aluminum	mg/L	1.2	0.2	6
Arsenic	mg/L	0.014	0.01	1.4
Barium	mg/L	410	2	205
Iron	mg/L	17	0.3	56
Manganese	mg/L	0.89	0.05	17.8
Hardness	mg/L	1750	500	3.5
T. Dissolved Solids	mg/L	31324	500	62
Nirate @ N	mg/L	90.1	44	2
pH	su	6.73	6.5 - 8.5	oK
Bromide	mg/L	61.8	0.01	6180
Chloride	mg/L	27000	250	108
Gross Alpha	pCi/L	223.3	15	15
Gross Beta	mrem/yr (Sr)	38.65	4	10
Radium 228	pCi/L	18.55	5	4
Radium 226	pCi/L	69.63	5	14

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## Flowback Water Chemistry

Flowback water is generated from drilling and it is what gets produced from the first 5% of water returned after a well is started

Parameter	Frac 1	Frac 2	Frac 3	Frac 4
barium mg/l	3,310	2,300	7,75	4,300
calcium mg/l	14,100	5,140	683	31,300
iron mg/l	52.5	11.2	211	134.1
magnesium mg/l	938	438	31.2	1,630
manganese mg/l	5.17	1.9	16.2	7.0
strontium mg/l	6,830	1,390	4,96	2,000
dissolved solids mg/l	175,268	69,640	6,220	248,428
suspended solids mg/l	416	48	490	330
chemical oxygen demand mg/l	600	567	1,814	2,272

May contain elevated levels of trace metals, nitrogen, bromide, uranium, and hydrocarbons. Most of the dissolved solids includes chloride and sodium.

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## Production Water

Produced water is wasted water that accompanies oil extraction and is high in saline. Typically, separated stored on site and then hauled to treatment/disposal facility.

Parameter	Result	Parameter	Result
pH	4.79	conductivity mmhos	366,600
total oil/grease mg/l	9	chemical oxygen demand mg/l	2,332
surfactants mg/l	105.7	barium mg/l	690
calcium mg/l	25,200	iron mg/l	160
magnesium mg/l	2,240	manganese mg/l	10.1
strontium mg/l	732	dissolved solids mg/l	224,300
suspended solids mg/l	33		

May contain elevated levels of trace metals, nitrogen, bromide, uranium, and hydrocarbons. Most of the dissolved solids includes chloride and sodium.

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## Injection Wells – Class II

Class II wells inject fluids associated with oil and natural gas production. Most of the injected fluid is salt water (brine), which is brought to the surface in the process of producing (extracting) oil and gas.

Regulated by:  
EPA - [http://www.epa.gov/safewater/uic/wells\\_class2.html](http://www.epa.gov/safewater/uic/wells_class2.html)

- Does the UIC Program regulate hydraulic fracturing?**  
Sometimes. The UIC Program regulates the following activities:
- Well injection of fluids into a formation to enhance oil and gas production (Class II wells).
  - Fracturing used in connection with Class II and Class V injection wells to "stimulate" (open pore space in a formation).
  - Hydraulic fracturing to produce methane from coal beds in Alabama.

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## Water Testing Recommendations

- Package # 1 – Based on Penn State University Recommendations and Workshops.
- Parameters: total coliform, e. coli, chloride, barium, pH, and total dissolved solids.
- Estimated Cost w/o Chain-of-Custody and Collection – **Approximately \$ 120.00 /sample.**
- Very inadequate !

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## Water Testing Recommendation

Package # 2- Based on what the PADEP is Recommendations.

- Chloride, T. Hardness, Magnesium, Strontium, Iron, Manganese, pH, Sodium, Conductivity, Calcium, Alkalinity, and Total Dissolved Solids
- Oil & Grease, and Methane/Ethane.
- Estimated Cost w/o Chain-of-Custody and Collection – **Approximately \$490.00 /sample.**
- Missing barium and other key parameters and can not conduct geochemical mapping.

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## Water Testing Recommendation

Package # 3- Based on a combination of what local gas company's are doing as part of their background or baseline analysis, plus added total coliform and pH.

- Alkalinity, pH, Barium, Calcium, Chloride, Conductivity, T. Hardness, Iron, Magnesium, Manganese, Oil/Grease, Potassium, Sodium, Sulfate, Total Dissolved Solids, MTBE/VOC's (includes BTEX), Sulfide, MBAS (Surfactants), Total Coliform, pH and Total Suspended Solids.
- Estimated Cost w/o Chain-of-Custody and Collection
- **\$ 680.00 per sample**
- Add Methane/Ethane in water - **\$ 165.00 per sample.**
- Problem – Does not include Strontium, Bromide, and radiological.

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## Water Testing Recommendations

Package # 4 Based on Gas Company Background Testing and A review of the chemical analysis of used Frac Water.

- pH, standard plate count, total coliform, nitrate, nitrite, alkalinity, chloride, bromide, sulfate, color, odor, conductivity, corrosion index, alpha/beta count, T, Hardness, Mercury, trace metals (13 metals- including strontium)
- VOC & MTBE, Radium 226/ 228, Total Dissolved Solids, Uranium, Total Kjeldahl Nitrogen, total suspended solids, MBAS, Methane/Ethane , Oil/ Grease, and Sulfide.
- Estimated Cost w/o Chain-of-Custody and Collection - \$ 1850.00 per sample.
- Estimated Cost without the radiological w/o Chain-of-Custody and Collection - \$ 1500.00 per sample.
- Comprehensive – Water Testing Package

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## Private Homeowner Drinking Water Issues Pike County Presentation Water Quality 2009 (Part II)

Presenter

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