



Natural Gas Development and the NYC Water Supply

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May 14th, 2012

- ❖ Marcellus Shale and Natural Gas drilling/hydrofracking
- ❖ DEP Technical Assessment
- ❖ Risks to the NYC Watershed
- ❖ DEP Recommendations
- ❖ Summary

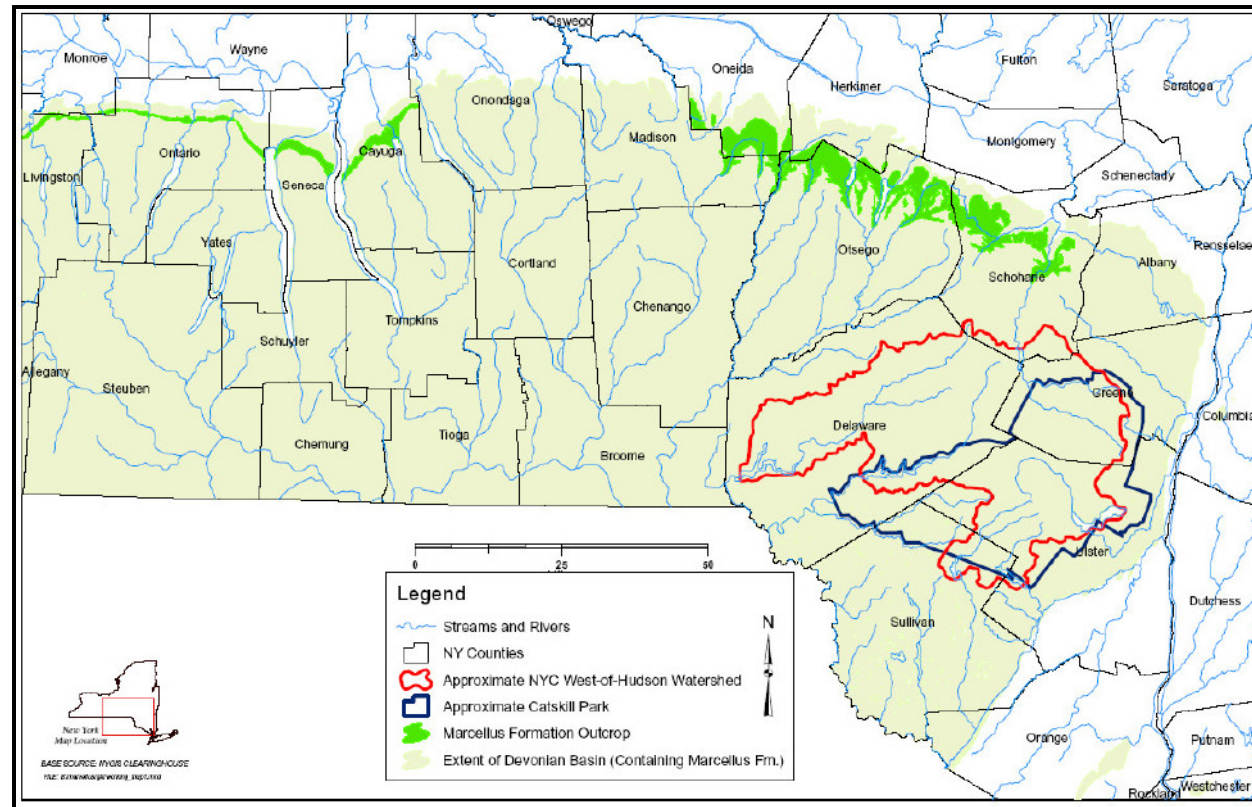
NYC Water Supply



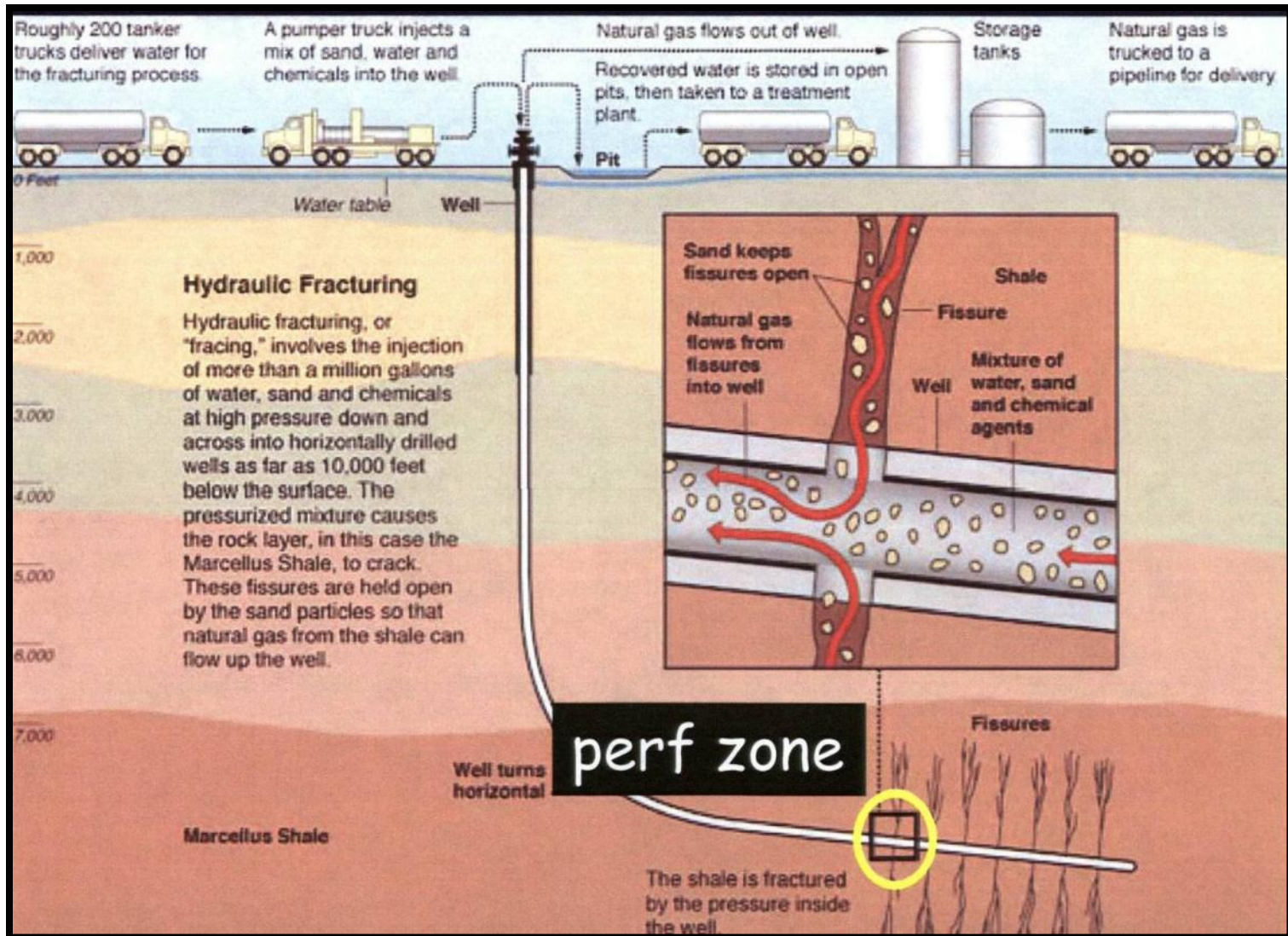
- ❖ Primarily a surface water supply
- ❖ 19 reservoirs; 3 controlled lakes
- ❖ Serves 9 million people (1/2 of population of New York State)
- ❖ Delivers approx. 1.1 billion gallons per day to the City
- ❖ Source of water is a 2,000 square mile watershed in parts of 8 upstate counties
- ❖ Operated and maintained by New York City Department of Environmental Protection (NYCDEP)

Natural Gas and the Marcellus Shale

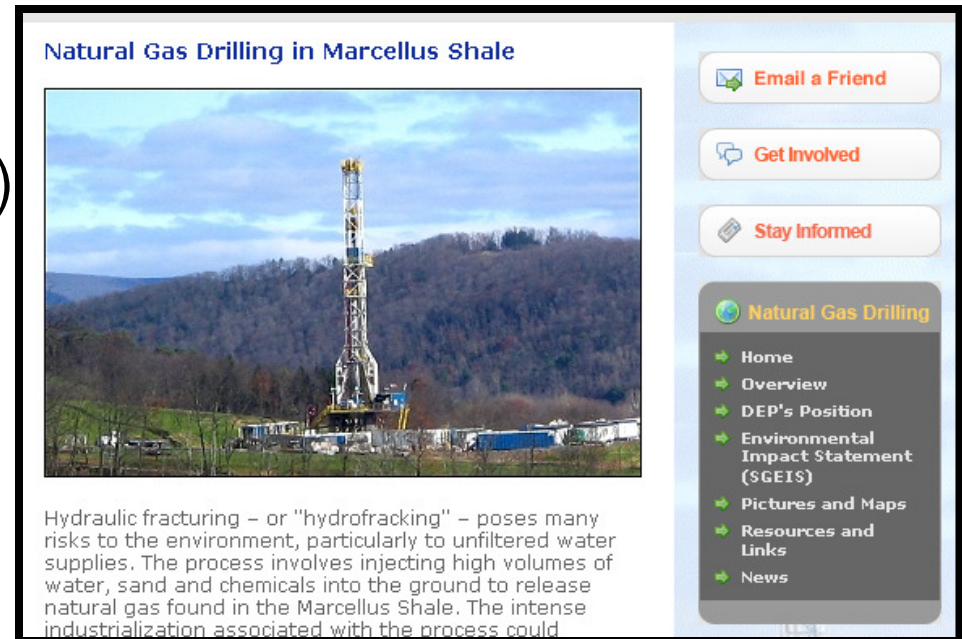
- ❖ Marcellus Shale covers ~95,000 mi²; potentially more than 500 tcf of gas reserves; base of the Marcellus occurs ~3,000 - 7,000 ft. underground
- ❖ Formation underlies the entire NYC WOH watershed




Hydrofracking Process



- ❖ In January 2009, NYC Water Board hired Hazen and Sawyer/Leggette, Brashears and Graham (Joint Venture) to conduct an assessment of potential impacts to the NYC watershed from natural gas drilling
- ❖ The assessment focused on potential impacts to water quality, water quantity, and water supply infrastructure.
- ❖ Three technical reports are available on the NYCDEP website (www.nyc.gov/dep/) on the natural gas page



Natural Gas Drilling in Marcellus Shale



Hydraulic fracturing – or "hydrofracking" – poses many risks to the environment, particularly to unfiltered water supplies. The process involves injecting high volumes of water, sand and chemicals into the ground to release natural gas found in the Marcellus Shale. The intense industrialization associated with the process could

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Risks to the NYC Water Supply

- ❖ “Industrialization” of the watershed
- ❖ Infrastructure Risks and Subsurface Migration
- ❖ Water Quality
 - ❖ Chemicals, pathways for contamination



- ❖ Water Withdrawals
 - ❖ Internal and external to the watershed
- ❖ Waste Treatment and Disposal
- ❖ Implications for City’s Unfiltered Supply

“Industrialization” of the Watershed

- ❖ High levels of site disturbance, truck traffic and intensive industrial activity, on a relatively constant basis, over a period of decades, and attendant impacts on overall watershed health



- ❖ Trucking activity will be accompanied by provision of equipment and material supply systems gas gathering and pipeline systems, compressor stations, and waste disposal systems.

Contamination Pathways

- ❖ Significant potential to adversely impact water quality: on-site spills, vehicle-related spills, and subsurface migration of contaminants.
 - ❖ Concerns include the undiluted chemicals, mixed fracking fluids and wastewater
 - ❖ A chronic and persistent occurrence of small scale surface spills and contamination incidents will inevitably accompany the thousands upon thousands of fluid transfer activities necessary for widespread hydrofracturing and gas well operation.
 - ❖ Occasional acute spills that could cause operational impacts, potential MCL violations and further undermine confidence in the ability to maintain current high water quality standards.



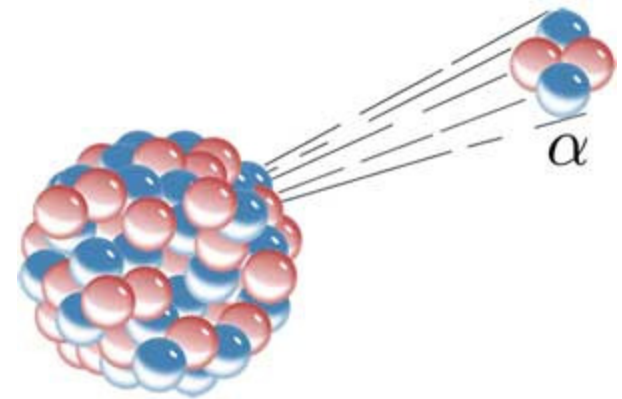
Water Withdrawals

- ❖ Water withdrawals for hydrofracturing could significantly impact commitments for water supply and habitat protection, particularly during periods of low flow.
- ❖ May also locally impact aquatic habitat and biota.



- ❖ May impact the NYC Water Supply even without water withdrawals or natural gas drilling within the watershed boundary – e.g. Delaware River Basin.

- ❖ Wastewater resulting from hydrofracturing and gas well operations will produce an industrial-strength waste stream with the potential for adverse health and water quality effects which can be expected to exceed existing treatment and assimilative capacities.
 - ❖ Flowback water = part of the hydrofracking fluid that is recovered
 - ❖ Produced water = water that is part of the rock formation (called formation water when in place) that is recovered along with the gas
- ❖ Disposal options are further complicated by elevated and variable levels of radioactivity in the wastewater and potentially in the wastewater treatment residuals.



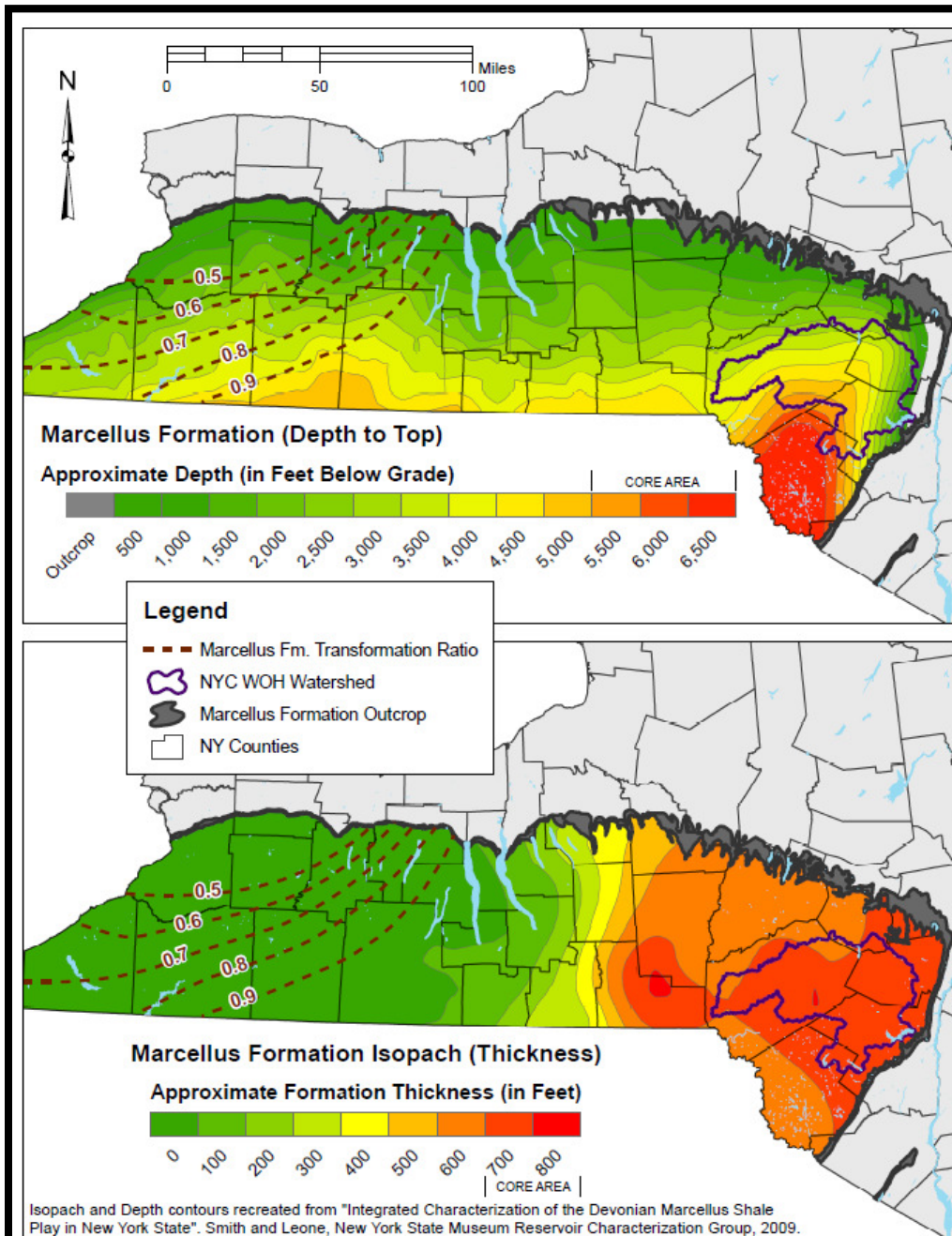
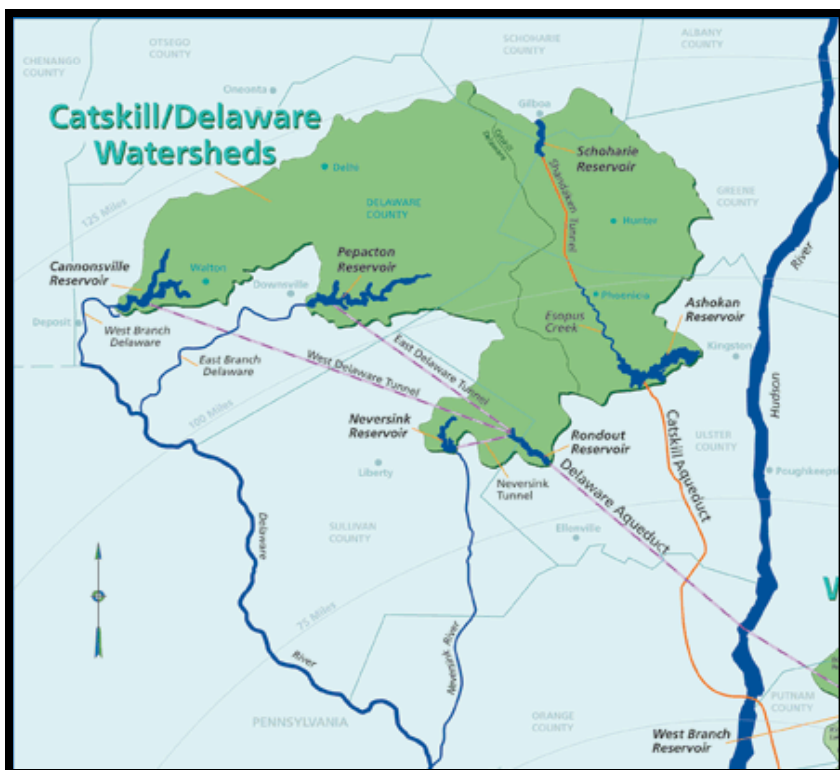
- ❖ Compromise both public confidence in the City's ability to adequately protect the water supply and technical compliance with water quality regulations. All of these potential impacts could jeopardize our Filtration Avoidance Determination.
- ❖ "Unfunded mandate" to build a filtration facility currently estimated at \$10 billion to build and \$100 million per year to operate.
- ❖ Current design would be inadequate to remove the chemicals that could be introduced into the watershed potentially raising costs by 50% - 100% and increase the size of the facility. Long lead time to design and construct plant.

Additional Infrastructure Analysis

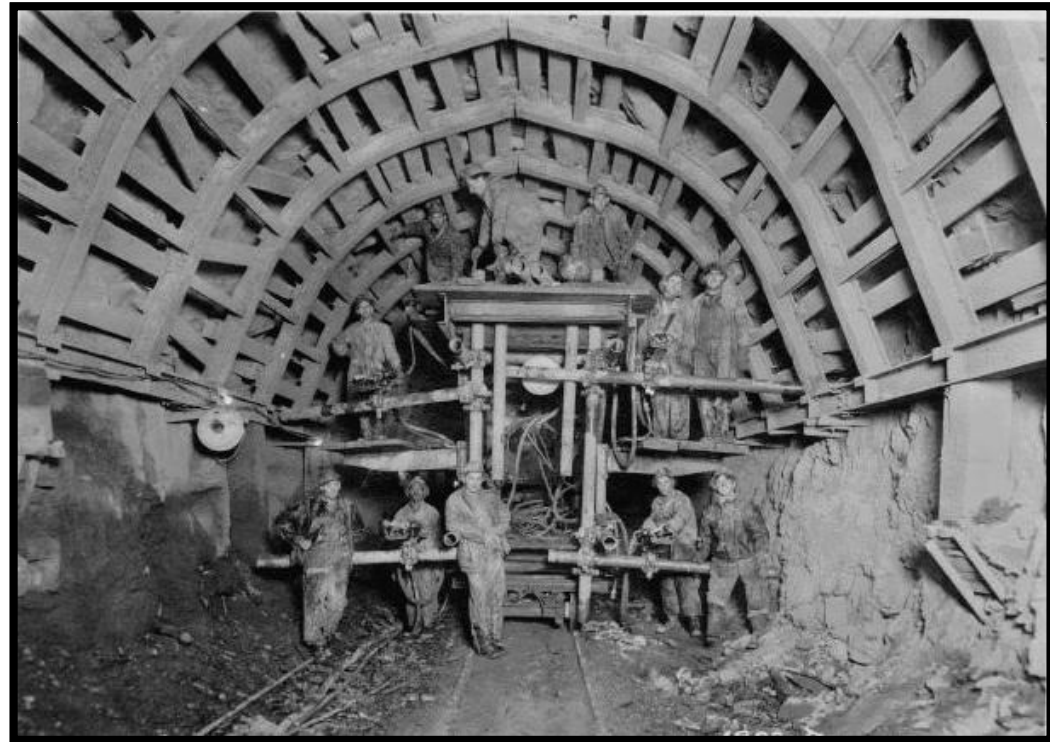
- ❖ DEP added Hager-Richter Geosciences to the Joint Venture project team in October 2011 to further evaluate the risks to DEP's tunnels
- ❖ Work includes:
 - ❖ Review and evaluate previously identified areas of risk to the infrastructure and the applicable RDSGEIS sections
 - ❖ Evaluate the potential impacts from microseismicity and reactivation of faults
 - ❖ Review orthoimagery, LIDAR and other geophysical data to identify previously unrecognized faults and fractures

Water Supply Infrastructure

DEP operates approximately 53 miles of tunnels outside of the watershed buffer in the potential core area for the Marcellus shale

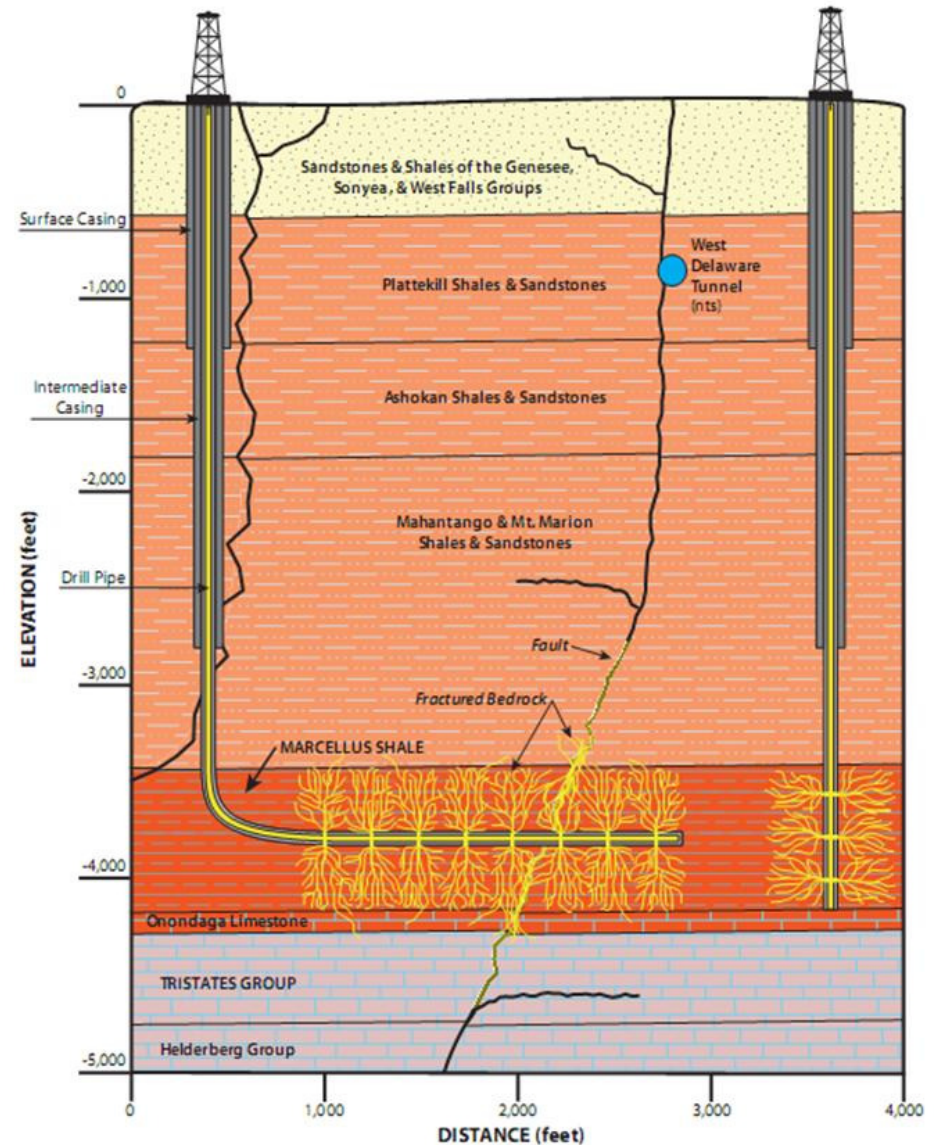


- ❖ Key Known Infrastructure Risks:
 - ❖ Direct penetration by drilling
 - ❖ Differential pressure
 - ❖ Migration of gas and poor-quality groundwater
 - ❖ Induced Seismicity

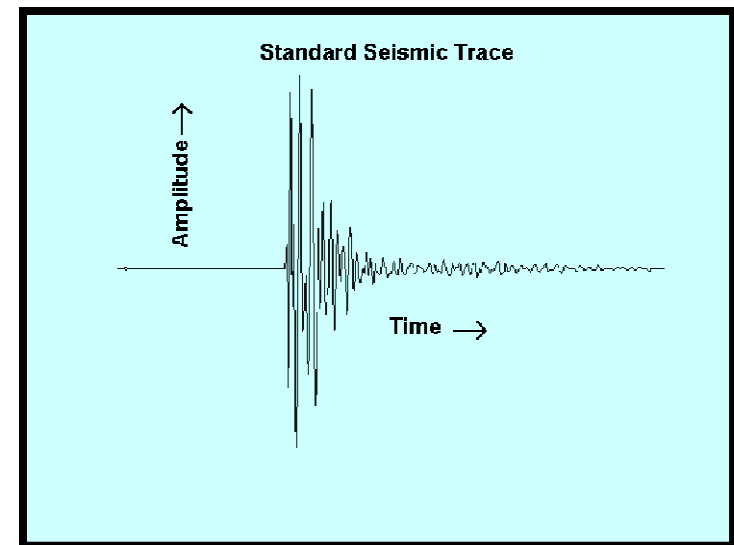


Subsurface Migration

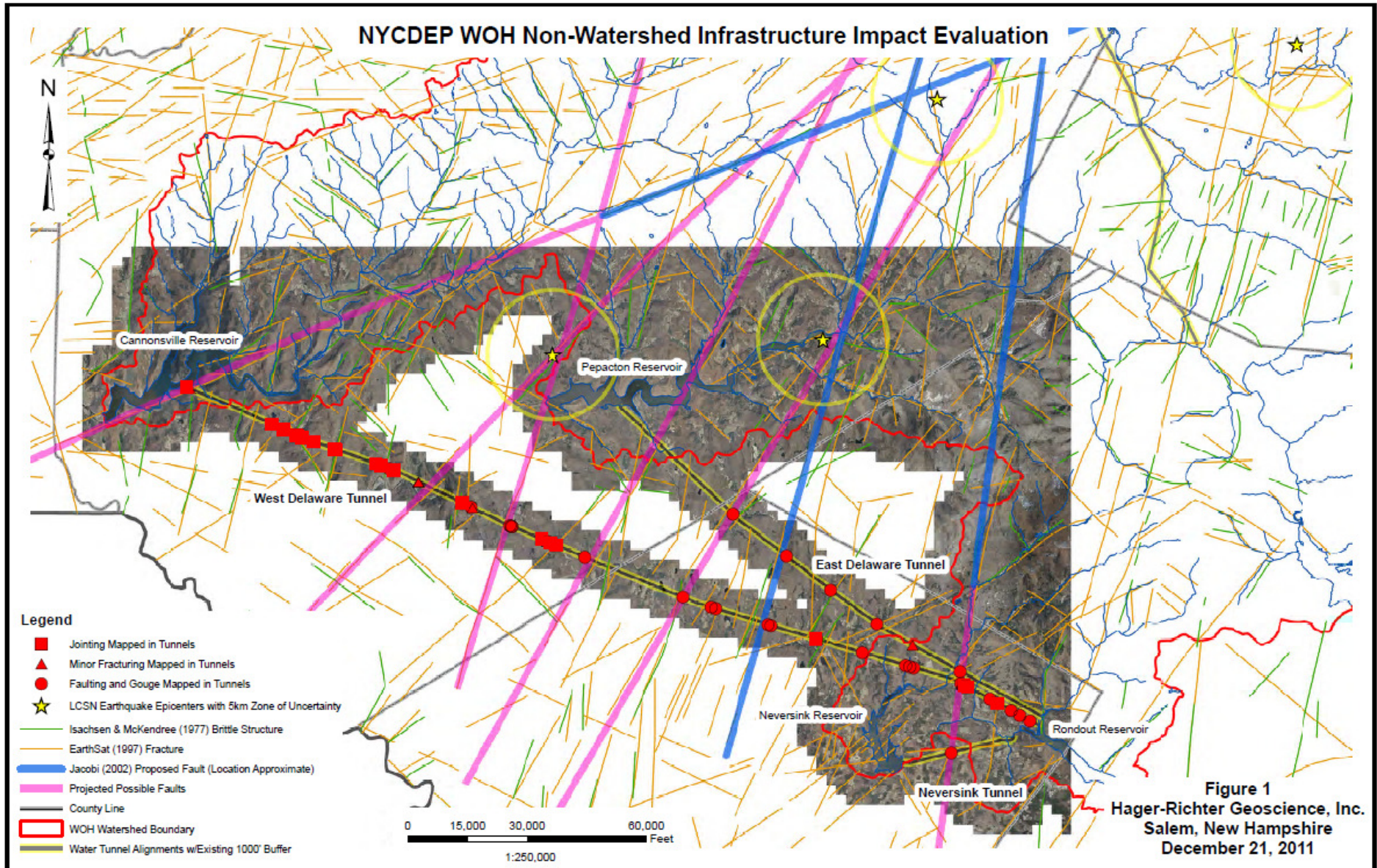
- ❖ Risk of structural compromise or contamination due to pre-existing fractures and faults that may be influenced by fracking
- ❖ Human error and failure to take proper precautions or use proper equipment during drilling and fracturing cited in most documented incidents
- ❖ Pathways:
 - Crushed and jointed zones
 - Faulted areas
 - Significant water-bearing zones
 - Discontinuities and geologic features



- ❖ Microseismicity from hydrofracking:
 - ❖ does not appear to be a concern for the tunnels
- ❖ Induced Seismicity:
 - ❖ earthquakes less than M4 and within 15 miles do have the potential to damage tunnels
- ❖ One or more faults in the vicinity of the WOH tunnels may be seismically active
- ❖ Recent research indicates fracking could lead to induced seismicity
 - ❖ Blackpool, UK
 - ❖ Oklahoma



Faults and Fractures in NY



- ❖ DEP has not identified any precedent for hydraulic fracturing in proximity to deep, large diameter, unreinforced concrete lined tunnels.
- ❖ Based on other shale gas plays there is the potential for thousands of wells drilled within 7 miles of NYC water supply infrastructure
 - ❖ A single well may not cause a problem, but risks increase with hundreds of wells drilled each year
- ❖ The full range of impacts to NYC's critical infrastructure from this level of development is unknown
- ❖ A risk to the NYC water supply for 9 million people must be assessed differently than to a private homeowner or small community supply.

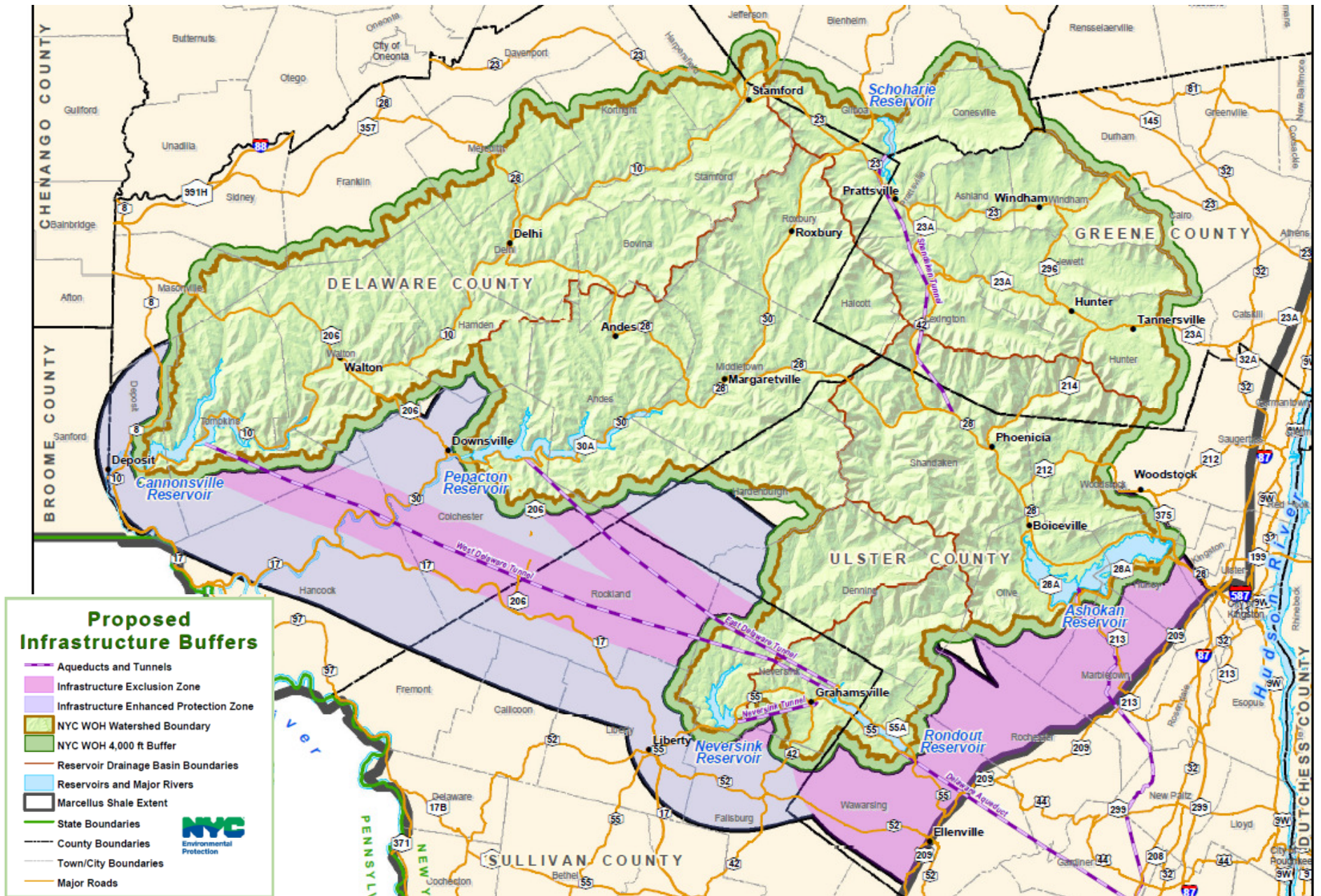
❖ **Water Supply Watershed**

- ❖ Ban on drilling using high-volume hydraulic fracturing within the Watershed and 4,000 ft buffer (*current NYSDEC proposal*)
- ❖ Reopen SEQRA if drilling using low-volume hydraulic fracturing is proposed within the watershed

❖ **Water Supply Infrastructure (outside of Watershed)**

- ❖ Catskill and Delaware Aqueducts
 - ❖ 7 mile exclusion zone
- ❖ Delaware Tunnels
 - ❖ 2 mile exclusion zone
 - ❖ 2 mi – 7 mi enhanced protection zone
- ❖ Dams
 - ❖ Site-specific review within 4,000 ft buffer

Proposed Buffers

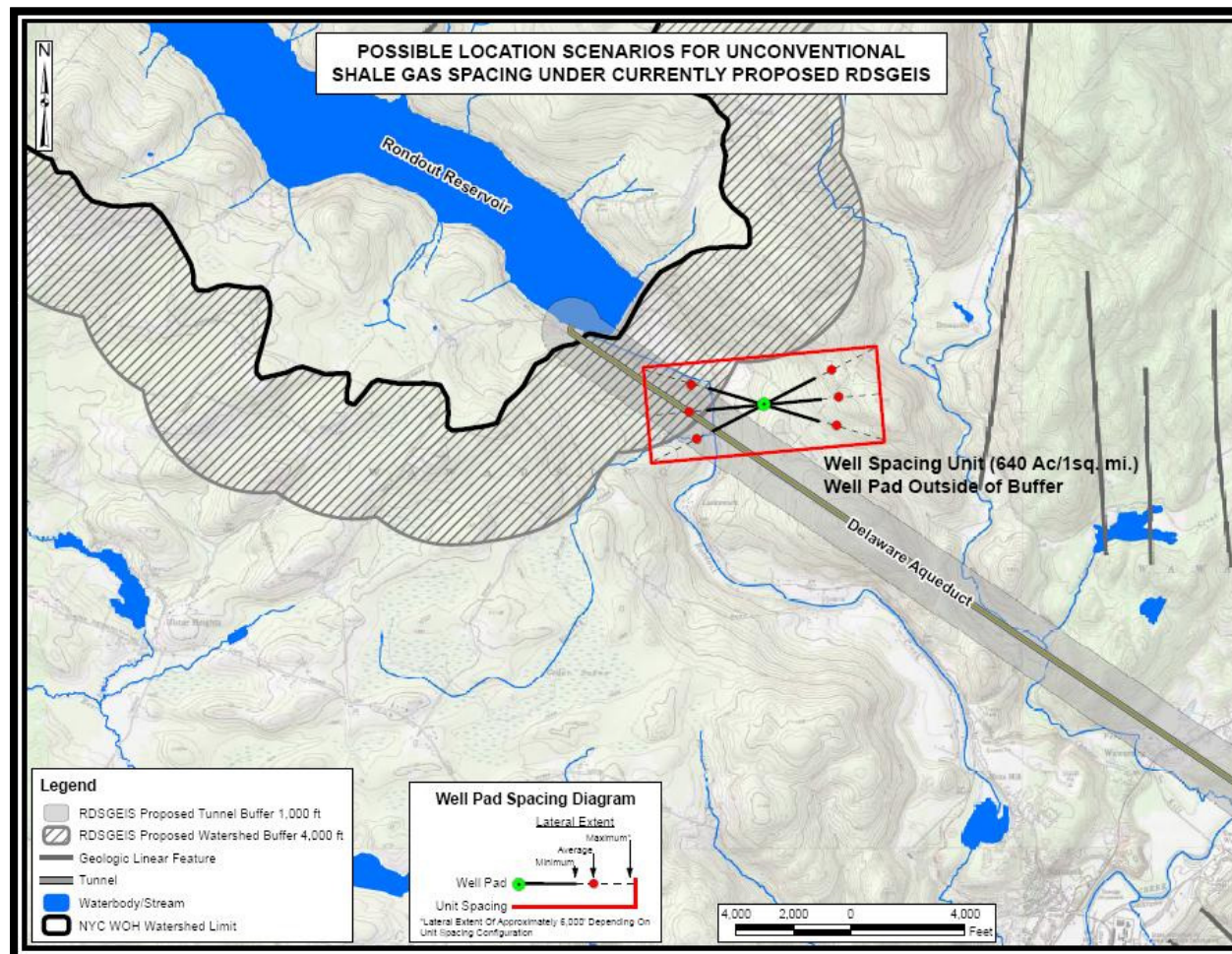


Proposed Infrastructure Buffers

- Aqueducts and Tunnels
- Infrastructure Exclusion Zone
- Infrastructure Enhanced Protection Zone
- NYC WOH Watershed Boundary
- NYC WOH 4,000 ft Buffer
- Reservoir Drainage Basin Boundaries
- Reservoirs and Major Rivers
- Marcellus Shale Extent
- State Boundaries
- County Boundaries
- Town/City Boundaries
- Major Roads

Setback Measurement

- ❖ Critical component of the buffer distance calculation is *how* the setback or buffer is measured



Conclusions

- ❖ Balancing environmental and public health concerns with the need for adequate energy resources and economic development is a complex and challenging issue.
- ❖ Based on the latest science, the many unknowns, and the consequence of failure, horizontal drilling/high-volume hydraulic fracturing pose an unacceptable threat to the NYC water supply and cannot safely be permitted within the NYC watershed or near the water supply infrastructure.

Questions?

