



Water Resources Issues Related To Marcellus Gas Drilling Activity



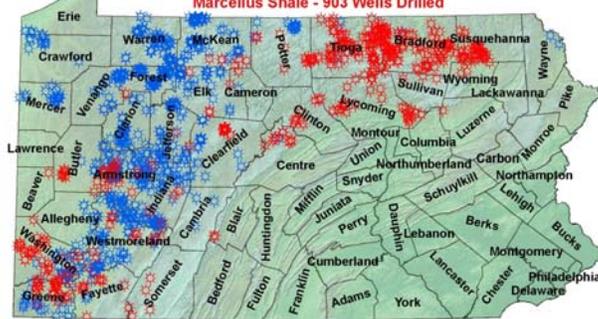
Bryan Swistock
Water Resources Extension Specialist
Penn State University
School of Forest Resources
brs@psu.edu

Gas Wells Drilled in 2010



Department of Environmental Protection
Bureau of Oil and Gas Management
Wells Drilled

2010 January-August Wells Drilled - 1,952
Non Marcellus Shale - 1,049 Wells Drilled
Marcellus Shale - 903 Wells Drilled



As Reported by Operators

Updated 09/08/2010

- 768 Marcellus wells drilled in all of 2009
- 54 rigs last year, 92 rigs today

Marcellus Water Issues

Protection of drinking water



Fracing chemicals



Adequate wastewater treatment



Photo courtesy – Paul Hart, Hart Resource Technologies, Inc

Impact of water withdrawals



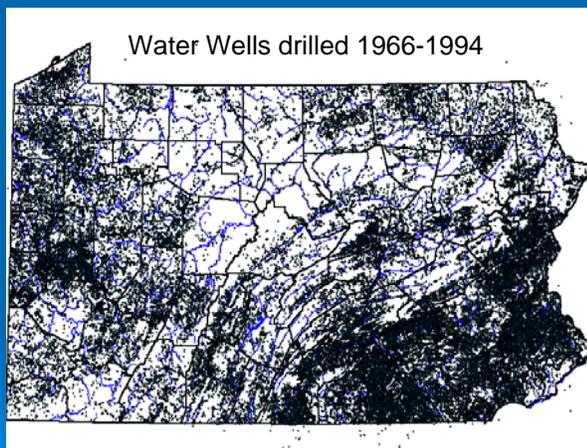
Surface water/floodplains



Regulations and enforcement



A Huge Population Served by Water Wells



- Over one million homes and farms
- 45% had never been properly tested (before Marcellus started!)
- NO STATEWIDE REGULATIONS!
- Only 10% of homeowners have a well completion report

Water Well Construction Poorly Protects PA Groundwater Supplies

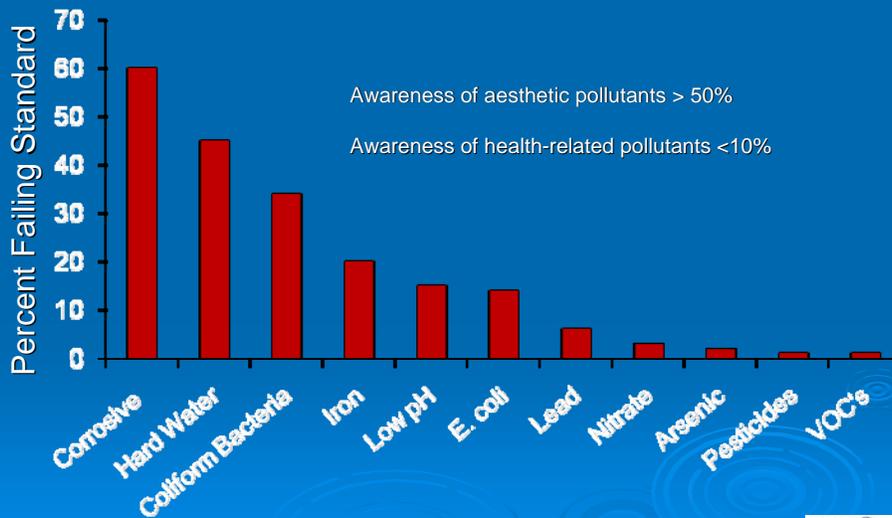


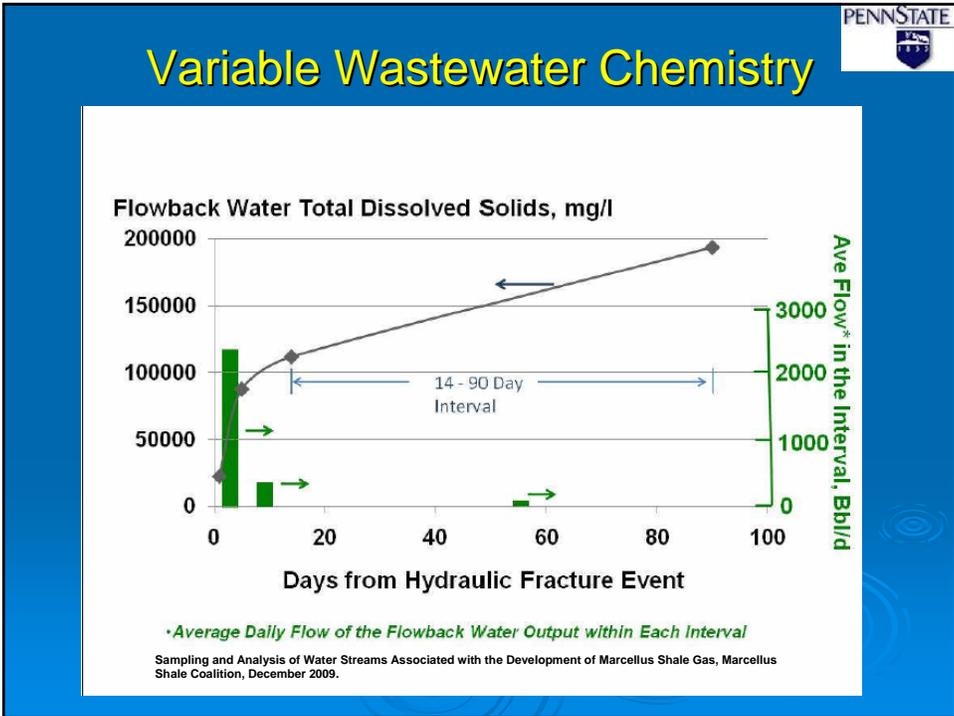
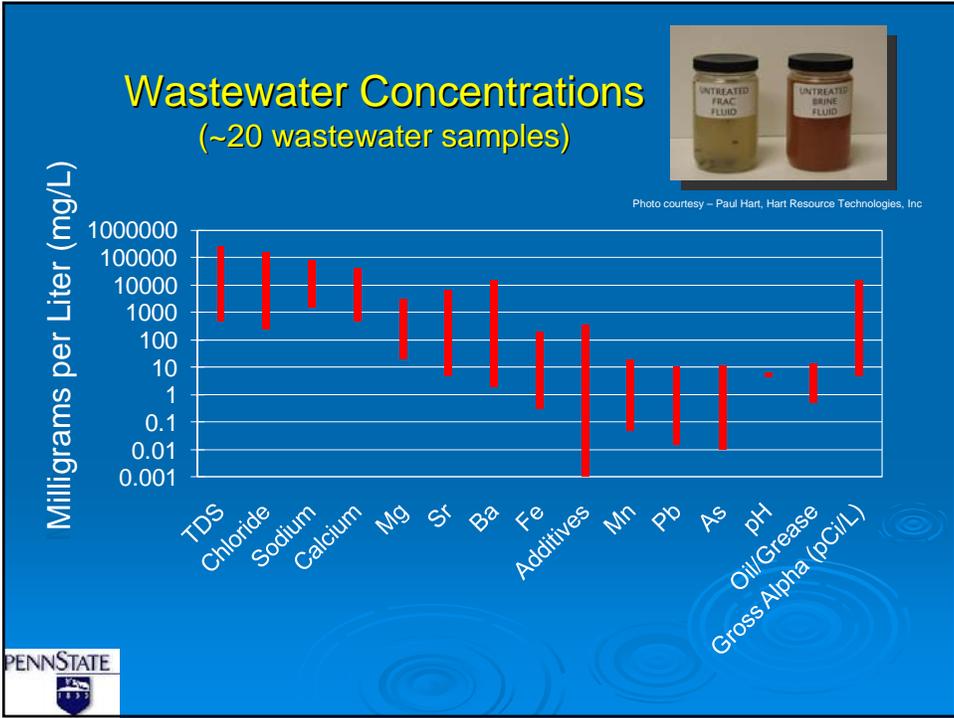
- Only 5% have sanitary construction
- Directly correlated to water quality



Pre-Drilling Problems are Common

(2006-07 survey of 701 water wells)





Issue = Dated Water Supply Protection Regulations (Many proposals to change these!)

- 200' setback from gas well to water supplies
- Pit and tank requirements for collection of waste fluids
- Certified mail notification if water supply is within 1,000' of gas well
- Freshwater protection string installed to protect groundwater
- Gas companies are "presumed responsible" for contamination of water supplies within 1,000' of gas well site (pre-drill survey water testing done to protect drilling company)



Illustration courtesy Range Resources



Industry Pre-Drilling Water Testing



- Usually on water supplies within 1,000 feet (some further)
- Must be done by a state accredited water laboratory
 - Parameters chosen by drilling company – very thorough
- Free to the water supply owner
 - Companies spending millions to do pre-drill testing
- Homeowner needs to cooperate with this testing to maintain "presumed responsibility"
- Problems:
 - Trust of data, biased collection?
 - Delay in delivery of results to homeowner
 - 1,000 foot limit



Photo courtesy: Todd Giddings and PA Ground Water Association

Issue Complex Water Test Reports

Client	Sample ID	Sample Name	Sample Date	Sample Time	Sample Location	Sample Depth	Sample Volume	Sample Container	Sample Preservation	Sample Handling	Sample Analysis	Sample Results	Sample Units	Sample Method	Sample Batch
[REDACTED]	NTA666-01	Ground Water	01/18/10	14:00											
ANALYTICAL REPORT															
General Chemistry Parameters															
Biochemical Oxygen Demand (BOD5)	ND		mg/L	1.00	1	05/10/10	17:30	SM 2220B							10A1180
Calcium as CaCO3	11.2		mg/L	10.0	1	05/10/10	17:30	SM 2220B							10A1182
Chloride	12.2	E	mg/L	1.00	1	05/10/10	17:30	EPA 100.0							10A2170
MBAS (mg/L I2)	0.000		mg/L	0.0000	1	05/10/10	14:07	SM 2220C							10A1183
Oil & Grease (H2O)	ND		mg/L	1.01	1	05/10/10	13:00	EPA 149.0A							10A2497
pH	8.29	NTD	pH Units	0.200	1	05/10/10	14:00	SM 4000-01B							10A1254
Specific Conductance	602		uS/cm	10.0	1	05/10/10	10:37	SM 2110 B							10A2081
Sulfide	17.9		mg/L	1.00	1	05/10/10	17:30	EPA 100.0							10A2170
Total Dissolved Solids	108		mg/L	20.0	1	05/10/10	11:01	SM 2400 C							10A1241
Total Suspended Solids	ND		mg/L	1.00	1	05/10/10	21:00	SM 2400 D							10A1337
Turbidity	ND	NTD	NTU	1.00	1	05/10/10	10:15	EPA 100.1							10A1060
Temperature of pH Measurement	11.2	NTD	Deg C	10A	1	05/10/10	14:00	EPA 170.1							10A1254
Metals, Ethanol, and Ethane by GC															
Methane	1.89		mg/L	0.0100	2	05/10/10	13:47	RICE 170							10A1404
Ethane	ND		mg/L	0.0200	1	05/10/10	12:30	RICE 170							10A1404
Propane	ND		mg/L	0.0400	1	05/10/10	12:30	RICE 170							10A1404
Sum of Ethanol (70/22%)	100%					05/10/10	12:30	RICE 170							10A1404
Total Metals by EPA Method 8010B															
Arsenic	ND		mg/L	0.0100	1	05/10/10	18:20	USEPA 8010B							10A1134
Barium	0.107		mg/L	0.0100	1	05/10/10	18:20	USEPA 8010B							10A1134
Cadmium	ND		mg/L	0.00100	1	05/10/10	18:20	USEPA 8010B							10A1134
Calcium	0.06		mg/L	1.00	1	05/10/10	18:20	USEPA 8010B							10A1134
Chromium	ND		mg/L	0.00100	1	05/10/10	18:20	USEPA 8010B							10A1134
Cobalt	0.0004		mg/L	0.00100	1	05/10/10	18:20	USEPA 8010B							10A1134
Copper	ND		mg/L	0.00100	1	05/10/10	18:20	USEPA 8010B							10A1134
Lead	ND		mg/L	0.00100	1	05/10/10	18:20	USEPA 8010B							10A1134
Magnesium	0.75		mg/L	1.00	1	05/10/10	18:20	USEPA 8010B							10A1134
Manganese	ND		mg/L	0.0100	1	05/10/10	18:20	USEPA 8010B							10A1134
Mercury	1.00		mg/L	1.00	1	05/10/10	18:20	USEPA 8010B							10A1134
Molybdenum	ND		mg/L	0.0100	1	05/10/10	18:20	USEPA 8010B							10A1134
Nickel	ND		mg/L	0.00100	1	05/10/10	18:20	USEPA 8010B							10A1134
Selenium	0.06		mg/L	1.00	1	05/10/10	18:20	USEPA 8010B							10A1134
Silver	ND		mg/L	0.00100	1	05/10/10	18:20	USEPA 8010B							10A1134
Sodium	ND		mg/L	1.00	1	05/10/10	18:20	USEPA 8010B							10A1134
Metals by EPA Methods 7470A/7471A															
Mercury	ND		mg/L	0.000100	1	05/10/10	10:22	USEPA 7470A							10A1067
Volatile Organic Compounds by EPA Method 8240B															
Benzene	ND		mg/L	0.100	1	05/10/10	02:30	USEPA 8240B							10A0000
Ethylbenzene	ND		mg/L	0.100	1	05/10/10	02:30	USEPA 8240B							10A0000
Toluene	ND		mg/L	0.100	1	05/10/10	02:30	USEPA 8240B							10A0000
Xylenes, m,p	ND		mg/L	0.100	1	05/10/10	02:30	USEPA 8240B							10A0000

- Many provide no drinking water standards or any indication of pre-drilling water quality issues
- Homeowners often do not understand water test reports to determine if they should collect their own water test data

Issue – What to Test For?



- No required set of parameters
- Many labs/consultants do not want to make choices of parameters
- Many different pollutants in waste fluids (costly to test for all)
 - Alkalinity, aluminum, ammonia-N, arsenic, barium, benzene, bromide, beryllium, boron, cadmium, calcium, chemical oxygen demand (COD), chloride, chromium, cobalt, copper, ethyl benzene, ethylene glycol, gross alpha, gross beta, hardness, iron, lead, magnesium, manganese, mercury, nickel, nitrate, oil&grease, pH, radium, radon, selenium, silver, sodium, strontium, sulfate, surfactants (MBAS), toluene, total dissolved solids, (TDS), total phenolics, total suspended solids (TSS), xylene, zinc
- Clear barrier at \$200 to \$400 for most homeowners
 - Tiered approach - basic, critical tests followed by others if they can afford them

Additional Testing Issues

- Chain-of-custody testing
 - Education about the need for it
 - Qualifications of those doing the testing
 - Lack of labs/consultants – long backlogs

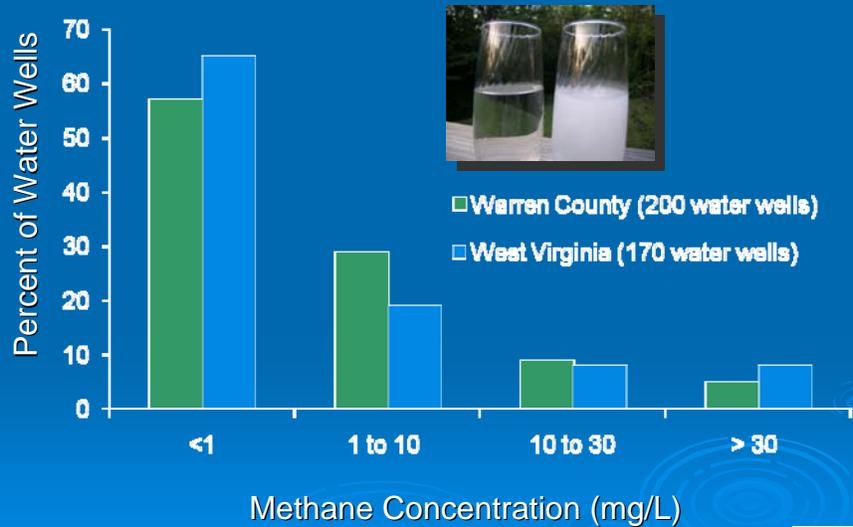
- Timeframe for testing
 - When to do pre-drilling testing?

- Post drilling testing?
 - “Presumed responsibility” only lasts for six months after drilling (which does not include fracing)

- Leasing education



Issue – Methane Migration / Stray Gas



Issue - Groundwater Data

	TDS (mg/L)		Barium (mg/L)		Chloride (mg/L)	
	Northeast	McKean	Northeast	McKean	Northeast	McKean
Standard (DWS)	500		2.0		250	
Mean	132	159	0.15	0.19	6.92	33.5
Median	121	124	0.08	0.07	3.1	9.1
Min	20	19	0.01	0.002	2	1
Max	1,080	3,642	1.75	6.02	114	2,196
% Failing DWS	0.5%	3%	0%	1%	0%	2%

- Northeast = 200 water wells tested in 2008 in counties with no history of gas well drilling

- McKean = 200 water wells tested in 2006 in a county with a long history of oil and gas well drilling

Penn State Water Well Research (Center for Rural Pennsylvania)

- Objectives
 - 1) Determine occurrence of groundwater contamination
 - 2) Determine factors related to contamination if it occurs
 - 3) Survey water supply owners to document their experiences

- Phase 1 – intensive monitoring
 - Thorough testing of 50 water wells before, during and after gas drilling

- Phase 2 – broad monitoring
 - Basic testing of 300+ water wells after drilling



Wastewater Issues – Reuse/Recycle

- 15-20% return of hydrofracturing fluids in first 30 days
- Why reuse/recycle?
 - Limited treatment capacity
 - Changes to discharge regulations
 - Realization that “clean” water is not needed for fracing
 - Cost (advanced treatment) and savings
 - ✓ One company – 28% of water used was reuse
 - ✓ 3-10 million \$\$ savings, no effect on gas well production
- How is it done?
 - Direct reuse of early flowback
 - Conventional treatment and dilution
 - Advanced treatment and direct use



Issues/ Challenges With Reuse

- Spill prevention
 - Piping, trucking of waste fluids
 - Storage - impoundments vs. tanks
 - Permitting
 - Leak detection – groundwater monitoring
 - Access – fencing
- Water quality
 - Solids, bacteria, hydrocarbons
 - Filtration, additional chemicals, separators
 - Changing chemistry – additives needs?
- Long term – what to do with production fluids when drilling declines

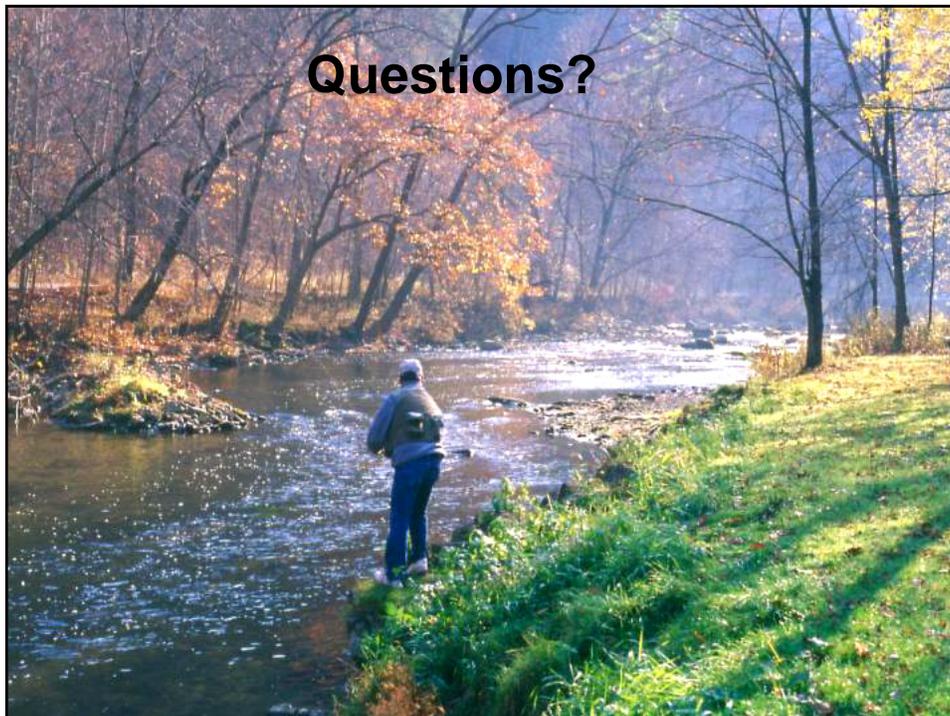


Penn State Cooperative Extension Resources

The screenshot shows the Penn State Cooperative Extension website. At the top, there is a search bar and the text "COOPERATIVE EXTENSION". Below this is a navigation menu with links for Home, Publications, Videos, Links, News, Events, and Contact Us. The main content area is titled "Water Resources" and features a large image of a waterfall. To the left of the waterfall image is a sidebar with a list of topics: Drinking Water, Pond Management, Water Conservation, Drought and Climate Information, Discovery Watersheds, Marcellus Shale, and Master Well Owners Network. Below the sidebar are buttons for "Nutrient and Water Policy" and "Septic Systems". The main content area includes a "LATEST NEWS" section with three articles: "Wading Through Water-Test Results Subject of Webinar" (September 10, 2010), "Summer 2010 Water Currents Newsletter" (July 14, 2010), and "Extension receives grant to enhance water-conservation education" (June 21, 2010). There is also a "SPOTLIGHT" section for "Penn State Water Testing" and an "ADDITIONAL RESOURCES" section with links to Publications, Frequently Asked Questions, Educational Materials, and Find a Local Educator. An "UPCOMING EVENTS" section lists "Managing Stormwater on Your Property".



<http://extension.psu.edu/water>



Questions?

Water Resources - Issues Associated with Marcellus Gas Drilling Activity in Pennsylvania