



Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed

Washington Energy Policy Conference
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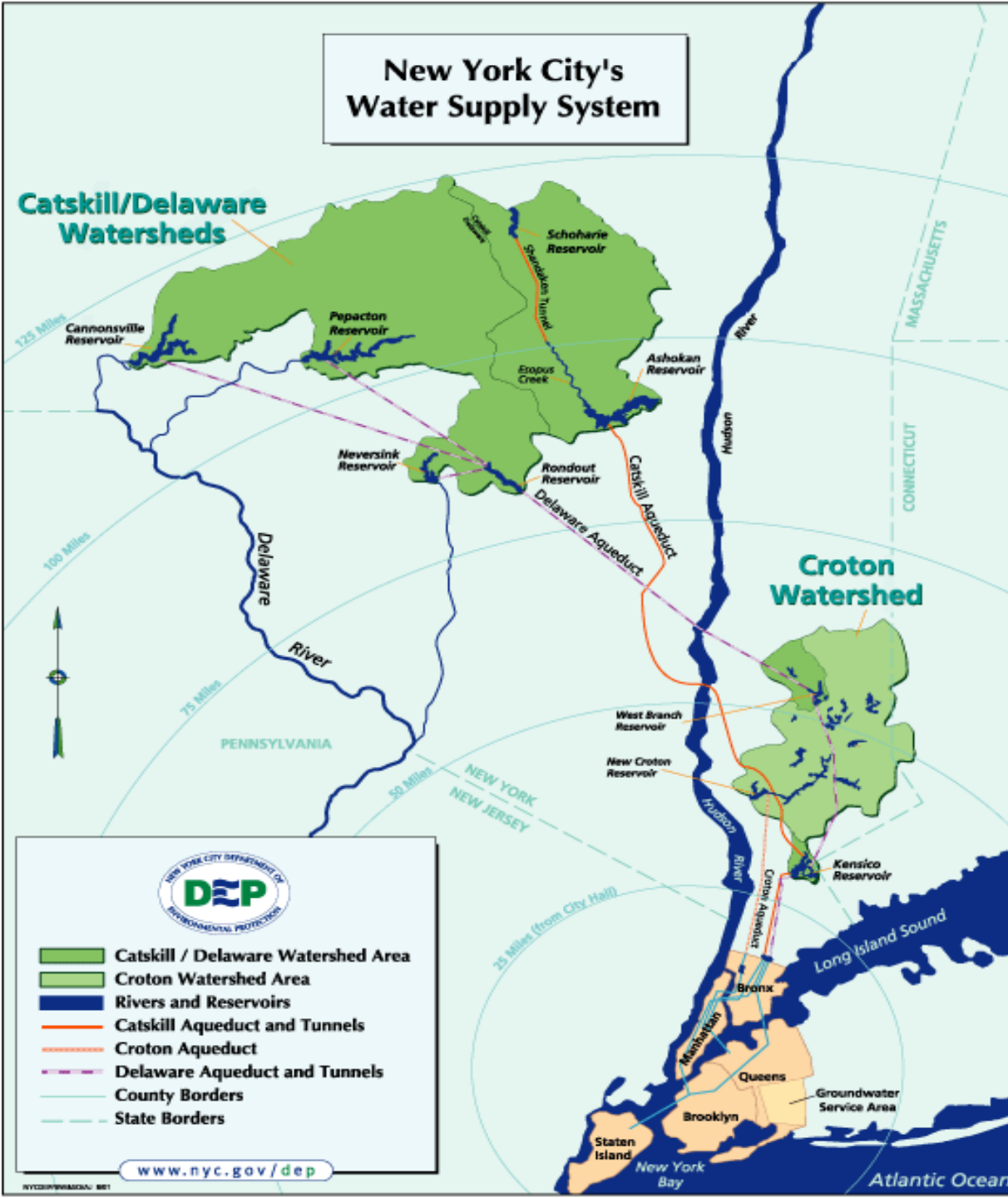


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Environmental Engineers & Scientists



*Impact Assessment of Natural Gas Production
in the New York City Water Supply Watershed*

New York City's Water Supply System



System

Highlights

- Primarily a surface water supply
- 19 reservoirs & 3 controlled lakes
- System Capacity: 550 billion gallons
- Serves 9 million people (1/2 of population of New York State)
- Delivers approx. 1.2 billion gallons per day
- Source of water is a 2,000 square mile watershed in parts of 8 upstate counties

Presentation Overview

- Project Overview
- Risk to the NYC watershed
 - ❑ “Industrialization” of the watershed
 - ❑ Infrastructure Risks and Subsurface Migration
 - ❑ Water Quality
 - ❑ Surface Spills
 - ❑ Water Withdrawals
 - ❑ Wastewater Treatment and Disposal
- Implications for NYC Water Supply

Natural Gas Impact Assessment Project

- In January 2009, 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 (DEP is managing the project)
- The assessment focuses on potential impacts to water quality, water quantity, and water supply infrastructure.

Project Scope

- Evaluation of natural gas development activities and their impacts
- Analysis of regional hydrogeology and potential water quality signatures
- Review of available data on drilling and fracturing chemicals
- Review of natural gas issues and regulations in other states
- Risk evaluation for DEP major infrastructure
- Cumulative risk evaluation for NYC watershed

Water Supply Risk

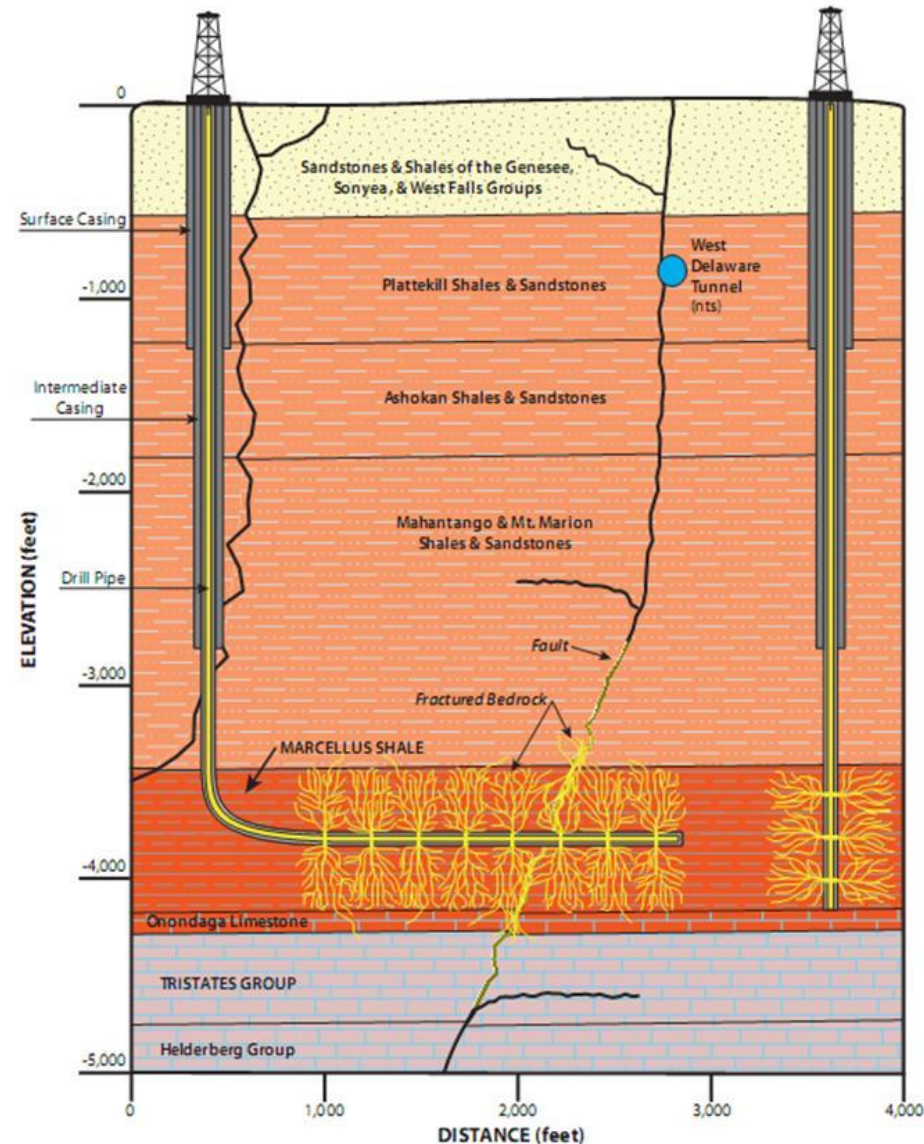
“Industrialization” of the Watershed

- 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.



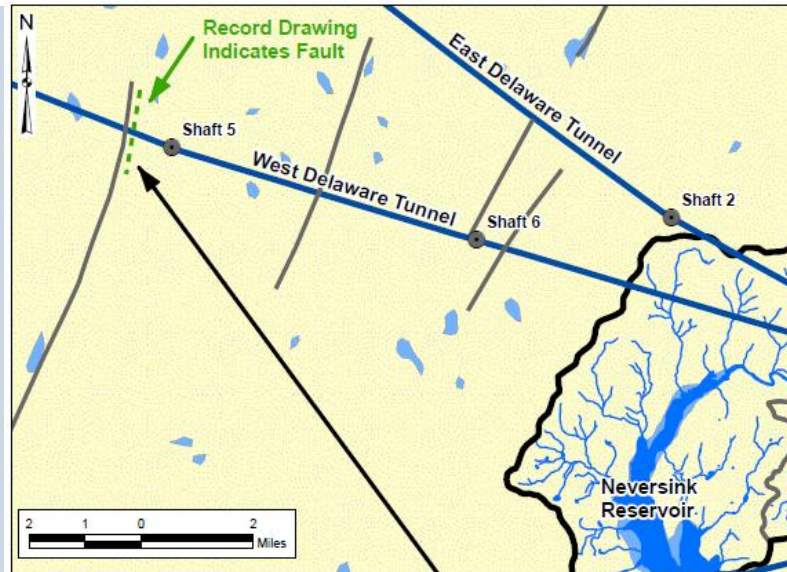
Water Supply Risk Infrastructure

- Risk of structural compromise or contamination due to pre-existing fractures and faults that may be influenced by fracking
- Pathways:
 - Crushed and jointed zones
 - Faulted areas
 - Significant water-bearing zones
 - Discontinuities and geologic features



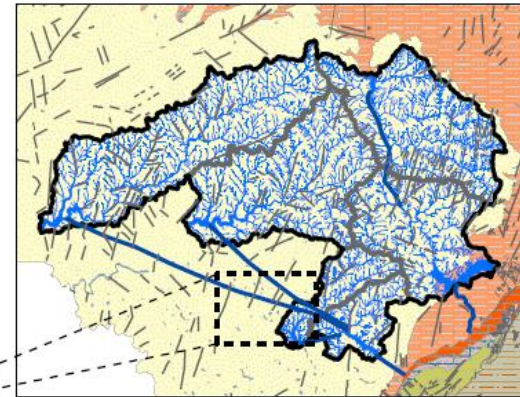
Water Supply Risk

Infrastructure - West Delaware Tunnel



Tunnel at this location is approximately 800' below grade

Marcellus Formation occurs approximately 4,500' below tunnel



Legend

- Tunnel Shaft
- Linear Feature
- Tunnel

LEGEND

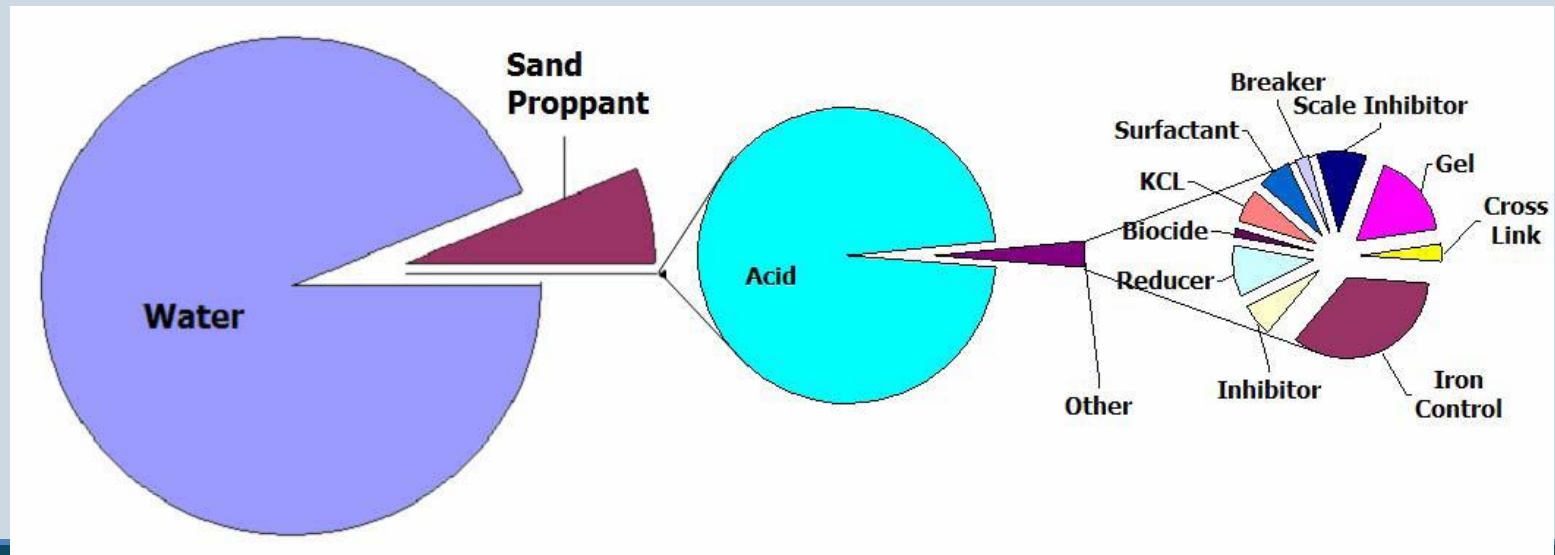
- GSS GRAY SANDSTONE
- RSS RED SANDSTONE
- GSH GRAY SHALE
- RSH RED SHALE
- COL CONGLOMERATE
- ST STRIKE
- D D.P

TUN	PLAN							
	SECTION	STATION						
		SLOPE						
	KIND OF ROCK		1455	1456	1457	1458	1459	1460
	BEDDING - THICKNESS		0.0033%					
	JOINTS		GSS, TRACE GSH	GSS	GSS	GSS	GSS	GSS AND THIN GSH LENSES
	WATER SUPPORT		THIN TO MEDIUM, FAIRLY HORIZONTAL.	THIN TO MEDIUM, HORIZONTAL.	THIN TO MEDIUM, FAIRLY HORIZONTAL.	THIN TO THICK, D. UP TO 5" S.W. TO HORIZONTAL.	THIN AT ROOF, MOSTLY THICK BELOW D. S.E., VICINITY +70.	THIN TO THICK, FAIRLY HORIZONTAL.
	OVERBREAKAGE		NONE	NONE	SERIES: +80 TO +1458, ST. 50°-85° L. D. 85° N.W. - 95° S.W. SPACING: 1'-15'. WET. SOME ROOF DRIPPING, 1457+75 TO 1458, LESS THAN 1/4 O.R.M.	SERIES: 1458+15 TO +40, ST. 45°-85° R. D. 80° N.W. - 95° S.W. SPACING: 1'-15'. ABOUT 1 O.R.M. AT FAULT. JOINTS WET, VICINITY 1458.	NONE	NONE
	ROCK QUALITY		BOLTS - STRAPS	BOLTS - STRAPS	BOLTS - STRAPS	BOLTS - STRAPS	BOLTS - STRAPS	BOLTS - STRAPS
	GUNITE		NONE	NONE	NONE	AT RIBS OF CRUSH ZONE 1'-2' ON SOUTH WALL.	NONE	NONE
	NOTES		VERY GOOD	VERY GOOD	GOOD	POOR	GOOD	GOOD
			NONE	NONE	NONE	NONE	NONE	NONE
			SOME GSS APPEARS BANDED WITH GSH.	FLAT ROOF.		FAULT WITH CRUSH ZONE 1458+20 TO +25, ST. 80° D. 80° N.W.	FLAT, FLAGSTONE-LIKE ROOF.	CROSS-BEDDING AT AT ROOF, 0.5'-10' S.E.

Water Supply Risk

Water Quality

- Because of the vast volumes of water utilized in hydraulic fracturing, 1 percent concentration of chemical additives to the fracking fluids results in 160 tons of “chemistry”; some of it benign, some of it hazardous, and much of it unknown and undisclosed.



Water Supply Risk

Water Quality

- 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
- Cumulatively, the introduction of hundreds of tons per day of fracturing chemicals into the watershed over a period of several decades is unacceptable for a public water supply.

Water Supply Risk

Surface Spills

- 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 Supply Risk

Water Withdrawals

- Withdrawals for hydrofracturing could significantly impact commitments for water supply and habitat protection, particularly during periods of low flow.
 - Delaware Basin withdrawals downstream of the NYC reservoirs
 - Withdrawals from the Upper Esopus Creek
- Excessive water withdrawals may also locally impact aquatic habitat and biota.

Water Supply Risk

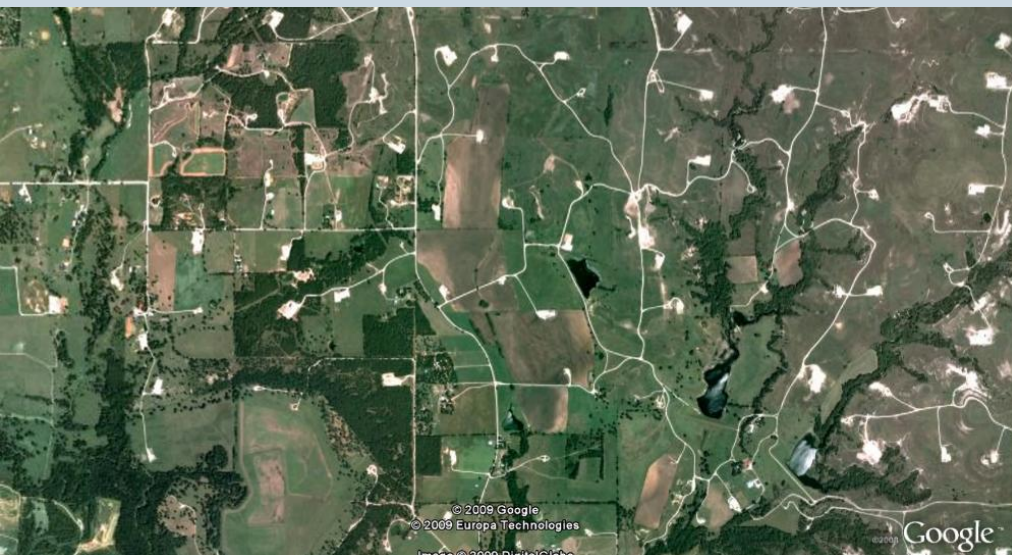
Wastewater Treatment and Disposal

- The flowback and produced waters 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.
- Disposal options are further complicated by elevated levels of radioactivity in the wastewater and potentially in the wastewater treatment residuals.

Cumulative Impacts

Well Development in the NYC Watershed

- Based on other comparable formations:
 - ▣ initial rates as low as 5 to 20 wells per year to an average of 100 to 300 wells per year, potentially peaking at 500 wells per year.



- ▣ Full buildout on the order of 3,000 to 6,000 wells

Cumulative Impacts

Parameter Estimates

Parameter (units) <i>Estimate (source)</i>	Quantity for One Well (range)	Annual Well Development (Quantity/year)		Full Build-out (Total Quantity)	
		Low	High	Low	High
Number of Wells <i>Assume 6 wells/square mile</i>	1	20	500	3,000	6,000
Site Disturbance (acres) <i>4 – 6 wells/pad (dSGEIS)</i>	7	28	700	3,500	10,500
Water Consumption (MG) <i>Industry and dSGEIS</i>	4 (3 – 8)	80	2,000	12,000*	24,000*
Chemical Usage (tons) <i>0.5 to 2% of fracture fluid; assume 1% (dSGEIS)</i>	167 (83 to 334)	3340	83,500	500,000*	1,000,000 *
Flowback (MG) <i>10 to ~70% of fracture fluid; assume 50%¹</i>	2 (0.4 to 2.8)	8	1,400	6,000*	12,000*
Produced Water (MG /yr) <i>Industry and dSGEIS</i>	0.075 (0.015 to 0.15)	1.5	37.5	225	450
Truck trips <i>800 – 2000 per well (RIA)</i> <i>890 – 1340 per well (dSGEIS)</i>	1,200 (800 – 2000)	24,000	600,000	3,600,000 *	7,200,000 *

Implications for City's Unfiltered Supply

- 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.

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 and available technology horizontal drilling/high-volume hydraulic fracturing pose an unacceptable threat to the NYC water supply and cannot safely be permitted within the NYC watershed.**

Questions?

