Private Well Sampling Near Oil & Gas Operations

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Private Wells as Drinking Water Sources in U.S. (USGS, 2009)

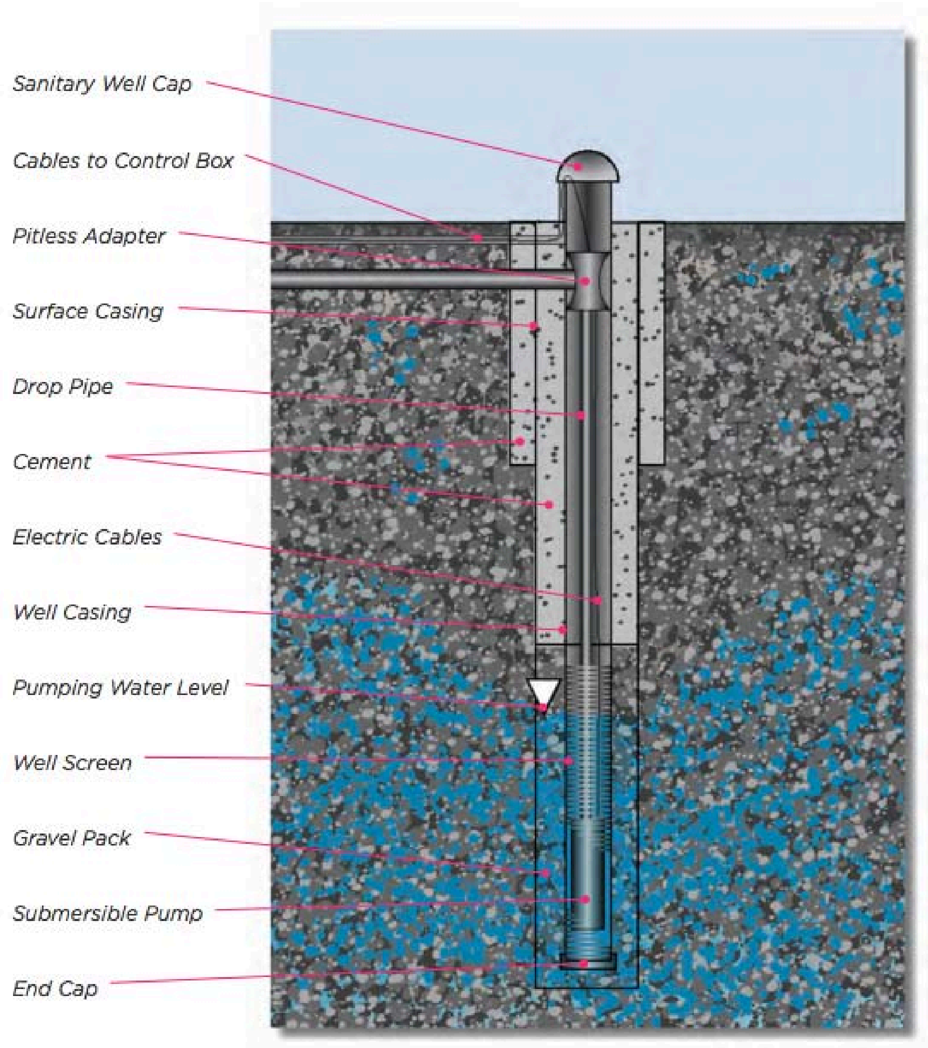
- 43 million people use private wells as their drinking water source
- 23 % have at least one contaminant at a level of potential health concern
- Strontium, arsenic, nitrate, manganese, uranium most common

Groundwater Basics

- Pumping groundwater at a well results in a decline in groundwater level near the well
- Pumping a single swell can have a local effect on the groundwater flow system locally
- Pumping many wells can have significant effects on regional groundwater flow
- Drilling new wells can temporarily affect existing wells nearby

Private well construction

- Select a licensed driller
- Obtain new well permit
- Select appropriate location
  - Away from septic system
- Water treatment?



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Private well protection

- Multiple common sources of contamination
  - Septic systems
  - Fuel tanks
  - Chemical storage
  - Animal holding pens/facilities
  - Oil and gas production
  - Landfills
- Maintain separation from sources; keep well head at least one foot above ground level, use care operating around the well

Why Collect Water Samples?

- In the absence of any pre-drilling characterization of your drinking water, it is difficult, if not impossible, to prove that oil & gas operations have impacted water quality
- It is important to know the quality of the water you are drinking; many private well owners have never tested their water
- Water quality in private wells is not regulated by federal or most state governments

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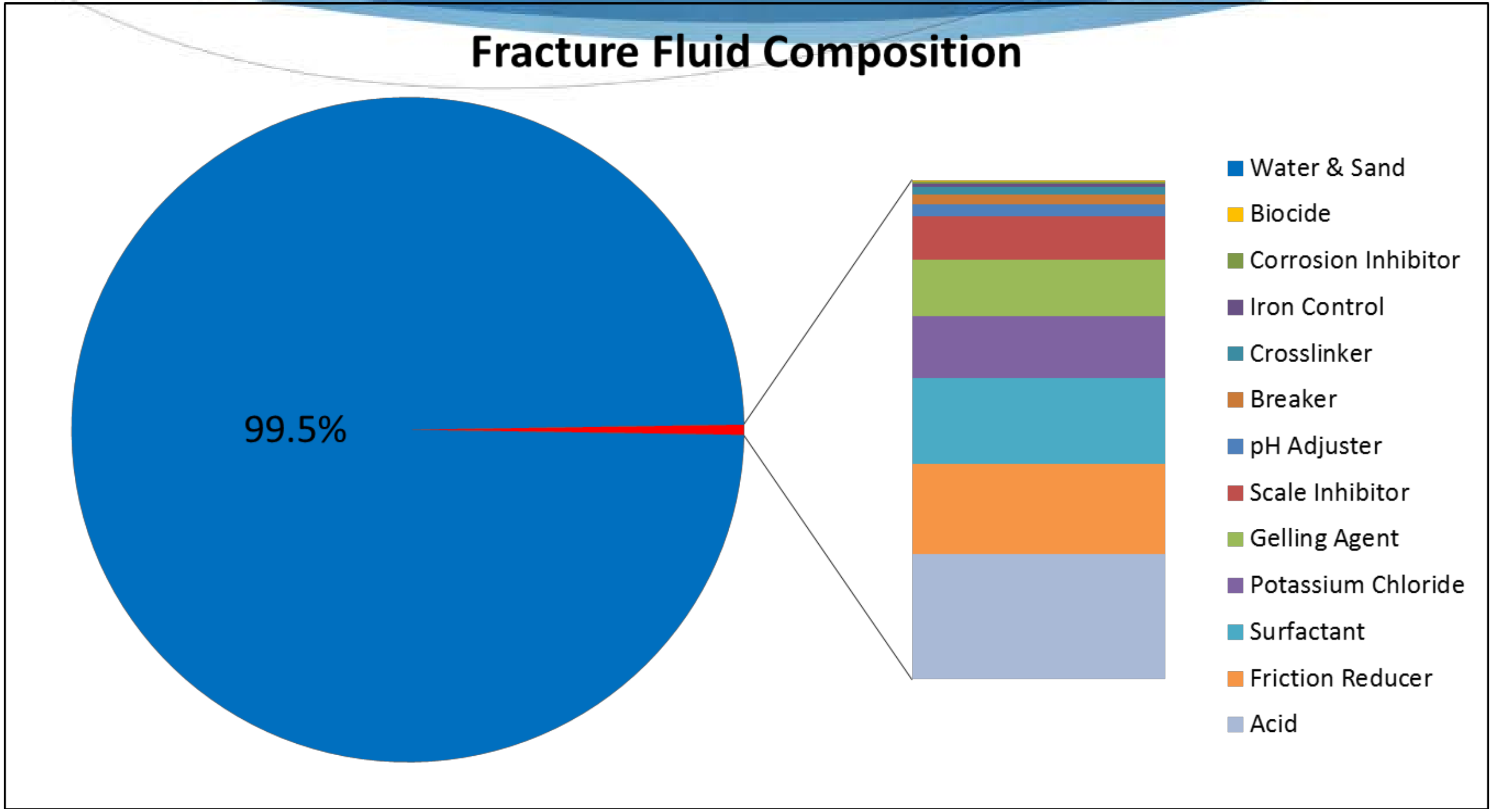
What are the Risks?

- Data from regulatory agencies and studies in PA indicate that the majority of domestic well complaints related to nearby oil and gas production activities were due to pre-existing conditions or other land use activities

Chemical Usage in Hydraulic Fracturing (DOE/NETL-2014/1651)



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Fracturing Fluid Composition Example

From FracFocus 2011

Component	Ingredient	Purpose	% Composition by mass
Water	Fresh water	Deliver proppant	75.1
Recycled water	Recycled water	Deliver proppant	11.3
Proppant	Sand	Keep fractures open	13.1
Acid	HCl	Dissolve minerals, initiate cracks	0.1
Friction reducer	Polyacrylamide, petroleum distillate	Minimize friction between pipe and fluid	0.07
Iron control	Citric acid	Prevent precipitation of metal oxides	0.002
Corrosion inhibitor	Ethylene glycol, dimethyl formamide, decanol, isopropanol, octanol, 2-butoxyethanol	Prevent pipe corrosion, winterizing agent	0.003
Biocide	Quaternary ammonium, ethanol, glutaraldehyde	Eliminate bacteria, clay stabilizers	0.008
Scale inhibitor	Methanol	Prevent scale deposits in pipe, winterizing agent	0.040

Chemical Risks

- Most chemicals used are of such quantities that when diluted would pose little risk to ground water if released outside the targeted fracing zone at depth
- Most of the risk is associated with transport and handling of concentrated chemicals on the surface and the management of produced waters from the production well

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Specific Constituents to Test

- Bromide – common in brackish water, brines
- Barium – indicator of radioactive elements in oil brines, production waters
- Boron – borate salts used in frac fluids
- Iron, manganese, arsenic – may be released into water from disturbance by drilling
- Other Major ions – calcium, magnesium, nitrate/nitrite, potassium, sodium, sulfate

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General Water Quality Parameters

- Water quality indicators – Alkalinity, pH, redox potential, specific conductance, temperature, total dissolved solids (TDS), turbidity
  - *Substantial increase in TDS may be early warning sign*
- Chloride (Cl) – Substantially increased levels of chloride may be an early warning sign of impacts from oil and gas activities because of high Cl in brines and use of chloride based compounds in the hydraulic fracturing process

Methane

- Naturally occurring, especially in oil and gas production areas
- If methane present, it can alter the oxidation-reduction potential of the water:
  - Produce sulfide in the water
  - Promote dissolution of iron oxide solids which may release iron, manganese, arsenic into the water
  - Solids dissolution will increase turbidity
- If there is elevated turbidity it may indicate other problems

Methane

- No health standards set for methane in water
- Main concern is explosion hazard (5% by volume; need ignition source)
- States vary as to what concentration in water may trigger a concern and further investigation
  - PA – 7 mg/L
  - WY – 5 mg/L
  - CO – 1 mg/L

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Water Quality Standards

- MCL = Maximun Contaminant Levels are standards set by USEPA for drinking water quality; Safe Drinking Water Act
  - e.g. As = 0.01 mg/L; Cr = 0.1 mg/L; Ba = 2 mg/L; Benzene = 0.005 mg/L
- SMCL = Secondary Maximum Contaminant Levels are non-mandatory water quality standards for aesthetic considerations such as taste, color, odor; Safe Drinking Water Act
  - e.g. Fe = 0.3 mg/L; Cl = 250 mg/L; Mn = 0.05 mg/L; TDS = 500 mg/L

Use Approved Groundwater Professionals

- *It is imperative that water sampling be performed by a professional who is familiar with up-to-date water sampling protocols and laboratory protocols. Otherwise the results may have little or no value.*
- NGWA maintains a list of groundwater professionals
  - http://info.ngwa.org/servicecenter/ngwadirectory/index.cfm?a=3

Where Should Samples be Collected?

- Most states provide some guidance either from the state regulator, agricultural extension office (e.g. PA, OK), or state environmental agency (e.g. LA)

- If at all possible, water samples should be collected directly from the well column. This is often not possible as the well is sealed. Use of the permanently installed pump is then used but samples should be taken upstream of any ancillary equipment (e.g. holding tank, pressure tank, water softener etc.)

Figure 10. Location 2 wellhead.

Well Purging and Sampling Objectives

- Initial water coming from the tap will be from pipes, treatment systems, and borehole, not from the aquifer itself
- Run water long enough to access water from aquifer (at least 15 min)
- Stabilization of water quality parameters often used as guide as to the presence of formation water (e.g. pH, temperature,

specific conductance)

Documentation

- History of complaints
- Existing water quality data (e.g. private wells, public wells, USGS database etc.) can be helpful to address temporal variability and aquifer heterogeneity
- Written and oral communications with well owner or industry rep
- Sampling procedures (SOPs), QA/QC docs, analytical methods
- Field sampling record sheets
  - Sample type, GPS coordinates, API well #, climate conditions, equip. calibrations, field parameters, type equipment used, depth to water, well depth, decontamination procedures, etc.
- Visual observations (well condition, weather conditions), photos

Purge and Sampling Methods

- USGS Field Manual National Field Manual for the Collection of Water-Quality Data, 2006
- Colorado Oil and Gas Association
  http://www.coga.org/pdfs_facts/COGA-sample-analysis-Plan.pdf
- Wyoming Oil & Gas Commission, Appendix K, http://wogcc.state.wy.us/downloads/WOGCC_APPENDIX_K_2013_Final122313.pdf

State Baseline Monitoring Programs

State	Sampling radius (ft)	Number of Wells	Timing* (*presumed liability)	Post-Drill Sampling
PA *	2500	All	1 year after*	No
WV*	1000	Owner request	Prior to drilling	TBD
CO	2640	All to 4 max	1 year prior	Yes, 2 (6-12, 60-72 mos)
OH	1500	All	Prior to drilling	No
ND	2640	All	1 year prior	No
NY	1000	All	Prior to site disturbance	Yes, TBD
CA	1500	All	Prior to drilling	Yes
IL (draft)	1500	All (3 samples)	Prior to drilling	Yes, 3 (6, 18, 30 mos)
WY	2640	All to 4 max	Prior to drilling	Yes, 2 (12-24, 36-48 mos.)
MI (draft)	1320	Up to 10	< 6 mos prior	No
NC (draft)	2640	All	Prior to drilling	Yes

Oil & Gas Sampling Related References

- *Colorado Oil and Gas Association*

  http://www.coga.org/pdfs_facts/COGA-sample-analysis-Plan.pdf

  Louisiana Department of Health

  http://www.dhh.louisiana.gov/assets/oph/Center-EH/ engineering/Private_Water_Well_Testing.pdf

- Oklahoma Cooperative Extension
  http://osufacts.okstate.edu/docushare/dsweb/Get/Document-9055/WREC-103web.pdf

Other References

- U.S. Environmental Protection Agency (US EPA) Groundwater Sampling Guidelines for Superfund and RCRA Project Managers (May 2002

  http://www.epa.gov/superfund/remedytech/tsp/download/gw_sampling_guide.pdf

- www.water.epa.gov

- http://cogcc.state.co.us/Library/WaterWellBooklet.pdf

SUMMARY

- Hydraulic Fracturing together with horizontal drilling has greatly improved the efficiency and profitability for shale gas and oil resource extraction.
- Baseline water quality data is important for adequate assessment of potential impacts
- How we collect the samples is as important as how well the samples are handled and analyzed
- Collection of baseline data will improve trust and protect all parties
- Increasing number of states now requiring baseline monitoring

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