What the experts have to say about ...

NATURAL GAS DRILLING, SEISMIC RISK & AQUIFER DEGRADATION

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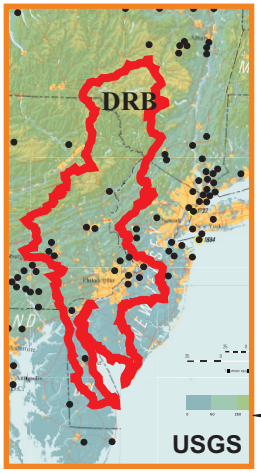
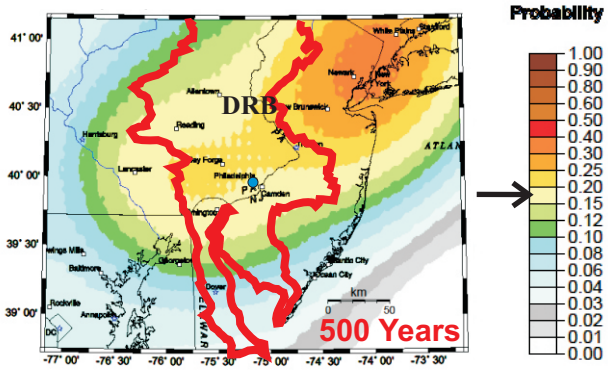
- **The Delaware River Basin (DRB) is within a seismically active region that has a documented history of earthquakes dating back to 1677. The largest quake that impacted the DRB occurred some 200 miles SW of Philadelphia in 2011 (magnitude 5.8). In Philadelphia, the quake had a shaking strength intensity of 4.7.**
- **The second largest quake occurred just offshore of New York City in 1884 (magnitude 5.25). Two 1800 PA earthquakes were reported as "severe" in Philadelphia. Earthquake activity has the potential to catastrophically deform and shear hundreds or thousands of casings instantly, thereby leading to aquifer degradation from commingling of formation fluids, methane, and fracking chemicals. While seismologists predict a magnitude 6.0 earthquake once every 670 years, hydrofracking may substantially increase the frequency.**

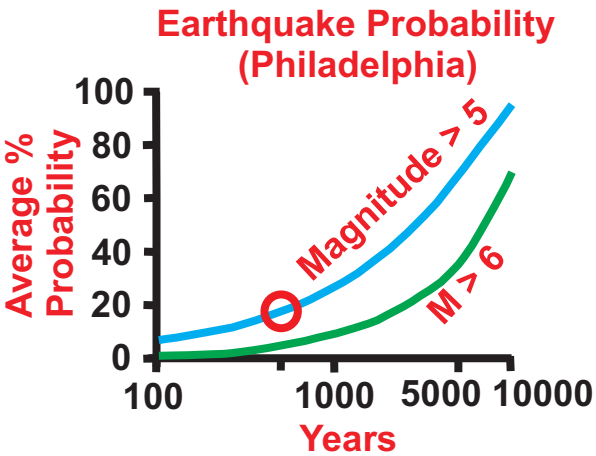


Historic earthquakes of magnitude (M) > 3.0 in and around the DRB

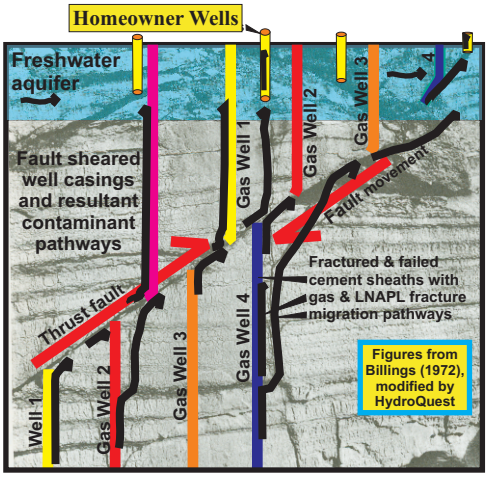
The planned location of gas wells in a seismically active region that regularly experiences major ground shaking will almost certainly result in the degradation of wellbore sealant materials needed to isolate our freshwater aquifers from downhole methane and toxic hydrofracking chemicals. Earthquakes and seismic activity, whether naturally occurring, or induced from hydrofracking or fluid injection episodes, may shear casings and **WILL crack cement sheaths** used to isolate and protect freshwater aquifers from drilling contamination. Similarly, seismic activity may also degrade other vulnerable items, including dams, pipelines, bridges, reservoirs, and nuclear power plants.

The productive life of gas wells is < 20 years compared to aquifer life of about one million years.



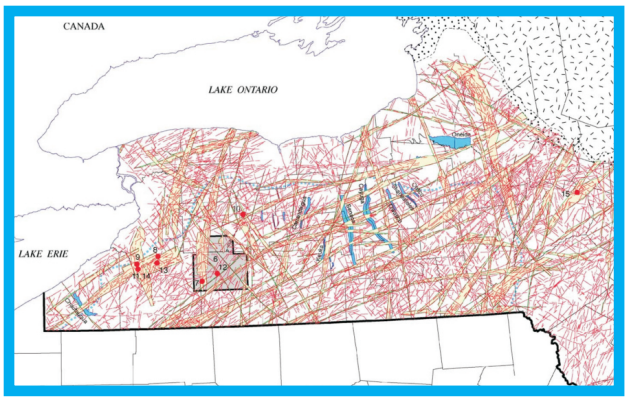


The example map above displays earthquake probabilities that were computed from the source model of the USGS-National Seismic Hazard Mapping Project update for Philadelphia, PA. The map generated shows the probability of earthquakes with a magnitude of > 5.0 within a radius of 50 km for a 500-year event (15-20%). The red circle on the graph above shows this singular data point compared to probabilities of other earthquakes with magnitudes >5 and >6 generated using the same USGS model. **The risk of earthquakes in the DRB** and surrounding region **is** both real and **great**. **The 5.8 magnitude earthquake of 8-23-11, with an epicenter 200 miles SW of Philadelphia, impacted Philadelphia structures in 48.8 seconds.** Just as ground vibrations can be sufficiently large to cause buildings to vibrate, windows to crack, and structures to crack, ground shaking associated with earthquakes can cause gas wellbores to shear, opening them as pathways of contamination to the underground geology. Ground shaking from earthquakes and aftershocks will almost certainly destroy the integrity of cement and steel sealant materials, thereby opening contaminant pathways that cannot readily be remediated, if at all. Further, monitoring of wellbore integrity following a quake is not required by PA, NY or Delaware River Basin Commission regulations.



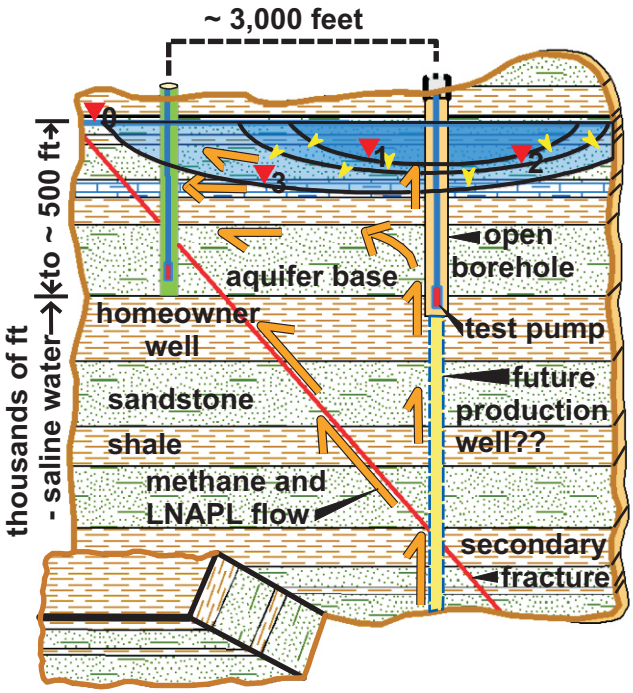
Schematic showing massive casing shear. Even minor shear or cement cracking can degrade the integrity of cement sheaths.

Gas Wells Pose A Serious Public Health Threat: As the number of new and failed gas production wells increases, so does the threat to public health, safety and welfare. Methane (and smaller amounts of ethane, ethene, propane, and butane), hydrocarbons and other gas field contaminants are degrading freshwater aquifers, surface waterways and air resources. At best, industry sealant technology used to isolate and protect freshwater aquifers may last up to 100 years - generally far less. While long-term aquifer contamination is assured, regulatory agencies and homeowners can predict and therefore decrease the immediate risk of contaminant migration to their water supplies by requiring basic hydrologic testing in advance of production well development. **This testing should be mandatory.**



Fractures & Faults ♦ Only portions of the Delaware River Basin (DRB) have been seriously examined for fault and fracture exposures. Jacobi's map at the left conservatively shows the density of these important features in NYS. Many fractures were mapped based on finding high concentration gas anomalies rising from gas-rich shales. Thus, even in the absence of fracking operations, upward-trending contaminant transport pathways are present. Many of these fractures are likely to be directly connected to homeowner wells and, as such, represent potential contaminant transport pathways (e.g., see secondary fracture on figure below).

Water Supply Protection ♦ The schematic to the right depicts geologic and hydrologic features exposed along a fracture face. Watertable draw-down (▼) is shown advancing downward and outward during a short-term (~ 24 hr), high-yield, pumping test designed to ascertain whether there is a hydraulic connection along fractures between a planned gas well and a homeowner well. If a connection is determined via pumping, then the planned gas production well should be abandoned and completed as a water supply well. Otherwise, after cement sheath and casing failure occur (< 1 year to 100 years), homeowner well contamination is assured. All homeowner and farm wells within 3,000 feet of planned gas wells should be electronically monitored with transducers before, during, and after aquifer testing. This advanced hydrologic testing should be conducted on **all** planned wells before they are drilled below the base of freshwater aquifers.



Existing Water Quality Risk ♦ Thousands of orphaned and abandoned natural gas and oil wells, and almost 200,000 additional wells of unknown status, pose a hydrogeologic risk to freshwater aquifers in the DRB. These wells breach important confining layers that, before drilling, contained pressurized fluids. When cement plugs and seals eventually fail, these contaminated fluids will commingle with overlying freshwater aquifers. Regulations should require currently operating gas companies to fully plug and abandon all old wells. Also, since most cement plugs **will** fail in less than 100 years, provision should be made to replug **each** existing gas or oil well at least 10,000 times over the 1,000,000 plus year life of freshwater aquifers.

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