STATE OF NEW YORK
OFFICE OF THE ATTORNEY GENERAL

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DIVISION OF SOCIAL JUSTICE
ENVIRONMENTAL PROTECTION BUREAU

April 15, 2011

By Hand

Commission Secretary
DRBC
P.O. Box 7360
25 State Police Drive
West Trenton, NJ 08628

Re: Proposed Natural Gas Development Regulations

Dear Commission Secretary:

Please accept for filing the enclosed "Comments by the New York State Attorney General's Office Concerning the Delaware River Basin Commission's Proposed Natural Gas Development Regulations," dated April 15, 2011.

Very truly yours,

Lemuel M. Srolovic
Bureau Chief
Environmental Protection Bureau
(212) 416-8448

Enclosures

Comments by the New York State Attorney General's Office Concerning the Delaware River Basin Commission's Proposed Natural Gas Development Regulations

The New York State Attorney General's Office ("New York AG") respectfully submits these comments concerning the Natural Gas Development Regulations proposed by the Delaware River Basin Commission ("DRBC" or "the Commission") on December 9, 2010. The proposed regulations would authorize drilling for natural gas within the Delaware sub-basin of New York City's West of Hudson Watershed ("WOH Watershed"), and in the drainage basin of the Upper Delaware River, a federally designated "Scenic and Recreational River" shared by New York and Pennsylvania. The WOH Watershed is a critical water resource in New York, providing over 90 percent of the *unfiltered* water consumed by 9 million New York residents and visitors each day.

Summary of Comments

The DRBC's natural gas development rulemaking is subject to the National Environmental Policy Act, 42 U.S.C. § 4321 et seq. ("NEPA"), which requires DRBC and the federal agencies participating in the rulemaking on behalf of the United States to prepare and make available for public review, a draft environmental impact statement ("draft EIS"). NEPA's purpose is to ensure that federal agencies act transparently -- with full public participation -- in considering the potential significant environmental impacts of its decisions. Preparation of a draft EIS is NEPA's "core requirement" for all actions which could cause such impacts, "provid[ing] a springboard for public comment."[1] The draft EIS must analyze the potential adverse impacts on water, air, other environmental resources, and on public health and safety, both within and outside the Delaware River Basin ("Basin").

DRBC estimates that between 15,000 and 18,000 natural gas wells would be drilled in the Basin pursuant to its regulations. The Commission and the United States Army Corps of Engineers, Fish and Wildlife Service, and National Parks Service, have all determined that natural gas development in the Basin would risk significant adverse environmental impacts to the Basin's water resources, and that a cumulative impact analysis of the proposed regulations should be performed. Nevertheless, these federal agencies, and the United States Environmental Protection Agency, have failed to prepare that required EIS. Because NEPA requires federal agencies to perform environmental review at the "earliest possible time" in the decision-making process, the federal agencies must prepare and integrate a draft EIS into the rulemaking process as quickly as possible, and before the adoption of any final regulations authorizing gas well development within the Basin.

Natural gas development within the unfiltered WOH Watershed portion of the Basin poses heightened environmental and public health risks. The New York City Department of Environmental Protection ("NYCDEP"), the entity responsible for providing an adequate supply

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[1] Department of Transportation v. Public Citizen, 541 U.S. 752, 757 (2004); Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 349 (1989).

of safe clean drinking water drawn from the City's watershed, has concluded "based on the latest science and available technology" that proposed natural gas development in that watershed would "pose an unacceptable threat to the unfiltered, fresh water supply of nine million New Yorkers, and cannot safely be permitted within the New York City watershed."[2] In reaching that conclusion, NYCDEP relied on studies prepared by respected outside environmental engineers and scientists.[3] Drilling for natural gas could introduce heavy industry on a large scale to an area long characterized by more benign and less intensive land uses which have proven compatible with clean unfiltered drinking water. Widespread drilling, however well regulated, would likely result in unplanned and unexpected spills, discharges of pollutants, and other incidents of concern, risking contamination of the WOH water supply with radioactive materials, brine, aromatic hydrocarbons, heavy metals, pathogens, turbidity, phosphorus, and other potentially harmful substances. It would potentially adversely affect the City's water quality, public confidence in its water, and the City's "filtration avoidance" status, placing at risk large public investments made over decades, which built and secured the City's water supply system.[4]

The proposed regulations do not distinguish between gas well development within the WOH Watershed and the area of the Basin outside that watershed. In light of the heightened risk of gas well development within the WOH Watershed, the draft EIS should develop and analyze, as an alternative, not authorizing gas well development within the WOH Watershed.

In the absence of a draft EIS, the proposed regulations are not accompanied by scientific or technical analysis; and no evaluation of alternatives to unrestricted drilling for natural gas in the Basin or assessment of cumulative impacts has been performed. Lacking those studies, the New York AG can provide only preliminary technical comments concerning the proposed regulations at this time.

The proposed regulations do contain positive elements. For example, the regulations require that drilling companies keep records of their management of flowback and production brine. This is a useful mechanism for tracking the storage, recycling, and disposal of these wastewaters at each stage in the drilling process, which would help hold drillers accountable for their activities. Similarly, the regulations require drilling companies to file natural gas development plans as part of their applications for approval to drill, providing DRBC a broader

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[2] Letter from Steven W. Lawitts to New York State Department of Environmental Conservation, dated December 22, 2009, http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/12_22_2009_impact_statement_letter.pdf

[3] See Hazen and Sawyer, P.C. and Leggette, Brashears and Graham, Inc., "Final Impact Assessment Report: Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed" (December 2009), available at http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/12_23_2009_final_assessment_report.pdf, and "Rapid Impact Assessment Report: Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed" (September 2009), available at http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/rapid_impact_assessment_091609.pdfNatural gas. The New York AG incorporates these reports within these comments as if fully set forth herein.

[4] Water quality has already been compromised in the City's East of Hudson Watershed (the Croton System), causing the City to minimize its reliance on that water source and, pursuant to a court order, forcing it to spend approximately $3 billion to construct a filtration plant to improve Croton water quality.

information base to administer its regulations and better protect the environment.

Other specific provisions proposed by DRBC need to be strengthened and additional requirements should be added to hold drilling companies accountable and to protect the environment and public health and safety. These include: (1) protections for surface and groundwater, including stormwater management, surface and groundwater monitoring, wastewater management, spill prevention, setbacks from streams, reservoirs, and other sensitive locations, and measures to ensure that water withdrawals do not restrict New York City's supply of clean water; and (2) addressing air pollution and greenhouse gas impacts from emissions of nitrogen oxides, particulate matter, and volatile organic compounds (contributing to smog), and the venting and fugitive emissions of methane (contributing to global warming).

In summary, before adoption, the DRBC's gas well development regulations should be fully evaluated in a draft EIS in order effectively to prevent and mitigate cumulative adverse impacts to water, air, and other environmental resources, including the WOH Watershed.

I. New York City's WOH Watershed

The Basin in New York consists of areas with underlying Marcellus Shale in Broome, Delaware, Greene, Sullivan, Ulster and Orange Counties, including the Delaware sub-watershed of the City's WOH Watershed. Most of the WOH water originates in the Delaware sub-watershed, often referred to as the Delaware Water Supply System ("Delaware System"). The map in Figure 1 (attached to these comments) depicts the Delaware System within the Basin overlying the Marcellus Shale.

When drinking water is obtained from surface waters (such as reservoirs and rivers), it is generally "filtered" to remove contaminants prior to distribution to consumers. However, water obtained from the WOH Watershed is not filtered; indeed, WOH water is the largest unfiltered surface drinking water supply in the Nation. The City has avoided filtration of WOH water in accordance with a series of Filtration Avoidance Determinations ("FADs") issued by the United States Environmental Protection Agency ("EPA") since the early 1990s under the federal Safe Drinking Water Act, 42 U.S.C. § 300f et seq. ("SDWA").

WOH water, including the water drawn from the Delaware System, is collected by streams and reservoirs from precipitation, runoff from rain and melting of snow, groundwater infiltration, and other sources. The water is disinfected and distributed by a system of aqueducts, tunnels and pipes to consumers in New York City, its northern suburbs, and in upstate communities. In accordance with the FADs, rather than filtering the water, the City has spent almost $1.5 billion on pollution prevention efforts to protect the WOH Watershed and ensure safe drinking water. This "Pollution Prevention" approach, adopted instead of filtration, represents the longstanding consensus of State and federal agencies, the City, Watershed communities, and environmental groups, as agreed in their landmark 1997 Memorandum of Agreement ("MOA").[5]

[5] See "New York City Watershed Memorandum of Agreement" (January 21, 1997) at www.nysefc.org?home/index.asp?page=294..

The Pollution Prevention approach includes purchasing Watershed lands to serve as buffers for pollutant discharges, strict regulation of human activities that generate pollution, upgrading sewage treatment plants, and various other programs. Pollution Prevention and filtration avoidance have been effective in ensuring the safety of WOH water and have been endorsed by the National Research Council (which functions under the auspices of the National Academy of Sciences).[6] In addition, the program has been much less expensive than filtration, which would require capital expenditures of over $10 billion and annual operation and maintenance costs exceeding $100 million.

The widespread introduction of heavy industry, such as natural gas drilling, into the WOH Watershed was never anticipated by EPA and the New York State Department of Health ("NYSDOH"), the agencies which have administered filtration avoidance for the City's drinking water supply system under the SDWA, or by the other signatories to the MOA.

II. The Upper Delaware River

The Upper Delaware River lies within the Basin and forms a portion of the Pennsylvania-New York border. The Upper Delaware River is a federally designated "Scenic and Recreational River" which, among other unique features, provides winter habitat for more bald eagles than any other river in the northeastern United States. The river and its tributaries are also among New York's most prized cold water trout fisheries with strong support among angler organizations.

Thousands of New Yorkers enjoy fishing and boating on the Upper Delaware River, and use the 11,967 acre Mongaup Valley Bird Conservation Area, various boat launches, and other facilities operated by the State along the River. In addition, the Basin is home to a variety of federally listed endangered species, including the dwarf wedgemussel which is found over a 22-mile section of the Upper Delaware.

In 2010, the environmental group American Rivers, named the Upper Delaware River as the nation's most endangered river because "this clean water source is threatened by natural gas activities in the Marcellus Shale."[7] In response to that action, the DRBC issued a statement acknowledging that:

> The collective effects of the thousands of wells and supporting facilities that are projected in the basin pose potentially significant adverse effects on the surface water and groundwater of the basin . . . There are also impacts to the land which can affect water resources. The headwaters region where gas drilling activities would be located is the most sensitive and vulnerable area of any

[6] National Research Council, Watershed Management for Potable Water Supply: Assessing the New York City Strategy (2000) ("NRC Study").

[7] http://www.americanrivers.org/assets/pdfs/mer-2010/americas-most-endangered-rivers-2010.pdf.

watershed. Over 80 percent of the DRB headwaters area is covered with forests that are critical to the protection and maintenance of water resources. One big concern is the effect of forest fragmentation on our waters.[8]

III. The DRBC Rulemaking

On May 19, 2009, the Executive Director of the DRBC issued a determination prohibiting natural gas extraction projects (unless authorized by the Commission) within the Basin's "Special Protection Waters," a large portion of the Basin which includes, among other areas, the full extent of the Basin in New York and nearby areas in Pennsylvania.

The Executive Director found that "as a result of water withdrawals, wastewater disposal and other activities, natural gas extraction projects in these formations may individually or cumulatively affect the water quality of Special Protection Waters by altering their physical, biological, chemical or hydrological characteristics."[9] Pending finalization of these regulations, DRBC has not issued drilling permits for production of natural gas within the Special Protection Areas and, on June 14, 2010, it extended that prohibition to wells intended solely for exploratory purposes.

On December 9, 2010, over the objection of New York's Governor David Paterson, DRBC commenced this rulemaking by publishing the proposed natural gas development regulations. Prior to publication of the regulations, Governor Paterson wrote to the DRBC Executive Director criticizing the Commission's decision to move forward with regulations without "the advantage of the full investigations and public deliberations taking place in New York."[10] Governor Paterson was referring to the environmental review process in New York concerning its proposed new permit conditions for natural gas development, involving the preparation and revision of a supplemental EIS under New York's State Environmental Quality Review Act, the State's analogue to NEPA.

In its April 7, 2011 comments concerning the proposed DRBC regulations, the New York City Department of Environmental Protection ("NYCDEP") echoed Governor Paterson's objection, stating that DRBC's regulations are premature because the agency "should conduct a rigorous analysis of the potential cumulative impacts natural gas development could have on water quantity and water quality in the Delaware River Basin."[11] NYCDEP also noted that "its own study determined that, based on the best available science and the current state of technology, hydrofracking cannot safely be conducted in the New York City Watershed."[12]

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[8] http://www.state.nj.us/drbc/DRBCstatement_EndangeredRivers_6-2-2010.pdf

[9] Determination of the Executive Director Concerning Natural Gas Extraction Activities in Shale Formations Within the Drainage Area of Special Protection Waters, DRBC, dated May 19, 2009.

[10] Letter from David A. Paterson to Carol Collier, dated December 6, 2010.

[11] Letter from Paul V. Rush to Paul Schmitt, dated April 7, 2011.

[12] Id.

DRBC and other federal agencies have consistently acknowledged the significant environmental issues at stake and the need for preparation of an EIS. Brigadier General Duke DeLuca of the United States Army Corps of Engineers ("Army Corps"), the federal commissioner on the DRBC, has stated that the "administration's position is to continue fully supporting the need for a cumulative impact study."[13] Similarly, the Fish and Wildlife Service ("FWS") and National Parks Service ("NPS") of the federal Department of Interior have stated that "[l]arge-scale changes in land use and increased water withdrawals, like those associated with natural gas development (including the construction of exploratory wells) will likely affect the Services' trust resources and should be reviewed for both individual and cumulative environmental effects."[14] Nevertheless, these federal agencies have approved moving forward with the rulemaking by "agree[ing] to vote against a moratorium on regulation development pending completion of an impact study."[15]

IV. NEPA

NEPA imposes on federal agencies the "obligation to consider every significant aspect of the environmental impact of a proposed action [and to] inform the public that it has indeed considered environmental concerns in its decision-making process." Baltimore Gas and Electric v. NRDC, 462 U.S. 87, 97 (1983). Preparation of an EIS, subject to public comment, is the "core requirement" of NEPA for every action which "might" cause significant environmental impacts. Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 349 (1989); American Bird Conservancy, Inc. v. FCC, 516 F.3d 1027, 1034 (D.C. Cir. 2008).

Because proposed natural gas development may have significant environmental impacts, the DRBC, Army Corps, FWS, NPS, EPA, and other involved federal agencies must comply with NEPA by preparing an EIS concerning the proposed regulations. 42 U.S.C. § 4332(C); Delaware River Basin Compact, § 15.1(o); 49 Fed. Reg. 49750, 49774 (December 21, 1984) (DRBC is subject to NEPA because it is a federal agency with approval authority over water resource matters within the Basin). Under NEPA, the EIS must assess the environmental effects (including cumulative impacts) of the proposed regulations, consider alternatives to them (such as a prohibition against drilling in the New York City Watershed), and specify appropriate mitigation measures. 42 U.S.C. § 4332(C)(iii); see 40 C.F.R. §§ 1502.16(a), 1502.16(b), 1508.7, 1508.8, 1502.14, 1502.14(f).

Federal agencies must perform environmental review under NEPA at the "earliest possible time" in the decision-making process. 40 C.F.R. § 1501.2. They must "integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than

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[13] Letter from Duke DeLuca to Congressman Maurice Hinchey, dated September 14, 2010.

[14] Letter from Marvin E. Moriarty and Dennis Reidenbach to Carol Collier, dated June 25, 2010.

[15] Letter from Peter A. DeLuca to Congressman Maurice Hinchey, dated November 24, 2010 (National Park Service and Fish and Wildlife Service)

consecutively." Id., 1500.2(c). In the context of a proposed rule, such as DRBC's proposed regulations for natural gas development here, "the draft EIS should normally accompany the proposed rule." Id., § 1502.5(d). Because a draft EIS has not been prepared on this rulemaking, DRBC and the involved federal agencies must implement that environmental review required by NEPA before proceeding with the adoption of gas well development rules.

V. Risks to Water Quality Posed by Natural Gas Drilling

Many aspects of natural gas development pose risks of polluting New York's surface water and groundwater.

When a natural gas well is drilled, it punctures the "geologic seal" which keeps various naturally occurring and potentially harmful substances sequestered deep underground. When gas is produced, these substances flow up through the well bore, travel through the freshwater aquifer, and to the surface. Production water, sometimes referred to as "production brine," includes brine, toxic metals (such as barium), and radioactive substances (such as radium-226 and radium-228).[16] EPA has found that production brine "can be very damaging to the environment and public health if it is discharged to surface water or the land surface."[17] The New York State Department of Environmental Conservation's September 2009 Draft Supplemental Generic Environmental Impact Statement ("DSGEIS") concerning proposed natural gas drilling in the Marcellus Shale disclosed sampling results from vertical wells in that geologic formation in New York. Eleven of the thirteen samples of production brine had extremely high concentrations of radium-226 -- orders of magnitude higher than applicable federal and State maximum contaminant levels and water quality standards for surface and groundwaters in the WOH Watershed.[18] Conventional wastewater treatment plants are ill-equipped to remove radium-226 and other contaminants found in production brine. In fact, the high concentrations of total dissolved solids ("TDS") in production brine, and the biocides found in flowback, if conveyed to a wastewater treatment plant, may interfere with the plant's ability to treat sanitary sewage, the core function of such plants.[19]

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[16] Congressional Research Service, Memorandum to House Committee on Natural Resources: Marcellus Shale Gas Development: Royalty Rates, Surface Owner Protection, and Water Issues (October 14, 2008) ("CRS Study"), at CRS-14.

[17] USEPA, Underground Injection Control Program. Oil and Gas Injection Wells: Class II, at www.epa.gov/safewater/uic/wells_class2.html.

[18] See DSGEIS, p. 2-16; 6 NYCRR § 703.5. Similarly, a recent New York Times investigation of natural gas development in the Marcellus Shale in Pennsylvania and elsewhere found "more than 179 wells producing wastewater with high levels of radiation, [with] at least 116 reported levels of radium or other radioactive materials 100 times as high as the levels set by federal drinking-water standards. At least 15 wells produced wastewater carrying more than 1,000 times the amount of radioactive elements considered acceptable." Ian Urbina, "Regulation Lax as Gas Wells' Tainted Water Hits Rivers," The New York Times, February 26, 2011, available at: http://www.nytimes.com/2011/02/27/us/27gas.html?ref=ianurbina.

[19] CRS Study at CRS-13 and CRS-14.

Natural gas drilling in the Basin is expected to employ horizontal drilling and high volume hydraulic fracturing, a technology used to release gas embedded in low permeable geologic formations by pumping between 1 and 10 million gallons of water containing "fracking" additives into the ground under high pressure. The fracking additives include many chemicals which can pose risks to health and the environment, including the aromatic hydrocarbons benzene, toluene, ethylbenzene, and xylene (often referred to as BTEX); microbiocides; glycols; glycol ethers; and petroleum products.[20] Flowback water, brought to the surface in the hydrofracking process, and some production water transported to the surface during the production phase, will contain these fracking additives.

Well development and natural gas production can pollute surface water and groundwater with these potentially harmful substances in the following ways: loss of integrity in well casings (including cement failures); loss of circulation in uncased portions of wells; breaches or leaks in pits, tanks, or impoundments containing source waters, drilling fluids, well stimulation (hydraulic fracturing) fluids, or produced fluids; spill events involving truck accidents; stormwater runoff and sedimentation, or flood events affecting well sites, pits, or impoundments, well field roads, or other facilities; leakage of naturally occurring radioactive materials; gas and fluid migration caused by drilling, well stimulation processes, or injection of wastewater. See attached report by Arcadis, New York AG's expert on environmental review of natural gas projects, "Review of the Draft Supplemental Generic Environmental Impact Statement Concerning Natural Gas Development in the Marcellus Shale within the New York City Watershed" (December 30, 2009), at pp. 13-17.

The cuttings derived from both the vertical and horizontal components of drilling may also contain contaminants such as toxic metals, radioactive materials, petroleum hydrocarbons, and volatile organic compounds. Often these cuttings are stored in open "reserve pits," which can leak or spill and contaminate surface waters or groundwater.[21]

One need only to look at the experience in Pennsylvania to understand the risks to public health and the environment posed by natural gas drilling activities. From January 1, 2008 through August 20, 2010 Pennsylvania issued 1,614 violations to drilling operators (not including traffic citations or written warnings), of which 1,056 were judged as having "the most potential for direct impact on the environment."[22] These violations included:

- 299 incidents of Improper Erosion and Sediment Control
- 212 incidents of Faulty Pollution Prevention Practices
- 155 illegal Discharges of Industrial Waste
- 91 violations of Pennsylvania Clean Stream Law

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[20] DSGEIS, pp. 5-46 through 5-66.

[21] See, e.g., "Cases Where Pit Substances Contaminated New Mexico's Groundwater," New Mexico Energy, Mining, and Natural Resources Department, at www.emrd.state.nm.us/ocd/documents/GWImpactPublicRecordsSixColumns20081119.pdf

[22] Pennsylvania Land Trust Association (October 1, 2010) available at http://conserveland.org/violationsrpt.

- 50 incidents of Improper Well Casing and Construction
- 20 incidents of Improper Post-Drilling Site Restoration
- 17 incidents of Improper Waste Management
- 4 incidents of Inadequate Blowout Prevention.

A substantial pollution incident occurred in Pennsylvania's Monongahela River in 2008, impairing the drinking water supply for hundreds of thousands of people over a period of months, when commercial and publicly owned treatment works discharged inadequately treated natural gas wastewater. As a result of these discharges, concentrations of TDS (total dissolved solids) and sulfate in the river reached historic highs, exceeding drinking water quality standards at all 17 potable water supply intakes south to the West Virginia state line.[23] EPA and Pennsylvania health officials also documented elevated levels of bromide in the river, likely to have originated from natural gas wastewater. When river water with elevated bromides is treated for drinking water, the bromides can form "brominated disinfection by-products," which can pose increased health risks to consumers.[24]

Other notable incidents occurred in Dimock, where 18 drinking water wells were contaminated with elevated levels of methane, and possibly other constituents resulting from natural gas operations conducted in 2009,[25] and Bradford County, where gas drilling resulted in stray methane bubbling up in private residential water systems and in the Susquehanna River approximately two to three miles away.[26] In both instances, inadequate gas well construction was faulted and the companies were ordered to inspect and correct deficiencies at hundreds of other gas wells. In Dimock, Cabot Oil and Gas, which appears responsible for the contamination, has refused to clean up the groundwater and residents have been forced to rely indefinitely on bottled water. The state considered building an $11.9 million pipeline to provide clean water to affected residents, but recently dropped that plan.

In June 2010 in Clearfield County, a Marcellus gas well "blowout" occurred, resulting in an uncontrolled discharge of approximately 35,000 gallons of hydraulic fracturing wastewater,

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[23] The Pennsylvania Bulletin, Proposed Rulemaking [25 PA. CODE CH. 95] Wastewater Treatment Requirements [39 Pa.B. 6467] (November 7, 2009). Available at: http://www.pabulletin.com/secure/data/vol39/39-45/2065.html

[24] Paul Handke, Water Program Specialist, Pennsylvania Department of Environmental Protection, "Trihalomethane Speciation and the Relationship to Elevated Total Dissolved Solid Concentrations Affecting Drinking Water Quality at Systems Utilizing the Monongahela River as a Primary Source During the Third and Fourth Quarters of 2008." Available at: http://files.dep.state.pa.us/Water/Wastewater%20Management/WastewaterPortalFiles/MarcellusShaleWastewaterPartnership/dbp_mon_report__dbp_correlation.pdf

[25] Pennsylvania DEP Press Release, "Dimock Residents to Share $4.1 Million, Receive Gas Mitigation Systems Under DEP-Negotiated Settlement with Cabot Oil and Gas" (December 16, 2010). Available at: http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=15595&typeid=1

[26] Pennsylvania DEP Press Release, "DEP Monitors Stray Gas Remediation in Bradford County; Requires Chesapeake to Eliminate Gas Migration: Chesapeake Commits to Evaluate, Remediate All PA Wells to Conform with Improved Casing Regulations" (September 17, 2010). Available at: http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=14274&typeid=1

brine, and natural gas over the course of 16 hours. The Pennsylvania Department of Environmental Protection Secretary John Hanger stated: "Had the gas blowing out of this well ignited, the human cost would have been tragic, and had an explosion allowed this well to discharge wastewater for days or weeks, the environmental damage would have been significant." An independent investigation identified multiple problems, including faulty and incorrectly used equipment, flawed employee practices, a failure to properly test the blowout preventer prior to use, an absence of trained personnel on-site at the time of the incident, and ignorance of spill notification procedures in the company emergency preparedness plan.[27]

VI. Particular Risks to Water Quality in the WOH Watershed

Natural gas development poses unique risks to the WOH Watershed, including the City's Delaware System within the Basin, which encompasses almost 40 percent of the area of the Basin within New York. Natural gas drilling could be the largest development in the WOH Watershed in many decades. DRBC estimates that between 15,000 and 18,000 wells would be developed within the Basin. This would result in the disturbance of thousands of acres of undeveloped and typically forested land. According to DRBC, forested land is "critical to the protection and maintenance of water resources."

The construction and development of land, including land used for natural gas production, is a major source of pollutants discharged to surface waterbodies, such as rivers and reservoirs, in stormwater runoff. Discharges of stormwater from construction sites include sediment which, when suspended in water contributes to turbidity (murkiness) in the water and serves as a carrier of other pollutants, such as phosphorus, metals, organic compounds, and pathogens. "It is generally acknowledged that erosion rates from construction sites are much greater than from almost any other land use."[28] Sediment loads in stormwater discharges from construction sites are typically 1,000 to 2,000 times the sediment loads in discharges from undeveloped forested land.[29]

Well development and natural gas production could risk exacerbating existing water quality problems in the WOH Watershed by causing increased discharges of stormwater polluted by turbidity, pathogens, phosphorus, and the wide variety of pollutants associated with natural gas development. Turbidity not only facilitates the transportation of pollutants, but it can shelter pathogens from exposure to attack by chlorine, a disinfectant routinely used in the WOH Watershed to protect public health. In addition, the organic particles that contribute to turbidity can also combine with chlorine to create disinfection by-products which may increase the risk of

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[27] Pennsylvania DEP Press Release, "Independent Report Faults Clearfield County Gas Well Operators for June 3 Blowout, DEP Outlines Proper Procedures for all Marcellus Drilling Firms" (July 13, 2010). Available at: http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=12818&typeid=1.

[28] "National Pollutant Discharge Elimination System – Regulations for Revision of the Water Pollution Control Program Addressing Stormwater Discharges; Final Rule," 64 Fed. Reg. 68722, 68724, 68728. (Dec. 8, 1999).

[29] EPA, "Storm Water Phase II Final Rule: Small Construction Program Overview (Fact Sheet 3.0)," EPA 833-F-00-013 (Jan. 2000), available at http://www.epa.gov/npdes/pubs/fact3-0.pdf.

cancer or early term miscarriage for people drinking the water.[30] For these reasons, EPA prohibits raw water turbidity measurements in unfiltered drinking water at the intake to the distribution system in excess of 5 nephelometric turbidity units. See 40 CFR § 141.71(a)(2).

Violations of this turbidity standard could provide grounds for the NYSDOH, which now holds primacy in enforcing Filtration Avoidance regulations, to require that the City filter the water from its WOH Watershed. In the 2007 Filtration Avoidance Determination, EPA and NYSDOH found that "significant improvement to the City's ability to prevent, manage, and control turbidity in the Catskill System is required in order to maintain filtration avoidance for the long-term."[31] Widespread development of natural gas within the Delaware System could add to the turbidity problem already experienced in the Catskill System.

Preventing pathogens from contaminating the water is of particular concern for the WOH Watershed because of the risks pathogens pose to public health. Pathogens include viruses and bacteria, such as Giardia llamblia, Cryptosporidium, and E. coli 0157:H7, which can cause serious illness or death, especially among the very young, the elderly, and the immunocompromised.[32] Because of the health risks of pathogens, EPA requires that each unfiltered water system meet strict requirements "ensuring that the system is not a source of a waterborne disease outbreak." 40 C.F.R. § 141.71. If the WOH Watershed fails to comply with these requirements, the City could be forced to filter that water supply.

Stormwater discharges of the nutrient "phosphorus" are also of great concern in the WOH Watershed because it contributes to the eutrophication of reservoirs, pathogenic and other contamination, and creation of harmful disinfection by-products. A eutrophic reservoir suffers from abundant algae growth (called algae blooms) in the growing seasons if phosphorus discharges into it are excessive. Algae blooms can impair the taste and odor of reservoir water and deplete levels of dissolved oxygen in the reservoir's bottom waters, impairing aquatic life and releasing into the water metals and phosphorus previously bound in the sediment.[33] Phosphorus-induced algae blooms increase organic and other matter suspended in the water and facilitate pathogenic contamination and can potentially result in the adverse effects associated with chlorination discussed above.[34]

Phosphorus pollution (and resulting algae growth) has been a longstanding problem for the Delaware System's Cannonsville Reservoir, which has the largest drainage area of the four

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[30] See NRC Study at 2, 5-6, 102-05, 109.

[31] 2007 FAD, pp. 13-14.

[32] In 1993, the water supply for the City of Milwaukee became contaminated with Cryptosporidium causing over 400,000 people to suffer stomach cramps, fever, diarrhea and dehydration, and killing over 100 people. In August 1999, the largest outbreak of waterborne E. coli O157:H7 illness in United States history occurred at the Washington County Fair in New York, when a drinking water supply well became contaminated with that pathogen, infecting 781 people, and resulting in the hospitalization of 71 people and two deaths.

[33] NRC Study at 106-07.

[34] NRC Study at 2.

City reservoirs within the Basin. Stormwater discharges associated with natural gas development may contribute to that problem and could undermine large prior public expenditures to address it. For several years prior to 2002, the New York City Department of Environmental Protection listed the Cannonville Reservoir's drainage area as a "phosphorus-restricted basin" because of excessive phosphorus pollution. Since then, conditions in the Cannonsville Basin have generally improved as a result of expenditures exceeding $70 million to upgrade sewage treatment plants and implement "whole farm planning" and other stormwater best management programs. In addition, $45 million has been spent to acquire lands to buffer pollutant discharges. However, the Cannonsville Reservoir remains at risk for eutrophication. For example, in 2006 phosphorus concentrations in the Cannonsville Reservoir exceeded regulatory limits and in 2005 those limits were nearly reached as a result of frequent and intense precipitation events which washed large loads of that pollutant into the reservoir in stormwater runoff. Stormwater discharges of phosphorus from natural gas development could contribute to future problems for the reservoir.

In addition to stormwater discharges, groundwater contamination of the various pollutants described in this section could also pollute watercourses and other surface waters in the WOH Watershed which supply drinking water. Spills and leaks from above-ground tanks, pits and containers, and leaks from defects in well design or construction can result in groundwater contamination. Groundwater generally flows toward and recharges surface waters. Local geologic features below the land surface, such as faults, fractured bedrock, coarse gravel, or other permeable materials can facilitate the migration of contaminated groundwater to surface waters. Moreover, the fracking process itself is likely to create many additional fractures in the underlying rock. This may further facilitate migration of contaminants to surface waters, especially if these fractures intersect faults, major fissures, or improperly abandoned oil or gas wells.

Given the heightened risks posed by gas well development within the WOH Watershed, the draft EIS must analyze not authorizing that type of development within that watershed as an alternative to undifferentiated authorization of gas well development within the Basin.

VII. Risks to Air Quality and Climate Change Impacts

As discussed above, the DRBC estimates that thousands of natural gas wells will be developed within the Basin. At this density of development there is the potential for significant air quality impacts on a local and regional scale. As discussed above, these cumulative impacts should be evaluated in an EIS pursuant to NEPA. Specifically, the federal government should perform an air quality impact evaluation of various sources of air pollution emissions from horizontal drilling and high-volume hydraulic fracturing of Marcellus Shale in the Basin. Air dispersion modeling of reasonable worst case scenarios for well construction, development and production should be conducted for criteria pollutants and non-criteria pollutants (toxics). The cumulative air impacts should be evaluated on a regional basis for all of the potential well sites.

The equipment and processes used for drilling, completion, and production of natural gas are sources of air pollutants such as volatile organic compounds ("VOCs"), nitrogen oxides ("NOx"), carbon monoxide ("CO"), particulate matter ("PM"), and a variety of air toxics, such

as benzene, toluene, and hydrogen sulfide. Sources of emissions associated with natural gas development include: (1) combustion from engines, compressors, line heaters, and flares during exploration, drilling, and production; (2) short-term venting and flaring of gas constituents; and (3) emissions from truck activities. Added up, these sources have the potential to significantly impact air quality not only on a local basis, but also on a regional basis.

In addition to being unhealthy in their own right, VOCs and NOx react with other compounds in the atmosphere to produce ground level ozone and PM2.5 (particulates with aerodynamic diameter of less than 2.5 microns). In New York, ozone pollution is primarily a concern during the summer months when the weather conditions needed to form ground level ozone - sunshine and hot temperatures - normally occur. Ozone is unhealthy to breathe, especially for people with respiratory diseases, children, the elderly, and adults who are active outdoors. Symptoms include reduced lung function and chest pain, and can lead to respiratory diseases such as bronchitis or asthma. In New York City alone this past summer, residents were subjected to 13 air quality alert days when ozone levels put human health at risk. Many Environmental Justice communities will be especially at risk.

The projected development of natural gas resources within the Basin may generate significant emissions of ozone and PM2.5 precursors, which may negatively impact local and regional air quality and impair New York's ability to meet air quality goals under applicable State Implementation Plans. Many areas within New York which are downwind of the Basin currently exceed EPA's national 8-hour ambient air quality standards ("NAAQS") for ground-level ozone of 75 parts per billion. The New York State Department of Environmental Conservation has recommended to EPA that Orange, Ulster and Greene Counties, which are each partially within the Basin, and many additional counties downwind of the Basin, including counties within the New York City Metropolitan Area, be designated as in nonattainment of NAAQS for ozone and PM2.5 under the Clean Air Act, 42 U.S.C. § 7409. See Figure 2 attached to these comments depicting these counties which exceed federal air quality standards.

In Wyoming, natural gas development has led to worsening air quality and nonattainment for ozone. While horizontal drilling with high-volume hydraulic fracturing has not occurred in New York, large scale operations are underway in many areas of Pennsylvania outside of the Basin. Pennsylvania has conducted short-term ambient air sampling at several well sites and has concluded that: "Although it is unlikely that drilling operations at a single site will cause an exceedance or violation of the NAAQS, combined effects from many of these operations in an area, along with other sources, may contribute to exceedances or violations of the NAAQS or interfere with the maintenance of the health-based standards in attainment areas."[35]

Once DRBC regulations are finalized, significant drilling operations could commence soon thereafter in the Pennsylvania portion of the Basin. Prevailing wind direction makes it likely that air pollutants released from natural gas development operations in the Basin in Pennsylvania will impact New York's air quality. The federal government should prepare an EIS to evaluate and consider ways to mitigate the potential cumulative impact of emissions of ozone

[35] Pennsylvania Department of Environmental Protection Northeastern PA Marcellus Shale Short-Term Ambient Air Sampling Report, at 21 (Jan. 12, 2011).

and PM precursors in the Basin on SIP emission budgets in relevant nonattainment areas.

The EIS should also examine, as a mitigation measure, requirements to eliminate to the maximum extent practicable releases of natural gas directly to the atmosphere from both venting and leakage. Emissions of greenhouse gases from the combustion of natural gas are significant, accounting for 29.8% of New York's carbon dioxide ("CO_2") emissions from fuel combustion in 2008.[36] Nonetheless, from a climate change perspective, natural gas is the cleanest burning fossil fuel, emitting approximately 50 percent less CO_2 per unit of energy delivered than coal and 30 percent less than oil. However, because the principal component of natural gas is methane, which is a greenhouse gas 25 times more potent over a 100 year timeframe than CO_2, the release of natural gas to the atmosphere during production, distribution, storage or use can eliminate any of the climate change benefits associated with its use. As such, it is important to ensure a regulatory framework is in place to eliminate releases of natural gas to the atmosphere, through either venting or distribution losses, with the added benefit that the captured gas can be used for energy production.

VIII Preliminary Technical Comments Concerning the Proposed Regulations

The proposed regulations contain significant positive elements, such as requiring that drilling companies: (1) keep records tracking water withdrawals and management of flowback and production brine for each stage of the development process,[37] (2) file natural gas development plans as part of their applications for approval to drill, providing DRBC a broader information base to administer its regulations and better protect the environment (Section 7.5(c)), (3) refrain from applying drilling wastewaters to roads or other surfaces within the Basin (Section 7.5(h)(1)(iv)(A)(4)), and (4) remove all cuttings and liquids from the drilling site, thereby preventing their on-site disposal (Section 7.5(h)(2)(iii)(A)).

Other proposed provisions can be improved and supplemented, as discussed below:

Transparency and Public Disclosure

All submissions by drilling companies to DRBC, including groundwater, surface water, and stormwater monitoring results, should be in Electronic Data Deliverable format and should be made available to the public by posting on the DRBC website. As part of their applications seeking approval to drill, drilling companies should be required to disclose to DRBC all constituents (and their concentrations) to be used in natural gas development activities (including fracking additives) at each well, and to update that information when it changes.

Groundwater Monitoring

DRBC proposes groundwater monitoring at all well pads where high volume hydraulically fractured wells will be drilled. Section 7.5(h)(2)(i)(A)(1). The New York AG

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[36] NYS Climate Action Plan Interim Report, at Fig. 3-7 (Nov. 2010).

[37] Sections 7.4(d)(1)(viii), 7.5(h)(1)(iii)(c), 7.5(h)(1)(iv)(B), (C).

agrees with DRBC concerning the importance of groundwater monitoring. However, the proposed regulations do not discuss the number of wells, parameters to be sampled, or sampling locations (e.g., downgradient or upgradient, and distances between well pads or wells). Without addressing those details, sampling may be ineffective in disclosing contamination. The New York AG recommends that pairs of shallow and deep groundwater monitoring wells be installed for each well pad as follows: one pair 100' up-gradient from the most up-gradient of the production wells in the pad and two pairs 100' down-gradient from the most down-gradient of the production wells in the pad. The down-gradient wells should be 50' apart from one another.

The New York AG recommends that groundwater monitoring include the following elements during the baseline period and during the development and operation of gas wells (initially on a quarterly basis): Static water level should be determined. Field analysis using an in-flow cell meter should be performed for pH, redox potential ("Eh"), conductivity, turbidity, dissolved oxygen, and temperature. Laboratory analysis could include RCRA metals, VOCs (EPA Method 8260), bicarbonate, chloride, total and fecal coliform bacteria, gross alpha, gross beta, radium-226, radium-228, iron, manganese, methane, sodium, sulfate, strontium, total dissolved solids, and appropriate additional parameters which are anticipated to be constituents of fracking fluids by DRBC.[38] If no contamination is reported during the first year of monitoring, the sampling frequency can be adjusted from quarterly to every 5 months for at least 3 years, and then to every 9 months if no contamination is reported during that 3 year period. Additional details to ensure the effectiveness of groundwater monitoring should be developed in the future, and, based on sampling results over time, parameters and monitoring frequency can be adjusted.

Stormwater Controls and Monitoring

DRBC proposes to require drilling companies to prepare and implement Non-Point Source Pollution Control Plans ("Stormwater Plans") which would include erosion and sediment controls during the construction phase of well drilling, water withdrawal sites, and diversion facilities, and stormwater control structures to be implemented post-construction. Section 7.4(e)(2)(ii), 7.5(h)(v). However, the proposed regulations do not provide actual standards or guidelines for these plans and should be revised to do so. The regulations also should provide for DRBC's review and approval of the individual Stormwater Plans, rather than rely on a "general permit" approach in which the plans would not be subject to review by regulators. The latter approach is less effective in preventing stormwater pollution.[39]

In addition, DRBC does not propose monitoring for stormwater pollutant discharges. Stormwater Plans should include provisions for monitoring. Each year stormwater samples

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[38] In addition, EPA is studying the feasibility of groundwater monitoring using "tracers" which would help fingerprint the source of contamination. DRBC should evaluate supplementing its monitoring efforts with this emerging technique in the future. See EPA, "Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources" (February 2011) at p. 34, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/HFStudyPlanDraft_SAB_020711.pdf.

[39] See Waterkeeper Alliance, Inc. v. EPA, 399 F.3d 486, 498-500 (2d Cir. 2005); Environmental Defense Center, Inc. v. EPA, 344 F.3d 832, 854-56 (9th Cir. 2003).

could be collected during spring snow melt, and in 5 rainstorms generating at least one inch of runoff. Samples should be taken where runoff enters the site, leaves the site, and where it discharges to a stream, creek, or other significant surface water body. The samples could be tested for the field parameters listed under groundwater monitoring above (pH, Eh, conductivity, turbidity, dissolved oxygen, and temperature) and for the following laboratory parameters, among others: pathogens, phosphorus, total petroleum hydrocarbons, flow, total dissolved solids, total suspended solids, gross alpha, radium-226 and radium-228 (if indicated by gross alpha results).

Surface Water Monitoring

DRBC proposes requirements for baseline and post-construction sampling of surface waters upstream and downstream of the wellpad for temperature, specific conductivity, water chemistry parameters, and benthic invertebrates. Sections 7.5 (h)(2)(i)(A)(3), (2)(i)(A)(1). The New York AG agrees with this requirement, but recommends that sampling consider inclusion of the parameters recommended for stormwater and groundwater monitoring above, and that post-construction surface water sampling should occur in conjunction with stormwater monitoring.

In addition to surface water monitoring near the gas well pad, the DRBC should develop a Real Time Water Quality Monitoring Network consisting of a network of water quality monitoring stations placed in rivers and streams throughout the Basin for the purpose of monitoring - in real time - water quality conditions. Such a monitoring network would aid DRBC in tracking long-term trends in water quality, detecting spills, and in enforcement. The Susquehanna River Basin Commission has taken steps towards establishing such a network within its basin.[40]

Wastewater Treatment

DRBC would require drilling companies to demonstrate that natural gas development wastewater will not interfere with the treatment operations, or sludge treatment and disposal operations of a sewage treatment plant receiving such wastewater, and that the plant's effluent will comply with permit discharge limitations along with EPA primary and secondary drinking water standards and toxicity limitations. Section 7.6. The New York AG agrees with these requirements, and also believes that because natural gas wells are "new sources" of pollutants, they should be required to remove pollutants to the degree required by "new source performance standards" under section 306 of the federal Clean Water Act. That pollutant removal should apply to the contaminants in the waste stream as disclosed by drilling companies (see Transparency and Public Disclosure above) in addition to the parameters listed by the DRBC.

Impacts of Water Withdrawals

As discussed by NYCDEP in its April 7, 2011 comment letter, water withdrawals for natural gas development may restrict the quantity of water available for the New York City water supply at times when the City is required to make releases to meet downstream flow

[40] Susquehanna River Basin Commission Information Sheet on Remote Water Quality Monitoring Network, January 2011, available at: http://www.srbc.net/pubinfo/docs/RWQMNInfoSheet.PDF

requirements. Because the Delaware System generally provides very high quality water, this could also impair the quality of water supplied by the City because it could have to rely more than it otherwise would on lower quality sources. To address these concerns, the DRBC should consider NYCDEP's request that drilling companies not be allowed to withdraw water when the City is required to make releases.

Setbacks and Exclusion Areas

DRBC proposes that wellpads not be sited on slopes exceeding 20 percent or within 500 feet of a surface water intake, reservoir, waterbody, or wetland. Section 7.5(b)(4), 7.5(b)(3)(ii). The New York AG believes that these setbacks and exclusion areas should be expanded so that no portion of the well pad could lie within 2000 feet of a reservoir;[41] within 1000 feet of a stream, underground geologic fault, major fissure, or significant deposit of coarse gravel or other highly permeable material (to mitigate the risk of migration of contaminated groundwater to surface waters);[42] or in areas which pose possible seismic risks to significant underground infrastructure (e.g., pipelines, tunnels, aqueducts).

Spill Prevention

The DRBC proposes that drilling companies be required to store wastewater in tanks before reuse or disposal and that the tanks be properly constructed, used, and maintained. Section 7.5 (h)(2)(iv) (A). The New York AG agrees that proper containment of wastewater is important and recommends that that this requirement extend beyond flowback and production water to include all other liquids containing potential contaminants (including other wastes and chemical and petroleum products, but excluding fresh water uncontaminated by natural gas development activities or conditions). These substances should be stored in above-ground tanks or other containers which comply with the standards set forth in 6 NYCRR § 360-6.3. In addition, as recommended by the NYCDEP, DRBC should require that drilling companies prepare spill control plans for review as a condition of project approval.

Closed Loop Systems Instead of Reserve Pits

The proposed regulations would require that drill cuttings and drilling fluids from horizontal wellbores in the target formation be reused or properly transported offsite. Section 7.5 (h)(2)(iii) (A). The New York AG recommends that drill cuttings and fluids from both horizontal and vertical wellbores be processed in closed-loop drilling fluid systems, entailing a series of storage tanks and related equipment used to separate and reuse liquids and solids, and that reserve pits should be prohibited because they are a common source of leaks and spills.[43]

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[41] Maryland imposes a similar limitation on natural gas drilling throughout that state. See 26 Code of Maryland Regulations § 19.01.09(G) (1,000 feet setback from a drinking water supply).

[42] These underground features should be identified in additional generic/site-specific environmental review. For example, linear topographic features (lineaments) in the WOH Watershed have been mapped by the New York State Museum. See www.nysm.nysed.gov/gis/index.html (click on nyfaults.zip). Further study should determine whether these lineaments are expressions of faults or major fissures.

[43] See, e.g., "Cases Where Pit Substances Contaminated New Mexico's Groundwater," New Mexico Energy,

Conclusion

Before proceeding with its natural gas well development rulemaking, DRBC and the involved federal agencies must prepare and consider a draft EIS as required by NEPA. The draft EIS should include a thorough analysis of all potential environmental impacts, including cumulative impacts. The draft EIS must also include analysis of not authorizing gas well development in the WOH Watershed as an alternative to undifferentiated gas well development within the Delaware River Basin.

Dated: April 15, 2011

Respectfully submitted,

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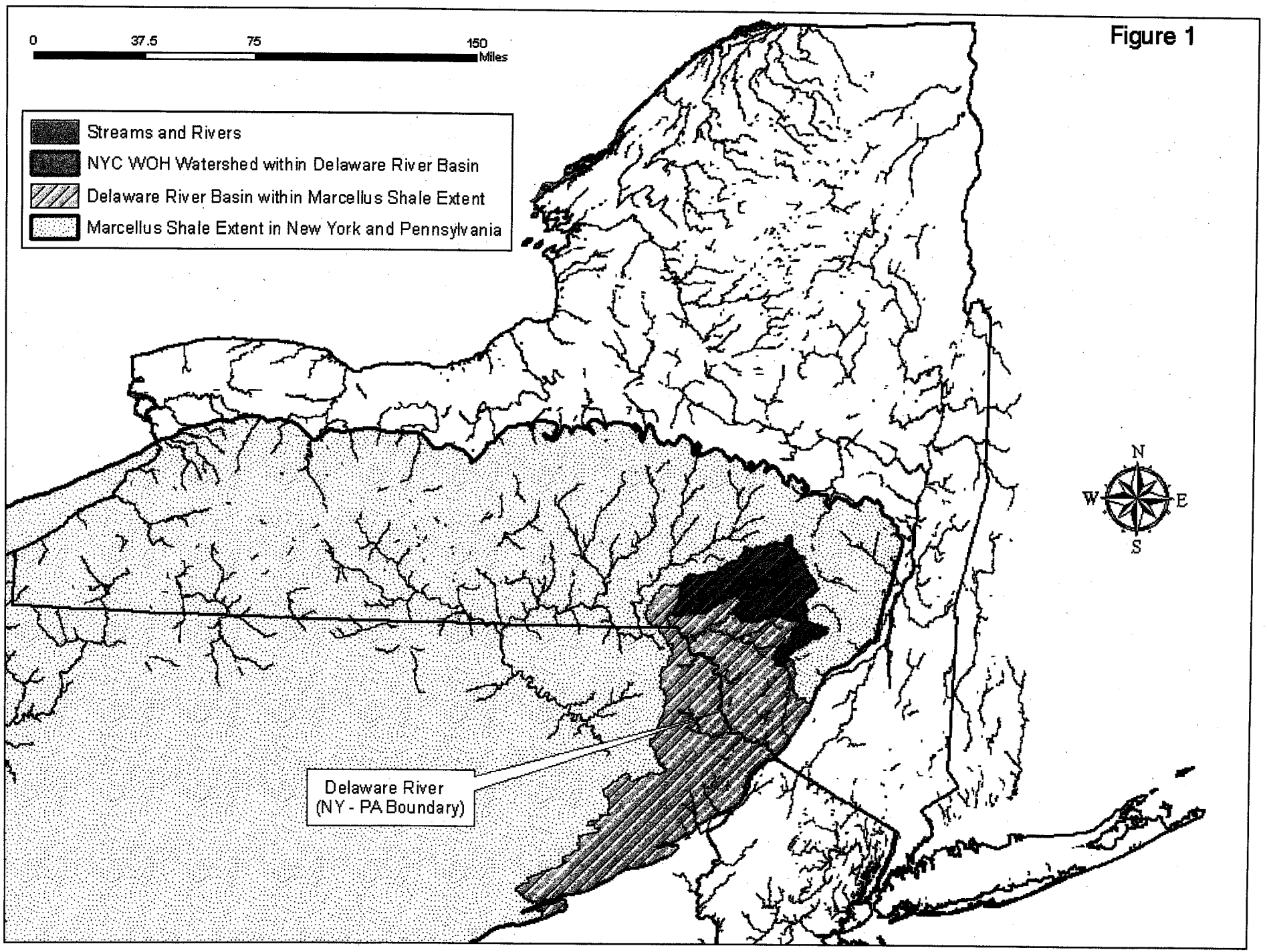
Mining, and Natural Resources Department, at
www.emrd.state.nm.us/ocd/documents/GWImpactPublicRecordsSixColumns20081119.pdf.

Figure 1



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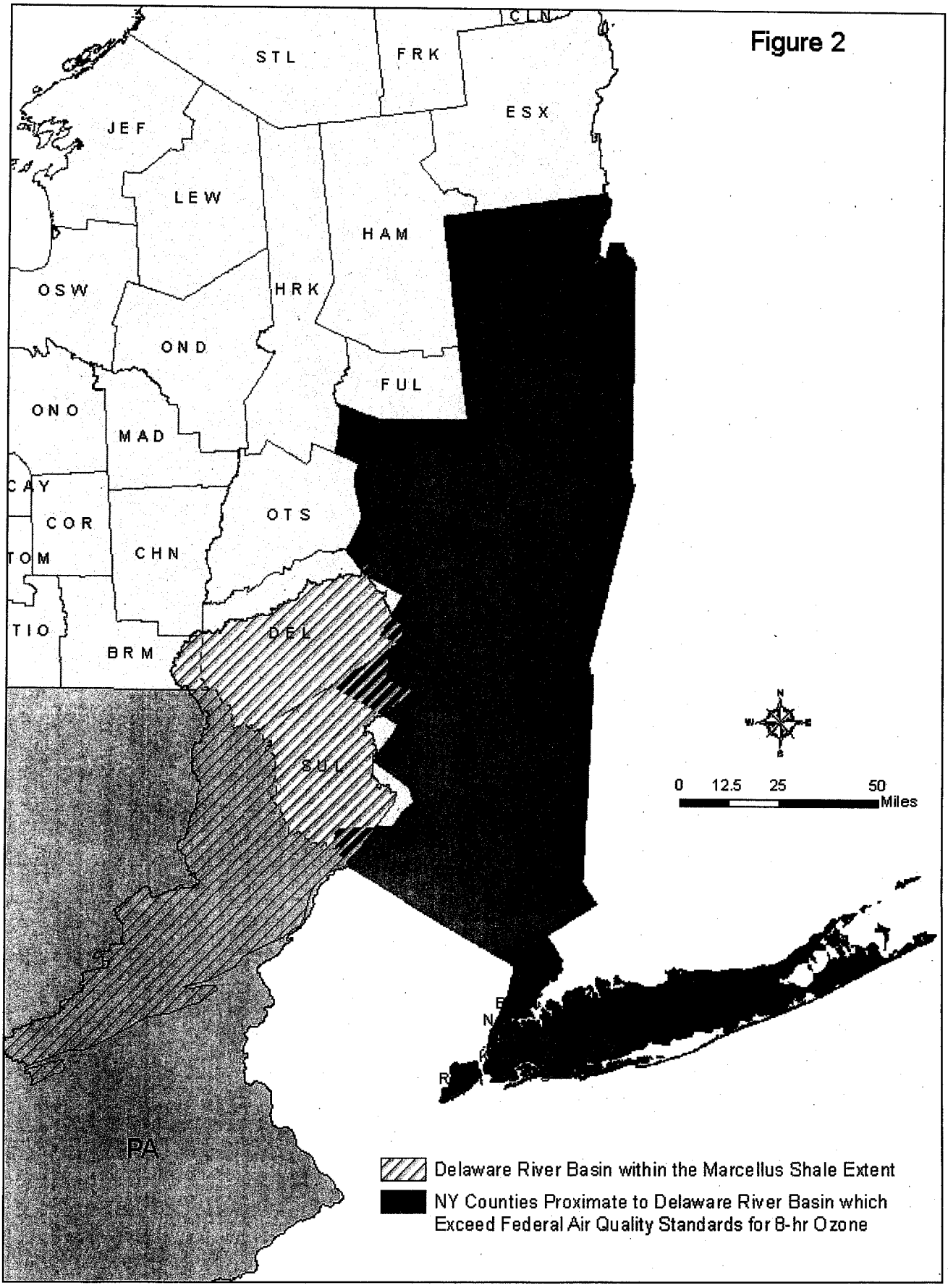

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Review of the Draft Supplemental Generic Environmental Impact Statement Concerning Natural Gas Development of the Marcellus Shale within the New York City Watershed

Prepared for the Watershed Inspector General,
Office of the Attorney General for the
State of New York

30 December 2009

ARCADIS

Jerry Koblitz
Senior Vice President

Review of the Draft Supplemental Generic Environmental Impact Statement Concerning Natural Gas Development of the Marcellus Shale within the New York City Watershed

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1. Introduction

The Watershed Inspector General, Office of the Attorney General (OAG) for the State of New York has contracted with ARCADIS U.S., Inc. (ARCADIS) to assist with review and comment on the draft Supplemental Generic Environmental Impact Statement (dSGEIS) concerning Natural Gas Development in the New Your City (NYC) Watershed. This document is currently open for the designated public comment period.

The scope of the ARCADIS review includes examination of the technical completeness of the assessment to determine potential environmental impacts associated with development of natural gas resources within the New York City water supply watershed.

This review includes the following sections that discuss ARCADIS' experience and expertise in oil and gas development projects, results of the review of the dSGEIS, and recommendations for further analyses.

2. ARCADIS' Experience and Expertise in Oil and Gas

ARCADIS is an international company providing consultancy, design, engineering, and management services in infrastructure, environment and buildings to enhance mobility, sustainability and quality of life. ARCADIS develops, designs, implements, maintains and operates projects for companies and governments. With more than 15,000 employees, the company has an extensive international network that is supported by strong local presence.

ARCADIS has a long history with our clients pursuing oil, gas, and mining opportunities in the United States and throughout the world. For oil, gas, and mining development, ARCADIS has prepared more than 50 environmental assessments (EAs) and environmental impact statement (EISs) for programmatic and individual project activities. As a result of this experience, ARCADIS can provide insight into development strategies, assessment of potential impacts that may result from development, and implementation of programs and projects with appropriate measures to lessen or eliminate potential impacts.

We have provided a variety of supporting assessments and analysis for issues potentially impacting various stages of development, including environment (e.g., ecology, air, water, and waste), water rights/availability/quality, cultural resources, socioeconomic, permitting and compliance support, sustainable development, and health and safety. The stages of development that have been assessed include exploration, field development, upgrading and processing alternatives, and restoration/ reclamation of facilities and disturbed areas. In addition, assessments have been made of associated infrastructure issues (e.g., well pads, surface transportation, pipelines, water sources and treatment, electrical power, etc).

ARCADIS has provided a multidisciplinary approach that engages a number of specialties, including the following:

- NEPA compliance
- Regulatory compliance and environmental management
- Permitting strategy and approval requirements
- Stakeholder engagement strategies and programs
- Ecological studies
- Ecological risk assessment
- Water resources
- Solid and wastewater engineering and management

- Air quality management
- Cultural resources
- Social and economic studies
- GIS/CADD

3. The Proposed Action

As noted in Chapter 1 of the dSGEIS, the Department of Environmental Conservation (DEC) has received applications for permits to drill horizontal wells to evaluate and develop the Marcellus Shale for natural gas production. The wells would undergo a stimulation process known as hydraulic fracturing, which functions to release gas embedded in shale deep below the surface. In addition, potential exists for development of the Utica Shale and other shale and low-permeability formations in New York using the same techniques, if the development of Marcellus Shale using these techniques is successful.

Chapter 2 of the dSGEIS describes the Proposed Action as "...the Department's issuance of permits to drill, deepen, plug back or convert wells for horizontal drilling and high-volume hydraulic fracturing in the Marcellus Shale and other low-permeability natural gas reservoirs." The primary target formations for this evaluation are the Marcellus Shale and Utica Shale. In addition, Chapter 2 notes that the "...SGEIS is focused on topics not addressed by the original GEIS, with emphasis on potential impacts associated with the large volumes of water required to hydraulically fracture horizontal shale wells using the slick water fracturing technique and the disturbance associated with multi-well sites." DEC will use the findings of this evaluation to determine the criteria and conditions for future approvals of permits for drilling and developing wells in these formations. Consequently, the dSGEIS (and GEIS as well) is a programmatic evaluation.

As a programmatic evaluation, we do not expect the dSGEIS to evaluate site-specific issues associated with individual development facilities. A variety of location-specific factors (e.g., soil type, watershed, habitat, vegetation, viewshed, and public sentiment) will vary considerably from site to site and county to county. In addition, the variations in project size and design will greatly determine the magnitude of the impacts from given projects. The combined effects of these location-specific and project-specific factors cannot be fully anticipated or addressed in a programmatic analysis; such effects must be evaluated at the project level. Thus, this dSGEIS should identify the range of potential impacts and relevant mitigation measures. Site-specific and species-specific issues will be addressed during individual project reviews. Individual project analyses, review, and approval may tier off of the dSGEIS but will not be supplanted by it.

4. Results of our Review of the Supplemental Generic Environmental Impact Statement

The description of the Proposed Action within the dSGEIS should be expanded for a more sufficient and effective impact analysis. The Proposed Action includes no scale of development, no rate of development, no potential distribution of wells, no estimate of overall potential disturbance, and only a limited description of ancillary facilities. There is little information on which to conduct an impact analysis, especially an evaluation of potential cumulative effects. For example, developing the Marcellus and Utica shales could be the greatest source of soil disturbance within the overlying watersheds in decades and the dSGEIS currently does not address it at an appropriate scale.

The West of Hudson (WOH) Watershed generally supplies 90 percent of NYC's drinking water. The dSGEIS concludes on page 6–42 that "degradation of New York City's drinking water supply as a result of surface spills is not a reasonably anticipated impact of the proposed activity." However, spills, leaks or breaches from pits, tanks, and impoundments can release contaminants. A reasonably foreseeable development (RFD) scenario can be used to project areas of surface disturbance, such as access roads, well sites, staging areas, pits, and impoundments, which can be affected by flood events where waters cover disturbed areas or erosion where surface runoff crosses disturbed areas. Surface waters can pick up contaminants from disturbed areas, affecting water quality downslope or downstream. Sedimentation of reservoirs or water courses can include the addition of phosphorous-rich soils to surface waters. The effectiveness of natural attenuation processes in soil and water and required setbacks from reservoirs or watercourses will be affected by the number, size, capacity, and location of the facilities anticipated in the RFD scenario, and the mitigating measures applied over the life of the RFD scenario. Further analysis of the effects and risks for the WOH Watershed should be documented in the dSGEIS.

One can readily assemble a scenario that suggests the Proposed Action would far exceed the current level of development and number of active natural gas wells in New York (the "baseline" number of wells), which is about 6,700 (as stated on page 2–4). For example, in Chapter 4, the dSGEIS notes that the Marcellus Shale covers approximately 18,700 square miles in New York (Section 4.4) and the Utica Shale covers approximately 28,500 square miles in New York (Section 4.3). The discussion in Section 5.1.3 suggests that under the scenario of horizontal wells with multiple wells drilled from common pads, 6 to 8 horizontal shale gas wells could access one square mile (640 acres). For example, if even just half of the Marcellus Shale is developed using 6 horizontal wells on a single well pad per square mile, the number of new wells developed would exceed 56,000. If between 5 and 10 percent of these wells are

developed in the WOH Watershed, there would be between 2,800 and 5,600 such wells. If one includes the additional wells for the Utica Shale (more than 85,000 with 50 percent development and 6 wells per square mile) and other low-permeability formations, the number of new natural gas wells would far exceed the number of current active natural gas wells.

When one considers the potential number of new wells, pads, miles of access roads, and other ancillary facilities that could be constructed in the various watersheds underlain by the formations, it becomes clear very quickly that the Proposed Action used in the dSGEIS and the discussion of its potential impacts requires further quantitative analysis.

The Proposed Action in the dSGEIS would benefit greatly from the development and use of the RFD scenario mentioned earlier. The use of such a scenario for NEPA analysis represents an accepted best practice in environmental decision making. All programmatic-level NEPA analyses that we have conducted recently have been based on the use of an RFD scenario. For example, we recently evaluated an RFD scenario that included the potential development of 40,000 new coal bed methane wells within an 8,000,000-acre project area over ten years. Input from the companies that had leases in the area and federal management personnel was used to develop all aspects of the scenario. The estimates used in an RFD scenario represent the professional judgments of company representatives, government regulators, and other professionals who are best informed regarding future plans for the area. Some estimates may be based on similar activities already ongoing in other areas.

When used as the foundation of a NEPA or New York State Environmental Quality Review Act (SEQRA) analysis, an RFD scenario provides the opportunity to analyze specific effects associated with the anticipated activities, allowing the description of the magnitude and intensity of the effects, rather than just a list of potential effects. An RFD scenario provides a programmatic projection of the anticipated level of development of the Marcellus Shale that can be effectively used to evaluate direct, indirect, and (especially) cumulative effects by watershed and develop appropriate alternatives to the Proposed Action.

Finally, we recommend that an alternative that eliminates potential natural gas development in the WOH Watershed be evaluated. The purpose of this alternative would be to address concerns about contamination of the water supply for millions of State residents. Use of an RFD scenario would readily facilitate the analysis of such an alternative and a comparison of the effects of this alternative with the Proposed Action.

This would include analysis of the economic effects of eliminating these watersheds from development.

Another alternative that we recommend be evaluated is staged development that delays drilling in the WOH Watershed for a period of time to allow full evaluation of the actual effects of development in other areas of the state. Again, use of an RFD scenario would readily facilitate the analysis of such an alternative and a comparison of the effects of this alternative with the Proposed Action.

4.1 The RFD Scenario

The potential RFD scenario for use in the dSGEIS would include a variety of components and levels of detail. We believe much of the information in the RFD scenario could come from the involved energy companies. Types of information commonly included in RFD scenarios for the development of natural gas are:

- Geographic or areal extent of the anticipated activities associated with the RFD scenario
- Planning horizons for anticipated activities
- Descriptions of anticipated activities (with input from the involved energy companies), including operating requirements of the energy companies and anticipated production rates
- Required management/regulatory constraints, mitigating measures, or performance standards for anticipated activities
- Type and quantity of surface disturbance for categories of anticipated activities, such as drill pads, roads, pipelines, injection wells, and other facilities
- Where possible, highlight key resources affected, such as surface and groundwater used, road surfacing and rock sources used, forested cover removed, water influence zones (wetlands, floodplains, watercourses, riparian and streamside areas) crossed, or sensitive soils disturbed
- Level and nature of human support activities needed for anticipated activities, including traffic changes in communities
- Contaminants (such as drilling or well stimulation additives), noise, emissions, sedimentation, and visual changes associated with anticipated activities
- Waste management and interim and final reclamation planned for anticipated activities

- Where possible, highlight available statistical risks for spills, explosions, human health problems, and traffic accidents associated with anticipated activities

We believe an RFD scenario can be developed with a reasonable level of effort and would return substantial dividends. The DEC should be able to work with companies in actively evaluating drilling in the Marcellus and Utica shales to develop an RFD scenario that could function as a programmatic projection of the anticipated level of development. In our experience, companies are willing to work with agencies in developing such a scenario when their information is kept confidential. Such work promotes both the quality and the expedition of environmental review. The DEC also could use information available from development activities in other locations, particularly in the Marcellus Shale in Pennsylvania, to guide preparation of the RFD scenario.

We have included an example of an RFD scenario for drilling in the Powder River Basin of Wyoming as Attachment 1 to this report.

4.1.1 Potential Components of a Marcellus Shale RFD Scenario

Extrapolating from other RFD scenarios with which we have worked, we have identified some potential components of an RFD scenario for development of gas from the Marcellus Shale in New York:

- Anticipated area of development (ideally should have geological rather than administrative limits);
- A starting point that represents existing development;
- Anticipated well spacing, including whether multi-well pads would be used;
- Estimated number of wells and supporting facilities over a 10 year planning horizon;
- Transportation and pipeline systems needed to support the RFD scenario;
- Intensity of construction and trucking activities associated with the RFD scenario;
- Facilities design factors for an anticipated drilling program and production period, with production rates estimated;
- There should be enough details provided about the well depth, rig size, pad size (incl. surfacing needs), road standards (width, turnouts, maximum gradient, surfacing needs), water supply for drilling and well stimulation, pipeline needs, etc., so that the surface disturbance and surface water/

groundwater impacts for the development anticipated over at least a 10-year planning horizon can be estimated and plotted to evaluate watershed and groundwater impacts. Details should allow some quantification and modeling of impacts;

- We recommend consideration of alternatives to the RFD scenario and other scenarios, such as no action, a prohibition on development in NYC's WOH Watershed, and staged development of the RFD scenario in areas outside the WOH Watershed combined with deferring development in WOH Watershed for years until monitoring results can provide assurance of negligible risk to the municipal water supply. These alternatives would preclude any adverse impacts associated with the RFD scenario in the WOH Watershed.

4.2 Comments on Specific Resource Areas

In addition to our recommendations that an RFD scenario be developed, we also have some comments on specific resource areas in the dSGEIS and how their analyses would be improved with an RFD scenario.

4.2.1 Water Resources

4.2.1.1 Affected Environment of the RFD Scenario

In order to analyze the potential effects of proposed activities on the WOH Watershed, it is necessary to have a good understanding of the proposed activities and the existing conditions for various resources. In order to perform an environmental impact analysis, it is necessary to know the starting point for conditions related to water resources within the WOH Watershed.

This baseline information is essential to any environmental impact analysis, whether programmatic, such as the dSGEIS, or site-specific, such as an analysis to consider a specific well pad. In a programmatic analysis baseline information will be less detailed than in a site-specific analysis. Baseline information presented in the dSGEIS is inadequate to evaluate the potential impacts on water-related resources.

A plan for the collection and compilation of baseline information on surface and groundwater resources should be developed. Baseline information should fully support the analysis. Baseline information should include surface and groundwater characteristics of potential water sources for proposed activities, including a comparison with the characteristics of surface waters used for municipal water supply in the WOH Watershed.

Supporting baseline information also will include data that extends beyond information that is strictly related to water resources. This will include information about the pattern of existing drilling activity in the WOH Watershed and data on existing surface disturbance in that watershed, soil types, erosion rates, forested cover, revegetation/reclamation potential, miles of roads in close proximity to watercourses and reservoirs, other developments in close proximity to watercourses and reservoirs, topography, areas not available for development, concerns regarding phosphorous and other pollutants of concern, and other relevant data.

The affected environment for water resources includes surface water resources and groundwater resources. The RFD scenario facilitates the opportunity to focus on specific aspects of the environment associated with the activities anticipated in the dSGEIS.

Surface water resources should be described by watershed, including lengths and descriptions of affected watercourses such as streams and rivers, existing watershed condition, geomorphic integrity, and sensitive soils. Perennial and intermittent streams, existing water quality and flows, stream channel/bank conditions and stability, natural flow characteristics, existing forested cover, reservoirs and lakes, designated uses, impaired water bodies, wetlands, floodplains, aquatic habitats, and existing water use would be described.

Groundwater resources should be described by water-bearing formation, focusing on groundwater quality, quantity, and use for each aquifer. Contributions to base flows of watercourses would also be described. Water use would identify the number, depth, target formation, beneficial use, flow, and quality of existing permitted water wells and similar information available for identified springs.

4.2.1.2 Anticipated Impacts on the Affected Environment of the RFD Scenario

The environmental effects on water resources include surface water resources and groundwater resources. The RFD scenario facilitates the opportunity to analyze the magnitude, intensity, and frequency of direct, indirect, and cumulative effects associated with the activities anticipated in the dSGEIS. It also facilitates writing mitigating measures as performance standards that can be analyzed for effectiveness, feasibility, and cost, and then subsequently monitored or enforced.

The environmental effects on surface and groundwater resources in the WOH Watershed should be described in more detail. The analysis should include the evaluation of the anticipated methodologies for proposed activities, full consideration of

the potential effects for the number of wells and other facilities proposed, analysis of risk to Filtration Avoidance and loss of public confidence in NYC's water, and thorough analysis of the effects related to phosphorous, turbidity, and pathogens. Potential discharges of phosphorous, turbidity, and pathogens must be explicitly evaluated because these contaminants are pollutants of concern for the WOH Watershed.

The anticipated direct and indirect environmental effects on surface water resources should be described by watershed, and should focus on stream health, watershed conditions, water quality and designated uses, surface water flows, anticipated surface water withdrawals, stormwater runoff and sedimentation, effect of flood events, and magnitude and intensity of potential effects associated with various water resource-related risks.

The anticipated direct and indirect environmental effects on groundwater resources should be described by water-bearing formation, focusing on groundwater quality, quantity, and consumptive use anticipated for each aquifer based on the RFD scenario. Effects on groundwater quality and quantity should be focused on the magnitude and intensity of potential effects associated with various water resource-related risks of the RFD scenario. Potential effects on contributions to base flows of watercourses and drawdown or other effects on existing permitted water wells should be described and modeled as necessary. Anticipated groundwater withdrawals for drilling and well stimulation should be described for an appropriate area of influence, such as a groundwater basin or other system. Groundwater effects also should be reported by watershed where appropriate.

4.2.1.3 Cumulative Effects of the RFD Scenario on Watersheds

The cumulative effects on surface and groundwater resources in the WOH Watershed should be described at greater length in an expanded analysis. An RFD scenario would facilitate the analysis of the water resource impacts by watershed from all past, present, and reasonably foreseeable activities in that watershed. For example, if a new housing development or road improvement project were proposed in the same watershed where Marcellus Shale development is anticipated, the cumulative effects of surface disturbance, cover removal, sedimentation, contaminants, water use, and other water resource impacts could be considered for the watershed, provided information on the other proposed developments is available.

4.2.2 Anticipated Economic Benefits and Risk of the RFD Scenario

Economic benefits of the RFD scenario include the gas produced, the jobs created and sustained directly by the anticipated activities and indirectly by increased services in

local communities, and the benefit to local businesses from the value of the goods supplied to RFD scenario activities. The economic benefits of the RFD scenario can be discussed in relation to water resource impacts associated with the RFD scenario, such as surface disturbance and removal of forested cover in watersheds, stormwater and sedimentation, water use, phosphorous in reservoirs, contaminants introduced, and possible spills. The potential economic cost of filtration/treatment of NYC's watershed resources or reduced consumption of WOH Watershed water also can be estimated and compared with economic benefits of the RFD scenario. Estimates of economic benefits of alternatives to the RFD scenario (such as no drilling in the WOH Watershed) can also be assessed to see if these benefits could be realized by drilling in other areas.

Any potential risk to Filtration Avoidance or loss of public confidence in NYC's water can be described based on anticipated potential changes to area watersheds. Any potential risks or losses to other non-priced resources, such as reservoir/lake/stream/ river-related tourism, can also be described, based on anticipated potential changes to area watersheds. Use of an RFD scenario would help put potential risks to scale, based on the number of wells and other facilities proposed in the WOH Watershed. The effects on these and other non-priced resources and values should be evaluated by a qualified natural resource economist.

Perspective on another shale gas play that could be useful in evaluating some of the potential economic benefits of Marcellus Shale development can be found in previous studies. These include statistics for the Barnett Shale development in Texas, found at http://www.rrc.state.tx.us/data/fielddata/barnettshale.pdf and Barnett Shale impact studies prepared by the Perryman Group (2007, 2009), found at http:// www.barnettshaleexpo.com/docs/Barnett_Shale_Impact_Study.pdf and http://www.barnettshaleexpo.com/docs/2009_eco_report.pdf (all accessed on December 4, 2009).

4.2.3 Anticipated Risks of the RFD Scenario

The RFD scenario facilitates the opportunity to analyze specific risks associated with the activities anticipated in the dSGEIS, allowing the description of the magnitude and intensity of the risks, rather than just a list of potential risks. Using an RFD scenario, the possible frequency of incidents can also be inferred using applicable oil and gas statistics from New York and other states, including ongoing shale gas developments.

Much of the need for a more in depth description of the risks to surface and groundwater resources is based on the potentially large number of wells and facilities

that could occur on WOH Watershed lands where development is not already prohibited. A thorough analysis, quantified to the extent possible, will put potential risks to scale, based on the number of wells and other facilities proposed in the WOH Watershed.

According to an article in the stargazette.com (2009), an independent researcher compiled 270 spill incidents related to past oil and gas activities in NY reported to DEC. A DEC official reportedly said that less than 300 instances out of more than 300,000 shows oil and gas issues are disproportionately small. However, an incident rate of one per thousand could yield dozens of incidents based on an RFD scenario that envisioned tens of thousands of wells being drilled.

Other incidents have not been reported to DEC. These other incidents have gone unreported because of the absence of systematic monitoring and sampling of surface waters and groundwater.

Incidents may be clustered in time and geographically. A news release from the Pennsylvania Department of Environmental Protection (2009) documents three separate spills in less than one week at the Cabot Oil and Gas Corp.'s Heitsman well in Dimock Township. About 8,000 gallons of a water/liquid gel mixture were lost during the spills, which polluted Stevens Creek and a nearby wetland. The company was subjected to a fine, required to cease hydraulic fracturing, and required to submit an updated preparedness, prevention and contingency plan and an engineering study. Activities have now been allowed to resume by the state.

Water resource related risks for the WOH Watershed that should be better described and analyzed in the dSGEIS include the following.

4.2.3.1 Loss of Integrity in Well Casings

Fluids can escape into surrounding underground formations, including aquifers or surface waters, if cracks or blowouts occur in well casing due to uncontrolled down-hole pressure during drilling, completion, or production activities. The integrity of a well can be vulnerable during the installation of surface casing, especially if shallow gas migration is an issue in the area. Under certain conditions, gas can migrate along fractures in bedrock and through permeable soils and groundwater aquifers.

An incident in Wyoming involving a blowout (sudden breakage) in the surface casing of Windsor Energy's Crosby 25-3 well contaminated shallow groundwater. This incident is recounted by the Wyoming Outdoor Council (2009) at <http://

wyomingoutdoorcouncil.org/html/what_we_do/public_lands/shoshone.shtml> as accessed on December 2, 2009. A well blowout in August 2006 along Line Creek in Clark, Wyoming contaminated groundwater aquifers and caused an emergency evacuation of the town of Clark. Windsor Energy has undertaken a voluntary remediation program with the Wyoming Department of Environmental Quality, but many local residents are not satisfied with the adequacy of these efforts and still fear for the safety of their drinking water.

In addition, the dSGEIS discusses the possible use of drilling rigs of varying sizes for the drilling of wells. The relative effectiveness of setting casing, controlling down-hole pressure, and the relative risk of a blowout causing surface or groundwater contamination, should be analyzed for each type of drilling rig that could be used.

4.2.3.2 Loss of Circulation in Uncased Portions of Wells

Drilling fluids can be lost into surrounding underground formations, including aquifers, if cracks, joints, or cavities in the uncased portion of the hole are encountered during drilling. Groundwater could be contaminated during this loss of circulation.

4.2.3.3 Reduced Surface Water Flows due to Water Use

The withdrawal of surface water from watercourses, reservoirs, or springs that contribute to base flow for use in drilling or well stimulation (hydraulic fracturing) could cause a reduction in surface flows if excessive withdrawals or withdrawals during low flows are made. Analysis of an RFD scenario by watershed, considering a likely development scenario (including water needs for drilling and well stimulation, estimated number and length of horizontal wells), would provide for improved analysis of the effects on surface flows from water withdrawals.

4.2.3.4 Contamination of Surface Waters by Breaches or Leaks in Pits, Tanks, or Impoundments Containing Source Water, Drilling Fluids, Well Stimulation (Hydraulic Fracturing) Fluids, or Produced Fluids

Risks of a variety of potential sources of surface water contamination, such as reserve pits containing drilling fluids and cuttings used during drilling, flow back tanks containing fluids used in hydraulic fracturing that are returned to the surface after use, mixing tanks for hydraulic fracturing fluids, onsite chemical storage tanks, production tanks containing produced fluids (brines) and possibly concentrations of naturally occurring radioactive material (NORM), and large impoundments that hold source water for drilling should be analyzed by watershed or basin, based on an RFD scenario. Analysis of risk using this scenario will allow a better projection of the magnitude, intensity and frequency of the risks involved.

Source water contained in impoundments prior to use may have different characteristics than municipal supply water. Any leakage or release of source water could introduce constituents that would alter the quality of the municipal water supply.

4.2.3.5 Contamination of Surface Waters by Spill Events Involving Truck Accidents

The risk of truck accidents involving the spills of non-potable water used for drilling or hydraulic fracturing, drilling fluids removed from reserve pits, hydraulic fracturing fluids, production fluids, or chemicals being transported to or from the well pad should be analyzed by watershed or basin, based on an RFD scenario. Analysis of risk based on an RFD scenario and applicable statistics from NY and other areas will allow a better projection of the magnitude, intensity, and frequency of the risks involved.

4.2.3.6 Contamination of Surface Waters by Stormwater Runoff and Sedimentation or Flood Events Affecting Well Sites, Pits, or Impoundments; Well Field Roads; or Other Facilities

Areas of surface disturbance, such as access roads, well sites, staging areas, pits, and impoundments can be affected by erosion where surface runoff crosses disturbed areas. Stormwater runoff crossing disturbed areas can pick up contaminants from disturbed areas (including phosphorous-rich soils), adversely impacting water quality downslope or downstream of the disturbed areas. Increases in turbidity and sedimentation of reservoirs or water courses that are downslope of the disturbed areas can be caused by the erosion of disturbed areas.

Areas of surface disturbance can also be affected by flood events where surface flows erode and scour disturbed areas and pits and impoundments are breached or slope failures occur, likely releasing contaminants to flood waters and affecting water quality downslope or downstream of the disturbed areas. Sedimentation of reservoirs or water courses that are downslope of the disturbed areas can also be caused by flood waters covering disturbed areas. Sedimentation can include the addition of phosphorous-rich soils to surface waters along with other contaminants.

The risk of reduced surface water quality and sedimentation caused by stormwater runoff crossing areas of surface disturbance or flood events should be analyzed by watershed or basin, based on an RFD scenario. Analysis of risk based on this scenario will allow a better projection of the magnitude, intensity, and frequency of the risks involved.

4.2.3.7 Contamination of Surface Water and Groundwater by Naturally Occurring Radioactive Material (NORM)

NORM can be brought to the surface in drill cuttings, flowback, or produced water, and can reach the surface along with the shale gas. Over time, NORM can become concentrated in sludge and sediment inside production tanks.

The risk of surface water and groundwater contamination by leakage of NORM that could be concentrated in flowback tanks or production tanks containing flowback and produced fluids (brines), respectively, should be analyzed by watershed or basin, based on an RFD scenario. Analysis of risk based on this scenario will allow a better description of the magnitude, intensity, and frequency of the risks involved.

4.2.3.8 Contamination of Surface Water and Groundwater by Gas and Fluid Migration Caused by Drilling, Well Stimulation Processes, or Injection of Wastewater

Under certain conditions, gas and fluids can migrate along fractures in bedrock and through permeable soils and groundwater aquifers. Naturally occurring joints or cracks in underground formations or joints or cracks induced by drilling, well stimulation processes, or injection of wastewater could serve as pathways for the movement of gas, fluids, or contaminants into near surface formations, where they could mix with groundwater and enter existing water wells or springs, reach water transport tunnels for the WOH Watershed, or mix with surface waters in reservoirs or watercourses. The gas can build up in nearby water wells or tunnels to levels where an explosion could occur. Analysis of risk based on an RFD scenario and applicable statistics from New York and other areas will allow a better projection of the magnitude, intensity, and frequency of the risks involved.

4.2.3.9 Contamination of Groundwater by Breaches or Leaks in Pits, Tanks, Wells or Impoundments Containing Source Water, Drilling Fluids, Well Stimulation Fluids, or Produced Fluids

Drilling, completion, or production fluids can escape into underground formations, including aquifers, if cracks or joints occur in underground formations. Analysis of risk based on an RFD scenario and applicable statistics from NY and other areas will allow a better projection of the magnitude, intensity, and frequency of the risks involved.

4.2.3.10 Drawdown of Groundwater Aquifers from Water Use

The withdrawal of groundwater from underground aquifers for use in drilling or well stimulation (hydraulic fracturing) could cause a reduction in groundwater availability if excessive withdrawals are made. Existing water wells completed in affected aquifers could experience drawdown of the water level. Analysis of an RFD scenario by groundwater basin or system, considering a likely development scenario (including

water needs for drilling, number, location, and depth of wells to be drilled for source water and well stimulation, estimated number and depth of vertical gas wells, estimated number and length of horizontal gas wells), would provide for improved analysis (and modeling where necessary) of the projected effects on groundwater from water withdrawals.

4.2.3.11 Potential Need for Filtration/Treatment of NYC's West of Hudson (WOH) Watershed Resources (conflict with the filtration avoidance determination) Due to Water Resource Impacts

Surface water impacts should be analyzed for the WOH Watershed based on an RFD scenario. Analysis based on an RFD scenario will allow a better projection of the magnitude, intensity, and frequency of the risks and effects involved, rather than just a quantitative list of potential risks and effects.

There is an apparent contradiction between pages 2–22 and 7–63 of the dSGEIS, where more than 1,000 square miles of the WOH Watershed appear to be available for development under an RFD scenario, but "review of the existing authorities relative to both water resources in general and the New York City Watershed in particular indicates that the City's water supply is adequately protected..."

As discussed in Section 4 above, the dSGEIS concluded that "degradation of New York City's drinking water supply as a result of surface spills is not a reasonably anticipated impact of the proposed activity." In doing so, however, it did not take into account the potential for breaches, discharges, spills, or leaks of pollutants regulated by the Filtration Avoidance Determination and the Safe Drinking Water Act, including turbidity and pathogens. Nor did it evaluate the effectiveness of proposed mitigation measures in light of the number, size, capacity, and location of drilling related facilities that could be anticipated in an RFD scenario. Further analysis of the effects and risks for the WOH Watershed relating to Filtration Avoidance should be conducted.

4.2.3.12 Effects on Aquatic Habitats Associated with RFD Scenario

The risk of changes in surface flows, surface water quality and sedimentation caused by water resource-related risks should be analyzed by watershed or basin, reservoir, watercourse, or other appropriate ecosystem, based on an RFD scenario and mitigating measures applied. Analysis of risk based on an RFD scenario will allow a better projection of the magnitude, intensity, and likelihood of the risks involved. Examples of risks that could be evaluated include releases of sediment from well pads and roads into streams that currently support fisheries and increases of turbidity in streams and reservoirs that service as municipal water supplies. A breach of an

impoundment could release water of differing temperature and pH into surface waters. These types of releases could have a detrimental effect on macroinvertebrates and fisheries, especially cold water fisheries such as trout fisheries.

4.2.3.13 Release of Oil and Gas Operations Wastewater Treated at Existing Wastewater Treatment Facilities into Surface Waters

Wastewater from oil and gas operations treated at existing wastewater treatment facilities is likely to have greater salts and dissolved solids than existing surface flows, as acknowledged by the dSGEIS on page 6–39: "Treatability of flowback water is a further concern. Residual fracturing chemicals and naturally occurring constituents from the rock formation could be present in flowback water and have treatment, sludge disposal, and receiving-water impacts. Salts and dissolved solids may not be sufficiently treated by municipal biological treatment and/or other treatment technologies which are not designed to remove pollutants of this nature."

4.3 Mitigating Measures

A mitigating measure is an operating requirement for a proposed activity used to reduce, eliminate, or avoid specific environmental effects that could occur without the measure. Feasibility, cost (as it effects the economics of the proposed activity), and effectiveness in reducing, eliminating, or avoiding impacts should be analyzed for mitigating measures. It will be possible to analyze a mitigating measure if it is written specifically enough, with details on how the activity would be performed.

For the most part, mitigating measures described in the dSGEIS do not contain details or contain only isolated details on how the proposed activity would be performed using the mitigating measure. Mitigating measures typically are written as performance standards that could be analyzed, and subsequently monitored or enforced, but they generally are not in the dSGEIS.

An RFD scenario is essential for the quantitative assessment of the effectiveness of mitigating measures in reducing risks. A thorough analysis, quantified to the extent possible and based on an RFD scenario, will put potential effectiveness of mitigating measures to scale, based on the number of wells and other facilities proposed in the WOH Watershed.

Pages 7–63 and 7–64 describe mitigating measures that would be applied in the WOH Watershed. Setbacks and procedures proposed in this Supplement, along with supplementary permit conditions for high-volume hydraulic fracturing will provide protection to surface water and ground water statewide. Proposed enhanced

procedures and requirements specifically applicable to the New York City Watershed include:

- "Prohibition against centralized flowback water surface impoundments within the boundaries of the New York City Watershed (Section 7.1.7),
- Requirement in an unfiltered watershed to remove fluids from any reserve pit or on-site (i.e., well pad) tanks within seven days of completing drilling and stimulation operations at the last well on the pad, or immediately if operations are suspended and the site will be left unattended (Section 7.1.3.2) , and
- Site-specific SEQRA determination for any proposed well pad within 300 feet of a reservoir, reservoir stem or controlled lake or within 150 feet of a watercourse (Section 7.1.12.2).
- To the extent practical, operators should place any blending unit with a mixing hopper used for fracturing operations at least 500 feet from reservoir, reservoir stem or controlled lake and 100 feet from a watercourse or state-regulated wetland in the New York City Watershed, in consideration of Section 18-32(b) of NYC's Watershed Rules and Regulations relative to process tanks."

The above mitigating measures that would be applied within the WOH Watershed represent a good starting point for the protection of NYC's municipal water supply, but are not comprehensive.

The effectiveness of setbacks from reservoirs and watercourses or other siting constraints (and the risk of locating pits, tanks, impoundments or other facilities near reservoirs or watercourses) will be affected by the size, capacity, and location of the facilities, and the mitigating measures applied to them.

Potential water resource-related mitigating measures that should be considered include use of a closed loop system for drilling, extensive requirements for secondary means of containment for fluids, a prohibition on land disposal or burial of cuttings unless advanced technology or a specific study indicates it is the preferred methodology, a network of surface water monitoring stations, a network of groundwater monitor wells, monitoring of nearby water wells, rigorous monitoring of stormwater pollution prevention measures, reclamation monitoring of disturbed areas, control of road alignments/standards and traffic to minimize accidents, and rigorous control and monitoring of construction activities to minimize erosion and sedimentation, and preventing drilling in locations of greater concern (e.g., near surface waters, on steep slopes, etc.).