New York State Office of the Attorney General

See attached comments supporting a prohibition on high volume hydraulic fracturing in the Delaware River Basin, including exhibits A, B1, B2, and C.

STATE OF NEW YORK
OFFICE OF THE ATTORNEY GENERAL

ERIC T. SCHNEIDERMAN
ATTORNEY GENERAL

DIVISION OF SOCIAL JUSTICE
ENVIRONMENTAL PROTECTION BUREAU

Comments of the New York State Attorney General's Office on the Proposed Regulation of the Delaware River Basin Commission to Prohibit High Volume Horizontal Hydrofracking in the Basin

March 30, 2018

The New York Attorney General's Office respectfully submits these comments in support of the proposed rule of the Delaware River Basin Commission (Commission) to prohibit high volume hydraulic fracturing (hydrofracking)[1] for natural gas in shale and other rock formations in the Delaware River Basin. The Attorney General supports the proposed rule because hydrofracking poses an unwarranted risk of harm to the environment and public health of New York and to that of the Basin as a whole.

I. Summary

In December 2010, the Commission published proposed regulations that would allow hydrofracking within the Basin subject to various conditions. It did so without preparing an environmental impact statement (EIS) to study the potential adverse impacts to the environment and public health. In May 2011, the New York State Attorney General brought suit in federal district court on behalf of the State to compel the Commission to prepare an EIS under the National Environmental Policy Act, 42 U.S.C. § 4321 *et seq.*, to address those potential impacts. The court dismissed the lawsuit as premature because the proposed regulations had not yet been finalized. *State of New York v. Army Corps of Engineers,* 896 F. Supp.2d 180 (E.D.N.Y. 2012).

Subsequently, the New York State Department of Environmental Conservation (NYDEC or the Department), with the assistance of the New York State Health Department (NYDOH), completed its own comprehensive environmental review under the New York State Environmental Quality Act, New York Environmental Conservation Law, article 8 (SEQRA) for potential impacts from hydrofracking to New York State and its resources. NYDEC determined

[1] *See* "Proposed Amendments to the Administrative Manual and Special Regulations Regarding Hydraulic Fracturing Activities; Additional Clarifying Amendments," Delaware River Basin Commission, November 17, 2018, at http://www.state.nj.us/drbc/programs/natural/. For simplicity, we use the term "hydrofracking" to describe the activity DRBC proposes to prohibit, even though at times the term is used to encompass vertical hydraulic fracturing which is not within the scope of the proposed ban. Vertical hydrofracking is a long-used and well-understood technology with a far smaller potential for adverse effects than high volume hydraulic fracturing, which entails extracting natural gas by using high volumes of fracking fluids and drilling horizontally over long distances.

that "authorizing high-volume hydraulic fracturing under any scenario would not adequately mitigate adverse impacts to ecosystems and wildlife, air and water resources, community character and public health and would likely have diminished economic and social benefits." Final Supplemental Generic EIS on the Oil, Gas and Solution Mining Regulatory Program (FSGEIS), Findings Statement, June 2015, p. 34, attached as Exhibit A. Accordingly, the Department prohibited hydrofracking everywhere in New York. *Id.*, p. 42. As discussed below, we believe that the Commission should follow the lead of New York and prohibit hydrofracking in the portion of the Delaware River Basin outside of New York.

II. Risks of Adverse Impacts to New York's Water Related Interests in the Upper Delaware River, and to the State's Air Quality Human Health

In its lawsuit, the State submitted unrebutted factual and expert declarations showing the following:[2]

A. Water-Related Impacts

The Delaware River Basin covers over 13,500 square miles and drains portions of four states (New York, New Jersey, Delaware, and Pennsylvania). The basin supplies drinking water to 15 million people, which includes 9 million New Yorkers each day. It also includes the beautiful and pristine Upper Delaware River, designated by the federal government as a "Scenic and Recreational River."

New York has significant interests in the environmental resources of the New York portion of the Basin, including the water of the Delaware River; the eagles, mussels and other wildlife that live in or near the river which are owned by the State; and State boat launches, fishing access points, eagle observation areas, wildlife preserves, and roads near the River. The State also has interests in the air, water, wildlife, and scenic vistas in the New York portion of the Basin. These resources and interests would be at risk if hydrofracking is not prohibited in the portion of the Basin outside of New York just as they are prohibited in the portion within the State.

Hydrofracking has the potential to result in development of thousands of natural gas wells within the Basin in Pennsylvania. This would have the potential to cause significant adverse environmental and human health impacts. Among other things, natural gas development employing hydrofracking poses a significant risk of water pollution. Gas extraction using hydrofracking produces large quantities of wastewater – as much as several million gallons from an individual well. The wastewater is contaminated with toxic metals, radioactive substances and dissolved solids. There have been repeated spills or other discharges of wastewater to surface waters and groundwater over the past few years in parts of Pennsylvania outside the Basin.

[2] The declarations, attached as Exhibits B1 and B2, were authored by Dr. Charles Silver (Attorney General's Office), William Rudge (NYDEC), Dr. Lyle Chinkin (Sonoma Technology, Inc.), and Dr. Joel Schwartz (Harvard Medical School).

Pennsylvania issued over 1,600 environmental violations to drilling operators in 2008-2010.[3] Some of these violations have been very serious, including discharges of wastewater that contaminated miles of the Monongahela River, rendering that important drinking water source not potable for several months.

Pollution of New York's portion of the Upper Delaware River could threaten the survival of aquatic organisms, such as the endangered dwarf wedgemussel, trout, and other wildlife that rely on food or water from the River, including the bald eagle. Pollution could also reduce New Yorkers' usage of State-owned facilities that the State makes available to the public for recreation on the River, including boat launches, fishing access points, eagle observation areas, and wildlife preserves. In addition to the water pollution, the installation of drilling rigs and other equipment on the Pennsylvania side of the Upper Delaware River threatens to degrade the scenic vistas viewed from New York, including from New York's scenic byway that snakes along that river.

B. Air Quality and Human Health

Many areas in New York suffer from high ozone levels. In particular, the New York City metropolitan area exceeds the current national air quality limit for ozone. Ozone is an air pollutant that harms human health in many ways. For example, breathing ozone can trigger chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema, and asthma and reduce lung function and inflame the linings of the lungs. Repeated exposure may permanently scar lung tissue. As a result, ozone causes premature mortality and results in increased emergency room visits and hospitalizations. Increases in ozone produce increases in these medical conditions and related costs.

In general, ozone is not directly emitted from pollution sources, but instead forms in the air when various types of nitrogen oxides ("NO_x") react with sunlight and certain hydrocarbons, known as volatile organic compounds. The source of the NO_x that produces ozone in the atmosphere is predominantly the combustion of fossil fuels, including the diesel fuel used in on- and off-road vehicles and equipment such as drilling rigs and hydraulic fracturing pumps.

Gas drilling and production activities using hydrofracking in the Pennsylvania portion of the Basin would increase emissions of NO_x, thereby producing more ozone able to travel significant distances across state lines. According to projections, during the peak-year of drilling, annual emissions are expected to increase by 870 to 12,420 tons, while during an average year annual emissions would increase by about two-thirds of those amounts. With a high degree of certainty, these increases in NO_x emissions would reach New York and increase ozone levels in the State, and in particular in the New York City metropolitan area and other counties near Pennsylvania, such as Orange County. The increased ozone in New York would likely cause increases in respiratory illness and premature mortality among New Yorkers. This would

[3] These problems have continued. Between 2008 and September of 2016, natural gas developers employing hydrofracking in Pennsylvania were cited for 4,351 environmental violations in that state. "Fracking Failures 2017: Oil and Gas Industry Environmental Violations in Pennsylvania," released March 28, 2017, Frontier Group, at https://frontiergroup.org/reports/fg/fracking-failures-2017.

increase emergency room visits and hospitalizations, including for individuals covered by Medicaid, so that New York's Medicaid expenditures would increase as well.

III. NYDEC Has Prohibited Hydrofracking in New York Because of its Risks of Harm to the Environment and Human Health

NYDEC has studied hydrofracking in the context of its SEQRA review and concluded in June 2015 that it would ban hydrofracking in New York. Exh. A, p. 42. In 1992, the Department issued a Generic EIS on the Oil, Gas and Solution Mining Regulatory Program, which addressed vertical gas drilling and hydraulic fracturing. But, because the technology for high volume hydrofracking had not yet been developed NYDEC did not address it. When hydrofracking was proposed for New York, NYDEC studied the environmental issues associated with this new technology, releasing a Draft Supplemental Generic EIS in 2009 and a revised draft in 2011.

At NYDEC's request, NYDOH conducted a review to determine whether proposed mitigation measures were adequate to protect public health. FSGEIS, Executive Summary, p. 2, attached as Exhibit C. In December 2014, NYDOH identified several potential adverse public health and environmental impacts that can result from hydrofracking used in the development of natural gas. These included: drinking water impacts from underground migration of methane and/or fracturing fluid chemicals associated with faulty well construction or seismic activity; surface spills potentially resulting in surface water, groundwater, and soil contamination; surface water contamination resulting from inadequate wastewater treatment; air impacts that could affect respiratory health due to increased levels of particulate matter, diesel exhaust, or volatile organic chemicals; and climate change impacts due to methane and other volatile organic chemical releases to the atmosphere. *Id.; see* "A Public Health Review of High Volume Hydraulic Fracturing for Shale Gas Development, NYSOH (December 2014), at https://www.health.ny.gov/press/reports/docs/high_volume_hydraulic_fracturing.pdf. NYDOH advised NYDEC that hydrofracking should not be permitted in New York "until the science provides sufficient information to determine the level of risk to public health . . . and whether the risks can be adequately managed." *Id.*

After receiving thousands of comments from academia, industry, municipalities, environmental organizations, and the general public, and following completion of NYDOH's review, in June 2015 NYDEC released the FSGEIS and its findings concerning hydrofracking. NYDEC determined that "there are no feasible or prudent alternatives that would adequately avoid or minimize adverse environmental impacts and that address the scientific uncertainties and risks to public health" from hydrofracking, and prohibited use of the technology in New York. Exh. C, p. 42.

IV. Conclusion

The proposed prohibition against hydrofracking in the Basin should be adopted by the Commission. As discussed above, there is ample evidence that hydrofracking there would harm the environmental, public health, and related interests of New York and of the Basin as a whole.

Respectfully submitted,

Philip Bein

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Exhibit A to
New York Attorney General's
Comments dated March 30, 2018

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

FINAL SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT

ON THE OIL, GAS AND SOLUTION MINING REGULATORY PROGRAM

Regulatory Program for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs

FINDINGS STATEMENT

June 2015

LEAD AGENCY: NYSDEC

LEAD AGENCY CONTACT: EUGENE J. LEFF
Deputy Commissioner of Remediation & Materials Management

NYSDEC, 625 Broadway, 14th Floor
Albany, NY 12233
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Pursuant to Article 8 of the Environmental Conservation Law, the State Environmental Quality Review Act (SEQRA), and its implementing regulations set forth at 6 NYCRR Part 617, the New York State Department of Environmental Conservation makes the following findings:

Lead Agency:	New York State Department of Environmental Conservation
Address:	Central Office, 625 Broadway, Albany, NY 12233
Name of Action:	Regulatory Program for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs
Description of Action:	High-volume hydraulic fracturing, which is often used in conjunction with horizontal drilling and multi-well pad development, is an approach to extracting natural gas that raises new and significant adverse impacts not studied in 1992 in the NYSDEC's previous Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program (GEIS). DEC prepared a Supplemental Generic Environmental Impact Statement (SGEIS) to satisfy the requirements of SEQRA by studying the high-volume hydraulic fracturing technique, identifying significant adverse impacts for these anticipated operations that were not identified in the GEIS, and identifying mitigation measures to minimize adverse environmental impacts. The SGEIS was therefore used in considering if and under what conditions high-volume hydraulic fracturing should be allowed in New York State.
Location:	Statewide
Date SGEIS filed:	May 13, 2015

I. INTRODUCTION

Pursuant to the State Environmental Quality Review Act (SEQRA) and its implementing regulations, and as mandated by Executive Order 41, this Findings Statement constitutes the findings of the New York State Department of Environmental Conservation (Department or DEC) with respect to whether permits to drill, deepen, plug back or convert wells that use high-volume hydraulic fracturing to develop natural gas resources in the Marcellus Shale and other low-permeability gas reservoirs should be authorized in New York State. This Findings Statement draws upon information in the Supplemental Generic Environmental Impact Statement (SGEIS or Final SGEIS) issued by the Department on May 13, 2015, and documents encompassed in the FSGEIS, including the extensive public comments and the Department's Response to Comments, the revised draft SGEIS prepared in September 2011 (rdSGEIS), the draft SGEIS prepared in September 2009 (dSGEIS), and the 1992 Generic Environmental Impact Statement (1992 GEIS) on the Department's Oil, Gas, and Solution Mining Regulatory Program.

A. Background and Description of Action

High-volume hydraulic fracturing utilizes a well stimulation technique that has greatly increased the ability to extract natural gas from very tight rock.[1] There are several distinct phases associated with well development that uses high-volume hydraulic fracturing. They are: 1) the construction phase, which consists of land disturbance and clearing of trees and other lands to

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[1] High-volume hydraulic fracturing is defined as the stimulation of a well using 300,000 or more gallons of water as the base fluid for hydraulic fracturing for all stages in a well completion, regardless of whether the well is vertical or directional, including horizontal. The 300,000-gallon threshold is the sum of all water, fresh and recycled, used for all stages in a well completion. Well stimulation requiring less than 300,000 gallons of water as the base fluid for hydraulic fracturing for all stages in a well completion is not considered high-volume, and will continue to be reviewed and permitted pursuant to the 1992 GEIS, and 1992 and 1993 Findings Statements. Wells using less than 300,000 gallons of water for hydraulic fracturing per completion do not have the same magnitude of impacts. Indeed, wells hydraulically fractured with less water are generally associated with smaller well pads and many fewer truck trips, and do not trigger the same potential water sourcing and disposal impacts as high-volume hydraulically fractured wells. The 300,000-gallon threshold also applies if a re-completion of an existing well involves hydraulic fracturing using 300,000 gallons or more of water for the re-completion. The 300,000-gallon threshold is calculated based on all stages per well completion or well re-completion, not cumulative use for separate completions or re-completions.

construct well pads, access roads, and other supporting infrastructure; 2) the drilling phase, which consists of the operation of heavy machinery to drill wells typically 4,000 feet in length, producing significant quantities of drill cuttings; 3) the hydraulic fracturing and completion phase, which consists of a well stimulation technique involving the pumping of a mixture of water and chemical additives, some of which potentially pose hazards to public health and the environment, down a well bore at high pressure, followed by the "flowback" of fluids and natural gas; 4) the production phase, which consists of removal of drilling and well completion equipment, partial reclamation of the well pad, and installation of equipment at the wellhead to capture natural gas and transmit the gas to compressor stations, gathering lines, and ultimately the end user; and 5) the reclamation phase, which occurs when the well or wells at the pad are no longer producing natural gas, the well is plugged and closed, and restoration of the disturbed area is implemented.

High-volume hydraulic fracturing, which is often used in conjunction with horizontal drilling and multi-well pad development, raises new, potentially significant, adverse impacts that were not studied in the 1992 GEIS.[2] High-volume hydraulic fracturing is distinct from other methods of well completion that have been allowed in the State under the 1992 GEIS and Department permits due to the much larger volumes of water used to conduct hydraulic fracturing operations. When using high-volume hydraulic fracturing with horizontal well drilling, a number of wells are drilled from a single well pad (a multi-well pad). Although horizontal drilling has the potential to result in fewer well pads than traditional vertical well drilling, pads where high-volume hydraulic fracturing would be employed are larger and the industrial activity associated with high-volume hydraulic fracturing on the pads would be more intense. Indeed, the average disturbance associated with a multi-well pad, access road and proportionate infrastructure during the drilling and fracturing stage is estimated at 7.4 acres, compared to the average disturbance associated with a well pad for a single vertical well during the drilling and fracturing stage, which is estimated at 4.8 acres. Horizontal drilling also facilitates natural gas extraction from many areas where conventional natural gas extraction had been commercially unprofitable. Therefore, drilling, well construction and well operation would likely be widespread in certain

[2] The 1992 GEIS is posted on the Department's website at http://www.dec.ny.gov/energy/45912.html. The 1992 GEIS includes an analysis of impacts from well drilling as well as hydraulic fracturing. Since 1992 the Department has used the 1992 GEIS as the basis of its SEQRA review for permit applications for gas drilling in New York State.

regions of the State and would impact areas that have previously not been subject to significant oil and gas development. Also, high-volume hydraulic fracturing requires significantly more water, and chemical additives, which may pose public health hazards through potential exposure. The high volumes of fracturing liquids associated with this type of well completion raise concerns about potential significant adverse impacts to water supplies, wastewater treatment and disposal and truck traffic. Horizontal wells also generate greater volumes of drilling waste (cuttings) than vertical wells drilled to the same target formation. In addition, development of low-permeability reservoirs using high-volume hydraulic fracturing has the potential to industrialize rural areas of New York. Industry projections of the level of drilling, as reflected in the intense development activity in neighboring Pennsylvania, have raised additional concerns relating to air quality, truck traffic, noise, habitat, cultural, historic and natural resources, agriculture, community character and socioeconomics.

In New York, the primary target for shale-gas development is currently the Marcellus Shale, with the deeper Utica Shale also identified as a potential resource. Additional low-permeability reservoirs may be considered in the future by project sponsors for development by high-volume hydraulic fracturing.

The purpose of the SGEIS process for high-volume hydraulic fracturing was to assess the potential environmental impacts created by this process of extracting natural gas. Once the potential impacts are assessed, the Department also must evaluate whether mitigation measures can eliminate or reduce significant adverse environmental impacts to the maximum extent practicable, and if so, whether measures should be imposed consistent with SEQRA and the Environmental Conservation Law (ECL).[3] The Department must conclude that a high-volume hydraulic fracturing permitting program is consistent with the Department's mission as laid out in Article 1 of the ECL to "conserve, improve, and protect its natural resources and environment and to prevent, abate and control water, land and air pollution, in order to enhance the health, safety and welfare of the people of the state and their overall economic and social well being."[4] Additionally, the Department's regulatory role related to mineral resources is described in

[3] See Article 8 of the ECL and 6 NYCRR Part 617

[4] ECL § 1-0101(1)

Article 23 of the Environmental Conservation Law where the legislature declared it "to be in the public interest to regulate the development, production, and utilization of natural resources of oil and gas in this state in such a manner as will prevent waste…."[5]

As explained in detail below, the Department has determined that there are potential significant adverse environmental and public health impacts associated with high-volume hydraulic fracturing operations. Even with the implementation of an extensive suite of mitigation measures considered by the Department and described in these findings, the significant adverse public health and environmental impacts from allowing high-volume hydraulic fracturing to proceed under any scenario cannot be adequately avoided or minimized to the maximum extent practicable in accordance with SEQRA. In addition, as further described below, significant uncertainty remains regarding the level of risk to public health and the environment that would result from permitting high-volume hydraulic fracturing in New York, and regarding the degree of effectiveness of proposed mitigation measures. Consequently, and due to the limited economic and social benefits that would be derived from high-volume hydraulic fracturing, the No-Action alternative is the only reasonable alternative consistent with social, economic and other essential considerations. The Department is therefore selecting the No-Action alternative. These findings will apply statewide.

B. Procedural History

In 2008, the Department determined that some aspects of the current and anticipated application of high-volume hydraulic fracturing warranted further review under SEQRA. The Department commenced a public process to develop the SGEIS with public scoping sessions in the autumn of 2008.

February 2009 Final Scope - The Department released a draft Scope for public review in October 2008, and held public scoping sessions at six venues in the Southern Tier and Catskills in November and December, 2008. A total of 188 verbal comments were received at these sessions. In addition, over 3,770 written comments were received (via e-mail, mail, or written

[5] ECL § 23-0301

comment card). The Department completed the Final Scope in February 2009, which outlined the analysis required for a thorough understanding of the potentially significant adverse environmental impacts of high-volume hydraulic fracturing in low-permeability reservoirs.

2009 Draft SGEIS - The Department released the 2009 draft SGEIS for public review on September 30, 2009 and held public hearings at four venues in New York City (NYC), the Catskills and the Southern Tier in October and November, 2009. Comments were accepted at the hearings verbally and in writing, by postal mail, by e-mail and through a web-based application developed specifically for that purpose. More than 2,500 people attended the Department hearings, and more than 200 verbal comments were delivered by individuals, local government officials, representatives of environmental groups and other organizations and members of the oil and gas industry. The Department also received over 13,000 comments via e-mail, postal mail and the web-based comment system. In addition, transcripts from hearings held by the New York State Assembly, the City of Oneonta, and the Tompkins County Council of Governments on the 2009 draft SGEIS also provided the Department with numerous comments.

Executive Order 41- On December 13, 2010, former Governor David Paterson issued Executive Order No. 41 (EO 41), which directed the Department to publish a revised draft SGEIS and to accept public comment on the revisions. EO 41 is commonly referred to as a “moratorium” on high-volume hydraulic fracturing because it recognizes that under SEQRA, permits to drill wells using this method cannot be issued until completion of the SGEIS process. On January 1, 2011, Governor Andrew Cuomo continued EO 41.

2011 Revised Draft SGEIS - The 2011 revised draft SGEIS was released for public comment on September 7, 2011 and the comment period was continued until January 11, 2012. Hearings were held in four locations throughout the state in November 2011. In response to the public comment period and public hearings, the Department received approximately 67,000 comments and public hearing statements on the revised draft.

2011 Draft Regulations – In October of 2011, following release of the 2011 revised draft SGEIS, the Department proposed draft regulations to be considered as part of a comprehensive regulatory program described in the draft SGEIS. The Department received 180,000 comments on the draft regulations. On February 27, 2013, the proposed regulations expired under provisions of the State Administrative Procedure Act.[6]

2014 DOH Public Health Review - In September of 2012, the Department requested that the New York State Department of Health (DOH) review and assess the Department's analysis of potential health impacts contained in the revised Draft SGEIS. DOH published that review in December 2014.

2015 Final SGEIS – The Final SGEIS includes a consolidated summary of the substantive comments received on both the 2009 dSGEIS and the 2011 rdSGEIS, along with responses to substantive comments. The Final SGEIS was publically released on May 13, 2015.

C. Interested Agencies

The Department, as the only agency with jurisdiction to fund, approve, or undertake the Action, is the lead agency for the Action and there are no other involved agencies in the Action. Nevertheless, the Department coordinated and consulted with many interested agencies during the SGEIS process. The following agencies have participated in the SGEIS process because of specific expertise or concerns related to it:

- The New York State Office of General Services (OGS)
- The New York State Public Service Commission (PSC)
- The New York State Department of Health (DOH)
- The New York State Department of Transportation (DOT)
- The New York State Department of Agriculture and Markets (Ag & Mrkts)
- The New York State Office of Parks, Recreation and Historic Preservation (OPRHP)

[6] See SAPA § 202(2) and (3)

- The New York State Energy Research and Development Authority (NYSERDA)
- The New York State Department of Financial Services (DFS)
- The New York State Department of Law (DOL)
- The United States Department of Transportation (USDOT)
- The United States Environmental Protection Agency (USEPA)
- The New York City Department of Environmental Protection (NYCDEP)
- The Susquehanna River Basin Commission (SRBC)
- The Delaware River Basin Commission (DRBC)

D. Purpose and Need for the Action

Article 23 of the ECL confers upon the Department jurisdiction to, among other things, regulate oil and natural gas development in New York State. Consequently, any person seeking to drill and extract oil or natural gas must obtain a permit from the Department pursuant to Title 5 of Article 23 of the ECL.

The exploration and development of natural gas resources provides one method of serving the public's need for energy. Natural gas consumption comprises approximately 23 percent of the total energy consumption in the United States. Natural gas is used for many purposes: home space and water heating; cooking; commercial and industrial space heating; commercial and industrial processes; as a raw material for the manufacture of fertilizer, plastics, and petrochemicals; as vehicle fuel; and for electric generation.

The Marcellus Shale formation has attracted attention as a significant source of natural gas production. The Marcellus Shale extends from Ohio and West Virginia into Pennsylvania and New York. In New York, the Marcellus Shale is located in much of the Southern Tier and adjoining areas, stretching from Chautauqua and Erie Counties in the west to the counties of Sullivan, Ulster, Greene and Albany in the east.

The Department recognizes that energy created from natural gas has had a relatively beneficial environmental impact in reducing the amount of energy derived from oil and coal-based sources The Department acknowledges the need for, and will continue to foster, the transition from fossil fuels to non-emitting clean energy sources in order to reduce greenhouse gas (GHG) emissions overall. However, increased availability of low-cost natural gas has the potential to reduce the implementation of various types of renewable energy and energy efficiencies.

While natural gas may serve as a "bridge" or "transitional fuel" towards greater utilization of non-emitting clean energy sources, increased natural gas development could extend the use of fossil fuels, or delay the necessary deployment of clean energy. Consequently, the reliance on natural gas resources for the State's energy needs should be balanced with the use of non-emitting sources into the future.

II. POTENTIAL ENVIRONMENTAL IMPACTS

High-volume hydraulic fracturing is a well stimulation technique which consists of pumping large volumes of water, chemical additives, and a proppant, such as sand, down the wellbore under high pressure to create fractures in the hydrocarbon-bearing rock. This process then releases natural gas into the well bore where it can be captured at the surface and moved through pipelines to end users of the gas.

The construction, drilling, hydraulic fracturing, production, and reclamation phases can result in adverse environmental impacts which can range in duration from acute impacts during only one phase, to more permanent impacts that could be present for years or decades after a well is reclaimed. In addition to the direct impacts from each phase of well development, the authorization of high-volume hydraulic fracturing would also induce growth in the natural gas industry. This growth would in turn generate the construction of natural gas pipelines, gathering lines, compressor stations and other associated infrastructure beyond the well pad. This ancillary activity has the potential to create adverse impacts to state-owned lands, freshwater wetlands, forests and other habitat due to fragmentation, streams where pipelines cross, air resources (from compressor stations), visual resources, agricultural lands, threatened and endangered species, and the spread of invasive species.

As explained in detail below, the drilling, hydraulic fracturing, and production phases involve other potential environmental impacts in areas such as spills, cuttings disposal, waste disposal, air emissions, and community character.

A. Water Resources, Floodplains and Wetlands

Potential significant environmental impacts to surface water and groundwater, floodplains, and wetlands from high-volume hydraulic fracturing include impacts resulting from water withdrawals needed for the fracturing stage; stormwater runoff during construction and operation of a well pad; surface spills; groundwater impacts associated with well drilling and construction; waste disposal and spills during the storage and transport of wastes; impacts to New York City's and Syracuse's unfiltered surface water supply and subsurface water supply infrastructure; impacts to other surface drinking water supplies; loss of habitat associated with construction; and potential groundwater contamination from the hydraulic fracturing procedure itself.

i. Water withdrawals

It is estimated that 2.4 million to 7.8 million gallons of water may be used for a multi-stage hydraulic fracturing procedure in a typical 4,000-foot lateral well. This water may be obtained by withdrawing it from surface water bodies away from the well site or through new or existing water-supply wells drilled into aquifers. Without proper controls on the rate, timing and location of such water withdrawals, the cumulative impacts of such withdrawals could cause modifications to groundwater levels, surface water levels, and stream flow that could result in significant adverse impacts, including but not limited to impacts to the aquatic ecosystem, downstream river channel and riparian resources, wetlands, and aquifer supplies.

At peak activity, the total amount of water necessary for hydraulic fracturing statewide would result in increased demand for fresh water of approximately 0.25% annually. However, the cumulative impact of such water withdrawals, if temporally proximate and from the same water resource, could be significant.

ii. Stormwater runoff

All phases of natural gas well construction and development, from initial land clearing for access roads, equipment staging areas and well pads, drilling and fracturing operations, to production and final reclamation, have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed. Initial land clearing exposes soil to erosion and more rapid runoff. Equipment and any materials that are spilled, including chemical additives and fuel, when exposed to rainfall, could convey contaminants off-site and into water resources during rain events if they are not properly contained. A natural gas production site, including access roads, is also a potential source of stormwater runoff impacts because its hydrologic characteristics, sediment, nutrient, contaminant, and water volumes may be substantially different from the pre-developed condition. The cumulative water resource impacts of all of these construction and development activities could be significant.

iii. Floodplains

High-volume hydraulic fracturing operations within floodplain areas would create serious and significant environmental risks to water and other resources. The 1992 GEIS summarizes the potential significant adverse impacts of flood damage relative to mud or reserve pits, brine and oil tanks, other fluid tanks, brush debris, erosion and topsoil, bulk supplies (including additives) and accidents. For high-volume hydraulic fracturing, potential significant adverse impacts are magnified given the potential geographic scope of hydraulic fracturing. Severe flooding is described as one of the ways that bulk supplies such as fracturing additives might accidentally enter the environment in large quantities and result in significant potential environmental and public health impacts.

iv. Wetlands

The 1992 GEIS broadly summarized the potential significant adverse impacts to wetlands associated with interruption of natural drainage, flooding, erosion and sedimentation, brush disposal, increased access and pit location. For high-volume hydraulic fracturing, potential impacts are magnified based on the potential scope of high-volume hydraulic fracturing and the larger well pad size required for these operations. Impacts to state- and federally-regulated wetlands can disrupt healthy ecosystems by jeopardizing essential breeding grounds for fish, birds, and other wildlife and by disrupting the flood control functions healthy wetlands provide.

v. Spills

The Department concludes that spills or releases in connection with high-volume hydraulic fracturing could have significant adverse impacts on water resources. The SGEIS identifies a significant number of contaminants contained in additives used in fracturing fluids and present in vehicle or machine fuels, and contaminants otherwise associated with high-volume hydraulic fracturing operations.

These additives and contaminants could result in significant adverse public health and environmental impacts if spilled or released taking into account potential exposure pathways. With the assistance of NYSDOH, Chapter 5 of the SGEIS described potential adverse health impacts from exposure to classes of chemicals such as petroleum distillate products, aromatic hydrocarbons, glycols, alcohols, aldehydes, microbiocides and other constituents.

Spills or releases of these contaminants can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents (including vehicle collisions), ground fires, improper operations and other incidents. Spilled, leaked or released fluids could flow overland to a surface water body or infiltrate the ground, reaching subsurface soils, aquifers, and drinking water sources. These types of environmental impacts could lead to significant and adverse public health outcomes.

vi. Well-drilling and fracturing fluid migration

Additional potential significant adverse impacts on groundwater and surface water resources could result from well drilling and construction associated with high-volume hydraulic fracturing. Those potential significant adverse impacts include impacts from turbidity, fluids pumped into or flowing from rock formations penetrated by the drilling of the well, and contamination from natural gas present in the rock formations, above the target shale deposits, that are penetrated by the drilling of the well.

Typically, the developable shale formations are vertically separated from potential freshwater aquifers by at least 1,000 feet of sandstones and shales of moderate to low permeability. In fact, most of the bedrock formations above the Marcellus Shale are other shale deposits.

High-volume hydraulic fracturing is engineered to target the prospective hydrocarbon-producing zone. The induced fractures create a pathway to the intended wellbore, but typically do not create a discharge mechanism or pathway beyond the fractured zone where none existed before.

While there is little likelihood of vertical migration of hydraulic fracturing fluids based on the nature of the activity and geological characteristics of the formation being targeted, uncertainty remains as to migration risks from wellbore failures or connectivity to nearby abandoned wells or faults. The location and depth of abandoned wells and existing faults in the Marcellus Shale region is not fully catalogued or understood. Therefore, it will be difficult in some cases to ensure that all abandoned wells and existing faults have been identified, and a failure to understand these geologic conditions prior to high-volume hydraulic fracturing activities has the potential to cause significant adverse environmental and health impacts.

Gas migration can potentially occur as a result of poor well construction (i.e., casing and cement problems), or through existing abandoned wells or faults. There are circumstances in which the casing and wellbore can be compromised from engineering control failures in the construction process. Thus, in the event that wellbores are compromised, there is an increased risk of unintended natural gas and fluid migration. The NYSDOH Public Health Review notes that: "Studies have found evidence for underground migration of methane associated with faulty well construction." In addition to these studies, there was a reported incident in 1996, in the Town of Freedom, during the drilling of a conventional oil and gas well. There, an underground blowout of natural gas occurred when the well bore became pressurized by a strong gas flow. This underground blowout caused methane migration that affected properties approximately one and a half miles away. In addition, methane detected in the shallow subsurface after the event, including in residential water wells and a pond, resulted in the evacuation of 12 families from their homes.

In sum, when local geologic conditions are fully understood, properly-constructed wells and properly-conducted fracturing operations would be expected to avoid potential fracturing fluid and methane migration into groundwater and surface water resources. However, there is a risk that well integrity can fail, especially over time, and questions have arisen about whether high-volume hydraulic fracturing can cause seismic changes which could potentially result in fracturing fluid migration through abandoned wells or existing fissures and faults. Thus, high-volume hydraulic fracturing could result in significant adverse impacts to water resources from well construction and fracturing fluid migration.

vii. Waste disposal

After the hydraulic fracturing procedure is completed and pressure is released, the direction of fluid flow reverses up the wellbore. The well is "cleaned up" by allowing water, chemical additives, and excess proppant (typically sand) to flow up through the wellbore to the surface. Both the process and the returned water (which also contains brine and other naturally occurring material from the shale zone) are commonly referred to as "flowback." The SGEIS estimates flowback water volume to range from 216,000 gallons to 2.7 million gallons per well, based on a pumped fluid estimate of 2.4 million to 7.8 million gallons.

The disposal of flowback water and production brine could cause a significant adverse impact if the wastewater is not properly stored and treated prior to disposal. Residual fracturing chemicals and/or naturally-occurring constituents from the rock formation could be present in production brine and could result in 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.

The 1992 GEIS findings determined that any proposed disposal wells require an individual site-specific determination under SEQRA. With respect to the use of disposal wells for waste disposal, the Department is not proposing to alter this finding. Any such proposal would be reviewed on a site-specific basis with consideration to local geology (including faults and seismicity), hydrogeology, nearby wellbores or other potential conduits for fluid migration and other pertinent site-specific factors.

Gamma ray logs from deep wells drilled in New York over the past several decades show the Marcellus Shale to be higher in naturally-occurring radioactive material (NORM) than other bedrock formations including other potential reservoirs that could be developed by high-volume hydraulic fracturing. As explained in Chapter 5 of the SGEIS, the total volume of drill cuttings produced from drilling a horizontal well may be about 40% greater than that for a well drilled vertically to the same depth below the ground surface. For multi-well pads, cuttings volume would be multiplied by the number of wells on the pad. Consequently, there is the potential for significant adverse environmental impacts associated with improper waste disposal.[7]

B. Ecosystems and Wildlife

Land disturbance directly associated with high-volume hydraulic fracturing would consist primarily of constructed gravel access roads, well pads and utility corridors. As previously indicated, the average total disturbance associated with a multi-well pad, including incremental portions of access roads and utility corridors is estimated at 7.4 acres.

The primary impacts of land disturbance and other high-volume hydraulic fracturing operations on ecosystems and wildlife are: (1) loss of habitat and habitat fragmentation; (2) potential introduction and spreading of invasive species; and (3) loss of endangered and threatened species. These impacts primarily occur as a result of the construction phases for access roads and well pads. However, significant adverse impacts to ecosystems and wildlife would occur during the construction and operation of associated infrastructure such as utility corridors, gas pipelines,

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[7] While not part of the Final SGEIS, USEPA issued a draft report entitled "Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources" (June 2015), that identifies "potential mechanisms by which hydraulic fracturing could affect drinking water resources." Specifically, the report found that "[a]bove ground mechanisms can affect surface and ground water resources and include water withdrawals at times or in locations of low water availability, spills of hydraulic fracturing fluid and chemicals or produced water, and inadequate treatment and discharge of hydraulic fracturing wastewater. Below ground mechanisms include movement of liquids and gases via the production well into underground drinking water resources and movement of liquids and gases from the fracture zone to these resources via pathways in subsurface rock formations." While the report did not find "widespread [or] systemic impacts on drinking water resources" it did confirm a number of specific instances where some of these potential mechanisms led to impacts on water resources. Specifically, the report found that "spills of hydraulic fracturing fluid and produced water in certain cases have reached drinking water resources, both surface and ground water" and that the "[d]ischarge of treated hydraulic fracturing wastewater has increased contaminant concentrations in receiving surface waters." The report further found that "[b]elow ground movement of fluids, including gas … have contaminated drinking water resources." Of the total spills, 300 reached an environmental receptor such as surface water, groundwater and/or soil. USEPA also acknowledged that factors limited the certainty of the draft report, including insufficient pre- and post-fracturing drinking water data and a lack of long-term systematic studies.

and compressor stations. Operations at a well pad can also create such impacts, including the noise generated during the hydraulic fracturing phase.

High-volume hydraulic fracturing operations have the potential to industrialize rural areas of New York, which would result in serious and unavoidable impacts to habitats (e.g., fragmentation, loss of connectivity, degradation, nighttime lighting and noise), species distributions and populations, and overall natural resource biodiversity. Habitat loss, conversion, and fragmentation (both short-term and long-term) would result from land grading and clearing, and the construction of well pads, roads, pipelines, and other infrastructure associated with gas drilling. Impacts to wildlife, habitats and biodiversity would be more severe in unique habitat areas including Forest Focus Areas and Grassland Focus Areas, which are areas that contain greater biodiversity and more productive habitat for birds and other wildlife. There are also potential impacts on fish and wildlife from the potential release of chemicals used in high-volume hydraulic fracturing into the environment.

Numerous vehicle trips associated with high-volume hydraulic fracturing, particularly at multi-well pads, have been identified as an activity which presents an opportunity to transfer invasive terrestrial species. Surface water withdrawals also have the potential to transfer invasive aquatic species. The introduction of terrestrial and aquatic invasive species could have a significant adverse impact on the environment.

The area underlain by the Marcellus Shale includes both terrestrial and aquatic habitat for 18 animal species listed as endangered or threatened in New York State that are protected under the State Endangered Species Law and associated regulations.[8] Endangered and threatened wildlife may be adversely impacted through project actions such as clearing, grading and road building that occur within the habitats that they occupy. Certain species are unable to avoid direct impact due to their inherent poor mobility (e.g., Blanding's turtle, club shell mussel, and the brook floater and green floater). Certain actions, such as clearing of vegetation or alteration of stream beds, can also result in the loss of nesting and spawning areas.

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[8] See ECL § 11-0535 and 6 NYCRR Part 182.

Accordingly, significant adverse impacts to ecosystems and wildlife would result from high-volume hydraulic fracturing.

C. Air Resources and Greenhouse Gas Emissions

High-volume hydraulic fracturing operations result in air emissions from several different types of sources. The fracturing phase in particular results in emissions from mobile sources (trucks carrying water) and from the equipment necessary for completing fracturing operations. After fracturing and into production, fugitive methane and other contaminant releases into air occur. Part of the Department's effort to assess the potential air quality impacts of high-volume hydraulic fracturing activities in the Marcellus Shale and other low-permeability gas reservoirs includes the performance of an air quality modeling analysis. The analysis identifies the emission sources involved in well drilling, completion and production, and the analysis of source operations for purposes of assessing compliance with applicable air quality standards. The air quality modeling analysis also assumed the maximum build-out projections of high-volume hydraulic fracturing wells.

Chapter 6 of the SGEIS provides a comprehensive list of federal and New York State regulations that apply to potential air emissions and air quality impacts associated with the drilling, completion (hydraulic fracturing and flowback) and production phases (processing, transmission and storage) of the wells. The total operations associated with well drilling can be assigned to three "types" of potential sources of air emissions: 1) combustion from engines, compressors, line heaters, and flares; 2) short-term venting of gas constituents which are not flared; and 3) emissions from truck activities near the well pad. Each of these source categories have limitations in terms of the size and number of the needed equipment, their possible simultaneous operations over a short-term period (e.g., 24-hour), and the time frames over which these equipment or activities could occur over a period of one year, which affects the corresponding annual impacts. The Department's modeling took all of these factors into account. The Department performed supplemental modeling specifically for short-term particulate matter (PM10/PM2.5) and nitrogen dioxide (NO_2) impacts, which were found to exceed the corresponding standards in the absence of mitigation measures. In addition, regional ozone modeling indicated that emissions of nitrogen oxides (NOx) from high-volume hydraulic fracturing development could contribute to increased ozone levels, including in the New York City metropolitan area, which is currently designated nonattainment for ozone. Other downwind areas, such as Albany-Schenectady-Troy, Poughkeepsie-Newburgh and Greater Connecticut (Hartford), are projected to be at or near the proposed ozone standard once finalized. Accordingly, high-volume hydraulic fracturing development could impact the ability of these areas to maintain air quality that meets the ozone standard. As discussed below, there are potential significant adverse health impacts associated with increased levels of particulate matter, ozone, diesel exhaust, and volatile organic compounds.

Additionally, all operational phases of proposed well pad activities were considered, and resulting greenhouse gas (GHG) emissions determined in the SGEIS. Emission estimates of carbon dioxide (CO_2) and methane (CH_4) are included as both short tons and as carbon dioxide equivalents (CO_2e) for proposed activities, where relevant and quantifiable. The Department not only estimated potential GHG emissions from activities, but also identified and characterized major sources of CO_2 and CH_4 during anticipated operations so that key contributors of GHGs could be addressed and mitigated, with particular emphasis placed on mitigating CH_4, with its greater Global Warming Potential (GWP). With respect to cumulative and macro-impacts of high-volume hydraulic fracturing, the Intergovernmental Panel on Climate Change considers the decarbonization of the energy system to be key to reducing and stabilizing GHGs in the atmosphere and avoiding the worst effects of climate change.[9] The State's overall goal is to reduce GHG emissions 80 percent by 2050, as discussed in the draft State Energy Plan (2014). The Department notes that, regardless of the magnitude of methane emissions from natural gas infrastructure, the consumption of fossil fuel, including natural gas, to produce energy contributes to climate change.[10] Additionally, the increased availability of low-cost natural gas has the potential to undermine the deployment of various types of renewable energy and energy efficiencies, thereby suppressing investment in and use of these clean energy technologies.

[9] IPCC AR5 WG3 Chapter 7 Energy Sources. IN IPCC, 2014. Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer et al. (eds)] Cambridge University Press, Cambridge

[10] e.g., Zhang, Xiaochun et al. 2014. "Key factors for assessing climate benefits of natural gas versus coal electricity generation." Environmental Research Letters 9: 114022

D. Geologic Resources: Naturally Occurring Radioactive Material (NORM) and Seismicity

Well drilling and high-volume hydraulic fracturing activities can bring NORM to the surface in the cuttings, flowback water and production brine, and NORM can accumulate in pipes and tanks (pipe scale and sludge). Based upon currently available information, it is anticipated that late-phase flowback water and production brine may contain elevated NORM levels. Although the highest concentrations of NORM are in production brine, it does not present a risk to workers because the external radiation levels for those handling the brine are very low. However, the build-up of NORM in pipes and equipment has the potential to cause a significant adverse impact because it could expose workers handling pipes, for cleaning or maintenance, to increased radiation levels. Disposal of this equipment also may cause significant adverse impacts. Finally, wastes from the treatment of flowback water and production brine may contain concentrated NORM.

The Department recognizes that there is increasing uncertainty about whether high-volume hydraulic fracturing can cause earthquakes and the potential magnitude of those earthquakes, even though much of the Marcellus and Utica Shales underlies portions of the state with the lowest seismic hazard class rating in New York. As discussed in the SGEIS, the smallest measurable seismic events are typically between 1.0 and 2.0 magnitude on the Richter scale. In contrast, seismic events with magnitude 3.0 are typically large enough to be felt by people. Fluid injection of any kind, including fluid injected during high-volume hydraulic fracturing operations, can trigger felt seismic events if the fluid reaches a geologic fault. While induced seismic events from this process are more typically associated with waste disposal or other long-term injections, there have been several instances where seismic events have been linked to hydraulic fracturing operations in the United Kingdom and Canada, and in the United States including Ohio, Oklahoma and Texas. Recent earthquakes observed in Poland, Ohio, which were linked to hydraulic fracturing, occurred in an area with the same seismic hazard class rating as those portions of New York with the lowest seismic hazard class rating in the State.

Potential seismic events from high-volume hydraulic fracturing could have more significant environmental impacts if they were to take place near subsurface water supply infrastructure (tunnels and aqueducts) associated with the New York City drinking water system, or if they were to take place in proximity to other subsurface water supply infrastructure in New York State.

E. Noise & Visual Resources

The construction of well pads and wells associated with high-volume hydraulic fracturing involves heavy machinery required to fell trees and move earth. The hydraulic fracturing phase results in significant truck traffic and the use of large diesel-powered pumps. The use of this equipment would result in adverse noise and visual impacts during those phases, which could be unavoidable.

Specific identified adverse impacts related to visual impacts include: temporary new landscape features at well pads, construction of new off-site facilities necessary for the high-volume hydraulic fracturing process, the congested appearance of staging areas and the increase in truck and other specialized vehicle traffic in certain areas. These visual impacts would be most problematic in areas that contain important viewsheds, as identified in the Department's Visual Impact Analysis policy.

Construction activity would result in temporary visual and noise impacts. There would be noise and visual impacts during drilling, and the noise impacts from drilling and hydraulic fracturing would be of longer duration for multi-well pad drilling. Any significant noise impacts at a well pad would cease after completion of the hydraulic fracturing stage, but there would continue to be noise impacts beyond the well pad related to the construction and operation of ancillary infrastructure. Additionally, there would be some longer-term visual impacts during the production phase.

Specific identified adverse impacts related to noise include: a potential 37-42 decibel increase over the quietest background areas measured at 2,000 feet during the drilling and hydraulic fracturing stage and increased traffic noise near well pads and on specific trucking routes.

F. Transportation

The introduction of high-volume hydraulic fracturing has the potential to generate significant truck traffic during the construction and hydraulic fracturing phases of the well. Estimates of early well pad development predict that there could be nearly 2,000 one-way heavy and light duty truck trips per well pad.[11]

The cumulative impact of this substantial amount of truck traffic has the potential to result in significant adverse impacts on local roads and, to a lesser extent, state roads where truck traffic from this activity is concentrated. It is not feasible to conduct a detailed traffic assessment given that the precise location of well pads is unknown at this time. However, such traffic has the potential to damage roads. In addition to road damage, increased truck traffic proportionally increases the number of vehicle breakdowns and vehicle accidents, and increases the risk of spills of potentially hazardous materials. These increased risks correspondingly increase the risk of and frequency of public health impacts. Increased truck traffic also creates potential adverse impacts related to noise and air emissions, discussed above. Finally, as discussed below, increased truck traffic could have direct impacts on community character in the municipality in which the well pad is located, but it could also have ancillary community character impacts on surrounding communities, some of which may have decided to limit or ban high-volume hydraulic fracturing operations through local law.

The potential adverse environmental impacts from transportation associated with high-volume hydraulic fracturing operations would be significant, and some of these adverse impacts would be unavoidable.

G. Socioeconomics & Community Character

As required by SEQRA, the Department considered the economic benefits and growth-inducing aspects of authorizing high-volume hydraulic fracturing.[12] As detailed in the SGEIS, the Department selected three representative regions to analyze the socioeconomic impacts of high-volume hydraulic fracturing. The Department utilized this approach as a way to assess the regional implications of high-volume hydraulic fracturing operations. The three representative

[11] SGEIS Table 6.60

[12] ECL § 8-0109(2)

regions were selected to provide a range of the scale of impacts that may occur. Since the actual location of the natural gas drilling had not been determined, it was impossible to assess the impacts at specific locations. The SGEIS notes that there could be significant variations in impacts at a town/municipal level across the state and within the same representative region.

The SGEIS considered a low and average rate of development based on industry estimates to predict the economic effects where high-volume hydraulic fracturing is expected to take place. However, for all of the reasons discussed below, projections of the expected employment, income, and tax generation impacts that would result from the approval of high-volume hydraulic fracturing in New York State have been reduced by the Department since the release of the 2011 revised draft SGEIS.

In light of changing development patterns in the natural gas industry, the Department considered revised projections in which the 20-year peak construction period (the previous assumption in the 2011 rdSGEIS) would be reduced to 10 years to more realistically reflect the development that could be expected, which would then be followed by a 10-year gradual decline in production. As detailed in the Department's response to comments, a 10-year peak construction period followed by a 10-year gradual decline in production would reduce employment projections, projected employee earnings and property tax receipts.

The potential economic benefits from high-volume hydraulic fracturing would also likely be further reduced by the New York Court of Appeals recent decision in the matter of *Wallach v. Town of Dryden* and *Cooperstown Holstein Corp. v. Town of Middlefield*, which found the ECL[13] does not preempt communities with adopted zoning laws from prohibiting high-volume hydraulic fracturing. As a result of this ruling, high-volume hydraulic fracturing could be prohibited in particular communities throughout the state.

Additionally, numerous mitigation measures proposed in the SGEIS and further considered by the Department (outlined in further detail in Section III below) would have limited where high-volume hydraulic fracturing could occur in New York State. Based on these limiting factors, the Department concluded that the number of wells that would be drilled would have been

[13] ECL § 23-0303(2)

substantially reduced. Consequently, the Department must consider the reduced forecast of economic benefits from a high-volume hydraulic fracturing permitting program when deciding on the appropriate alternative to select in this Findings Statement.

High-volume hydraulic fracturing would have negative socioeconomic and community character impacts. For example, some of the negative impacts associated with high-volume hydraulic fracturing operations, including increased traffic, noise, and visual impacts, may adversely affect visitors' experience of certain traditional tourist destinations. As a result, tourist destination enterprises that are more geared to traditional tourists may experience a loss in visitors, sales, and employment. In addition to negatively impacting the tourism experience, increased truck traffic may also lead to additional demands for expanded road infrastructure and related improvements.

Depending upon the level of development, some agricultural land could be lost due to high-volume hydraulic fracturing activities, as well as adverse impacts to organic agriculture. The potential significant adverse environmental impacts relating to agricultural land must be considered within the framework of the goals of Article 14, Section 4 of the New York State Constitution, which specifically states that the policy of the state is to "encourage the development and improvement of its agricultural lands for the production of food and other agricultural products [which]…shall include the protection of agricultural lands."

An increase in natural gas development and related truck traffic by permitting high-volume hydraulic fracturing activities in New York State would change the economic, demographic, and social characteristics of some of the affected communities, which would be viewed as negative impacts by some and as positive impacts by others. The degree of change in community character that would occur from high-volume hydraulic fracturing activities would be primarily dependent on the manner in which the community identifies itself, as well as the community's natural physical features, history, demographics and socioeconomics, and culture. The severity of impacts on community character in rural communities would be greater for those areas where development is focused in a particular location or region.

Some of the most significant negative impacts on the local communities would result from the expected increases in the transient and permanent populations. As described in the SGEIS, population would increase in local communities affected by the proposed high-volume hydraulic fracturing operations. Thus, the demand for locally provided services and facilities, such as school, fire, police, and health care, would expand, thereby increasing both the need for one-time capital expenditures as well as increasing recurring annual operating costs, as more residents would need to be served.

H. Special and Unique Places

There are several places within New York State that, because of their special or unique character, have been afforded additional protection to ensure their availability for public use, enjoyment, and appreciation. These areas include state-owned lands and state parks, federal lands and federal parks, the Adirondack and Catskill Park, historical districts, and other places containing important historical, archeological or cultural resources.

State-owned lands, including state-owned forests, reforestation areas, wildlife management areas and state parks, play a unique role in New York's landscape because they are managed under public ownership to allow for sustainable use of natural resources, provide recreational opportunities for all New Yorkers, and provide important wildlife habitat and open space. Surface disturbance associated with high-volume hydraulic fracturing could have negative impacts on habitats on state-owned lands, and recreational use of those lands, especially in large contiguous forest patches that are valuable because they sustain wide-ranging forest species and provide important habitat for forest interior species.

The noise, visual and truck traffic impacts from high-volume hydraulic fracturing activities on state-owned lands could adversely affect the public's recreational use and overall experience on state-owned lands. Furthermore, truck traffic coming to and from private parcels conducting high-volume hydraulic fracturing embedded within state-owned lands could create similar adverse impacts to the public's use of the surrounding state-owned land.

A similar potential adverse impact would be created by high-volume hydraulic fracturing on privately owned lands in the Catskill Park. A significant increase of visual, noise, and traffic impacts on private parcels in the Catskill Park could result in greater significant site-specific and cumulative impacts to constitutionally protected Forest Preserve land, adversely impacting its mandated “forever wild” forest land character and preventing the public from having a Forest Preserve experience characterized by peace and quiet as envisioned by those who framed the Forest Preserve’s constitutional protection.

The potential impacts from high-volume hydraulic fracturing in state and federally-designated historical districts are similar, as these districts may be vulnerable to visual and noise impacts associated with such operations and related truck traffic. The Department recognizes the potential for the character of these historic districts to be significantly adversely impacted over many years as a consequence of activities associated with high-volume hydraulic fracturing.

High-volume hydraulic fracturing operations would result in significant adverse impacts to special places and cultural resources, but the degree of impact would be highly dependent on site-specific conditions.

I. Public Health

As described in the NYSDOH Public Health Review from December of 2014, there are several potential adverse environmental impacts that could result from high-volume hydraulic fracturing. These impacts may be associated with adverse public health outcomes and include: 1) air impacts that could affect respiratory health due to increased levels of particulate matter, ozone, diesel exhaust, or volatile organic compounds; 2) drinking water impacts from underground migration of methane and/or fracturing fluid chemicals associated with faulty well construction or seismic activity; 3) surface spills from use, transport or storage of chemicals or wastewater potentially resulting in soil, groundwater, and surface water contamination; 4) surface water contamination resulting from inadequate wastewater treatment; 5) earthquakes and creation of fissures; 6) community character impacts such as increased vehicle traffic, road damage, noise, odor complaints, and increased demand for housing and medical care; and 7) climate change impacts due to methane and other volatile organic compound releases to the atmosphere and their resulting public health impacts.

Several recently published reports cited in the NYSDOH Public Health Review present data from surveys of health complaints among residents living near high-volume hydraulic fracturing activities. Commonly reported symptoms include skin rash or irritation, nausea or vomiting, abdominal pain, breathing difficulties or cough, nosebleeds, anxiety/stress, headache, dizziness, eye irritation, and throat irritation in populations within close proximity to high-volume hydraulic fracturing natural gas development. Additionally, ongoing studies by the National Institutes of Health, the National Science Foundation, the Environmental Protection Agency, and several different state and academic institutions continue to explore the relationship between high-volume hydraulic fracturing and public health risks and outcomes.[14] Many of these studies are several years from completion.

Linking health complaints and outcomes to specific chemicals or substances emitted from a high-volume hydraulic fracturing operation is difficult, and the NYSDOH concluded "that significant gaps exist in the knowledge of potential public health impacts from HVHF [high-volume hydraulic fracturing]." Any assessment of health risks from a given chemical is highly dependent on understanding the route (ingestion, inhalation, or skin contact), degree, extent, and timing of human exposure (if any) to that chemical. In the absence of data from a specific exposure incident, the NYSDOH stated that this assessment would entail making many assumptions and extrapolations regarding the exposure conditions under which risks are estimated.

The NYSDOH, recognizing the current uncertainty and identified risk with respect to the correlation between high-volume hydraulic fracturing and public health impacts, found that there are continuing and unfinished studies to amass more scientific information to better understand likely public health risks and outcomes. Until completion of ongoing studies by the National Institutes of Health, the National Science Foundation, the Environmental Protection Agency, and others regarding public health impacts from high-volume hydraulic fracturing, the Department will adhere to the NYSDOH recommendation in its public health review that "until the science provides sufficient information to determine the level of risk to public health from HVHF [high-

[14] NYSDOH, Public Health Review, December 2014, pp. 7-11

volume hydraulic fracturing] to all New Yorkers and whether the risks can be adequately managed … HVHF should not proceed in New York State."

J. Pipelines

The Public Service Commission (PSC) would be the principal regulatory entity in overseeing the construction of intrastate pipelines. Gas pipeline and compressor station siting actions undertaken pursuant to Public Service Law (PSL) Article VII are designated Type II SEQRA actions.[15] In addition, Section 130 of the PSL overrides the Department's State permitting authority, so that the Public Service Commission is the single State authority empowered to grant or deny applications to these site pipelines. However, in considering site-specific impacts of pipelines, PSC and the Department have historically coordinated and would continue to coordinate their reviews within the PSC proceedings. The PSC's Article VII proceedings are an analogue of the SEQRA process. The Department is a statutory party to such proceedings and additionally retains Federally delegated or authorized separate jurisdiction over any required air pollution control permits and registrations (usually for associated compressor stations and dehydrators) as well as under the State Pollution Discharge Elimination System (SPDES) for stormwater runoff. Consequently, significant site-specific adverse impacts would be addressed through the Article VII proceeding. However, on a generic level authorization of high-volume hydraulic fracturing would result in the construction and operation of pipelines and associated infrastructure and equipment that have the potential to result in significant adverse impacts.

The construction of natural gas pipelines, compressor stations and other associated infrastructure has the potential to create adverse impacts to state-owned lands, freshwater wetlands, forests and other habitat due to fragmentation, streams where pipelines cross, air resources (from compressor stations), visual resources, agricultural lands, and threatened and endangered species, and to contribute to the spread of invasive species.

Additionally, there is the potential for cumulative adverse impacts from gathering lines necessary to support high-volume hydraulic fracturing operations and these cumulative impacts could affect community character and wildlife habitat from the network of pipelines needed to

[15] See 6 NYCRR 617.5(c)(35)

facilitate high-volume hydraulic fracturing activities. Consequently, because the SGEIS is a generic SEQRA review of an activity that would be widespread across certain regions and would induce the construction of gathering lines, pipelines and compressor stations, the Department considered the general potential impacts associated with these ancillary activities. The Department recognizes that these considerations are limited where the Department is preempted by federal law (e.g., Surface Transportation Act, Natural Gas Act).

K. Cumulative Impacts

A generic environmental impact analysis is intended to consider the common impacts of an activity that will be performed using a standard process in various locations.[16] With respect to high-volume hydraulic fracturing, regardless of where a well is drilled, there would be impacts common to all well pads and wells. In many sections of Chapter 6, the SGEIS analyzes the combined, or cumulative, impacts of drilling more than one high-volume hydraulically fractured well or multi-well pad because the Department had sufficient information to conduct such analysis on a generic basis (e.g., air impacts). In certain instances there is insufficient information regarding the actual number of wells to be drilled in a town or county, the distribution of such wells statewide, and the timing of drilling, to conduct a cumulative analysis of the impacts of several wells or well pads. However, even with the significant uncertainty surrounding the scope and siting of high-volume hydraulic fracturing, the Department anticipates that high-volume hydraulic fracturing would impact many areas, including some that previously have not been widely exposed to oil and gas development. Moreover, beyond directly impacting those areas where the activity would be allowed, the ancillary activities associated with high-volume hydraulic fracturing and their corresponding significant adverse impacts would likely spread to those areas of the State where high-volume hydraulic fracturing is prohibited and would lead to significant adverse cumulative impacts.

Indeed, as NYSDOH stated in its Public Health Review, "[t]he number of well pads and associated high-volume hydraulic fracturing activities could be vast and spread out over wide geographic areas where environmental conditions and populations vary. The dispersed nature of

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[16] 6 NYCRR 617.10

the activity magnifies the possibility of process and equipment failures, leading to the potential for cumulative risks for exposures and associated adverse health outcomes."

The cumulative effects caused by the aggregate of past development patterns, present expectations concerning high-volume hydraulic fracturing development, and reasonably foreseeable future development would, taken together, result in significant adverse impacts to some resources, particularly community character and wildlife from habitat fragmentation. For example, the cumulative impacts of high-volume hydraulic fracturing and its associated truck traffic could have adverse impacts on the community character of specific areas, including special and unique places, state-owned lands, the Catskill Park, and state and federally-designated historic districts.

There would be cumulative impacts to surface water bodies from erosion and sedimentation resulting from the construction of well pads. Sediment loading from disturbed soils on construction sites is a significant problem. EPA estimates that one un-stabilized acre subject to construction activity releases 1,000 to 2,000 times the sediment during a rain event that an acre of forest or natural meadow does. Such eroded sediments often carry adsorbed contaminants and nutrients to nearby streams and water bodies. Eroded sediments can fill wetlands and silt in the rock cobble that serves as spawning beds for trout. Sediment may impair drinking water quality by contributing to the transport of pathogens and interfering with the effectiveness of disinfection. Furthermore, in terms of the impact on the quality of waters in the State, phosphorus is one of the more significant water pollutants. Erosion and sediment loads from the construction of high-volume hydraulic fracturing wells, well pads, and associated infrastructure would introduce phosphorus and other pollutants into surface waters, accelerating their eutrophication.

III. MITIGATION MEASURES

SEQRA requires that the lead agency preparing an environmental impact statement set forth the mitigation measures that would minimize identified significant adverse environmental impacts.[17]

[17] ECL § 8-0109(2)(f)

In the SGEIS, the Department identified numerous mitigation measures intended to avoid and reduce adverse environmental and public health impacts.

Following the issuance of the 2011 revised draft SGEIS and faced with ever-increasing information and scientific studies detailing the risks and uncertainties regarding the environmental and public health impacts that could result from high-volume hydraulic fracturing development, the Department considered significant additional mitigation measures beyond those originally proposed in the SGEIS that could further reduce or avoid the impacts to water and other natural resources, wildlife, air, transportation, and community character.

The Department considered extensive mitigation measures, including measures to: heighten protections for water resources and provide for enhanced monitoring, reduce air pollution and greenhouse gas emissions, further protect habitat and wetlands, ban any high-volume hydraulic fracturing development in state-owned lands and in the Catskill Park, and provide for greater disclosure of fracturing additives and create opportunities for public comment in a permitting process.

The SGEIS outlined a potential program that would in some instances effectively mitigate potential significant adverse impacts. As discussed more fully below, the Department considered additional measures where the proposed mitigation measures were regarded as either ineffective in avoiding or adequately minimizing significant adverse impacts. However, in many instances the potential for significant adverse environmental impacts remains notwithstanding the mitigation measures the Department considered.

A. Water Resources

With respect to water resources, the Department considered mitigation measures that would heavily rely on setbacks and buffers, which would have prohibited high-volume hydraulic fracturing within:

- The New York City and Syracuse drinking water supply watersheds and within 4000’ of related water tunnels or supply infrastructure;

- 500’ of, and including, Primary Aquifers;
- 2000’ of public drinking water supply wells and intakes;
- 1000’ of each side of the main flowing water body and any tributary to that water body, both for a distance of 1 mile upstream from a public drinking water supply intake;
- 500’ of private water wells;
- 100-year floodplains;

Additionally, the Department considered mitigation measures that would have required a site-specific environmental review for high-volume hydraulic fracturing within

- 500’ of, and including, Principal Aquifers; and
- 300’ of a perennial or intermittent stream, storm drain, lake, pond and freshwater wetlands.

In addition to setbacks, the Department considered requiring operators to develop and implement a groundwater monitoring program to detect potential spills and releases around the well pad and to detect potential contamination in groundwater drawn by nearby drinking water wells before they are impacted. The Department also considered extending buffer zones on tributaries to public drinking water supplies. The Department determined that beneficial use determinations (BUDs) for the road spreading of brine produced from wells stimulated by high-volume hydraulic fracturing in the Marcellus Shale or other low-permeability formations will not be issued until additional data on its chemical content is available and evaluated by the Department and NYSDOH.

To further protect drinking water sources, the Department considered requiring specific methodologies for determining the depth to the base of fresh potable water and confirming that all potable freshwater zones are above the depth of the surface casing, including use of geophysical logs in either the uncased surface hole or the drilled intermediate hole up to and including the surface casing seat for the first well on a pad. The Department also considered requiring use of external casing packers on the intermediate string or other means approved by the Department to permanently isolate any potable freshwater zone found below the surface casing seat from deeper, poor-quality water and/or gas-bearing zones.

Furthermore, to address concerns about flooding beyond the 100-year floodplain and in recognition of the increasing frequency and intensity of recent and potentially future flood events, the Department considered requiring that well pads be elevated two feet above the 500-year floodplain elevation or the known elevation of the flood of record, if such data are available.

In response to concerns raised about infrastructure associated with the Syracuse and New York City watersheds, the Department considered extending its initial 4,000-foot setback for surface disturbance to additionally apply to the water supply infrastructure, including tunnels that transport drinking water supplies. Beyond the setback, the placement of any portion of a wellbore less than 2,000 feet from any water tunnel or underneath a tunnel would be prohibited, and enhanced site-specific review plus consultation with the municipality would be required for any wellbore located within two miles of any water supply infrastructure for the Syracuse and NYC drinking water supplies. This measure recognizes the existence of uncertainty regarding high-volume hydraulic fracturing-induced earthquakes, both as to their probability and magnitude.

In further recognition that spills or engineering control failures could result in exposure to the harmful elements of high-volume hydraulic fracturing, and the potential for noise and lighting impacts, the Department considered establishing a 500-foot or greater setback from the edge of the well pad to inhabited private dwellings and places of assembly, such as schools and hospitals, unless the Department issues a variance from the requirement with the consent of the owner and any tenants.

B. Ecosystems and Wildlife

In response to concerns raised about impacts to wildlife habitat and wetlands, the Department considered requiring the applicant to address potential impacts to habitat connectivity in cases where a well permit application for high-volume hydraulic fracturing proposes a new access road within the 100-year floodplain or within 50 feet of surface water.

C. Air Resources and Greenhouse Gases

To reduce the air quality impacts, the Department proposed requiring the use of cleaner engines and retrofits in the drilling and fracturing equipment. Some comments from the public, however, argued that this mitigation measure would be considered a federally preempted regulation of emissions and emission-control technology for non-road engines. If a court were to agree with this argument, then additional air quality impacts could occur due to the use of dirtier engines. Additionally, to reduce GHG emissions, the Department considered requiring that a Reduced Emission Completion (REC) with minimal venting and flaring be performed whenever a commercial sales line, interconnecting gathering line and operating compressor station, if necessary, are available. The Department also proposed requiring a GHG emissions mitigation plan.

D. Public Disclosure

Based upon comments from the public with respect to chemicals used in the high-volume hydraulic fracturing process, the Department considered expanding the fracturing fluid chemical disclosure requirements to ensure that each chemical, and not merely each product, would be disclosed both before drilling and after completion of each well. The Department also considered requiring that every ECL Article 23 well application proposing high-volume hydraulic fracturing on a new well pad be subject to a fifteen-day public notice period, limited to site-specific issues on the subject application not addressed in the 1992 GEIS or this SGEIS. Similarly, the Department considered requiring operators to produce semiannual forecasts of high-volume hydraulic fracturing and related activities expected to occur within the ensuing three years, revising the forecast every six months. This measure recognizes that local governments, including emergency responders and local and state health workers, could be significantly impacted if high-volume hydraulic fracturing were allowed to proceed.

E. Community Character & Socioeconomics

The Department has also recognized that high-volume hydraulic fracturing activities could have a profound impact on community character, especially on those areas that have unique, historic and “special” identities. In this respect the Department considered prohibiting high-volume hydraulic fracturing development in the Catskill Park (outside the NYC drinking water supply watershed) and requiring a site-specific review in state and federally designated historic districts.

To mitigate the possibility that adverse socioeconomic impacts would result from concentrated well construction activity in a short period of time within a given area, the so-called "boomtown" phenomenon, the Department considered consulting with local governments and placing limits on the number of wells and/or well pads that could be constructed in a specific area at a single time.

As more fully explained below, collectively these mitigation measures would reduce, but not eliminate, impacts to ecosystems and wildlife, air and water resources, community character and public health. Indeed, this ever-increasing collection of proposed mitigation measures demonstrates three essential facets of the proposed program: (1) the effectiveness of the mitigation is uncertain; (2) the potential risk and impact from high-volume hydraulic fracturing to the environment and public health cannot be quantified at this time, and (3) there are some impacts that are simply unavoidable.

IV. FINDINGS & SELECTED ALTERNATIVE

Before embarking on one of the most unique and environmentally-challenging activities confronting New York State, the Department, as required by SEQRA, must select the alternative that will avoid or minimize significant adverse environmental and public health impacts to the maximum extent practicable consistent with social, economic and other essential considerations. Here, the No-Action alternative is the only alternative that meets the SEQRA legal mandate because authorizing high-volume hydraulic fracturing under any scenario would not adequately mitigate adverse impacts to ecosystems and wildlife, air and water resources, community character and public health and would likely have diminished economic and social benefits.[18] This selected alternative is consistent with the Department's mission, which charges the agency

[19] See 6 NYCRR 617.11(d)[19] See ECL § 1-0101(1)

with conserving, improving, and protecting natural resources to enhance the health, safety, and welfare of the people of the state and their overall economic and social well-being.[19]

High-volume hydraulic fracturing presents significant environmental impacts and challenges to New York State, including multiple wells drilled on a single pad and well pads constructed throughout numerous counties of the State, some of which have not previously been exposed to this type of intense industrial activity. Some of the engineering controls and management practices that would be required for this activity are untested in New York and consequently, it remains uncertain whether they would be adequate to prevent spills and other unplanned events resulting in the discharge of pollutants associated with high-volume hydraulic fracturing. In addition, the risk of environmental impacts from human error and mechanical failure could result in significant adverse impacts. In the event of a spill or emergency, available mitigation measures, such as setbacks and buffers, may fail to adequately minimize adverse impacts to water resources. Compounding this risk is the current uncertainty identified by NYSDOH as to level of risk high-volume hydraulic fracturing activities pose to public health.

Setbacks or buffers are used as a measure to reduce risk because, even with engineering controls and best management practices in place, spills or engineering control failures occur during activities related to high-volume hydraulic fracturing, such as drilling, chemical storage, and truck transportation. When compared to conventionally drilled wells, high-volume hydraulically fractured horizontal wells produce and use significantly more drilling and fracturing fluids, cuttings, flowback water and production brine for wells drilled to the same vertical depth below the ground surface and in the same geological formation. Consequently, wells stimulated by high-volume hydraulic fracturing create larger waste disposal impacts, such as an increased likelihood of spills from accidents occurring during the storage and transportation of this waste. Setbacks are traditionally used as one tool to protect a resource from being impacted from such a spill. However, determining the sufficiency of a setbacks for this particular activity is extremely difficult. In this regard, the adequacy of a buffer for high-volume hydraulic fracturing is complicated by a number of factors, including the effectiveness of control measures, the potential for spills and the uncertainty of the risk posed from those spills, the potential risks

[19] See ECL § 1-0101(1)

posed by ancillary activities, and the risks posed from the subsurface access to natural gas resources below water resources. Furthermore, the proposal to monitor groundwater around well pads, while providing some level of comfort for the public and the regulator, does not prevent impacts of a spill from affecting water resources or public health. These concerns led NYSDOH to acknowledge uncertainties regarding the "kinds of adverse health outcomes that may be associated with HVHF."

Waste disposal, as a general matter, also presents risks because of the uncertainty as to how and where high-volume hydraulic fracturing-generated-waste could be properly disposed. Overall, the absence of existing facilities with recognized capacity to accept large volumes of wastewater raises the potential of significant impacts, including improper or illegal disposal. Specifically, there are no publicly owned treatment works (POTWs) permitted to accepted high-volume hydraulic fracturing wastewater in New York State, and the Department has yet to receive any requests from any POTW in the State to accept this source of wastewater.

The Department also recognizes that there remains some level of uncertainty as to the potential impact of earthquakes induced by high-volume hydraulic fracturing. A recent study ascribed a series of earthquakes in Poland, Ohio to high-volume hydraulic fracturing operations.[20] Between March 4 and March 12, 2014, 77 earthquakes, ranging between 1.0 and 3.0 in magnitude, were identified and found to be closely related spatially and temporally to hydraulic fracturing operations at a nearby well. After the Ohio Department of Natural Resources ordered the high-volume hydraulic fracturing well to be shut down on March 10, 2014 the rate of incidence decreased until the earthquakes stopped. Moreover, the likely presence of unknown faults in New York raises concern as to the effectiveness of evaluating and monitoring mapped fault lines and other proposed safeguards. Consequently, it is unclear whether the operators or the Department could adequately identify these faults prior to the drilling and hydraulic fracturing phases of well development.

Some identified mitigation measures would inevitably fail to fully address the impacts that they are intended to address. For example, in trying to protect "special places" from impacts

[20] Skoumal, R., Brudzinski, M.R., and Currie, B.S. January 2015. Earthquakes induced by hydraulic fracturing in Poland Township, Ohio. *Bulletin of the Seismological Society*

associated with high-volume hydraulic fracturing, the Department considered prohibiting the activity on private lands in the Catskill Park (the Forest Preserve is constitutionally protected and needs no additional protections). By limiting this prohibition to one unique part of the State, the measure excludes many other communities and regions that also have unique features that would be susceptible to impacts from the extensive changes to the landscape that high-volume hydraulic fracturing could cause. Moreover, the prohibition of high-volume hydraulic fracturing on State-owned lands would not address impacts from truck traffic coming to and from private parcels where high-volume hydraulic fracturing might be conducted that are surrounded by or adjacent to state-owned lands.

Further, the Department concludes that identified mitigation measures to protect forest and grassland focus areas would reduce impacts to the precise location of a well pad and associated infrastructure. However, these measures would not address the cumulative impacts of future construction of well pads and infrastructure within focus areas, which could result in habitat fragmentation that would adversely impact these areas. Furthermore, beyond focus areas, there are countless smaller forests and grasslands that provide important habitat for declining species that would be negatively impacted both individually and collectively if high-volume hydraulic fracturing were allowed to proceed. Thus, while the proposed mitigation measures, including reclamation requirements, would reduce impacts from high-volume hydraulic fracturing activities, significant unavoidable and unmitigated adverse environmental impacts would still remain.

High-volume hydraulic fracturing development could also increase ozone levels by 1 to 3 parts per billion (ppb) in areas downwind of the areas of development, including the New York City metropolitan area, which currently measures above the current National Ambient Air Quality Standard (NAAQS) for ozone of 75 ppb and is projected to be at or around that level in 2018. Based on methodology that EPA uses to characterize the impact of emissions in one state on ozone levels in downwind states, EPA has determined that any contribution to ozone nonattainment in excess of 1 % of the standard (0.75 ppb) is significant, as well as contributions that would interfere with maintenance of the standard in excess of 1 % of the standard. The significance of the contribution of high-volume hydraulic fracturing development to ozone nonattainment in New York could increase in the future if EPA finalizes its regulatory proposal to reduce the ozone NAAQS to the range of 65-70 ppb.

Establishing a high-volume hydraulic fracturing permitting program in New York State would have significant impacts on community character in light of the anticipated pervasive nature of the activity, as well as the induced growth that extends far beyond the well pads. The Department recognizes that taken alone, the impacts of high-volume hydraulic fracturing on individual resource areas may be reduced or mitigated, but that community character is defined as a combination of several environmental factors. While the Department acknowledges that some communities may experience some positive benefits, and that various mitigation measures could be required to address or reduce adverse impacts on individual resource areas that contribute to community character, these measures would not adequately mitigate the transformation of various localities from high-volume hydraulic fracturing. In this respect, it is far less certain that specific mitigation measures can address potential cumulative impacts beyond a well pad or pads to a particular area, especially where the activity is clearly inconsistent with the area's previous history of development or experience with intense industrial activity.

Local government entities, through the use of zoning and municipal development tools, can define and influence community character. The recent New York Court of Appeals decision in the matters of *Wallach v. Town of Dryden* and *Cooperstown Holstein Corp. v. Town of Middlefield* found that ECL Section 23-0303(2) does not preempt communities with adopted zoning laws from prohibiting the use of land for high-volume hydraulic fracturing drilling. As a result of this ruling, high-volume hydraulic fracturing is expected to be prohibited by numerous municipalities throughout the state.

Both the recent New York Court of Appeals rulings and the extensive proposed mitigation measures considered by the Department all have the effect of reducing the amount of land in New York State available for the high-volume hydraulic fracturing development. By the Department's estimates, based on municipal bans and the imposition of the mitigation measures the Department would impose on the activity, more than 63% of land area of New York over the Marcellus Shale would not be available for high-volume hydraulic fracturing development.

These restrictions on the amount of available land would, in turn, reduce the number of wells that could be permitted and any projected economic benefits associated with this activity.

In addition, the Department acknowledges that the *Dryden* and *Middlefield* decision, as well as the consideration of several mitigation measures and site-specific review requirements, would increase the costs of developing New York State's shale gas reserves, which would slow the pace of development of the natural gas industry even if a high-volume hydraulic fracturing permitting program were established. It is understood that the costs to industry associated with the court decisions and implementation of the proposed mitigation measures may make it financially impractical to recover certain natural gas reserves in the state, particularly given the current and uncertain future price of natural gas.

In light of the Court's decision and the proposed mitigation measures, the expected positive socioeconomic impacts on employment, income, and tax generation associated with high-volume hydraulic fracturing would be substantially less (in the tens to hundreds of millions of dollars) than originally projected in the SGEIS and as projected under the revised development scenarios discussed above. Even with these reduced and uncertain economic prospects, it remains likely that because of the evolution of the technology that facilitates extraction of natural gas from deep low-permeability shale formations where it was previously not feasible, high-volume hydraulic fracturing would impact areas that previously have not been exposed to intense oil and gas development. As discussed above, if high-volume hydraulic fracturing were authorized, the proposed restrictions and prohibitions in certain areas would likely lead to intensified development in those areas where high-volume hydraulic volume would be permissible and where the shale was productive. Moreover, as discussed below, beyond directly impacting areas where high-volume hydraulic fracturing would be permissible, the ancillary and transport activities associated with a regulatory program and its corresponding significant adverse impacts would likely affect other areas of the State where high-volume hydraulic fracturing is prohibited. Consequently, the footprint on certain regions of the State and the associated impacts would be greater than for traditional methods of extraction.

In addition to the diminished economic benefits to the private sector from high-volume hydraulic fracturing, there would be substantial administrative and technical oversight costs to the

Department, other state agencies, and local municipal entities associated with ensuring compliance with implementation of stringent mitigation measures. The complexity and multiplicity of reviews and permits required would necessitate that state and local government entities dedicate a substantial amount of resources to the oversight of high-volume hydraulic fracturing operations. The Department estimates that its cost of administering this program under the average development scenario would grow from approximately $14 million in the first year to nearly $25 million in the fifth year. These projected costs do not consider other substantial costs that would be incurred by other state and local agencies. The cost of additional regulatory oversight costs would further reduce the fiscal benefits associated with authorizing high-volume hydraulic fracturing in New York.

Considering all of the impacts described above as well as the increased administrative costs and the reduced and uncertain economic benefits, the Department would need to be highly confident that the extensive and wide-ranging environmental impacts described in Section II above would be mitigated to the maximum extent practicable and that the risks to sensitive environmental and public health receptors would be adequately minimized. Unlike any other activity regulated by the Department, there is a potential for significant adverse impacts to be wide-ranging and widespread, including impacts to water resources, forests, and ecosystems and wildlife across a substantial portion of the State.

The Department adopts the NYSDOH statement in the Public Health Review that "[w]hile a guarantee of absolute safety is not possible, an assessment of the risk to public health must be supported by adequate scientific information to determine with confidence that the overall risk is sufficiently low to justify proceeding with HVHF in New York. The current scientific information is insufficient. Furthermore, it is clear from existing literature and experience that HVHF activity has resulted in environmental impacts that are potentially adverse to public health."

The Department concludes that while the mitigation measures in some instances would likely be effective in reducing the risk of impacts, in other instances impacts would only be partially mitigated, and in some instances the Department recognizes that there is insufficient information, or too much uncertainty as to the effectiveness of the mitigation, to determine if the impacts could be adequately mitigated at all. The Department concludes that there would be unavoidable cumulative impacts to community character and wildlife habitat.

Based on unavoidable adverse environmental impacts and uncertainty regarding the science surrounding high-volume hydraulic fracturing and its potential impacts to public health and the environment, the Department finds that the best course of action is to select the No Action alternative. Selection of the No Action alternative means that the Department will not establish a high-volume hydraulic fracturing permitting program; that no individual or site-specific permit applications for wells using high-volume hydraulic fracturing will be processed; and that high-volume hydraulic fracturing will be prohibited in New York State.

The Department rejects the other available alternatives (the "phased-permitting approach," the "environmentally-friendly chemical approach," and the "Special Places" alternative) because they all fail to limit unavoidable adverse environmental impacts and fail to address the risks and uncertainties of high-volume hydraulic fracturing.

The phased permitting alternative could limit and/or restrict resource development in designated areas to reduce certain unavoidable adverse environmental impacts identified in the SGEIS, such as identified impacts on community character, and visual, noise and transportation impacts that are anticipated to occur as a result of the development. However, the phased permitting alternative would not address the risks and uncertainties arising from accidents, spills and unforeseen events as effectively as the No Action alternative would succeed in addressing those concerns. Additionally, a phased permitting approach would further reduce the potential economic benefits from high-volume hydraulic fracturing development and could reduce the economic viability of these operations in New York.

The "environmentally-friendly chemical alternative" and "Special Places" alternatives address potential environmental impacts for only certain resources, namely water resources and community character, and do not comprehensively address all of the potential adverse environmental impacts from the activity.

V. CONCLUSION AND CERTIFICATION

The prospect of high-volume hydraulic fracturing development in the State of New York has generated immense levels of public interest and concern. The over 80,000 public comments on the draft and revised draft SGEIS constitute the most comments, by far, that the Department has received on an environmental impact statement which it has prepared. Additionally, the 180,000 public comments the Department received on the draft regulations (which have since expired) were similarly unprecedented. The vast majority of the over 260,000 comments received urged the Department to severely restrict the practice of high-volume hydraulic fracturing or to prohibit it altogether.

These findings are the culmination of a nearly seven-year process to fully and exhaustively evaluate the environmental impacts of this activity, determine the measures and controls that would minimize such impacts, review and understand the science and experiences observed in other parts of the country, and understand the risks and uncertainties arising from the activity.

In the end, there are no feasible or prudent alternatives that would adequately avoid or minimize adverse environmental impacts and that address the scientific uncertainties and risks to public health from this activity. The Department's chosen alternative to prohibit high-volume hydraulic fracturing is the best alternative based on the balance between protection of the environment and public health and economic and social considerations.

Having considered the 1992 GEIS, the 2009 dSGEIS, the 2011 rdSGEIS and the Final SGEIS, and having considered the preceding facts and conclusions relied upon to meet the requirements of 6 NYCRR 617.9, this Statement of Findings certifies that:

1. The requirements of 6 NYCRR Part 617 have been met;

2. Consistent with the social, economic and other essential considerations from among the reasonable alternatives available, the No-Action alternative avoids adverse environmental impacts to the maximum extent practicable; including impacts disclosed in the supplemental environmental impact statement (and in Section II of this Findings Statement), and;

3. Consistent with the applicable policies of Article 42 of the Executive Law, as implemented by 19 NYCRR Part 600.5, approval of the No-Action alternative will achieve the appropriate balance between the protection of the environment and the need to accommodate social and economic considerations.

New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233-1750

Joseph J. Martens
Commissioner
Dated: JUN 29 2015

Exhibit B (Part 1) to
New York Attorney General's
Comments dated March 30, 2018

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK
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STATE OF NEW YORK,

Plaintiff,

v.

UNITED STATES ARMY CORPS OF ENGINEERS; *et al.*,

Defendants.
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DECLARATION OF DR. CHARLES SILVER

CV-11-2599
(Garaufis, J.)
(Pollak, M.J.)

ECF Case

DR. CHARLES SILVER states as follows:

1. I am the Watershed Inspector General Scientist in the Environmental Protection Bureau of the New York State Attorney General's Office. I submit this declaration in opposition to defendants' motions for dismissal and/or summary judgment and in support of plaintiff State of New York's cross-motion for summary judgment.

2. In this action, New York asserts that defendant federal agencies are violating the National Environmental Policy Act of 1969, 42 U.S.C. § 4321 et seq. ("NEPA"), by refusing to prepare an environmental impact statement to study and develop measures to prevent potential adverse environmental impacts from proposed federal regulations that would authorize natural gas development, including horizontal drilling and high volume hydraulic fracturing, within the Delaware River Basin (the "Basin").

3. The purpose of this declaration is to show the substantial risk of injury to New York's waters, wildlife, and related interests resulting from defendants' failure to perform environmental review pursuant to NEPA.

I. **Professional Qualifications**

4. I have been employed as the Watershed Inspector General Scientist in the Attorney General's Environmental Protection Bureau since June 2000. My duties and responsibilities include scientific analysis of the impacts of water pollution on surface waters and groundwater within the New York City Watershed and elsewhere within New York and the Nation.

5. I received a Ph.D. in Soil Pollution/Soil Ecology in 1985 from the State University of New York College of Environmental Science and Forestry, and a B.A. in Zoology from Ohio Wesleyan University in 1975, and have been employed as an environmental scientist in both the private and public sectors for 28 years. I have edited, authored, and/or commented on many environmental impact statements ("EISs") prepared pursuant to NEPA and New York law concerning the fate and transport of pollutants, and impacts of pollution on water quality, endangered species and other organisms. In my current position, I have frequently evaluated and commented on EISs concerning potential water pollution impacts of major development projects in the New York City Watershed, including natural gas development employing horizontal drilling and high volume hydraulic fracturing ("HVHF"). My past government work includes employment as an aquatic biologist with Defendant United States Environmental Protection Agency ("EPA") in its Region II laboratory, assessing whether industrial pollutant discharges were toxic to fish and crustaceans.

II. **The Governmental Consensus that Natural Gas Development Employing HVHF Has the Potential to Cause Significant Adverse Environmental Impacts**

6. The Basin is an area comprising approximately 13,539 square miles, draining parts of Pennsylvania, New Jersey, New York, and Delaware into the Delaware River, and supplies drinking water to 15 million people. The Basin includes the Delaware portion of the

New York City Watershed, which provides most of the unfiltered drinking water consumed by 9 million New Yorkers each day, and the pristine Upper Delaware River, a federally designated "Scenic and Recreational River" administered by Defendant National Park Service ("NPS").

7. The Marcellus shale and potentially other rock formations within the Basin contain natural gas. Natural gas development in the Basin is expected to employ HVHF, a technique that liberates the natural gas by pumping millions of gallons of water, sand, and chemicals (some of which are toxic) under high pressure deep underground. This technique releases natural gas by creating multiple fractures within the Marcellus shale formation. Defendant Delaware River Basin Commission ("DRBC" or "the Commission") and Defendant NPS have stated that they expect thousands of natural gas wells to be developed using this technology within the Basin.

8. There is broad consensus, shared by Defendant federal agencies, Plaintiff New York, and other federal and local government agencies that natural gas development employing HVHF has the potential to cause significant adverse environmental impacts and that an environmental impact analysis should be performed to assess those impacts and mitigate them.

9. That consensus can be summarized as follows:

a. Defendant Collier, as Executive Director of Defendant DRBC issued a finding on May 19, 2009 that "as a result of water withdrawals, wastewater disposal and other activities, natural gas extraction projects in these [gas bearing] formations may individually or cumulatively affect the water quality of Special Protection Waters [including the Delaware portion of the New York City Watershed and the Upper Delaware River and its drainage basin] by altering their physical, biological, chemical or hydrological characteristics."[1] Based on that finding, DRBC has imposed a moratorium on natural gas development within the Basin pending its promulgation of regulations that would authorize such development.

b. In June 2010, DRBC stated 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."[2] DRBC stated that these potential impacts result from three major areas of concern: (1) "reducing the flow in streams and/or aquifers used to supply the significant amounts of fresh water needed in the gas mining process," (2) "drilling operations may potentially add, discharge or cause the release of pollutants into the groundwater or surface water," and (3) "recovered 'frac water' must be treated and disposed of properly."[3]

c. Defendants United States Fish and Wildlife Service ("FWS") and NPS, services within Defendant Department of Interior, have concluded 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

[1] *See* DRBC "Determination of the Executive Director Concerning Natural Gas Extraction Activities in Shale Formations within the Drainage Area of Special Protection Waters," dated May 19, 2009, available at: http://www.nj.gov/drbc/library/documents/EDD5-19-09.pdf, attached as Exhibit A.

[2] *See* "Statement by the Delaware River Basin Committee (DRBC) on the Upper Delaware River Being Named by American Rivers to its 'America's Most Endangered Rivers' List," dated June 2, 2010, available at: http://www.nj.gov/drbc/library/documents/DRBCstatement_EndangeredRivers_6-2-2010.pdf, attached as Exhibit B.

[3] *See* DRBC, "Natural Gas Drilling Index Page," available at: http://www.state.nj.us/drbc/programs/natural/, attached as Exhibit C.

and should be reviewed for both individual and cumulative environmental effects."[4] Those trust resources include over two hundred migratory birds and various endangered and threatened species under the jurisdiction of FWS, and the "Upper Delaware Scenic and Recreational River," administered by NPS. The representative of Defendant Army Corps of Engineers on the DRBC, who in turn represents various other federal agencies in matters before the Commission, previously stated that the federal government's "position is to continue fully supporting the need for a cumulative impact study."[5]

d. Defendant United States Environmental Protection Agency ("EPA") has frequently acknowledged the potential significant adverse impacts of natural gas development employing HVHF, and is engaged in a study it expects to complete in 2014 of potential impacts on drinking water resources from HVHF activities including: large volume water withdrawals; surface spills on or near well pads of hydraulic fracturing fluids, flowback, and produced water; and inadequate treatment of hydraulic fracturing wastewaters.[6] Given the potential for adverse impacts to water, EPA has expressed "serious reservations about whether gas drilling in the New York City watershed [including its Delaware portion within the Basin] is consistent with the vision of long-term maintenance of a high quality unfiltered water supply."[7] EPA has also

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[4] *See* Letter from Marvin E. Moriarty and Dennis Reidenbach to Carol Collier, dated June 25, 2010, attached as Exhibit D.

[5] *See* Letter from Duke DeLuca to Congressman Maurice Hinchey, dated September 14, 2010, attached as Exhibit E.

[6] *See* EPA Office of Research and Development, "Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources," at xi (November 2011), available at: http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/hf_study_plan_110211_final_508.pdf, p. xi attached as Exhibit F.

[7] *See* Letter from John Filippelli, Chief of EPA's Strategic Planning and Multi-Media Programs Branch, to New York State Department of Environmental Conservation, dated December 30, 2009, attached as Exhibit G.

recently concluded in a draft report that natural gas development employing HVHF was likely responsible for shallow and deep groundwater contamination in Pavillion, Wyoming, where elevated concentrations of methane, benzene, toluene, ethylbenzene, xylene, diesel, and various chemicals used in hydraulic fracturing were found.[8]

e. The federal government's Shale Gas Production Subcommittee of the Secretary of Energy Advisory Board ("SEAB") has also acknowledged potential adverse environmental impacts of natural gas development employing HVHF, including "four major areas of concern: (1) Possible pollution of drinking water from methane and chemicals used in fracturing fluids; (2) Air pollution; (3) Community disruption during shale gas production; and (4) Cumulative adverse impacts that intensive shale production can have on communities and ecosystems."[9] SEAB has concluded "that if action is not taken to reduce the environmental impact accompanying the very considerable expansion of shale gas production expected across the country - perhaps as many as 100,000 wells over the next several decades - there is a real risk of serious environmental consequences."[10]

f. The New York State Department of Environmental Conservation ("the New York DEC" or "the Department") has determined that HVHF "raises new, potentially

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[8] *See* EPA Office of Research and Development, "Investigation of Ground Water Contamination Near Pavillion, Wyoming," at xi-xiii (December 2011), available at: http://www.epa.gov/region8/superfund/wy/pavillion/EPA_ReportOnPavillion_Dec-8-2011.pdf, pp. xi - xiii attached as Exhibit H.

[9] *See* United States Department of Energy, "The SEAB Shale Gas Production Subcommittee Ninety-Day Report - August 11, 2011," available at: http://www.shalegas.energy.gov/resources/081111_90_day_report.pdf, pp. 1 and 8 attached as Exhibit I.

[10] *See* United States Department of Energy, "The SEAB Shale Gas Production Subcommittee Second Ninety Day Report - November 18, 2011," at Exec. Summary, p. 10, available at: http://www.shalegas.energy.gov/resources/111811_final_report.pdf, p. 10 attached as Exhibit J.

significant adverse impacts" to the environment not previously subject to environmental review by the Department.[11] Compared to previous natural gas development activities in New York, with HVHF, well pads "are larger and the industrial activity taking place on the pads is more intense. Also hydraulic fracturing requires chemical additives, some of which may pose hazards when highly concentrated."[12] New York DEC has concluded that "[a]ll phases of natural gas well development. . . have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed[,]"[13] and that "spills or releases in connection with high-volume hydraulic fracturing could have significant adverse impacts on water resources."[14] New York DEC recommended that HVHF be prohibited in the New York City Watershed based on the risk that "significant high volume hydraulic fracturing activities in [the New York City Watershed] could result in a degradation of drinking water supplies from accidents, surface spills, etc. Moreover, such large scale industrial activity in these areas, even without spills, could imperil EPA's Filtration Avoidance Determinations and result in [the City] incurring substantial costs to filter [its] drinking water supply."[15] Pursuant to those determinations, New York City has been able to avoid expenditures exceeding $10 billion associated with construction of a filtration plant for drinking water supplies.

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[11] *See* New York State DEC, Revised Draft Supplemental Generic Environmental Impact Statement, ("DSGEIS"), dated September 7, 2011, at Exec. Summary p. 1, available at http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf, Exec. Summary, p.1 attached as Exhibit K.

[12] *See id.*

[13] *See id.*at Exec. Summary, p. 10.

[14] *See id.*

[15] *See id.* at Exec. Summary, p. 20.

g. The New York City Department of Environmental Protection ("NYCDEP"), which supplies the drinking water obtained from the City's Watershed, has stated in comments to DRBC concerning its proposed regulations to authorize natural gas development: (1) "Clearly this type of industrial activity has the potential to have a significant impact on the Delaware River and its tributaries, and the City continues to believe that it is premature for the Delaware River Basin Commission (DRBC) to adopt these regulations;"[16] and (2) "Prior to issuing any regulations, DRBC should conduct a rigorous analysis of the potential cumulative impacts natural gas development could have on water quantity and water quality in the Delaware Basin."[17] NYCDEP has also concluded, based on third-party scientific studies, that natural gas development 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."[18]

h. The City of Philadelphia Water Department ("PWD") provides drinking to almost two million consumers in the Philadelphia region. In light of potential adverse impacts to the Delaware River, a source of much of its water, PWD has concluded that "a study of the long-term implications of natural gas drilling for Philadelphia's drinking water supply is needed. At a minimum, this study should include an evaluation of the cumulative impact on surface waters of

[16] *See* Testimony of Paul V. Rush, P.E., Deputy Commissioner, NYCDEP, at DRBC Hearing, February 22, 2011, available at: http://www.state.nj.us/drbc/library/documents/NGC/Agencies/NYCDEP022211.pdf, attached as Exhibit L.

[17] *See* Letter of Paul V. Rush, P.E. to DRBC, dated April 7, 2011, available at: http://www.state.nj.us/drbc/library/documents/NGC/Agencies/NYCDEP040711.pdf, attached as Exhibit M.

[18] *See* Letter from Steven W. Lawitts to New York State DEC, dated December 22, 2009, available at: http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/12_22_2009_impact_statement_letter.pdf, attached as Exhibit N.

improperly cased wells and on-site spills and accidents involving toxic substances. Additionally the study should evaluate transportation pathways in the Delaware River Basin of hydraulic fracturing fluids and wastewater and determine the risk of spills and accidents in proximity to drinking water supplies."[19]

10. I agree with the broad consensus of federal, state, and local agencies that natural gas development employing HVHF poses potential significant adverse environmental impacts and that an environmental impact statement should be prepared to study and address those impacts before federal regulations authorizing such development in the Basin are finalized. For the reasons discussed below, if defendants do not comply with NEPA and do not prepare an environmental impact statement, New York's waters, wildlife, and related interests will be at significant risk of injury from natural gas development in nearby areas in Pennsylvania.

III. Generation of Potential Harmful Water Pollutants from Natural Gas Development Employing HVHF

11. Unlike traditional methods of natural gas development, HVHF requires large volumes of water obtained from rivers, streams, lakes, or groundwater within the Basin, from recycled HVHF fluids, or by importing water from outside the Basin. Various chemicals or "fracking additives" are mixed in with the water to facilitate hydraulic fracturing, including chemicals which can pose risks to health and the environment, such as benzene, toluene, ethylbenzene, and xylene (referred to as BTEX); microbiocides; glycols; glycol ethers; and petroleum products.[20]

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[19] *See* Letter from Howard Neukrug, P.E., Commissioner, City of Philadelphia Water Department to DRBC, dated March 3, 2010, available at: http://www.phila.gov/water/pdfs/DRBC_Letter.pdf, attached as Exhibit O.

[20] *See* DSGEIS, pp. 5-46 through 5-66, attached as Exhibit K.

12. The U.S. House Committee on Energy and Commerce recently asked the 14 leading oil and gas companies to disclose the types and volumes of hydraulic fracturing additives they used in their fluids between 2005 and 2009. In their responses, the companies identified 29 chemicals in these fluids that are considered toxic because they are known or possible human carcinogens; regulated under the Safe Drinking Water Act for their risks to human health; or listed as hazardous air pollutants under the Clean Air Act. Five of the 29 chemicals were classified in all three categories. In addition, some of the 29 chemicals (e.g. naphthalene and xylene) have the propensity to bioaccumulate in fish and other aquatic organisms. The 29 toxic chemicals are constituents of 652 products used as fracking additives, which means that one quarter of these products contain toxic constituents. The 14 companies used 780 million gallons of hydraulic fracturing additives between 2005 and 2009.[21]

13. Natural gas is contained within Marcellus shale, which is typically more than 4,000 feet below ground. During HVHF, as much as 10 million gallons of water containing sand and fracking additives (collectively referred to as "fracking fluids") are injected into each well under high pressure causing numerous fractures to develop along the well bore. The sand keeps the newly fractured shale from compressing or closing up and allows the liberated natural gas to flow to the well, where it can be extracted.

14. In addition to natural gas, naturally occurring brine is present in the Marcellus shale. Brine can contain toxic metals and radioactive substances.[22] EPA has found that brine

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[21] U.S. House of Representatives Committee on Energy and Commerce Minority Staff April 2011 "Chemicals Used in Hydraulic Fracturing," available at: http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf, 30 pp.

[22] 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) at CRS-13 and CRS-14.

"can be very damaging to the environment and public health if it is discharged to surface water or the land surface."[23] Prior to HVHF, brine remains deep underground where it is generally unable to migrate into and contaminate fresh groundwater or surface waters above. However, brine mixes with the fracking fluids once they are injected into the Marcellus shale formation.

15. Some 15 to 20% of fracking fluids flow back up through the well and are collected at the ground surface. These returning fluids are referred to as "flowback," and most surface within ten days after HVHF. Flowback contains barium, calcium, iron, magnesium, and sulfur from the shale formation as well as brine that may contain radioactive elements. The production phase follows the hydrofracking/well completion phase. During the natural gas production phase, brine continues to flow up through the well. The brine coming up to the surface during this phase is referred to as "production brine." Like flowback, production brine must be stored and subsequently treated, reused, and/or disposed.

16. Both flowback and production brine contain high concentrations of total dissolved solids ("TDS"). TDS is a general term for particles suspended in a liquid which can easily flow through a small filter. The TDS associated with natural gas development includes minerals, metals, and various soluble salts. TDS in production brine and flowback can reach concentrations as high as 200,000 milligrams per liter (mg/L) or 200,000 parts per million.[24]

17. The high levels of TDS found in flowback and production brine, if discharged into freshwater streams, rivers or lakes in the Basin, would likely present a severe threat to water

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[23] USEPA, Underground Injection Control Program. Oil and Gas Injection Wells: Class II, available at: http://water.epa.gov/type/groundwater/uic/class2/index.cfm.

[24] *See* Source: Ohio Environmental Protection Agency, "Drilling for Natural Gas in Marcellus and Utica Shales: Environmental Regulatory Basics," follow link to "The Basics," available at: http://www.epa.ohio.gov/shale.aspx

quality and the survival of aquatic organisms, including fish.[25] TDS in flowback and production brine includes elevated levels of salts, such as sodium chloride. Due to the toxic impact of chlorides on freshwater organisms, EPA assembled and evaluated lethal and sublethal toxicity data for a wide variety of freshwater plants and animals, including snails, clams, crustaceans, insects and five species of fish. EPA developed acute (one hour) and chronic (four day) water quality criteria for chlorides in fresh water. The acute water quality criteria for sodium chloride is 860 mg/L and the chronic water quality criteria is 230 mg/L. This means that exposure of aquatic organisms to water having chloride concentrations exceeding these criteria would harm or kill some of these organisms.[26]

18. Because of the large number of wells expected to be developed within the Basin, billions of gallons of flowback and production brine would have to be treated, reused, and/or disposed of within the Basin, or these wastewaters would have to be exported for treatment or disposal elsewhere. I am not aware of any facilities currently within the Basin capable of treating these wastewaters. Existing sewage treatment plants within the Basin are generally not suitable for treating these wastewaters because the high concentrations of total dissolved solids in production brine and flowback (and the biocides and other toxic additives found in flowback) may interfere with their ability to treat sanitary sewage.[27] In addition, disposal by underground injection within the Basin, at this time, is unlikely. Accordingly, to treat and dispose of HVHF

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[25] *See id.*

[26] USEPA Ambient Water Quality Criteria for Chloride-1988 (a.k.a. Ambient Aquatic Life Water Quality Criteria for Chloride) EPA 440/5-88-001 39, dated February 1988, available at: http://water.epa.gov/scitech/swguidance/standards/criteria/upload/chloride1988.pdf, pp. 46.

[27] 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) at CRS-15.

wastewaters within the Basin would require construction of new treatment facilities; otherwise these wastewaters must be exported.

19. The scale of anticipated natural gas development in the Basin means that some spills, leaks, blowouts, well operation failures, and other incidents would likely result in pollutant discharges of natural gas, fracking fluids, flowback, production brine, and/or other chemicals related to natural gas development unless adequate protective measures are put in place. Spills and leaks can occur from above-ground tanks, impoundments and containers, compressor engines, trucks, and from defects in well design or construction (including problems in well cementing and casing) and other failures.

20. Leaking or spilled substances can contaminate surface waters directly or indirectly when they are carried by stormwater runoff or otherwise flow overland into streams and rivers within the Basin. Groundwater generally flows toward and discharges to surface water. Groundwater can become contaminated from leaks, spills, and discharges at the well pad and from defects below the ground in well casings and cementing. Local geologic features below the land surface, such as faults, fractured bedrock, coarse gravel, or other permeable materials can serve as conduits for the rapid migration of contaminated groundwater to surface waters.

IV. Pollution Problems From Natural Gas Development in Pennsylvania

21. Currently natural gas development in Pennsylvania is proceeding on a large scale outside the Basin. However, protective measures have not been followed or have been inadequate and significant pollution discharges to surface waters and groundwater have occurred. From January 1, 2008 through August 20, 2010, natural gas development in Pennsylvania outside of the Basin resulted in issuance by the Pennsylvania Department of Environmental

Protection of 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."[28]

22. A few examples illustrate the significant pollution problems that have been occurring in Pennsylvania.

23. In October 2008, levels of TDS exceeded federal and state drinking water standards in Pennsylvania's Monongahela River for 70 miles, affecting eleven public water suppliers. According to PADEP Secretary John Hanger, much of the TDS was from natural gas development well drilling wastewaters that were discharged from sewerage treatment plants along the river. To address this, the PADEP directed all applicable sewage treatment plants located along the Monongshela River to reduce their intake of drilling wastewaters by up to 95%.[29] In addition to TDS, bromide concentrations in the Monongahela River were also recorded at elevated levels, which would potentially subject people drinking the water to increased health risks from disinfection.[30]

24. Polluted stormwater from natural gas development activities occurring in McKean County, Pennsylvania, has repeatedly flowed across the border into Yeager Brook within New York's Allegany State Park from August 2010 through January 17, 2012. The pollution

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[28] Pennsylvania Land Trust Association Report, "Marcellus Shale Drillers in Pennsylvania Amass 1614 Violations since 2008," dated October 1, 2010, available at: http://conserveland.org/violationsrpt.

[29] Don Hopey, "DEP Seeks Cause of River Pollution," *Pittsburgh Post-Gazette*, dated October 22, 2008, available at: http://www.post-gazette.com/pg/08296/922096-100.stm.

[30] 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," pp. 27.

discharges, apparently caused by improper drilling operations and ineffective stormwater pollution prevention measures, caused New York's Yeager Brook to turn variously milky white, yellowish brown, and grey in color in violation of State water quality standards. The drilling company responsible for the pollution, U.S. Energy Development Corporation, has entered into two administrative consent orders with New York DEC without disputing the underlying facts.[31]

25. On April 19, 2011, Chesapeake Energy Corporation, a national leader in natural gas development, experienced a failure at a natural gas well in Bradford County, Pennsylvania, located outside of the Basin, during the hydraulic fracturing process. As a result of the failure, thousands of gallons of water containing fracking chemicals were discharged into a nearby creek, and seven families were evacuated from the area.[32] [33]

26. In the week prior to September 25, 2009, three spills occurred at the Heitsman well, located outside of the Basin, during Cabot Oil and Gas Corporation's hydrofracking operations in Dimock Township, Susquehanna County, Pennsylvania. According to a Consent Order and Settlement Agreement with Cabot, the Pennsylvania Department of Environmental Protection ("PADEP") determined that the drinking water at nineteen nearby homes was adversely affected by the drilling activities and required Cabot Oil and Gas Corporation to provide water to the residents. At least once every two weeks, the adversely affected water

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[31] *See* New York DEC Orders on Consent, (File No. 10-46; R9-20100913-39 December 20, 2010), and (File No. 11-01; R9-20110111-1 August 24, 2011). *See also* New York DEC Administrative Complaint, *In re U.S. Energy Development Corp.*, (File No. 11-57, R9-20111104-150 January 24, 2012).

[32] Marshall, C.J., *The Daily Review*, "Spill at well drilling site causes evacuation," dated April 21, 2011, available at: 2011 WLNR 7782375.

[33] Notice of Violation to Chesapeake Energy from the Pennsylvania DEP, published April 23, 2011, available at: http://thedailyreview.com/news/notice-of-violation-to-chesapeake-energy-from-the-pennsylvania-dep-1.1136743.

supplies for the affected houses were to be sampled and analyzed for dissolved methane, dissolved ethane, and dissolved propane.[34]

IV. The Role of Environmental Impact Statements in Preventing Adverse Environmental Impacts Associated with Natural Gas Development in New York

27. I have substantial experience in editing, drafting, and commenting on environmental impact statements as part of the environmental review process under NEPA and under New York's state law analogue to that statute, the State Environmental Quality Review Act (New York Environmental Conservation Law, Article 8) ("SEQRA"). The environmental review process under these laws requires government decision makers to identify, analyze, and document potential adverse environmental impacts, and consider alternatives or mitigation measures that would prevent or lessen such impacts. While there are no guarantees that these laws will achieve those results, it is my experience that they typically do reduce environmental impacts.

28. In fact, the environmental review New York DEC is engaged in concerning natural gas development in the State, including development in New York's portion of the Basin, will likely reduce such impacts. The Department has prepared two detailed draft environmental impact statements based on its review of thousands of public comments, the input of Department staff, and reports from expert consultants. As a result of that process, New York DEC has proposed (but has not yet finalized) a wide array of protective measures. For example, in its Revised Supplemental Draft Generic Environmental Impact Statement, dated September 7, 2011 ("Revised Draft EIS"), the Department analyzed potential adverse impacts to the New York City Watershed and the Skaneateles Lake Watershed (which provide unfiltered drinking water to residents of New York City and Syracuse, respectively), "primary aquifers" (major municipal

[34] PADEP Consent Order and Settlement Agreement, dated December 15, 2010.

drinking water systems relying on groundwater), and State lands. Based on that analysis, the Department has proposed prohibiting natural gas development altogether within these areas and in buffer areas surrounding those watersheds and primary aquifers.

29. Within the Basin, the proposed prohibitions against HVHF, if finalized by New York DEC, would apply to the Delaware portion of the New York City Watershed, which include the Cannonsville, Neversink, Pepacton, and Rondout Reservoirs and their drainage areas, and to State lands along the Upper Delaware River. These state lands are intended to facilitate the public's recreational use of the River and to protect State forests, fish and wildlife. As described in greater detail in the Declaration of William Rudge, those lands include fishing and boating access sites, the Mongaup Valley Wildlife Management and Bird Conservation areas, forest preserve lands, and a scenic highway.

30. The EIS process has also resulted in proposals by New York DEC to prevent water pollution in areas of New York in which it proposes to authorize natural gas development employing HVHF. In its Revised Draft EIS, the Department analyzed potential adverse impacts to surface waters and groundwater from stormwater runoff, spills, and releases associated with such development. New York DEC found that "all phases of natural gas well development, from initial land clearing for access roads, equipment staging areas and well pads, to drilling and fracturing operations, and production and final reclamation, have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed."[35] The Department also found that, in the course of natural gas development "[s]pilled, leaked or

[35] *See* DSGEIS, p. 6-14, attached as Exhibit K.

released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers."[36]

31. To address such impacts, New York DEC has proposed regulations that would require drilling companies to: (1) evaluate the use of alternative fracking additives that exhibit reduced aquatic toxicity and pose less risk to water resources and the environment, and use less toxic additives if feasible;[37] (2) create and implement separate comprehensive stormwater pollution prevention plans for specific phases of natural gas development to minimize or eliminate introduction of pollutants into stormwater;[38] and (3) impose requirements for well pad operations to prevent conditions that have resulted in water pollution in Pennsylvania.[39]

32. These comprehensive measures, not required in Pennsylvania or proposed by DRBC, would likely prevent pollution or, in the case of measures to reduce the use of toxic hydraulic fracturing additives, lessen the harm from pollution. New York DEC's proposed stormwater pollution measures would include detailed spill prevention and good housekeeping measures to prevent pollution from occurring. According to EPA: "Spill response, good housekeeping, and material management are critical elements of the HVHF SWPPP (stormwater pollution prevention plan)."[40] In addition, the proposed stormwater pollution measures would

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[36] *See id.*, pp. 6-15 through 6-17.

[37] *See id.*, p. 8-30.

[38] NYSDEC Draft SPDES General Permit for Stormwater Discharges from High-Volume Hydraulic Fracturing GP-0-XX-00X, available at: http://www.dec.ny.gov/docs/water_pdf/hvhfgp.pdf, pp. 16 to 21 & 29 to 40.

[39] *See* DSGEIS, pp. 1-12 and 7-52, Exhibit K.

[40] USEPA Region 2 Comments on the NYSDEC's SPDES General Permit for Stormwater Discharges from High Volume Hydraulic Fracturing (HVHF) December 22, 2011, available at: http://www.epa.gov/region2/newsevents/pdf/HVHF%20NYSDEC%20Permit%20Enclosure.pdf, p. 4.

require periodic sampling and laboratory analysis of stormwater to detect potential contaminants. This would help identify pollution problems and correct them before discharges to water courses occur.[41]

33. New York is also proposing in its Revised Draft EIS that drillers generally be required to install three casings at each HVHF well, in contrast to Pennsylvania which generally requires two.[42] The installation of three casings is designed to ensure there is no subsurface leakage of potential contaminants into fresh groundwater supplies. In general, when three casings are installed, the surface casing extends from the ground surface to below the base of the freshwater aquifer, the intermediate casing extends from the ground surface to below areas that may have shallow gas bearing zones, and the production casing extends from the ground surface to the furthest extent of the horizontal component of the well.

34. Problems in Pennsylvania have occurred when the intermediate casing was not installed and only two casings were used. For example, the PADEP entered into a consent order and agreement with Chesapeake Appalachia, LLC (Chesapeake) on May 16, 2011, concerning seven discrete areas in five townships in Bradford County affecting 18 residences. The PADEP issued Chesapeake a notice of violation (NOV) for the failure to prevent the migration of natural gas into fresh groundwater at all seven areas. In addition, six of the seven areas received NOVs for the unpermitted discharge of polluting substances. Two of the seven areas also received NOVs for defective well casing and cementing. As a result, all gas wells drilled after May 16,

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[41] *See* fn. 35, *infra*, p. 41-77.

[42] *See* fn. 34, *infra*; *see* 25 PA Code Chapter 78. Oil and Gas Wells Sections 78.81 to 78.87, available at: http://www.pacode.com/secure/data/025/chapter78/chap78toc.html.

2011 by, or on behalf of, Chesapeake in the areas identified in the consent order are required to install three casings, unless they notify the PADEP of alternate practices.[43]

V. Environmental Review Under NEPA Is Needed to Prevent Harm to New York's Waters, Wildlife, Lands and Scenic Vistas From Natural Gas Development in the Basin in Pennsylvania

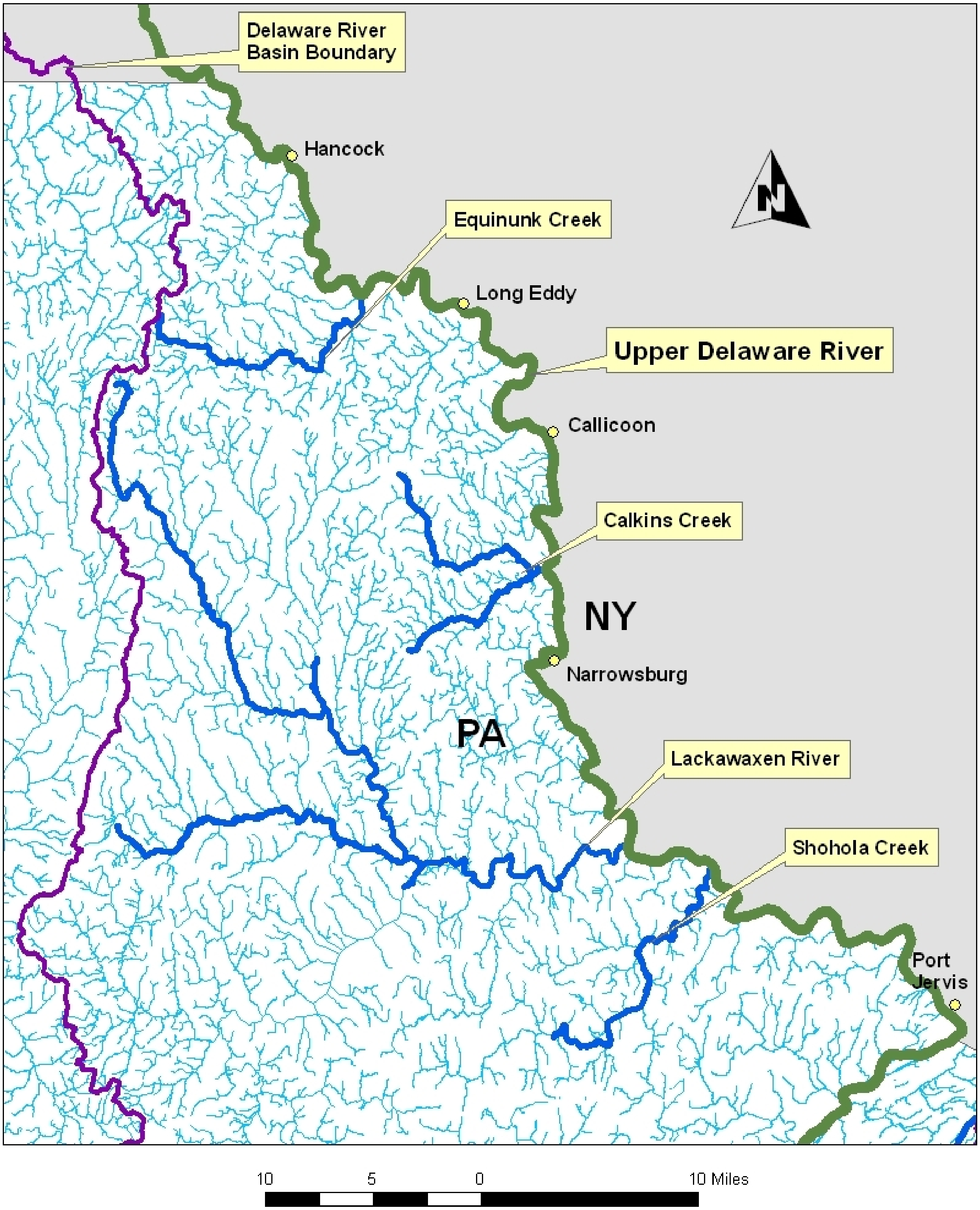
35. The preventive measures that the New York DEC has proposed (but not yet finalized), would apply only to natural gas development employing HVHF in New York, and would not apply to areas of the Basin within Pennsylvania that drain into New York waters, such as in Wayne and Pike Counties.

36. Surface waters in those Pennsylvania counties flow from many smaller waterbodies into Equinunk Creek, Calkins Creek, Lackawaxen River, and Shohala Creek, which in turn drain to the Upper Delaware River, the eastern half of which lies within New York as depicted in Figure 1 below. Accordingly, unless adequate protective measures are taken in Pennsylvania, discharges of pollutants that occur in these watersheds would likely be transported downstream into the New York portion of the Upper Delaware River. The continuing flow of stormwater pollution into New York waters from natural gas development sites outside the Basin in McKean County, Pennsylvania, illustrates this problem.

37. Unlike SEQRA which applies in New York, Pennsylvania does not have a state environmental review law analogous to NEPA. Pennsylvania regulations of natural gas development, promulgated without benefit of such environmental review, include less stringent measures to prevent pollution discharges. As discussed above, Pennsylvania does not require drilling companies to use alternatives to toxic fracking additives, or to implement strict and comprehensive stormwater pollution prevention measures or more stringent well pad operation

[43] PADEP Consent Order and Settlement Agreement, dated May 16, 2011.

Figure 1



Pennsylvania Tributaries to the Upper Delaware River measures. Moreover, Pennsylvania does not prohibit natural gas development within its state lands and parks. This means that large tracts of Pennsylvania state lands on the banks of the Upper Delaware River, including State Game Lands and the Delaware State Forest, would be subject to natural gas development employing HVHF within the Basin.

38. DRBC has published successive sets of draft regulations that would authorize natural gas development in the Basin. But these proposed regulations do not include the protective measures described above or similar measures to prevent pollution impacts to surface waters and groundwater. Instead, pursuant to DRBC's draft regulations, Pennsylvania's stormwater and well pad operation regulations would apply to drilling in the portion of the Basin within that state and DRBC's general stormwater controls (not tailored to natural gas development) would also apply.[44]

39. If environmental review pursuant to NEPA is not performed by DRBC and other federal agencies, New York's half of the Upper Delaware River will be at risk from pollution emanating from natural gas development in nearby areas of Pennsylvania. As past experience in Pennsylvania outside the Basin suggests, some of that polluted water will likely flow downstream into New York's portion of the Upper Delaware River.

40. Pollution of the Upper Delaware River with fracking fluids, flowback, and production brine would likely harm water quality in that river and adversely impact the fish and wildlife that depend on clean water. As discussed above, fracking fluids, flowback and production brine contain a variety of toxic chemicals which, if discharged into a water bodydraining into the Upper Delaware River, would risk significant adverse impacts to the River and life within it.

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[44] *See* Delaware River Basin Commission Natural Gas Development Regulations, dated

41. For example, production brine at a gas development site in Tioga County, Pennsylvania, was tested in 2010 and found to have a chloride concentration of 151,000 mg/L or 175 times the acute water quality criteria and 656 times the chronic criteria established by EPA to prevent the harm or death of aquatic organisms.[45] A spill of this magnitude into a water body draining into the Upper Delaware River would present a very serious risk of harm to aquatic organisms found there.

42. The federally endangered dwarf wedge mussel and other freshwater mussels found in the Upper Delaware River would be especially at risk from natural gas development in the Basin, as Defendant FWS found in testimony it previously submitted to DRBC.[46] Of the twelve species of mussels residing in the Upper Delaware River, nine are endangered, threatened, or imperiled. In 1990, FWS identified water pollution as a major cause for the endangerment of the dwarf wedge mussel.[47] According to FWS, freshwater mussels filter large volumes of water to respire and to feed. As a result, the mussels are susceptible to the impacts of water pollution because they rapidly assimilate and digest dissolved toxins, such as metals and biocides. In addition, because of their relative immobility, mussels are extremely vulnerable to spills of toxic chemicals. Unlike fish, which may be able to swim out of harm's way, mussels

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November 8, 2011, §§ 7.1(i) p. 5, §§ 7.4(d)(1)(viii) p. 53 and §§ 7.4(e)(4)(viii) p. 69-70.

[45] Form 26 R Chemical Analysis of Residual Waste Annual Report by Generator Submitted to the PADEP by AMEC Geomatrix, Inc. on behalf of Ultra Resources, Inc. on March 11, 2010.

[46] Anderson, R.M. (U.S. Fish & Wildlife Service) and D.A. Kreeger (Partnership for the Delaware Estuary). 2010. Testimony to the Delaware River Basin Commission available at: http://www.delawareriverkeeper.org/resources/Reports/DRBC_Expert_Reports_Gas.pdf, attached as Exhibit P.

[47] 55 Federal Register 9,447-01, Rules and Regulations, Department of the Interior, Fish and Wildlife Service, 50 C.F.R. Part 17, RIN 1018-AB31, *Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Dwarf Wedge Mussel*, dated March 14, 1990.

can respond by closing their shells, if they can detect the toxin, which has limited effectiveness in protecting them. According to Defendant NPS, freshwater mussels, including the dwarf wedge mussel, make up the greatest animal biomass in the Delaware River. See Rudge Declaration, par. 11. Because of the important role played by mussels in removing suspended particles from the water by filter feeding, harm to these organisms would adversely effect the Upper Delaware River's water quality because the important benefit they provide in filtering water will be lost.[48]

43. Fish populations would also be put at risk by spills of toxic chemicals and brine into the aquatic environment from well sites in Pennsylvania, as illustrated by the high chlorides found in flowback and production brine which frequently exceed EPA's water quality criteria.

44. Moreover, because fish serve as a primary component of the bald eagle diet in the Delaware River Basin, adverse impacts to fish populations would also pose risks to these threatened birds because it could deplete their food resources. The eagles could also suffer from ingesting contaminated fish or those that have been bioaccumulating toxic chemicals. In addition to consuming live fish, bald eagles scavenge dead fish, which could include fish killed by toxic chemicals. Ingesting contaminated fish by bald eagles could lead to breeding and/or behavioral modifications, illness, and potentially to death.

45. As discussed in greater detail in the Declaration of William Rudge, the Upper Delaware River is noted for its unique scenic beauty. Natural gas development within the Basin could cause significant adverse visual impacts along the River. As found by New York DEC in its Revised EIS, gas development employing HVHF would involve use of drilling rigs up to 170

[48] Anderson, R.M. (U.S. Fish & Wildlife Service) and D.A. Kreeger (Partnership for the Delaware Estuary). 2010. Testimony to the Delaware River Basin Commission.

feet in height along with ancillary equipment that could cause visual impairments.[49] The Department has proposed a variety of measures to reduce such adverse impacts.[50] In contrast to New York, DRBC has not proposed any measures to mitigate visual impacts associated with natural gas development in the Basin.

46. Unless DRBC and the other federal agencies perform environmental review pursuant to NEPA, adverse visual impacts may occur in New York as a result of natural gas development on the Pennsylvania side of the River. Areas adjacent to the River in Pennsylvania are observable from New York, as I can attest based on a tour I recently took along the New York side of the Upper Delaware River.

47. While DRBC proposes generally prohibiting drilling within a narrow corridor adjacent to the banks of the "Upper Delaware Scenic and Recreational River" administered by Defendant NPS, that prohibition would not prevent drilling that could impair views in New York. Under DRBC's proposed regulations, applicants for drilling permits would have the opportunity to seek variances from DRBC allowing them to develop natural gas within that corridor, and DRBC would not prevent drilling at all in other areas adjacent to the River outside of the corridor administered by NPS. In addition, it is possible to see very substantial distances inside of Pennsylvania beyond that corridor from areas in New York along the River.

48. Adverse water pollution, impacts to New York fish and wildlife, and visual impacts resulting from natural gas development in Pennsylvania, risk harm to New York's land holdings along the Upper Delaware, including boat launches, the Scenic Byway, and wildlife management areas. As owner of these lands, the State has chosen to make them available to its

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[49] *See* DSGEIS, pp. 6-263 to 6-264.

[50] *See id.*, pp. 7-121 through 7-128.

residents for their recreational use and enjoyment. Unless adequate protective measures are in place, pollution and visual impairments from natural gas development in Pennsylvania would risk a reduction in the use and enjoyment of these lands by boaters, anglers, hikers, and bird watchers.

VI. Conclusion

49. Defendants' compliance with NEPA cannot guarantee that harms to New York's waters, wildlife and State lands caused by natural gas development in Pennsylvania will be eliminated or lessened. However, based on my experience with environmental review under NEPA and SEQRA, and the ongoing environmental review process in New York, there is a substantial likelihood that NEPA compliance would achieve those results.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on February 13, 2012.

Charles Silver

Charles Silver

EXHIBIT A

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

Delaware River Basin Commission
25 State Police Drive
PO Box 7360
West Trenton, New Jersey
08628-0360
Phone: (609) 883-9500 Fax: (609) 883-9522
Web Site: http://www.drbc.net

Carol R. Collier
Executive Director

Robert Tudor
Deputy Executive Director

DETERMINATION OF THE EXECUTIVE DIRECTOR CONCERNING NATURAL GAS EXTRACTION ACTIVITIES IN SHALE FORMATIONS WITHIN THE DRAINAGE AREA OF SPECIAL PROTECTION WATERS

Technological advances in horizontal drilling and hydraulic fracturing have led to an increase in the number of active and planned natural gas extraction projects in shale formations within the Delaware River Basin. Each of these projects typically involves the construction of a well pad and associated roadways at or about surface elevations, the drilling of a well bore to depths of as much as 6000 feet or more, the withdrawal and transport of surface or ground water, the injection of the water and chemical fracturing mixtures into the wells to release the trapped gas, the recovery and storage of recovered fracturing fluid, water and associated leached constituents extracted with the gas, the storage and potentially the reuse of the recovered wastewater and chemicals and the eventual disposal of the water and chemicals. Each of these activities if not properly performed may cause adverse environmental effects, including effects on water resources.

Section 3.8 of the Delaware River Basin Compact provides in part: "No project having a substantial effect on the water resources of the basin shall hereafter be undertaken by any person, corporation or governmental authority unless it shall have been first submitted to and approved by the Commission…." In section 2.3.5 of the Commission's *Rules of Practice and Procedure* ("RPP"), the Commission has defined those projects that may have a substantial effect on the water resources of the basin in part by establishing thresholds for the daily average gross water withdrawal during any 30 consecutive day period and by the daily average design capacity of domestic sewage treatment facilities. Some natural gas extraction projects may exceed these thresholds and therefore be subject to review pursuant to these provisions, while others may fall below the thresholds and therefore not be subject to review pursuant to these provisions. The RPP further require the sponsor of any project that involves any discharge of pollutants into surface or ground waters of the basin irrespective of quantity to obtain Commission approval. RPP section 2.3.5B.6. See also Commission Water Code section 3.40

In recognition of the importance of protecting high quality waters that are subject to the Commission's antidegradation regulations, the RPP also give the Executive Director the authority in her discretion to require a project sponsor to obtain Commission approval notwithstanding the fact that the thresholds in the RPP have not been exceeded. Section 2.3.5B.18 of the RPP includes as a reviewable project: "Any other project that the Executive Director may specially direct by notice to the project sponsor or land owner as having a potential substantial water quality impact on waters classified as Special Protection Waters." Most of the shale formations that may be subject to the new horizontal drilling and hydraulic fracturing techniques are located within the drainage area to Special Protection Waters. The Executive Director has considered and has now determined that as a result of water withdrawals, wastewater disposal and other activities, natural gas extraction projects in these shale formations may individually or cumulatively affect the water quality of Special Protection Waters by altering their physical, biological, chemical or hydrological characteristics.

The Executive Director therefore specially directs by this notice to natural gas extraction project sponsors that they may not commence any natural gas extraction project located in shale formations within the drainage area of Special Protection Waters without first applying for and obtaining Commission approval. For this purpose a project encompasses the drilling pad upon which a well intended for eventual production is located, all appurtenant facilities and activities related thereto and all locations of water withdrawals used or to be used to supply water to the project. Wells intended solely for exploratory purposes are not covered by this Determination. Commencing a project encompasses performing any of the activities associated with the project, including the activities identified in the first paragraph above. The Commission recognizes that each natural gas extraction project will also be subject to the review of the environmental agency of the state or Commonwealth in which the project is located and in some cases, subject to federal agency review. The Commission intends to coordinate with and where feasible to utilize the review process and approvals of the applicable state or federal agency to minimize duplication of effort and redundant requirements imposed on project sponsors.

A copy of this Declaration will be posted on the Commission's website, and additional copies will be mailed directly to those project sponsors and potential project sponsors that the Commission has identified. The Commission intends to promulgate regulations pertaining to the subject matter of this Declaration after public notice and a full opportunity for public comment.

Any person adversely affected by this Determination may request a hearing by submitting a request in writing to the Commission Secretary within thirty (30) days of the date of this Determination in accordance with the RPP.

Carol R. Collier

Carol R. Collier, Executive Director
Dated: May 19, 2009

EXHIBIT B

Statement by the Delaware River Basin Commission (DRBC) on the Upper Delaware River Being Named by American Rivers to its "America's Most Endangered Rivers" List
June 2, 2010

Being named to a "most endangered list" can lead uninformed people to draw incorrect conclusions that the quality of the Upper Delaware River is deteriorating. This is far from the truth and the five members of the Delaware River Basin Commission (DRBC) – Pennsylvania, New York, New Jersey, Delaware, and the federal government – intend on keeping it that way.

The DRBC recognizes the importance of natural gas development to the region and the nation, and is not opposed to the appropriate development of this natural resource. But we must make sure that any natural gas development is done smartly so we do not harm the incredible water resources of the Delaware River Basin (DRB) and the over 15 million people it serves.

Over three-quarters of the non-tidal Delaware River has been added to the National Wild and Scenic Rivers System. To support that federal action, DRBC has designated the entire 197-mile non-tidal Delaware River as Special Protection Waters (SPW) precisely because the water quality is better than the standards that protect the designated uses of the waterway. This designation provides these waters with protection under the DRBC's anti-degradation regulations and coincides with the location of shale deposits in the DRB.

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. Direct water resource concerns include 1) the potentially large amount of water consumed in the shale fracking process; 2) potential on-site spills and impacts to groundwater and nearby streams; and 3) storage, transport, treatment, and disposal of the "flow-back and production waters."

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 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.

Both Pennsylvania and New York regulate gas well drilling activities in their respective states. The DRBC, which has separate legal authority over both water quality and water quantity-related issues throughout the basin, has also asserted its review over gas well drilling projects. The DRBC's role, which complements state requirements, reflects the significance and importance of a basin that supplies water to over 15 million people. To date, the DRBC has not approved any natural gas well drilling within the basin or natural gas-related water withdrawal.

On May 5, 2010, the DRBC commissioners agreed that no natural gas well pad applications for shales would be considered by the agency until specific regulations are adopted. DRBC staff were already in the process of drafting the regulations, and the commissioners determined that it

(over)

was logical for the development of new regulations to move forward in advance of any individual project decisions relating to natural gas well pads. The rulemaking process followed by the commission includes public notice and a full opportunity for public comment before the commissioners adopt the regulations.

Due to the May 2010 decision by the commissioners to postpone DRBC consideration of well pad applications until the new regulations are adopted, there has been a lot of recent interest about exploratory wells. Policy options now under consideration include: 1) possibly supplementing the May 2009 executive director determination to also cover wells intended solely for exploratory purposes; and 2) addressing both production and exploratory wells in the new regulations now under development.

The DRBC looks forward to working with the entire basin community to ensure that proper environmental controls are provided to safeguard the outstanding water resources of the Delaware River Basin both now and in the future.

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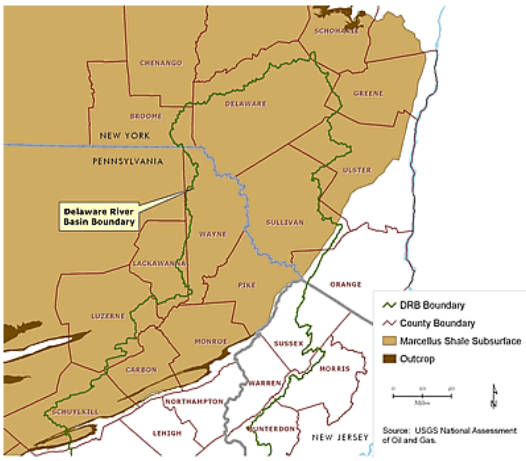
EXHIBIT C

Natural Gas Drilling Index Page

Background



Much of the new drilling interest taking place in northeastern Pennsylvania and southern New York is targeted at reaching the natural gas found in the Marcellus Shale formation, which underlies about 36 percent of the Delaware River Basin. Because the Marcellus Shale is considered a tight geologic formation, natural gas deposits were not previously thought to be practically and economically mineable using traditional techniques. New horizontal drilling and extraction methods, coupled with higher energy costs, have given energy companies reason to take a new interest in mining the natural gas deposits within the Marcellus Shale.

However, these new extraction methods require large amounts of fresh water to fracture the formation to release the natural gas. A significant amount of water used in the extraction process is recovered, but this "frac water" includes natural gas and chemicals added to facilitate the extraction process, as well as brine and other contaminants released from the formation.

Why Is The DRBC Involved?

The DRBC is a federal-interstate compact government agency that was formed by concurrent legislation enacted in 1961 by the United States and the four basin states (Pennsylvania, New York, New Jersey, and Delaware). Its five members include the basin state governors and the Division Engineer, North Atlantic Division, U.S. Army Corps of Engineers, who serves as the federal representative. The commission has legal authority over both water quality and water quantity-related issues throughout the basin.

In connection with natural gas drilling, the commission has identified three major areas of concern:

1. Gas drilling projects in the Marcellus Shale or other formations may have a substantial effect on the water resources of the basin by reducing the flow in streams and/or aquifers used to supply the significant amounts of fresh water needed in the natural gas mining process.
2. On-site drilling operations may potentially add, discharge or cause the release of pollutants into the ground water or surface water.
3. The recovered "frac water" must be treated and disposed of properly.

Note: The commission does not get involved in the private negotiations taking place between natural gas drilling companies and private property owners. However, property owners are advised to seek appropriate technical and legal representation to ensure that they obtain adequate protection of their property.

Status of DRBC Adoption of Regulations

The commissioners at their May 5, 2010 meeting unanimously directed staff to develop draft regulations in the shales for notice and comment rulemaking and postponed the DRBC's consideration of well pad dockets until regulations are adopted. The special meeting scheduled for Nov. 21, 2011 to consider adoption of draft natural gas development regulations was postponed to allow additional time for review by the five DRBC members. There are still some unresolved issues that the commissioners are working through and no new date has yet been announced for a vote on the draft regulations. Further information regarding the rulemaking will be posted on DRBC's web site as soon as it becomes available.

Natural Gas Drilling Index Page

Natural Gas Archives

Draft Natural Gas Regulations (info. on 12/9/10 draft and 11/8/11 revised draft)

Comments on Dec. 2010 Draft Regulations

Map: DRBC SPW, SPW Drainage Area, and Marcellus Shale Formation (pdf 1.1 MB)

Related Links

Sign Up to Receive Email Notice of Important DRBC Natural Gas Updates

DRBC Authorities, Regulations, and Guidance

DRBC Project Review/Permitting

New York State Dept. of Environmental Conservation

Pennsylvania Department of Environmental Protection

U.S. Environmental Protection Agency

EXHIBIT D

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 Westgate Center Drive
Hadley, MA 01035-9589

In Reply Refer To:
FWS/Region 5/ES

JUN 25 2010

Carol Collier, Executive Director
Delaware River Basin Commission
P.O. Box 7360
West Trenton, New Jersey 08628-0360

Dear Ms. Collier:

The National Park Service (NPS) and the U.S. Fish and Wildlife Service (USFWS) (jointly the Services) strongly support the Delaware River Basin Commission's (Commission) June 14, 2010, Supplemental Determination of the Executive Director expanding the requirement for Commission approval to new natural gas "exploratory" well projects and gas wells drilled through shale formations, in the area draining to the Special Protection Waters (SPW) in the Delaware River Basin. However, the Services believe that those "exploratory" wells already approved by the Pennsylvania Department of Environmental Protection (PADEP) should also be subject to Commission review under the new regulations now being drafted by your staff.

Consideration of all Natural Gas Projects

With the exception of activities related to hydraulic fracturing (for increasing production), the environmental effects of natural gas well construction, either as a "production" well or as an "exploratory" well, or into shale or non-shale formations, is virtually identical. Each drilling project involves construction of a well pad and associated roadways, the drilling of a well bore, the withdrawal and transport of surface or groundwater, and the recovery and handling of flow-back water and drilling fluids. As stated in your May 19, 2009, Executive Director's Determination, "Each of these activities, if not performed properly, may cause adverse environmental effects, including effects on water resources."

Additionally, it appears to be industry standard to convert exploratory or test wells to full production wells if suitable gas deposits are encountered. Based on our discussions with PADEP staff working on Marcellus permitting in southwestern Pennsylvania, we concluded that exploratory wells fall into two general categories. A small number of wells (e.g., one to two per county) are drilled during the initial phase of expansion into a new area and are truly exploratory wells intended to optimize drilling practices for the new area. The second and larger category of "exploratory" wells includes wells drilled during subsequent expansion into an area. Only a very small percentage of these wells are abandoned without being converted to a production well. In fact, Pennsylvania regulations do not distinguish between exploratory and production wells for State-issued permits. The high rate of exploratory-to-production well conversion, the environmental effects common to both, and the cumulative effects are of concern to the Services.

Trust Resources

The high quality waters and habitats of the upper Delaware Basin support a variety of natural resources that are managed in trust by the Services for the benefit of the American people. Large-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.

The natural resources of concern include the NPS Upper Delaware Scenic and Recreational River, the Delaware Water Gap National Recreation Area, the Middle Delaware National Scenic River, and the Lower Delaware Wild & Scenic River. The legislation establishing these units cited the need to protect the "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values ...and to fulfill other vital national conservation purposes."

USFWS trust resources in the Delaware Basin include federally listed species, migratory birds, several inter-jurisdictional fishes, and an approved National Wildlife Refuge. The species are protected under the Endangered Species Act (16 U.S.C. 1531 et. seq.) include the federally listed dwarf wedgemussel (*Alasmidonta heterodon*), Indiana bat (*Myotis sodalis*), bog turtle (*Glyptemys muhlenbergii*), and Northeastern bulrush (*Scirpus ancistrochaetus*).

The USFWS administers migratory birds under the Migratory Bird Treaty Act (16 U.S.C. 703 et seq.) and the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d). Approximately 200 species of migratory birds have been identified within the upper Delaware Basin, including an increasing population of bald eagles (*Haliaeetus leucocephalus*) and the largest congregation of wintering bald eagles in the northeast. Additionally, the Delaware River corridor and the corridor along the Kittatinny Ridge within the watershed are designated as Audubon Important Bird Areas. Many species of migratory birds for which USFWS has responsibility breed in or migrate through the high-quality riparian corridors of the Basin.

Managed fish species inhabiting the Delaware River and its tributaries include, but are not limited to, the federally endangered shortnose sturgeon (*Acipenser brevirostrum*), the American shad (*Alosa sapidissima*), Eastern brook trout (*Salvelinus fontinalis*), and American eel (*Anguilla rostrata*). These and other migratory fish species in the Delaware River and its tributaries are important to the aquatic environment and to the economies of many Pennsylvania, New York, and New Jersey communities.

The USFWS has also recently approved the creation of the Cherry Valley National Wildlife Refuge in eastern Pennsylvania. Cherry Creek, in the bottom of the valley, ultimately flows into the Delaware River. The established boundary for this new refuge encompasses 20,466 acres in Monroe and Northampton counties, and when completed will protect an area that stretches west from the Delaware Water Gap National Recreation Area and encompasses a stretch of the Appalachian Trail and the slopes of Kittatinny Ridge.

Summary

Natural gas development has the potential to significantly degrade the natural habitats and water quality in the Delaware River Basin, therefore we fully support the Commission's review of all natural gas well projects in the areas draining to SPW. Furthermore, we strongly support the Commission's promulgation of new regulations for assessing the individual and cumulative effects of natural gas development and believe that through thoughtful siting of gas well pads and infrastructure and the use of Best Management Practices, degradation of the high quality natural resources in the Basin can be minimized. We look forward to working with you in the future on this issue. Please contact Paul Phifer, Assistant Regional Director for Ecological Services, at 413-253-8304, if you have any questions.

Sincerely,

Marvin E. Moriarty
Acting Northeast Regional Director, USFWS

Dennis R. Reidenbach

Dennis Reidenbach
Northeast Regional Director, NPS

EXHIBIT E

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers, North Atlantic Division
Bldg 302, General Lee Avenue
Brooklyn, NY 11252

September 14th, 2010

Office of Rep. Hinchey
2431 Rayburn H.O.B.
Washington, DC 20515
Phone: (202) 225-6335
Fax: (202) 226-0774

Dear Congressman Hinchey:

Thank you very much for your letter and concern regarding the Delaware River Basin Commission's role and tasks regarding Marcellus Shale Gas Drilling in the basin.

The commissioners and staff of the DRBC all appreciate your efforts, with your colleagues in Congress, to secure the required funding to enable the joint U.S. Geological Survey-DRBC cumulative impact study on water withdrawals for gas drilling within the Basin, and we look forward to final approval and appropriation of these resources for Fiscal Year 2011.

The process to execute this study and its results would greatly enhance the ability of the Commission to make informed decisions over the long life cycle of gas energy development in the region. However, there are many steps left in the legislative process; and even if things progress promptly, it could be several years before the final results of the study are known.

The federal family of agencies that I represent on the commission are collectively charged with a requirement to support the economic needs of the region and our nation's need to secure energy reserves while protecting the environment. The citizens of the Basin are counting on the Commission to make smart choices that allow for environmental protection to proceed together with economic development. This balancing was an underlying reason for the creation of the Commission. The DRBC has therefore attempted to avoid undue delays to the exploratory well program and is continuing to approve water withdrawal requests from drilling companies while withholding approvals for production wells so far.

The results of test wells within the basin could better inform the scope and scale of the needed cumulative impacts study and frame the parameters of it with fewer assumptions and more facts. This is of great benefit to the Commission in its responsibilities and to the basin. Natural gas is not uniformly distributed throughout the Marcellus and Utica Shales nor is it uniformly distributed around the Delaware Basin. For these reasons among others, the DRBC is moving forward very deliberately and carefully with draft regulations that are designed to facilitate natural gas development while protecting the water resources of the basin.

The Commission has stated that it will not approve production wells until the regulations are refined and are in place. I will do my part to stand by that commitment because I believe the economic development and resource protection goals can both be achieved if the entire Basin community works together cooperatively. If draft regulations proceed as expected, there will be several public hearings as well as a written comment period sometime later in the calendar year. The Commission values public participation from all stakeholders and invites their comments, as the final regulations will be the benchmark for future decisions on proposed projects.

As you may know, Lt. Col. Philip M. Secrist, the U.S. Army Corps of Engineers Philadelphia District Engineer and alternate Federal Commissioner, will represent the federal government at the Commission public meeting on Sept. 15, 2011. He is aware of your concerns, the position of the federal agencies, and of my thoughts summarized here, on how to best represent our federal partners within the Commission.

I would welcome a chance to talk with you and/or your staff regarding the Federal programs and oversight activities related to natural gas energy development in the Marcellus Shale and the Delaware Basin and how we are representing these agencies in the activities of the Commission. You or your staff may contact me r my administrative assistant anytime at 347-370-4500 to set up a meeting or telephone conversation.

Sincerely,

Duke DeLuca
Brigadier General, U.S. Army
Division Engineer/DRBC Federal Commissioner

EXHIBIT F

EPA/600/R-11/122/November 2011/www.epa.gov/research

United States
Environmental Protection
Agency

Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

United States Environmental Protection Agency
Office of Research and Development

EPA/600/R-11/122
November 2011

United States
Environmental Protection
Agency

Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

Office of Research and Development

US Environmental Protection Agency

Washington, D.C.

November 2011

surface or ground water and ends with discharge into surface waters or injection into deep wells. Specifically, the water lifecycle for hydraulic fracturing consists of water acquisition, chemical mixing, well injection, flowback and produced water (collectively referred to as "hydraulic fracturing wastewater"), and wastewater treatment and waste disposal.

The EPA study is designed to provide decision-makers and the public with answers to the five fundamental questions associated with the hydraulic fracturing water lifecycle:

- Water Acquisition: What are the potential impacts of large volume water withdrawals from ground and surface waters on drinking water resources?
- Chemical Mixing: What are the possible impacts of surface spills on or near well pads of hydraulic fracturing fluids on drinking water resources?
- Well Injection: What are the possible impacts of the injection and fracturing process on drinking water resources?
- Flowback and Produced Water: What are the possible impacts of surface spills on or near well pads of flowback and produced water on drinking water resources?
- Wastewater Treatment and Waste Disposal: What are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?

Answering these questions will involve the efforts of scientists and engineers with a broad range of expertise, including petroleum engineering, fate and transport modeling, ground water hydrology, and toxicology. The study will be conducted by multidisciplinary teams of EPA researchers, in collaboration with outside experts from the public and private sector. The Agency will use existing data from hydraulic fracturing service companies and oil and gas operators, federal and state agencies, and other sources. To supplement this information, EPA will conduct case studies in the field and generalized scenario evaluations using computer modeling. Where applicable, laboratory studies will be conducted to provide a better understanding of hydraulic fracturing fluid and shale rock interactions, the treatability of hydraulic fracturing wastewaters, and the toxicological characteristics of high-priority constituents of concern in hydraulic fracturing fluids and wastewater. EPA has also included a screening analysis of whether hydraulic fracturing activities may be disproportionately occurring in communities with environmental justice concerns.

Existing data will be used answer research questions associated with all stages of the water lifecycle, from water acquisition to wastewater treatment and waste disposal. EPA has requested information from hydraulic fracturing service companies and oil and gas well operators on the sources of water used in hydraulic fracturing fluids, the composition of these fluids, well construction practices, and wastewater treatment practices. EPA will use these data, as well as other publically available data, to help assess the potential impacts of hydraulic fracturing on drinking water resources.

Retrospective case studies will focus on investigating reported instances of drinking water resource contamination in areas where hydraulic fracturing has already occurred. EPA will conduct retrospective case studies at five sites across the US. The sites will be illustrative of the types of problems that have been reported to EPA during stakeholder meetings held in 2010 and 2011. A determination will be made

EXHIBIT G

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

DEC 30 2009

dSGEIS Comments
Bureau of Oil & Gas Regulation
NYSDEC Division of Mineral Resources
625 Broadway, Third Floor
Albany, NY 12233-6500

Dear Sir or Madam:

The U.S. Environmental Protection Agency (EPA) has reviewed the September 2009 draft Supplemental Generic Environmental Impact Statement (dSGEIS) that was prepared by the New York State Department of Environmental Conservation (NYSDEC) Division of Mineral Resources on the Oil, Gas and Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs. The purpose of the dSGEIS is to satisfy the requirements of the State Environmental Quality Review Act (SEQRA) for NYSDEC to review and process permit applications for the horizontal drilling and hydraulic fracturing (hydrofracturing) of natural gas bearing shales, including the Marcellus Shale. This letter responds to NYSDEC's requests for comments on the dSGEIS and presents EPA's major concerns. Technical comments on the dSGEIS are enclosed.

EPA believes that the analysis and discussion of cumulative and indirect impacts in the dSGEIS need to be significantly expanded. Even with its generic format, the dSGEIS should discuss the impacts that may result from past, present, and reasonably foreseeable future projects as well as those impacts associated with gas drilling and hydrofracturing that may occur later in time or at a distance from the immediate project site. For example, as the New York State Public Service Commission (PSC) has the regulatory authority over the construction and operation of the natural gas gathering pipes, the dSGEIS does not include an evaluation of the environmental impacts of the separate yet interrelated actions of siting and constructing gathering lines. EPA also notes that the dSGEIS does not analyze the impacts from new drilling service industries that would undoubtedly result. To ensure a full analysis of cumulative and indirect impacts, we recommend that the PSC become a cooperating agency and that the PSC-related issues be fully integrated in the finalization of this document, and that all potential environmental impacts for the actions of drilling, hydrofracturing, collecting and transporting natural gas from the Marcellus Shale be assessed. Such collaboration may also provide the opportunity to coordinate actions in order to minimize the amount of flaring of gas between the time of opening a well and the construction of gathering lines.

In addition, a greater emphasis needs to be placed on the potential health impacts that may be associated with gas drilling and hydrofracturing. EPA suggests that the New York State Department of Health (DOH) join NYSDEC as a co-lead on the SEQRA document. Not only does DOH have expertise to offer on health impacts, but it was delegated primary enforcement responsibility (primacy) of the Safe Drinking Water Act by EPA. This is of direct interest to EPA as we are responsible for overseeing DOH's implementation and enforcement of the drinking water program.

While EPA understands that this dSGEIS is the SEQRA documentation to specifically evaluate hydraulic fracturing, it supplements a 1992 SEQRA document. EPA is concerned that over the past 17 years since the 1992 GEIS was written, the "existing" environment and conditions in New York State have changed sufficiently that using the information from that report as a baseline for the dSGEIS will not take into account the cumulative impacts from habitat fragmentation, population increase, and climate change that may have occurred during that time.

EPA is particularly concerned about the potential risks associated with gas drilling activities in the New York City watershed and the reservoirs that collect drinking water for nine million people. As a signatory to the 1997 New York City Watershed Memorandum of Agreement (MOA), EPA strongly supports its major tenets, one of which is that watershed protection and community vitality can be achieved concurrently. Nevertheless, the potential for gas drilling in the watershed poses new challenges that were unanticipated at the point at which the MOA signatories agreed on a common approach to protect drinking water. Despite the mitigation measures already proposed by NYSDEC in the dSGEIS, EPA has serious reservations about whether gas drilling in the New York City watershed is consistent with the vision of long-term maintenance of a high quality unfiltered water supply. As NYSDEC is well aware, the watershed supplies drinking water to over nine million people and the avoidance of filtration saves New York taxpayers billions of dollars that would be needed to construct and operate a water filtration plant should the watershed be compromised.

EPA agrees with the sentiments expressed by Acting Commissioner Steven Lawitts of the New York City Department of Environmental Protection (NYCDEP) in his December 23, 2009 comment letter to NYSDEC: "Balancing environmental and public health concerns with the need for adequate energy resources and economic development is a complex and challenging issue – not only in New York but throughout the nation." Acting Commissioner Lawitts also states, "New York City's watershed is a unique resource and deserves special attention and consideration." To address this concern, EPA recommends a very cautious approach in all watershed areas so that NYSDEC can gain experience with, as well as ensure it has the resource capacity for regulating, high volume hydraulic fracturing activities.

Periodically, EPA reviews drinking water quality in the New York City watershed to ensure that drinking water meets all drinking water standards. If gas drilling, however, adversely impacts water quality in the watershed, the city of New York would likely be required to build a filtration treatment system at an expenditure of $10 billion in capital costs and $100 million in annual operating costs. Clearly, it is in all our interests to avoid this scenario.

Although EPA has not had the opportunity to fully review the information contained in NYCDEP's Final Impact Assessment Report, we expect NYSDEC to incorporate appropriate technical information into the SEQRA document. Furthermore, we repeat our proposal of late 2008, that NYSDEC partner with EPA and the NYCDEP to develop an enhanced oversight approach for the New York City watershed that would allow for coordination of regulatory programs such as stormwater permitting, industrial pretreatment, and underground injection control as they relate to horizontal drilling and high volume hydraulic fracturing of the Marcellus Shale. While protecting the New York City watershed is important because of the millions of New Yorkers who rely on this drinking water supply, we also have concerns about water quality impacts throughout the state. Just because fewer people rely on upstate water sources does not imply that these supplies are not also worthy of protection. Therefore, we extend an offer to partner with NYSDEC on similar coordinated efforts state-wide.

Moreover, EPA strongly recommends that the SEQRA documentation reflect any and all direct consultation with each of the Indian Nations in New York State as the dSGEIS does not specifically discuss the impact on the nations. While EPA is aware that NYSDEC has already taken steps in this regard, at the EPA annual Indian leaders meeting in November 2009, representatives of virtually every Indian Nation expressed serious opposition to hydrofracturing. Indian Nation concerns include the radioactivity of cuttings and flowback materials, the fate of toxic/carcinogenic chemicals used in hydrofracturing solutions, the impact on water quality and supply, climate impacts and long-term sustainability.

In addition, to the extent allowed by law, EPA encourages NYSDEC to release information regarding the composition of the hydrofracturing solutions that are expected to be used.

In conclusion, EPA believes that NYSDEC has prepared an informative dSGEIS on hydrologic fracturing of the Marcellus Shale. However, we have concerns regarding potential impacts to human health and the environment that we believe warrant further scientific and regulatory analysis. Of particular concern to EPA are issues involving water supply, water quality, wastewater treatment operations, local and regional air quality, management of naturally occurring radioactive materials disturbed during drilling, cumulative environmental impacts, and the New York City watershed. EPA recommends that these concerns be addressed and essential environmental protection measures established prior to the completion of the SEQRA process.

Thank you for the opportunity to comment on the dSGEIS. EPA's technical comments on the document are enclosed. If you have any questions, please call Lingard Knutson of my staff at (212) 637-3747.

Sincerely,

John Filippelli

John Filippelli, Chief
Strategic Planning and Multi-Media Programs Branch

Enclosure

EXHIBIT H

EPA United States Environmental Protection Agency

EPA 600/R-00/000 | December 2011 | www.epa.gov/ord

DRAFT

Investigation of Ground Water Contamination near Pavillion, Wyoming

Office of Research and Development
National Risk Management Research Laboratory, Ada, Oklahoma 74820

DRAFT

Investigation of Ground Water Contamination near Pavillion, Wyoming

Dominic C. DiGiulio
Richard T. Wilkin
Carlyle Miller
U.S. Environmental Protection Agency
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Gregory Oberley
U.S. Environmental Protection Agency
Region 8
1595 Wynkoop Street
Denver, CO 80202

Office of Research and Development
National Risk Management Research Laboratory, Ada, Oklahoma 74820

Extended Abstract

In response to complaints by domestic well owners regarding objectionable taste and odor problems in well water, the U.S. Environmental Protection Agency initiated a ground water investigation near the town of Pavillion, Wyoming under authority of the Comprehensive Environmental Response, Compensation, and Liability Act. The Wind River Formation is the principal source of domestic, municipal, and stock (ranch, agricultural) water in the area of Pavillion and meets the Agency's definition of an Underground Source of Drinking Water. Domestic wells in the area of investigation overlie the Pavillion gas field which consists of 169 production wells which extract gas from the lower Wind River Formation and underlying Fort Union Formation. Hydraulic fracturing in gas production wells occurred as shallow as 372 meters below ground surface with associated surface casing as shallow as 110 meters below ground surface. Domestic and stock wells in the area are screened as deep as 244 meters below ground surface. With the exception of two production wells, surface casing of gas production wells do not extend below the maximum depth of domestic wells in the area of investigation. At least 33 surface pits previously used for the storage/disposal of drilling wastes and produced and flowback waters are present in the area. The objective of the Agency's investigation was to determine the presence, not extent, of ground water contamination in the formation and if possible to differentiate shallow source terms (pits, septic systems, agricultural and domestic practices) from deeper source terms (gas production wells).

The Agency conducted four sampling events (Phase I - IV) beginning in March 2009 and ending in April, 2011. Ground water samples were collected from domestic wells and two municipal wells in the town of Pavillion in Phase I. Detection of methane and dissolved hydrocarbons in several domestic wells prompted collection of a second round of samples in January, 2010 (Phase II). During this phase, EPA collected additional ground water samples from domestic and stock wells and ground water samples from 3 shallow monitoring wells and soil samples near the perimeter of three known pit locations. Detection of elevated levels of methane and diesel range organics (DRO) in deep domestic wells prompted the Agency to install 2 deep monitoring wells screened at 233 - 239 meters (MW01) and 293 - 299 meters (MW02) below ground surface, respectively, in June 2010 to better evaluate to deeper sources of contamination. The expense of drilling deep wells while utilizing blowout prevention was the primary limiting factor in the number of monitoring wells installed. In September 2010 (Phase III), EPA collected gas samples from well casing from MW01 and MW02. In October 2010, EPA collected ground water samples from MW01 and MW02 in addition to a number of domestic wells. In April 2011 (Phase IV), EPA resampled the 2 deep monitoring wells to compare previous findings and to expand the analyte list to include glycols, alcohols, and low molecular weight acids.

Detection of high concentrations of benzene, xylenes, gasoline range organics, diesel range organics, and total purgeable hydrocarbons in ground water samples from shallow monitoring wells near pits indicates that pits are a source of shallow ground water contamination in the area of investigation. When considered separately, pits represent potential source terms for localized ground water plumes of unknown extent. When considered as whole they represent potential broader contamination of shallow ground water. A number of stock and domestic wells in the area of investigation are fairly shallow (e.g., < 30 meters below ground surface) representing potential receptor pathways.

Determination of the sources of inorganic and organic geochemical anomalies in deeper ground water was considerably more complex than determination of sources in shallow media necessitating the use of mulitiple lines of reasoning approach common to complex scientific investigations. pH values in MW01 and MW01 are highly alkaline (11.2-12.0) with up to 94% of the total alkalinity contributed by hydroxide suggesting addition of a strong base as the causative factor. Reaction path modeling indicates that sodium-sulfate composition of ground water typical of deeper portions of the Wind River Formation provides little resistance to elevation of pH with small addition of potassium hydroxide. Potassium hydroxide was used in a crosslinker and in a solvent at this site.

The inorganic geochemistry of ground water from the deep monitoring wells is distinctive from that in the domestic wells and expected composition in the Wind River formation. Potassium concentration in MW02 (43.6 milligrams per liter) and MW01 (54.9 milligrams per liter) is between 14.5 and 18.3 times values in domestic wells and expected values in the formation. Chloride concentration in monitoring well MW02 (466 milligrams per liter) is 18 times the mean chloride concentration (25.6 milligrams per liter) observed in ground water from domestic wells and expected in the formation. Chloride enrichment in this well is significant because regional anion trends show decreasing chloride concentration with depth. In addition, the monitoring wells show low calcium, sodium, and sulfate concentrations compared to the general trend observed in domestic well waters. The formulation of fracture fluid provided for carbon dioxide foam hydraulic fracturing jobs typically consisted of 6% potassium chloride. Potassium metaborate was used in crosslinkers. Potassium hydroxide was used in a crosslinker and in a solvent. Ammonium chloride was used in crosslinker.

A number of synthetic organic compounds were detected in MW01 and MW02. Isopropanol was detected in MW01 and MW02 at 212 and 581 micrograms per liter, respectively. Diethylene glycol was detected in MW01 and MW02 at 226 and 1570 micrograms per liter, respectively. Triethylene glycol was detected in MW01 and MW02 at 46 and 310 micrograms per liter, respectively. Another synthetic compound, *tert*-butyl alcohol, was detected in MW02 at a concentration of 4470 micrograms per liter. Isopropanol was used in a biocide, in a surfactant, in breakers, and in foaming agents. Diethylene glycol was used in a foaming agent and in a solvent. Triethylene glycol was used in a solvent. *Tert*-butyl alcohol is a known breakdown product of methyl *tert*-butyl ether (a fuel additive) and *tert*-butyl hydroperoxide (a gel breaker used in hydraulic fracturing). Material Safety Data Sheets do not indicate that fuel or tert-butyl hydroperoxide were used in the Pavillion gas field. However, Material Safety Data Sheets do not contain proprietary information and the chemical ingredients of many additives. The source of *tert*-butyl alcohol remains unresolved. However, *tert*-butyl alcohol is not expected to occur naturally in ground water.

Benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected in MW02 at concentrations of 246, 617, 67, and 750 micrograms per liter, respectively. Trimethylbenzenes were detected in MW02 at 105 micrograms per liter. Gasoline range organics were detected in MW01 and MW02 at 592 and 3710 micrograms per liter. Diesel range organics were detected in MW01 and MW02 at 924 and 4050 micrograms per liter, respectively. Aromatic solvent (typically BTEX mixture) was used in a breaker. Diesel oil (mixture of saturated and aromatic hydrocarbons including naphthalenes and alkylbenzenes) was used in a guar polymer slurry/liquid gel concentrate and in a solvent. Petroleum raffinates (mixture of paraffinic, cycloparaffinic, olefinic, and aromatic hydrocarbons) were used in a breaker. Heavy aromatic petroleum naphtha (mixture of paraffinic, cycloparaffinic and aromatic hydrocarbons) was used in surfactants and in a solvent. Toluene and xylene were used in flow enhancers and a breaker.

Detections of organic chemicals were more numerous and exhibited higher concentrations in the deeper of the two monitoring wells. Natural breakdown products of organic contaminants like BTEX and glycols include acetate and benzoic acid. These breakdown products are more enriched in the shallower of the two monitoring wells, suggesting upward/lateral migration with natural degradation and accumulation of daughter products. Hydraulic gradients are currently undefined in the area of investigation. However, there are flowing conditions in a number of deep stock wells suggesting that upward gradients exist in the area of investigation.

Alternative explanations were carefully considered to explain individual sets of data. However, when considered together with other lines of evidence, the data indicates likely impact to ground water that can be explained by hydraulic fracturing. A review of well completion reports and cement bond/variable density logs in the area around MW01 and MW02 indicates instances of sporadic bonding outside production casing directly above intervals of hydraulic fracturing. Also, there is little lateral and vertical continuity of hydraulically fractured tight sandstones and no lithologic barrier (laterally continuous shale units) to stop upward vertical migration of aqueous constituents of hydraulic fracturing in the event of excursion from fractures. In the event of excursion from sandstone units, vertical migration of fluids could also occur via nearby wellbores. For instance, at one production well, the cement bond/variable density log indicates no cement until 671 m below ground surface. Hydraulic fracturing occurred above this depth at nearby production wells.

A similar lines of reasoning approach was utilized to evaluate the presence of gas in monitoring and domestic wells. A comparison of gas composition and stable carbon isotope values indicate that gas in production and monitoring wells is of similar thermogenic origin and has undergone little or no degradation. A similar evaluation in domestic wells suggests the presence of gas of thermogenic origin undergoing biodegradation. This observation is consistent with a pattern of dispersion and degradation with upward migration observed for organic compounds.

Elevated levels of dissolved methane in domestic wells generally increase in those wells in proximity to gas production wells. Near surface concentrations of methane appear highest in the area encompassing MW01. Ground water is saturated with methane at MW01 which is screened at a depth (239 meters below ground surface) typical of deeper domestic wells in the area. A blowout occurred during drilling of a domestic well at a depth of only 159 meters below ground surface close to MW01. A mud-gas log conducted in 1980 (prior to intensive gas production well installation) located only 300 m from the location of the blowout does not indicate a gas show (distinctive peaks on a gas chromatograph) within 300 meters of the surface. Again, with the exception of two production wells, surface casing of gas production wells do not extend below the maximum depth of domestic wells in the area of investigation. A number of production wells in the vicinity of MW01 have sporadic bonding or no cement over large vertical instances. Again, alternate explanations of data have been considered. Although some natural migration of gas would be expected above a gas field such as Pavillion, data suggest that enhanced migration of gas has occurred within ground water at depths used for domestic water supply and to domestic wells. Further investigation would be needed to determine the extent of gas migration and the fate and transport processes influencing migration to domestic wells.

EXHIBIT I

The SEAB Shale Gas Production Subcommittee
Ninety-Day Report – August 11, 2011

Executive Summary

The Shale Gas Subcommittee of the Secretary of Energy Advisory Board is charged with identifying measures that can be taken to reduce the environmental impact and improve the safety of shale gas production.

Natural gas is a cornerstone of the U.S. economy, providing a quarter of the country's total energy. Owing to breakthroughs in technology, production from shale formations has gone from a negligible amount just a few years ago to being almost 30 percent of total U.S. natural gas production. This has brought lower prices, domestic jobs, and the prospect of enhanced national security due to the potential of substantial production growth. But the growth has also brought questions about whether both current and future production can be done in an environmentally sound fashion that meets the needs of public trust.

This 90-day report presents recommendations that if implemented will reduce the environmental impacts from shale gas production. The Subcommittee stresses the importance of a process of continuous improvement in the various aspects of shale gas production that relies on best practices and is tied to measurement and disclosure. While many companies are following such a process, much-broader and more extensive adoption is warranted. The approach benefits all parties in shale gas production: regulators will have more complete and accurate information; industry will achieve more efficient operations; and the public will see continuous, measurable improvement in shale gas activities.

A list of the Subcommittee's findings and recommendations follows.

- Improve public information about shale gas operations: Create a portal for access to a wide range of public information on shale gas development, to include current data available from state and federal regulatory agencies. The portal should be open to the public for use to study and analyze shale gas operations and results.

The rapid expansion of production is rooted in change in applications of technology and field practice. It had long been recognized that substantial supplies of natural gas were embedded in shale rock. But it was only in 2002 and 2003 that the combination of two technologies working together – hydraulic fracturing and horizontal drilling – made shale gas commercial.

These factors have brought new regions into the supply mix. Parts of the country, such as regions of the Appalachian mountain states where the Marcellus Shale is located, which have not experienced significant oil and gas development for decades, are now undergoing significant development pressure. Pennsylvania, for example, which produced only one percent of total dry gas production in 2009, is one of the most active new areas of development. Even states with a history of oil and gas development, such as Wyoming and Colorado, have experienced significant development pressures in new areas of the state where unconventional gas is now technically and economically accessible due to changes in drilling and development technologies.

The urgency of addressing environmental consequences

As with all energy use, shale gas must be produced in a manner that prevents, minimizes and mitigates environmental damage and the risk of accidents and protects public health and safety. Public concern and debate about the production of shale gas has grown as shale gas output has expanded.

The Subcommittee identifies four major areas of concern: (1) Possible pollution of drinking water from methane and chemicals used in fracturing fluids; (2) Air pollution; (3) Community disruption during shale gas production; and (4) Cumulative adverse impacts that intensive shale production can have on communities and ecosystems.

There are serious environmental impacts underlying these concerns and these adverse environmental impacts need to be prevented, reduced and, where possible, eliminated as soon as possible. Absent effective control, public opposition will grow, thus putting continued production at risk. Moreover, with anticipated increase in U.S. hydraulically fractured wells, if effective environmental action is not taken today, the potential environmental consequences will grow to a point that the country will be faced a more

EXHIBIT J

Secretary of Energy Advisory Board

Shale Gas Production Subcommittee Second Ninety Day Report

November 18, 2011

U.S. DEPARTMENT OF
ENERGY

production over the coming years disciplined attention must be devoted to reducing the environmental impact that accompanies this development, and (2) a prudent balance between development and environmental protection is best struck by establishing a strong foundation of regulation and enforcement, and adopting a policy and practice that measures, discloses, and continuously improves shale gas operations.

The Subcommittee believes that if action is not taken to reduce the environmental impact accompanying the very considerable expansion of shale gas production expected across the country – perhaps as many as 100,000 wells over the next several decades – there is a real risk of serious environmental consequences causing a loss of public confidence that could delay or stop this activity. Thus, the Subcommittee has an interest in assessing and reporting on, the progress that is being made on implementing its recommendations or some sensible variations of these recommendations.

The Subcommittee has the impression that its initial report stimulated interest in taking action to reduce the environmental impact of shale gas production by the administration, state governments, industry, and public interest groups. However, the progress to date is less than the Subcommittee hoped and it is not clear how to catalyze action at a time when everyone's attention is focused on economic issues, the press of daily business, and an upcoming election. The Subcommittee cautions that whether its approach is followed or not, some concerted and sustained action is needed to avoid excessive environmental impacts of shale gas production and the consequent risk of public opposition to its continuation and expansion.

EXHIBIT K

New York State Department of Environmental Conservation

Revised Draft

Supplemental Generic Environmental Impact Statement

On The Oil, Gas and Solution Mining

Regulatory Program

Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs

Lead Agency:

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Action Location: **Statewide**

Comments Due By: **December 12, 2011**

Prepared By:

NYSDEC, with Assistance from Alpha Environmental, Inc., Ecology and Environment Engineering, P.C., ICF International, URS Corp, NTC Consultants and Sammons/Dutton LLC.

Date of Completion of dSGEIS: **September 30, 2009**

Date of Completion of Revised dSGEIS: **September 7, 2011**

REVISED DRAFT

Supplemental Generic Environmental Impact Statement

On The Oil, Gas and Solution Mining Regulatory Program

Well Permit Issuance for Horizontal Drilling And High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs

Prepared By:

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NYSDEC DIVISION OF LANDS AND FORESTS

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Coordinated and Edited By:

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NEW YORK STATE ENERGY RESEARCH & DEVELOPMENT AUTHORITY*

NEW YORK STATE DEPARTMENT OF HEALTH
Bureau of Water Supply Protection
Bureau of Toxic Substance Assessment
Bureau of Environmental Radiation Protection

NYSDEC OFFICE OF CLIMATE CHANGE
NYSDEC DIVISION OF MATERIALS MANAGEMENT
NYSDEC DIVISION OF ENVIRONMENTAL PERMITS
NYSDEC DIVISION OF ENVIRONMENTAL REMEDIATION

* NYSERDA research assistance for September 2009 draft SGEIS contracted to Alpha Environmental Inc., ICF International, URS Corporation and NTC Consultants. NYSERDA research assistance for 2011 revised draft contracted to Alpha Geological Services, Inc., URS Corporation, NTC Consultants and Sammons/Dutton LLC.

EXECUTIVE SUMMARY

High-volume hydraulic fracturing is a well stimulation technique that has greatly increased the ability to extract natural gas from very tight rock. High-volume hydraulic fracturing, which is often used in conjunction with horizontal drilling and multi-well pad development, is an approach to extracting natural gas in New York that raises new, potentially significant, adverse impacts not studied in 1992 in the Department of Environmental Conservation's (Department or DEC) previous Generic Environmental Impact Statement (1992 GEIS) on the Oil, Gas and Solution Mining Regulatory Program.[1] Increased production of domestic natural gas resources from deep underground shale deposits in other parts of the country has dramatically altered future energy supply projections and has the promise of lowering costs for users and purchasers of this energy commodity.

High-volume hydraulic fracturing is distinct from other types of well completion that have been allowed in the State under the 1992 GEIS and Department permits due to the much larger volumes of water and additives used to conduct hydraulic fracturing operations. The use of high-volume hydraulic fracturing with horizontal well drilling technology provides for a number of wells to be drilled from a single well pad (multi-pad wells). Although horizontal drilling results in fewer well pads than traditional vertical well drilling, the pads are larger and the industrial activity taking place on the pads is more intense. Also, hydraulic fracturing requires chemical additives, some of which may pose hazards when highly concentrated. The extra water associated with such drilling may also result in significant adverse impacts relating to water supplies, wastewater treatment and disposal and truck traffic. Horizontal wells also generate greater volumes of drilling waste (cuttings). The industry projections of the level of drilling, as

[1] The Generic Environmental Impact Statement (1992 GEIS) on the Oil, Gas and Solution Mining Regulatory Program is posted on the Department's website at http://www.dec.ny.gov/energy/45912.html. The 1992 GEIS includes an analysis of impacts from vertical gas drilling as well as hydraulic fracturing. Since 1992 the Department has used the 1992 GEIS as the basis of its State Environmental Quality Review Act (SEQRA) review for permit applications for gas drilling in New York State.

were temporally proximate and from the same water resource, could potentially be significant. The mitigation measures to ensure that such impacts are prevented are described in Chapter 7, summarized below.

Chapter 6 also describes the potential impacts on water resources from stormwater flow associated with the construction and operation of high-volume hydraulic fracturing well pads. All phases of natural gas well development, from initial land clearing for access roads, equipment staging areas and well pads, to drilling and fracturing operations, production and final reclamation, have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed. Proposed mitigation measures to prevent significant adverse impacts from stormwater runoff are described in Chapter 7.

The dSGEIS concludes that spills or releases in connection with high-volume hydraulic fracturing could have significant adverse impacts on water resources. The dSGEIS identifies a significant number of contaminants contained in fracturing additives, or otherwise associated with high-volume hydraulic fracturing operations. Spills or releases can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents (including vehicle collisions), ground fires, or improper operations. Spilled, leaked or released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers. Proposed mitigation measures to prevent significant adverse impacts from spills and releases are described in Chapter 7.

Chapter 6 also assesses the potential significant adverse impacts on groundwater resources from well drilling and construction associated with high-volume hydraulic fracturing. Those potential impacts include impacts from turbidity, fluids pumped into or flowing from rock formations penetrated by the well, and contamination from natural gas present in the rock formations penetrated by the well. The dSGEIS concludes that these potential impacts are not unique to horizontal wells or high-volume hydraulic fracturing and are described and fully assessed in the 1992 GEIS. Nevertheless, because of the concentrated nature of the activity on multi-well pads and the larger fluid volumes and pressures associated with high-volume hydraulic fracturing, enhanced procedures and mitigation measures are proposed and described in Chapter 7.

No High-Volume Hydraulic Fracturing Operations in the New York City and Syracuse Watersheds

In April 2010 the Department concluded that due to the unique issues presented by high-volume hydraulic fracturing operations within the drinking watersheds for the City of New York and Syracuse, the SGEIS would not apply to activities in those watersheds. Those areas present unique issues that primarily stem from the fact that they are unfiltered water supplies that depend on strict land use and development controls to ensure that water quality is protected.

The revised analysis of high-volume hydraulic fracturing operations in the revised dSGEIS concludes that the proposed high-volume hydraulic fracturing activity is not consistent with the preservation of these watersheds as an unfiltered drinking water supply. Even with all of the criteria and conditions identified in this dSGEIS, a risk remains that significant high-volume hydraulic fracturing activities in these areas could result in a degradation of drinking water supplies from accidents, surface spills, etc. Moreover, such large scale industrial activity in these areas, even without spills, could imperil EPA's Filtration Avoidance Determinations and result in the affected municipalities incurring substantial costs to filter their drinking water supply. Accordingly, this dSGEIS supports a finding that site disturbance relating to high-volume hydraulic fracturing operations not be permitted in the Syracuse and New York City watersheds or in a protective 4,000 foot buffer area around those watersheds.

No High-Volume Hydraulic Fracturing Operations on Primary Aquifers

Although not subject to Filtration Avoidance Determinations, 18 other aquifers in the State of New York have been identified by the New York State Department of Health as highly productive aquifers presently utilized as sources of water supply by major municipal water supply systems and are designated as "primary aquifers." Because these aquifers are the primary source of drinking water for many public drinking water supplies, the Department recommends in this dSGEIS that site disturbance relating to high-volume hydraulic fracturing operations should not be permitted there either or in a protective 500-foot buffer area around them. Horizontal extraction of gas resources underneath primary aquifers from well pads located outside this area would not significantly impact this valuable water resource.

- Requirement for fully cemented production casing or intermediate casing (if used), with the cement bond evaluated by use of a cement bond logging tool; and

- Required certification prior to hydraulic fracturing of the sufficiency of as-built wellbore construction.

1.7.7.2 Revised Draft SGEIS

Additional well construction enhancements for high-volume hydraulic fracturing that the Department proposes to require pursuant to permit condition and/or regulation are listed below:

- Specific American Petroleum Institute (API) standards, specifications and practices would be incorporated into permit conditions related to well construction. Among these would be requirements to adhere to specifications for centralizer type and for casing and cement quality;

- Fully cemented intermediate casing would be required unless supporting site-specific documentation to waive the requirement is presented. This directly addresses gas migration concerns by providing additional barriers (i.e., steel casing, cement) between aquifers and shallow gas-bearing zones;

- Additional measures to ensure cement strength and sufficiency would be incorporated into permit conditions, also directly addressing gas migration concerns. Compliance would continue to be tracked through site inspections and required well completion reports, and any other documentation the Department deems necessary for the operator to submit or make available for review; and

- Minimum compressive strength requirements.

    - Minimum waiting times during which no activity is allowed which might disturb the cement while it sets;

    - Enhanced requirements for use of centralizers which serve to ensure the uniformity and strength of the cement around the well casing; and

    - Required use of more advanced cement evaluation tools.

1.7.8 Flowback Water Handling On-Site

The Department proposes to require that operators storing flowback water on-site would be required to use watertight tanks located within secondary containment, and remove the fluid from the wellpad within specified time frames.

Product Name
Unicide 100 / EC6116A
Unifoam
Unigel 5F
UniHibA / SP-43X
UnihibG / S-11
Unislik ST 50 / Stim Lube
Vicon NF
WG-11
WG-17
WG-18
WG-35
WG-36
WLC-6
XL-1
XL-8
XLW-32
Xylene

Table 5.5 - Fracturing Additive Products – Partial Composition Disclosure to the Department (Updated July 2011)

Product Name
20 Degree Baume Muriatic Acid
AcTivator / 78-ACTW
AMB-100
B869 / Corrosion Inhibitor B869 / Corrosion Inhibitor A262
B885 / ClearFRAC LT B885 / ClearFRAC LT J551A
B892 / EZEFLO B892 / EZEFLO F110 Surfactant
CL-22UC
CL-28M
Clay Master 5C
Corrosion Inhibitor A261
FAW- 5
FDP-S798-05
FDP-S819-05
FE ACID
FR-48
FRW-16
FRW-18
Fracsal FR-143
Fracsal III
Fracsal NE-137
Fracsal Ultra
Fracsal Ultra-FM1
Fracsal Ultra-FM2
Fracsal Ultra-FM3
Fracsal Waterbase
Fracsal Waterbase-M1
FRW-25M
GA 8713
GBW-15L
GW-3LDF
HVG-1, Fast Hydrating Guar Slurry
ICA 400
ICP-1000
Inflo-102
Inhibisal Ultra CS-135
Inhibisal Ultra SI-141
J134L / Enzyme Breaker J134L
KCLS-2, KCL Substitute

Product Name
L065 / Scale Inhibitor L065
LP-65
Magnacide 575 Microbiocide
MSA ACID
Multifunctional Surfactant F105
Nitrogen, Refrigerated Liquid
Product 239
PS 550
S-150
SandWedge WF
SilkWater FR-A
Super TSC / Super Scale Control TSC
Super Sol 10/20/30
Ultra Breake-C
Ultra Breake-CG
Ultra Breake-M
Ultra-Breake-MG
Unislick 30 / Cyanaflo 105L
WC-5584
WCS 5177 Corrosion Scale Inhibitor
WCW219 Combination Inhibitor
WF-12B Foamer
WF-12B Salt Inhibitor Stix
WF-12B SI Foamer/Salt Inhibitor
WF12BH Foamer
WRR-5
WFR-C
XLBHT-1
XLBHT-2

Information in sections 5.4.1-3 below was compiled primarily by URS Corporation,[46] under contract to NYSERDA.

5.4.1 *Properties of Fracturing Fluids*

Additives are used in hydraulic fracturing operations to elicit certain properties and characteristics that would aide and enhance the operation. The desired properties and characteristics include:

- Non-reactive;
- Non-flammable;
- Minimal residuals;
- Minimal potential for scale or corrosion;
- Low entrained solids;
- Neutral pH (pH 6.5 – 7.5) for maximum polymer hydration;
- Limited formation damage;
- Appropriately modify properties of water to carry proppant deep into the shale;
- Economical to modify fluid properties; and
- Minimal environmental effects.

5.4.2 *Classes of Additives*

Table 5.6 lists the types, purposes and examples of additives that have been proposed to date for use in hydraulic fracturing of gas wells in New York State.

[46] URS, 2011, p. 2-1 & 2009, p. 2-1.

Table 5.6 - Types and Purposes of Additives Proposed for Use in New York State (Updated July 2011)

Additive Type	Description of Purpose	Examples of Chemicals[47]
Proppant	"Props" open fractures and allows gas / fluids to flow more freely to the well bore.	Sand [Sintered bauxite; zirconium oxide; ceramic beads]
Acid	Removes cement and drilling mud from casing perforations prior to fracturing fluid injection, and provides accessible path to formation.	Hydrochloric acid (HCl, 3% to 28%) or muriatic acid
Breaker	Reduces the viscosity of the fluid in order to release proppant into fractures and enhance the recovery of the fracturing fluid.	Peroxydisulfates
Bactericide / Biocide / Antibacterial Agent	Inhibits growth of organisms that could produce gases (particularly hydrogen sulfide) that could contaminate methane gas. Also prevents the growth of bacteria which can reduce the ability of the fluid to carry proppant into the fractures.	Gluteraldehyde; 2,2-dibromo-3-nitrilopropionamide
Buffer / pH Adjusting Agent	Adjusts and controls the pH of the fluid in order to maximize the effectiveness of other additives such as crosslinkers	Sodium or potassium carbonate; acetic acid
Clay Stabilizer / Control /KCl	Prevents swelling and migration of formation clays which could block pore spaces thereby reducing permeability.	Salts (e.g., tetramethyl ammonium chloride Potassium chloride (KCl)
Corrosion Inhibitor (including Oxygen Scavengers)	Reduces rust formation on steel tubing, well casings, tools, and tanks (used only in fracturing fluids that contain acid).	Methanol; ammonium bisulfate for Oxygen Scavengers
Crosslinker	Increases fluid viscosity using phosphate esters combined with metals. The metals are referred to as crosslinking agents. The increased fracturing fluid viscosity allows the fluid to carry more proppant into the fractures.	Potassium hydroxide; borate salts
Friction Reducer	Allows fracture fluids to be injected at optimum rates and pressures by minimizing friction.	Sodium acrylate-acrylamide copolymer; polyacrylamide (PAM); petroleum distillates
Gelling Agent	Increases fracturing fluid viscosity, allowing the fluid to carry more proppant into the fractures.	Guar gum; petroleum distillates
Iron Control	Prevents the precipitation of metal oxides which could plug off the formation.	Citric acid;
Scale Inhibitor	Prevents the precipitation of carbonates and sulfates (calcium carbonate, calcium sulfate, barium sulfate) which could plug off the formation.	Ammonium chloride; ethylene glycol;
Solvent	Additive which is soluble in oil, water & acid-based treatment fluids which is used to control the wettability of contact surfaces or to prevent or break emulsions	Various aromatic hydrocarbons
Surfactant	Reduces fracturing fluid surface tension thereby aiding fluid recovery.	Methanol; isopropanol; ethoxylated alcohol

5.4.3 Composition of Fracturing Fluids

The composition of the fracturing fluid used may vary from one geologic basin or formation to another or from one area to another in order to meet the specific needs of each operation; but the

[47] Chemicals in brackets [ ] have not been proposed for use in the State of New York to date, but are known to be used in other states or shale formations.

range of additive types available for potential use remains the same. There are a number of different products for each additive type; however, only one product of each type is typically utilized in any given hydraulic fracturing job. The selection may be driven by the formation and potential interactions between additives. Additionally not all additive types will be utilized in every fracturing job.

Sample compositions, by weight, of fracturing fluid are provided in Figure 5.3, Figure 5.4 and Figure 5.5. The composition depicted in Figure 5.3 is based on data from the Fayetteville Shale[48] while those depicted in Figure 5.4 and Figure 5.5 are based on data from Marcellus Shale development in Pennsylvania. Based on this data, between approximately 84 and 90 percent of the fracturing fluid is water; between approximately 8 and 15 % is proppant (Photo 5.17); the remainder, typically less than 1 % consists of chemical additives listed above.

Photo 5.17 - Sand used as proppant in hydraulic fracturing operation in Bradford County, PA

[48] Similar to the Marcellus Shale, the Fayetteville Shale is a marine shale rich in unoxidized carbon (i.e. a black shale). The two shales are at similar depths, and vertical and horizontal wells have been drilled/fractured at both shales.

Barnett Shale is considered to be the first instance of extensive high-volume hydraulic fracturing technology use; the technology has since been applied in other areas such as the Fayetteville Shale and the Haynesville Shale. URS notes that data collected from applications to drill Marcellus Shale wells in New York indicate that the typical fracture fluid composition for operations in the Marcellus Shale is similar to the provided composition in the Fayetteville Shale. Even though no horizontal wells have been drilled in the Marcellus Shale in New York, applications filed to date as well as information provided by the industry[49] indicate that it is realistic to expect that the composition of fracture fluids used in the Marcellus Shale in New York would be similar to the fluids used in the Fayetteville Shale and the Marcellus Shale in Pennsylvania.

[49] ALL Consulting, 2010, p. 80.

Figure 5.3 - Sample Fracturing Fluid Composition (12 Additives), by Weight, from Fayetteville Shale[50]

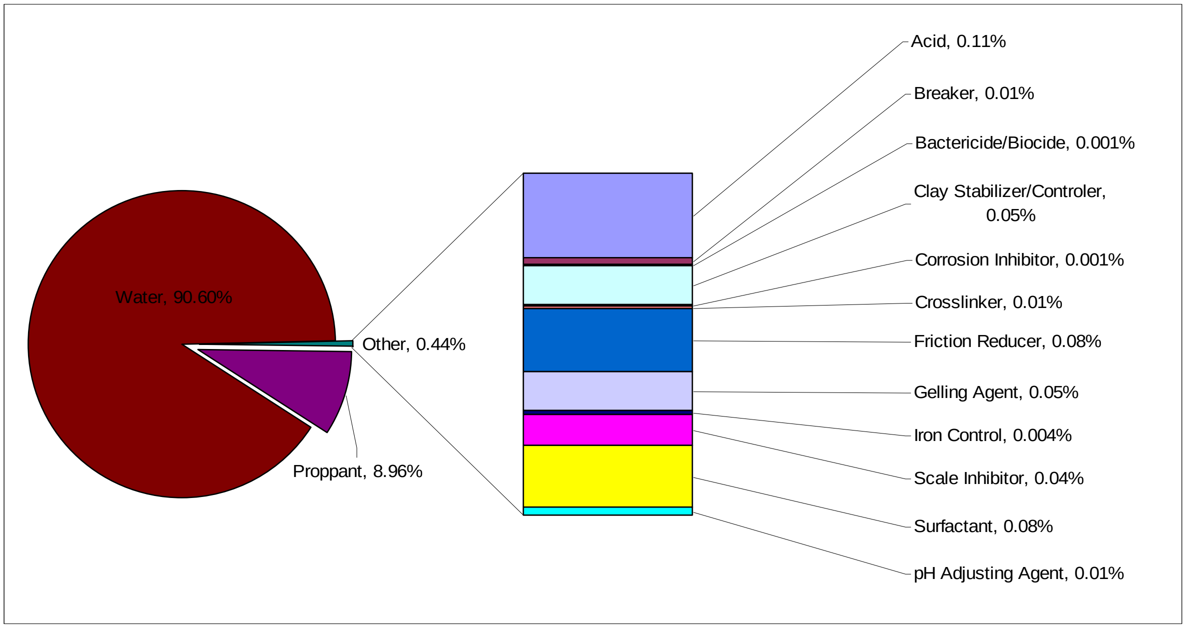
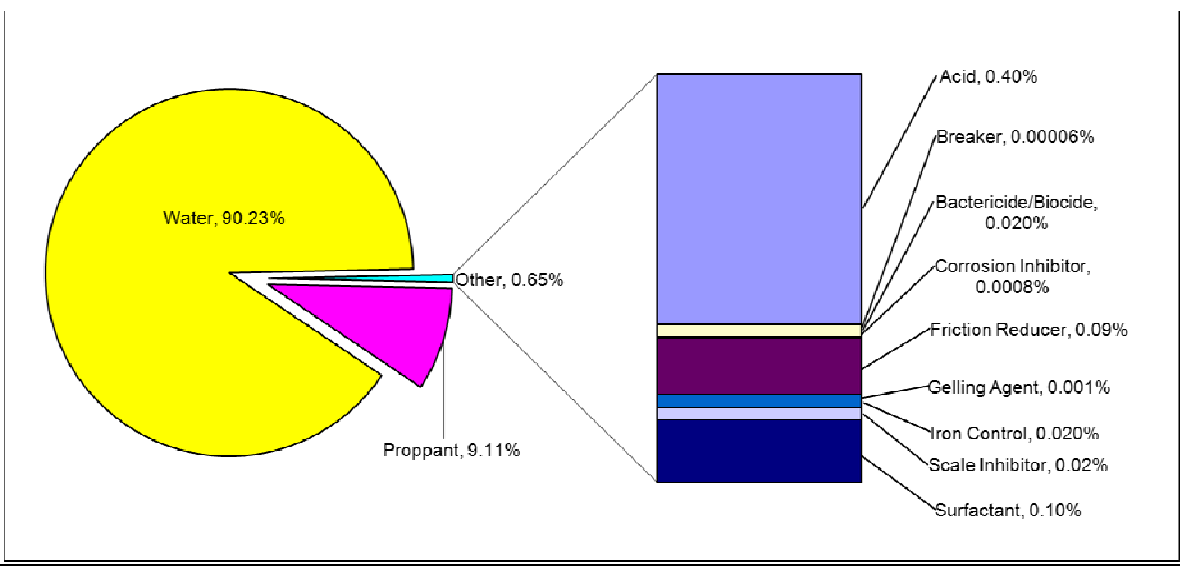


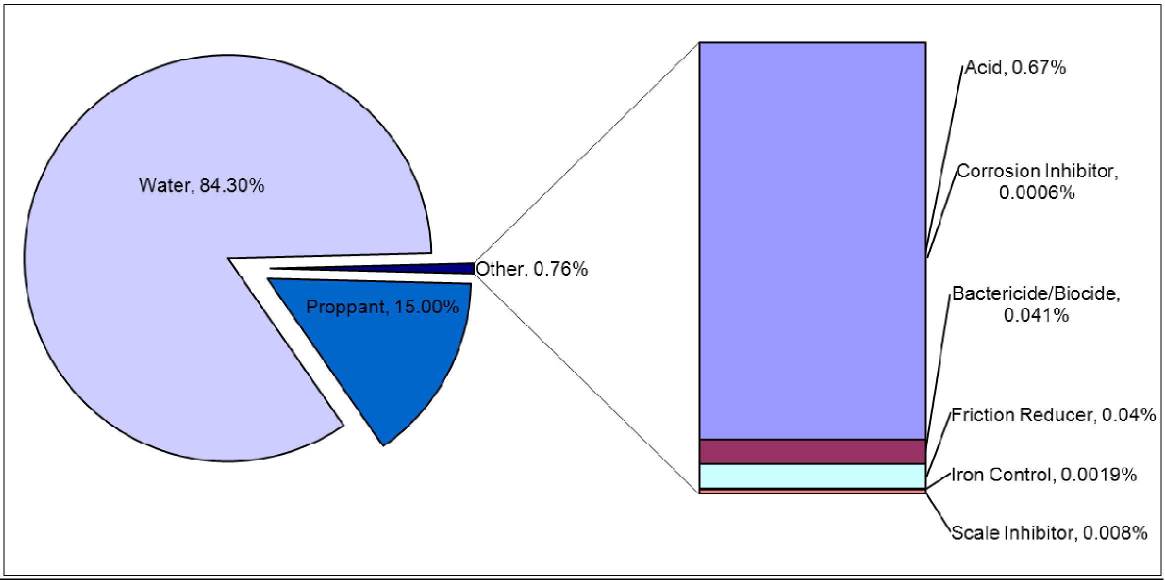
Figure 5.4 - Sample Fracturing Fluid Composition (9 Additives), by Weight, from Marcellus Shale[51] (New July 2011)



[50] URS, 2009, p. 2-4.

[51] URS, 2011, p. 2-4, adapted from ALL Consulting, 2010, p.81.

Figure 5.5 - Sample Fracturing Fluid Composition (6 Additives), by Weight, from Marcellus Shale[52] (New July 2011)



Each product within the 13 classes of additives may be made up of one or more chemical constituents. Table 5.7 is a list of chemical constituents and their CAS numbers, that have been extracted from product composition disclosures and MSDSs submitted to the Department for 235 products used or proposed for use in hydraulic fracturing operations in the Marcellus Shale in New York. It is important to note that several manufacturers/suppliers provide similar products (i.e., chemicals that would serve the same purpose) for any class of additive, and that not all types of additives are used in a single well.

Data provided to the Department to date indicates similar fracturing fluid compositions for vertically and horizontally drilled wells.

[52] URS, 2011, p.2-5, adapted from ALL Consulting, 2010, p. 81.

Table 5.7 - Chemical Constituents in Additives[53,54,55] (Updated July 2011)

CAS Number[56]	**Chemical Constituent**
106-24-1	(2E)-3,7-dimethylocta-2,6-dien-1-ol
67701-10-4	(C8-C18) and (C18) Unsaturated Alkylcarboxylic Acid Sodium Salt
2634-33-5	1,2 Benzisothiazolin-2-one / 1,2-benzisothiazolin-3-one
95-63-6	1,2,4 trimethylbenzene
93858-78-7	1,2,4-Butanetricarboxylicacid, 2-phosphono-, potassium salt
123-91-1	1,4 Dioxane
3452-07-1	1-eicosene
629-73-2	1-hexadecene
104-46-1	1-Methoxy-4-propenylbenzene
124-28-7	1-Octadecanamine, N, N-dimethyl- / N,N-Dimthyloctadecylamine
112-03-8	1-Octadecanaminium, N,N,N-Trimethyl-, Chloride /Trimethyloctadecylammonium chloride
112-88-9	1-octadecene
40623-73-2	1-Propanesulfonic acid
1120-36-1	1-tetradecene
95077-68-2	2- Propenoic acid, homopolymer sodium salt
98-55-5	2-(4-methyl-1-cyclohex-3-enyl)propan-2-ol
10222-01-2	2,2 Dibromo-3-nitrilopropionamide
27776-21-2	2,2'-azobis-{2-(imidazlin-2-yl)propane}-dihydrochloride
73003-80-2	2,2-Dobromomalonamide
15214-89-8	2-Acrylamido-2-methylpropanesulphonic acid sodium salt polymer
46830-22-2	2-acryloyloxyethyl(benzyl)dimethylammonium chloride
52-51-7	2-Bromo-2-nitro-1,3-propanediol
111-76-2	2-Butoxy ethanol / Ethylene glycol monobutyl ether / Butyl Cellusolve
1113-55-9	2-Dibromo-3-Nitriloprionamide /~~(~~2-Monobromo-3-nitriilopropionamide~~)~~
104-76-7	2-Ethyl Hexanol
67-63-0	2-Propanol / Isopropyl Alcohol / Isopropanol / Propan-2-ol
26062-79-3	2-Propen-1-aminium, N,N-dimethyl-N-2-propenyl-chloride, homopolymer
9003-03-6	2-propenoic acid, homopolymer, ammonium salt
25987-30-8	2-Propenoic acid, polymer with 2 p-propenamide, sodium salt / Copolymer of acrylamide and sodium acrylate
71050-62-9	2-Propenoic acid, polymer with sodium phosphinate (1:1)
66019-18-9	2-propenoic acid, telomer with sodium hydrogen sulfite

[53] Table 5.7, is a list of chemical constituents and their CAS numbers that have been extracted from product composition disclosures and MSDSs submitted to the Department. It was compiled by URS Corporation (2011) and was adapted by the Department to ensure that it accurately reflects the data submitted.

[54] These are the chemical constituents of all chemical additives proposed to be used in New York for hydraulic fracturing operations at shale wells. Only a few chemicals would be used in a single well; the list of chemical constituents used in an individual well would be correspondingly smaller.

[55] This list does not include chemicals that are exclusively used for drilling.

[56] Chemical Abstracts Service (CAS) is a division of the American Chemical Society. CAS assigns unique numerical identifiers to every chemical described in the literature. The intention is to make database searches more convenient, as chemicals often have many names. Almost all molecule databases today allow searching by CAS number.

CAS Number[56]	Chemical Constituent
107-19-7	2-Propyn-1-ol / Progargyl Alcohol
51229-78-8	3,5,7-Triaza-1-azoniatricyclo[3.3.1.13,7]decane, 1-(3-chloro-2-propenyl)-chloride,
106-22-9	3,7 - dimethyl-6-octen-1-ol
5392-40-5	3,7-_dimethyl-2,6-octadienal
115-19-5	3-methyl-1-butyn-3-ol
104-55-2	3-phenyl-2-propenal
127-41-3	4-(2,6,6-trimethyl-1-cyclohex-2-enyl)-3-buten-2-one
121-33-5	4-hydroxy-3-methoxybenzaldehyde
127087-87-0	4-Nonylphenol Polyethylene Glycol Ether Branched / Nonylphenol ethoxylated / Oxyalkylated Phenol
64-19-7	Acetic acid
68442-62-6	Acetic acid, hydroxy-, reaction products with triethanolamine
108-24-7	Acetic Anhydride
67-64-1	Acetone
79-06-1	Acrylamide
38193-60-1	Acrylamide - sodium 2-acrylamido-2-methylpropane sulfonate copolymer
25085-02-3	Acrylamide - Sodium Acrylate Copolymer / Anionic Polyacrylamide / 2-Propanoic Acid
69418-26-4	Acrylamide polymer with N,N,N-trimethyl-2[1-oxo-2-propenyl]oxy Ethanaminium chloride / Ethanaminium, N, N, N-trimethyl-2-[(1-oxo-2-propenyl)oxy]-, chloride, polymer with 2-propenamide (9Cl)
68891-29-2	Alcohols C8-10, ethoxylated, monoether with sulfuric acid, ammonium salt
68526-86-3	Alcohols, C11-14-iso, C13-rich
68551-12-2	Alcohols, C12-C16, Ethoxylated / Ethoxylated alcohol
64742-47-8	Aliphatic Hydrocarbon / Hydrotreated light distillate / Petroleum Distillates / Isoparaffinic Solvent / Paraffin Solvent / Napthenic Solvent
64743-02-8	Alkenes
68439-57-6	Alkyl (C14-C16) olefin sulfonate, sodium salt
9016-45-9	Alkylphenol ethoxylate surfactants
1327-41-9	Aluminum chloride
68155-07-7	Amides, C8-18 and C19-Unsatd., N,N-Bis(hydroxyethyl)
73138-27-9	Amines, C12-14-tert-alkyl, ethoxylated
71011-04-6	Amines, Ditallow alkyl, ethoxylated
68551-33-7	Amines, tallow alkyl, ethoxylated, acetates
1336-21-6	Ammonia
631-61-8	Ammonium acetate
68037-05-8	Ammonium Alcohol Ether Sulfate
7783-20-2	Ammonium bisulfate
10192-30-0	Ammonium Bisulphite
12125-02-9	Ammonium Chloride
7632-50-0	Ammonium citrate
37475-88-0	Ammonium Cumene Sulfonate
1341-49-7	Ammonium hydrogen-difluoride
6484-52-2	Ammonium nitrate
7727-54-0	Ammonium Persulfate / Diammonium peroxidisulphate

CAS Number[56]	Chemical Constituent
1762-95-4	Ammonium Thiocyanate
12174-11-7	Attapulgite Clay
121888-68-4	Bentonite, benzyl(hydrogenated tallow alkyl) dimethylammonium stearate complex / organophilic clay
71-43-2	Benzene
119345-04-9	Benzene, 1,1'-oxybis, tetratpropylene derivatives, sulfonated, sodium salts
74153-51-8	Benzenemethanaminium, N,N-dimethyl-N-[2-[(1-oxo-2-propenyl)oxy]ethyl]-, chloride, polymer with 2-propenamide
122-91-8	Benzenemethanol,4-methoxy-, 1-formate
1300-72-7	Benzenesulfonic acid, Dimethyl-, Sodium salt /Sodium xylene sulfonate
140-11-4	Benzyl acetate
76-22-2	Bicyclo (2.2.1) heptan-2-one, 1,7,7-trimethyl-
68153-72-0	Blown lard oil amine
68876-82-4	Blown rapeseed amine
1319-33-1	Borate Salt
10043-35-3	Boric acid
1303-86-2	Boric oxide / Boric Anhydride
71-36-3	Butan-1-ol
68002-97-1	C10 - C16 Ethoxylated Alcohol
68131-39-5	C12-15 Alcohol, Ethoxylated
1317-65-3	Calcium Carbonate
10043-52-4	Calcium chloride
1305-62-0	Calcium Hydroxide
1305-79-9	Calcium Peroxide
124-38-9	Carbon Dioxide
68130-15-4	Carboxymethylhydroxypropyl guar
9012-54-8	Cellulase / Hemicellulase Enzyme
9004-34-6	Cellulose
10049-04-4	Chlorine Dioxide
78-73-9	Choline Bicarbonate
67-48-1	Choline Chloride
91-64-5	Chromen-2-one
77-92-9	Citric Acid
94266-47-4	Citrus Terpenes
61789-40-0	Cocamidopropyl Betaine
68155-09-9	Cocamidopropylamine Oxide
68424-94-2	Coco-betaine
7758-98-7	Copper (II) Sulfate
14808-60-7	Crystalline Silica (Quartz)
7447-39-4	Cupric chloride dihydrate
1490-04-6	Cyclohexanol,5-methyl-2-(1-methylethyl)
8007-02-1	Cymbopogon citratus leaf oil
8000-29-1	Cymbopogon winterianus jowitt oil
1120-24-7	Decyldimethyl Amine
2605-79-0	Decyl-dimethyl Amine Oxide

CAS Number[56]	Chemical Constituent
3252-43-5	Dibromoacetonitrile
25340-17-4	Diethylbenzene
111-46-6	Diethylene Glycol
22042-96-2	Diethylenetriamine penta (methylenephonic acid) sodium salt
28757-00-8	Diisopropyl naphthalenesulfonic acid
68607-28-3	Dimethylcocoamine, bis(chloroethyl) ether, diquaternary ammonium salt
7398-69-8	Dimethyldiallylammonium chloride
25265-71-8	Dipropylene glycol
34590-94-8	Dipropylene Glycol Methyl Ether
139-33-3	Disodium Ethylene Diamine Tetra Acetate
64741-77-1	Distillates, petroleum, light hydrocracked
5989-27-5	D-Limonene
123-01-3	Dodecylbenzene
27176-87-0	Dodecylbenzene sulfonic acid
42504-46-1	Dodecylbenzenesulfonate isopropanolamine
50-70-4	D-Sorbitol / Sorbitol
37288-54-3	Endo-1,4-beta-mannanase, or Hemicellulase
149879-98-1	Erucic Amidopropyl Dimethyl Betaine
89-65-6	Erythorbic acid, anhydrous
54076-97-0	Ethanaminium, N,N,N-trimethyl-2-[(1-oxo-2-propenyl)oxy]-, chloride, homopolymer
107-21-1	Ethane-1,2-diol / Ethylene Glycol
111-42-2	Ethanol, 2,2-iminobis-
26027-38-3	Ethoxylated 4-nonylphenol
9002-93-1	Ethoxylated 4-tert-octylphenol
68439-50-9	Ethoxylated alcohol
126950-60-5	Ethoxylated alcohol
67254-71-1	Ethoxylated alcohol (C10-12)
68951-67-7	Ethoxylated alcohol (C14-15)
68439-46-3	Ethoxylated alcohol (C9-11)
66455-15-0	Ethoxylated Alcohols
84133-50-6	Ethoxylated Alcohols (C12-14 Secondary)
68439-51-0	Ethoxylated Alcohols (C12-14)
78330-21-9	Ethoxylated branch alcohol
34398-01-1	Ethoxylated C11 alcohol
78330-21-8	Ethoxylated C11-14-iso, C13-rich alcohols
61791-12-6	Ethoxylated Castor Oil
61791-29-5	Ethoxylated fatty acid, coco
61791-08-0	Ethoxylated fatty acid, coco, reaction product with ethanolamine
68439-45-2	Ethoxylated hexanol
9036-19-5	Ethoxylated octylphenol
9005-67-8	Ethoxylated Sorbitan Monostearate
9005-70-3	Ethoxylated Sorbitan Trioleate
64-17-5	Ethyl alcohol / ethanol
100-41-4	Ethyl Benzene

CAS Number[56]	Chemical Constituent
93-89-0	Ethyl benzoate
97-64-3	Ethyl Lactate
9003-11-6	Ethylene Glycol-Propylene Glycol Copolymer (Oxirane, methyl-, polymer with oxirane)
75-21-8	Ethylene oxide
5877-42-9	Ethyloctynol
8000-48-4	Eucalyptus globulus leaf oil
61790-12-3	Fatty Acids
68604-35-3	Fatty acids, C 8-18 and C18-unsaturated compounds with diethanolamine
68188-40-9	Fatty acids, tall oil reaction products w/ acetophenone, formaldehyde & thiourea
9043-30-5	Fatty alcohol polyglycol ether surfactant
7705-08-0	Ferric chloride
7782-63-0	Ferrous sulfate, heptahydrate
50-00-0	Formaldehyde
29316-47-0	Formaldehyde polymer with 4,1,1-dimethylethyl phenolmethyl oxirane
153795-76-7	Formaldehyde, polymers with branched 4-nonylphenol, ethylene oxide and propylene oxide
75-12-7	Formamide
64-18-6	Formic acid
110-17-8	Fumaric acid
111-30-8	Glutaraldehyde
56-81-5	Glycerol / glycerine
9000-30-0	Guar Gum
64742-94-5	Heavy aromatic petroleum naphtha
9025-56-3	Hemicellulase
7647-01-0	Hydrochloric Acid / Hydrogen Chloride / muriatic acid
7722-84-1	Hydrogen Peroxide
64742-52-5	Hydrotreated heavy napthenic (petroleum) distillate
79-14-1	Hydroxy acetic acid
35249-89-9	Hydroxyacetic acid ammonium salt
9004-62-0	Hydroxyethyl cellulose
5470-11-1	Hydroxylamine hydrochloride
39421-75-5	Hydroxypropyl guar
35674-56-7	Isomeric Aromatic Ammonium Salt
64742-88-7	Isoparaffinic Petroleum Hydrocarbons, Synthetic
64-63-0	Isopropanol
98-82-8	Isopropylbenzene (cumene)
68909-80-8	Isoquinoline, reaction products with benzyl chloride and quinoline
8008-20-6	Kerosene
64742-81-0	Kerosine, hydrodesulfurized
63-42-3	Lactose
8022-15-9	Lavandula hybrida abrial herb oil
64742-95-6	Light aromatic solvent naphtha
1120-21-4	Light Paraffin Oil

CAS Number[56]	Chemical Constituent
546-93-0	Magnesium Carbonate
1309-48-4	Magnesium Oxide
1335-26-8	Magnesium Peroxide
14807-96-6	Magnesium Silicate Hydrate (Talc)
1184-78-7	methanamine, N,N-dimethyl-, N-oxide
67-56-1	Methanol
119-36-8	Methyl 2-hydroxybenzoate
68891-11-2	Methyloxirane polymer with oxirane, mono (nonylphenol) ether, branched
8052-41-3	Mineral spirits / Stoddard Solvent
64742-46-7	Mixture of severely hydrotreated and hydrocracked base oil
141-43-5	Monoethanolamine
44992-01-0	N,N,N-trimethyl-2[1-oxo-2-propenyl]oxy Ethanaminium chloride
64742-48-9	Naphtha (petroleum), hydrotreated heavy
91-20-3	Naphthalene
38640-62-9	Naphthalene bis(1-methylethyl)
93-18-5	Naphthalene, 2-ethoxy-
68909-18-2	N-benzyl-alkyl-pyridinium chloride
68139-30-0	N-Cocoamidopropyl-N,N-dimethyl-N-2-hydroxypropylsulfobetaine
68424-94-2	N-Cocoamidopropyl-N,N-dimethyl-N-2-hydroxypropylsulfobetaine
7727-37-9	Nitrogen, Liquid form
68412-54-4	Nonylphenol Polyethoxylate
8000-27-9	Oils, cedarwood
121888-66-2	Organophilic Clays
628-63-7	Pentyl acetate
540-18-1	Pentyl butanoate
8009-03-8	Petrolatum
64742-65-0	Petroleum Base Oil
64741-68-0	Petroleum naphtha
101-84-8	Phenoxybenzene
70714-66-8	Phosphonic acid, [[(phosphonomethyl)imino]bis[2,1-ethanediylnitrilobis(methylene)]]tetrakis-, ammonium salt
8000-41-7	Pine Oil
8002-09-3	Pine Oils
60828-78-6	Poly(oxy-1,2-ethanediyl), a-[3,5-dimethyl-1-(2-methylpropyl)hexyl]-w-hydroxy-
25322-68-3	Poly(oxy-1,2-ethanediyl), a-hydro-w-hydroxy / Polyethylene Glycol
31726-34-8	Poly(oxy-1,2-ethanediyl), alpha-hexyl-omega-hydroxy
24938-91-8	Poly(oxy-1,2-ethanediyl), α-tridecyl-ω-hydroxy-
9004-32-4	Polyanionic Cellulose
51838-31-4	Polyepichlorohydrin, trimethylamine quaternized
56449-46-8	Polyethlene glycol oleate ester
9046-01-9	Polyethoxylated tridecyl ether phosphate
63428-86-4	Polyethylene glycol hexyl ether sulfate, ammonium salt
62649-23-4	Polymer with 2-propenoic acid and sodium 2-propenoate
9005-65-6	Polyoxyethylene Sorbitan Monooleate

CAS Number[56]	Chemical Constituent
61791-26-2	Polyoxylated fatty amine salt
65997-18-4	Polyphosphate
127-08-2	Potassium acetate
12712-38-8	Potassium borate
1332-77-0	Potassium borate
20786-60-1	Potassium Borate
584-08-7	Potassium carbonate
7447-40-7	Potassium chloride
590-29-4	Potassium formate
1310-58-3	Potassium Hydroxide
13709-94-9	Potassium metaborate
24634-61-5	Potassium Sorbate
112926-00-8	Precipitated silica / silica gel
57-55-6	Propane-1,2-diol, /Propylene glycol
107-98-2	Propylene glycol monomethyl ether
68953-58-2	Quaternary Ammonium Compounds
62763-89-7	Quinoline,2-methyl-, hydrochloride
62763-89-7	Quinoline,2-methyl-, hydrochloride
15619-48-4	Quinolinium, 1-(phenylmethl),chloride
8000-25-7	Rosmarinus officinalis l. leaf oil
7631-86-9	Silica, Dissolved
5324-84-5	Sodium 1-octanesulfonate
127-09-3	Sodium acetate
95371-16-7	Sodium Alpha-olefin Sulfonate
532-32-1	Sodium Benzoate
144-55-8	Sodium bicarbonate
7631-90-5	Sodium bisulfate
7647-15-6	Sodium Bromide
497-19-8	Sodium carbonate
7647-14-5	Sodium Chloride
7758-19-2	Sodium chlorite
3926-62-3	Sodium Chloroacetate
68-04-2	Sodium citrate
6381-77-7	Sodium erythorbate / isoascorbic acid, sodium salt
2836-32-0	Sodium Glycolate
1310-73-2	Sodium Hydroxide
7681-52-9	Sodium hypochlorite
7775-19-1	Sodium Metaborate .8H_2O
10486-00-7	Sodium perborate tetrahydrate
7775-27-1	Sodium persulphate
68608-26-4	Sodium petroleum sulfonate
9003-04-7	Sodium polyacrylate
7757-82-6	Sodium sulfate
1303-96-4	Sodium tetraborate decahydrate
7772-98-7	Sodium Thiosulfate

CAS Number[56]	Chemical Constituent
1338-43-8	Sorbitan Monooleate
57-50-1	Sucrose
5329-14-6	Sulfamic acid
68442-77-3	Surfactant: Modified Amine
112945-52-5	Syntthetic Amorphous / Pyrogenic Silica / Amorphous Silica
68155-20-4	Tall Oil Fatty Acid Diethanolamine
8052-48-0	Tallow fatty acids sodium salt
72480-70-7	Tar bases, quinoline derivs., benzyl chloride-quaternized
68647-72-3	Terpene and terpenoids
68956-56-9	Terpene hydrocarbon byproducts
533-74-4	Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione (a.k.a. Dazomet)
55566-30-8	Tetrakis(hydroxymethyl)phosphonium sulfate (THPS)
75-57-0	Tetramethyl ammonium chloride
64-02-8	Tetrasodium Ethylenediaminetetraacetate
68-11-1	Thioglycolic acid
62-56-6	Thiourea
68527-49-1	Thiourea, polymer with formaldehyde and 1-phenylethanone
68917-35-1	Thuja plicata donn ex. D. don leaf oil
108-88-3	Toluene
81741-28-8	Tributyl tetradecyl phosphonium chloride
68299-02-5	Triethanolamine hydroxyacetate
68442-62-6	Triethanolamine hydroxyacetate
112-27-6	Triethylene Glycol
52624-57-4	Trimethylolpropane, Ethoxylated, Propoxylated
150-38-9	Trisodium Ethylenediaminetetraacetate
5064-31-3	Trisodium Nitrilotriacetate
7601-54-9	Trisodium ortho phosphate
57-13-6	Urea
25038-72-6	Vinylidene Chloride/Methylacrylate Copolymer
7732-18-5	Water
8042-47-5	White Mineral Oil
11138-66-2	Xanthan gum
1330-20-7	Xylene
13601-19-9	Yellow Sodium of Prussiate

Chemical Constituent
Aliphatic acids
Aliphatic alcohol glycol ether
Alkyl Aryl Polyethoxy Ethanol
Alkylaryl Sulfonate
Anionic copolymer
Aromatic hydrocarbons
Aromatic ketones
Citric acid base formula
Ethoxylated alcohol blend/mixture

Hydroxy acetic acid
Oxyalkylated alkylphenol
Petroleum distillate blend
Polyethoxylated alkanol
Polymeric Hydrocarbons
Quaternary amine
Quaternary ammonium compound
Salt of amine-carbonyl condensate
Salt of fatty acid/polyamine reaction product
Sugar
Surfactant blend
Triethanolamine

The chemical constituents listed in Table 5.7 are not linked to the product names listed in Table 5.4 and Table 5.5 because a significant number of product compositions have been properly justified as trade secrets within the coverage of disclosure exceptions of the Freedom of Information Law [Public Officers Law §87.2(d)] and the Department's implementing regulation, 6 NYCRR § 616.7. The Department however, considers MSDSs to be public information ineligible for exception from disclosure as trade secrets or confidential business information.

5.4.3.1 Chemical Categories and Health Information

The Department requested assistance from NYSDOH in identifying potential exposure pathways and constituents of concern associated with high-volume hydraulic fracturing for low-permeability gas reservoir development. The Department provided DOH with fracturing additive product constituents based on MSDSs and product-composition disclosures for hydraulic fracturing additive products that were provided by well-service companies and the chemical supply companies that manufacture the products.

Compound-specific toxicity data are very limited for many chemical additives to fracturing fluids, so chemicals potentially present in fracturing fluids were grouped together into categories according to their chemical structure (or function in the case of microbiocides) in Table 5.8, compiled by NYSDOH. As explained above, any given individual fracturing job will only involve a handful of chemicals and may not include every category of chemicals.

Table 5.8 - Categories based on chemical structure of potential fracturing fluid constituents.[57] (Updated July 2011)

Chemical	CAS Number
Amides	
Formamide	75-12-7
acrylamide	79-06-1
Amides, C8-18 and C19-Unsatd., N,N-Bis(hydroxyethyl)	68155-07-7
Amines	
urea	57-13-6
thiourea	62-56-6
Choline chloride	67-48-1
tetramethyl ammonium chloride	75-57-0
Choline Bicarbonate	78-73-9
Ethanol, 2,2-Iminobis-	111-42-2
1-Octadecanaminium, N,N,N, Trimethyl-, Chloride (aka Trimethyloctadecylammonium choride)	112-03-8
1-Octadecanamine, N,N-Dimethyl- (aka N,N-Dimethyloctadecylamine)	124-28-7
monoethanolamine	141-43-5
Decyldimethyl Amine	1120-24-7
methanamine, N,N-dimethyl-, N-oxide	1184-78-7
Decyl-dimethyl Amine Oxide	2605-79-0
dimethyldiallylammonium chloride	7398-69-8
polydimethyl dially ammonium chloride	26062-79-3
dodecylbenzenesulfonate isopropanolamine	42504-46-1
N,N,N-trimethyl-2[1-oxo-2-propenyl]oxy ethanaminium chloride	44992-01-0
2-acryloyloxyethyl(benzyl)dimethylammonium chloride	46830-22-2
ethanaminium, N,N,N-trimethyl-2-[(1-oxo-2-propenyl)oxy]-, chloride, homopolymer	54076-97-0
Cocamidopropyl Betaine	61789-40-0
Quaternary Ammonium Chloride	61789-71-7
polyoxylated fatty amine salt	61791-26-2
quinoline, 2-methyl, hydrochloride	62763-89-7
N-cocoamidopropyl-N,N-dimethyl-N-2-hydroxypropylsulfobetaine	68139-30-0
tall oil fatty acid diethanolamine	68155-20-4
N-cocoamidopropyl-N,N-dimethyl-N-2-hydroxypropylsulfobetaine	68424-94-2
amines, tallow alkyl, ethoxylated, acetates	68551-33-7
quaternary ammonium compounds, bis(hydrogenated tallow alkyl) dimethyl, salts with bentonite	68953-58-2

[57] The chemicals listed in this table are organized in order of ascending CAS Number by category.

Chemical	CAS Number
amines, ditallow alkyl, ethoxylated	71011-04-6
amines, C-12-14-tert-alkyl, ethoxylated	73138-27-9
benzenemethanaminium, N,N-dimethyl-N-[2-[(1-oxo-2-propenyl)oxy]ethyl]-, chloride, polymer with 2-propenamide	74153-51-8
Erucic Amidopropyl Dimethyl Betaine	149879-98-1
Petroleum Distillates	
light paraffin oil	1120-21-4
kerosene	8008-20-6
Petrolatum	8009-03-8
White Mineral Oil	8042-47-5
stoddard solvent	8052-41-3
Distillates, petroleum, light hydrocracked	64741-77-1
petroleum naphtha	64741-68-0
Mixture of severely hydrotreated and hydrocracked base oil	64742-46-7
<u>Multiple names listed under same CAS#:</u> LVP aliphatic hydrocarbon, hydrotreated light distillate, low odor paraffin solvent, paraffin solvent, paraffinic napthenic solvent, isoparaffinic solvent, distillates (petroleum) hydrotreated light, petroleum light distillate, aliphatic hydrocarbon, petroleum distillates, mixture of severely hydrotreated and hydrocracked base oil	64742-47-8
naphtha, hydrotreated heavy	64742-48-9
Multiple names listed under same CAS#: hydrotreated heavy napthenic distillate, Petroleum distillates	64742-52-5
petroleum base oil	64742-65-0
kerosine (petroleum, hydrodesulfurized)	64742-81-0
kerosine (petroleum, hydrodesulfurized)	64742-88-7
<u>Multiple names listed under same CAS#:</u> heavy aromatic petroleum naphtha, light aromatic solvent naphtha	64742-94-5
light aromatic solvent naphtha	64742-95-6
alkenes, C> 10 α-	64743-02-8
Aromatic Hydrocarbons	
benzene	71-43-2
naphthalene	91-20-3
naphthalene, 2-ethoxy	93-18-5

Chemical	CAS Number
1,2,4-trimethylbenzene	95-63-6
cumene	98-82-8
ethyl benzene	100-41-4
toluene	108-88-3
dodecylbenzene	123-01-3
xylene	1330-20-7
diethylbenzene	25340-17-4
naphthalene bis(1-methylethyl)	38640-62-9
Alcohols & Aldehydes	
formaldehyde	50-00-0
sorbitol (or) D-sorbitol	50-70-4
Glycerol	56-81-5
propylene glycol	57-55-6
ethanol	64-17-5
isopropyl alcohol	67-63-0
methanol	67-56-1
isopropyl alcohol	67-63-0
butanol	71-36-3
2-(4-methyl-1-cyclohex-3-enyl)propan-2-ol	98-55-5
3-phenylprop-2-enal	104-55-2
2-ethyl-1-hexanol	104-76-7
3,7 - dimethyloct-6-en-1-ol	106-22-9
(2E)-3,7-dimethylocta-2,6-dien-1-ol	106-24-1
propargyl alcohol	107-19-7
ethylene glycol	107-21-1
Diethylene Glycol	111-46-6
3-methyl-1-butyn-3-ol	115-19-5
4-hydroxy-3-methyoxybenzaldehyde	121-33-5
5-methyl-2-propan-2-ylcyclohexan-1-ol	1490-04-6
3,7-dimethylocta-2,6-dienal	5392-40-5
Ethyloctynol	5877-42-9
Glycol Ethers, Ethoxylated Alcohols & Other Ethers	
phenoxybenzene	101-84-8
1-methyoxy-4-prop-1-enylbenzene	104-46-1
propylene glycol monomethyl ether	107-98-2
ethylene glycol monobutyl ether	111-76-2

6.1.2 Stormwater Runoff

Stormwater, whether as a result of rainfall or snowmelt, is a valuable resource. It is the source of water for lakes and streams, as well as aquifers. However, stormwater runoff, particularly when it interacts with the human environment, is a pathway for contaminants to be conveyed from the land surface to streams and lakes and groundwater. This is especially true for stormwater runoff from asphalt, concrete, gravel/dirt roads, other impervious surfaces, outdoor industrial activity, and earthen construction sites, where any material collected on the ground is washed into a nearby surface water body. Stormwater runoff may also contribute to heightened peak flows and flooding.

On an undisturbed landscape, precipitation is held by vegetation and pervious soil, allowing it to slowly filter into the ground. This benefits water resources by using natural filtering properties, replenishing groundwater aquifers and feeding lakes and streams through base flow during dry periods. On a disturbed or developed landscape, it is common for the ground surface to be compacted or otherwise made less pervious and for runoff to be shunted away quickly with greater force and significantly higher volumes. Such hydrological modifications result in less groundwater recharge and more rapid runoff to streams, which may cause increased stream erosion and result in water quality degradation, habitat loss and flooding.

All phases of natural gas well development, from initial land clearing for access roads, equipment staging areas and well pads, to drilling and fracturing operations, production and final reclamation, have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed.

Excess sediment can fill or bury the rock cobble of streams that serve as spawning habitat for fish and the macro-invertebrate insects that serve as their food source. Stormwater runoff and heightened sediment loads carry excess levels of nutrient phosphorus and nitrogen that is a major cause of algae bloom, low dissolved oxygen and other water-quality impairments.

Initial land clearing exposes soil to erosion and more rapid runoff. Construction equipment is a potential source of contamination from such things as hydraulic, fuel and lubricating fluids. Equipment and any materials that are spilled, including additive chemicals and fuel, are exposed

Values and Groundwater Effluent Limitations.[9,10] In NYS, the state drinking water standards (10 NYCRR 5) apply to all public water supplies and set maximum contaminant levels (MCLs) for essentially all organic chemicals in public drinking water. See Table 6.1.

6.1.3.3 Flowback Water and Production Brine

Gelling agents, surfactants and chlorides are identified in the 1992 GEIS as the flowback water components of greatest environmental concern.[11] Other flowback components can include other dissolved solids, metals, biocides, lubricants, organics and radionuclides. Opportunities for spills, leaks, and operational errors during the flowback water recovery stage are the same as they are during the prior stages with additional potential releases from:

- hoses or pipes used to convey flowback water to tanks or a tanker truck for transportation to a treatment or disposal site; and
- tank leakage.

In general, *flowback water* is water and associated chemical constituents returning from the borehole during or proximate in time to hydraulic fracturing activities. *Production brine*, on the other hand, is fluid that returns from the borehole after completion of drilling operations while natural gas production is underway. The chemical characteristics and volumes of flowback water and production brine are expected to differ in significant respects.

Flowback water composition based on a limited number of out-of-state samples from Marcellus wells is presented in Table 5.9. A comparison of detected flowback parameters, except radionuclides, to regulated parameters is presented in Table 6.1.[12]

Table 5.10 lists parameters found in the flowback analyses, except radionuclides, that are regulated in New York. The number of samples that were analyzed for the particular parameter is shown in Column 3, and the number of samples in which parameters were detected is shown in Column 4. The minimum, median and maximum concentrations detected are indicated in

[9] URS, 2009, p. 4-18, et seq.

[10] http://www.dec.ny.gov/regulations/2652.html.

[11] NYSDEC, 1992, GEIS, p. 9-37.

[12] URS, 2009, p. 4-18, et seq.

6.8.5 Environmental Justice

As described in previous sections, there is potential for some localized negative impacts to occur as a result of allowing high-volume hydraulic fracturing. Therefore, implementation of such projects could have localized negative impacts on environmental justice populations if the projects are sited in identified environmental justice areas. However, specific project site locations have not been selected at this time.

Currently, natural gas well permit applications are exempt from requirements in NYSDEC Commissioner Policy 29, Environmental Justice and Permitting (CP-29); therefore, additional environmental justice screening would not be required for individual well permit applications. However, some of the auxiliary permits/approvals that would be needed prior to well construction may require environmental justice screening.

When necessary, project applicants would determine whether the proposed project area is urban or rural and would perform a geographic information system (GIS)-based analysis at the census tract or block group level to identify potential environmental justice areas. If a potential environmental justice area is identified by the preliminary screening, additional community outreach activities would be required.

6.9 Visual Impacts[135]

The visual impacts associated with vertical drilling in the Marcellus and Utica Shales would be similar to those discussed in the 1992 GEIS (NYSDEC 1992). Horizontal drilling and high-volume hydraulic fracturing are, in general, similar to those discussed in the 1992 GEIS (NYSDEC 1992), although changes that have occurred in the industry over the last 19 years may affect visual impacts. These visual impacts would typically result from the introduction of new landscape features into the existing settings surrounding well pad locations that are inconsistent with (i.e., different from) existing landscape features in material, form, and function. The introduction of these new landscape features would result in changes to visual resources or visually sensitive areas and would be perceived as negative or detrimental by regulating agencies and/or the viewing public.

[135] Section 6.9, in its entirety, was provided by Ecology and Environment Engineering, P.C., August 2011, and was adapted by the Department.

The visual impacts of horizontal drilling and high-volume hydraulic fracturing would result from four general on-site processes associated with the development of viable well locations: construction, well development (drilling and fracturing), operation or production, and post-production reclamation. The greatest visual impacts would be associated with the construction of well pads and associated facilities, which would create new long-term features within surrounding landscapes, and well drilling and completion activities at viable well locations, which would be temporary and short-term in nature. Additional off-site activities could also result in visual impacts, including the presence of increased workforce personnel and vehicular traffic, and the use of existing or development of new off-site staging areas or contractor/storage yards.

The visual impacts of horizontal drilling and hydraulic fracturing would vary depending on topographic conditions, vegetation characteristics, the time of year, the time of day, and the distance of one or more well sites from visual resources, visually sensitive areas, or other visual receptors.

6.9.1 Changes since Publication of the 1992 GEIS that Affect the Assessment of Visual Impacts

A number of changes to equipment and drilling procedures since the 1992 GEIS have the potential to result in visual impacts over a larger surrounding area and/or visual impacts over a longer period of time. These changes can generally be separated into three categories: changes in equipment and drilling techniques; changes in the size of well pads; and changes in the nature and duration of drilling and hydraulic-fracturing activities.

6.9.1.1 Equipment and Drilling Techniques

The 1992 GEIS stated that drill rigs ranged in height from 30 feet for a small cable tool rig to 100 feet or greater for a large rotary rig. By comparison, the rigs currently used by the industry for horizontal drilling can be 140 feet or greater in height and have more supporting equipment. While a substantial amount of on-site equipment, including stationary tanks, compressors, and trucks, would be periodically present at each site during specific times of well development (drilling and fracturing), the amount of necessary on-site equipment during these times is similar to that addressed in the 1992 GEIS.

Intermediate Casing

Intermediate casing is run in a well after the surface casing but before production hole is drilled. Fully cemented intermediate casing can be necessary in some wells to prevent possible pressurization of the surface casing seat, and to effectively seal the hole below the surface casing to prevent communication between separate hydrocarbon-bearing strata and between hydrocarbon and water-bearing strata. The primary uses of intermediate casing are to 1) provide a means of controlling formation pressures and fluids below the surface casing, 2) seal off problematic zones prior to drilling the production hole and 3) ensure a casing seat of sufficient fracture strength for well control purposes. The intermediate casing's design and setting depth is typically based on various factors including anticipated or encountered geologic characteristics, wellbore conditions and the anticipated formation pressure at total depth of the well. Factors can also include the setting depth of the surface casing, occurrence of shallow gas or flows in the open hole, mud weights used to drill below intermediate casing, and well-control and safety considerations.

Current casing and cementing practices attached as conditions to all oil and gas well drilling permits state that intermediate casing string(s) and cementing requirements will be reviewed and approved by the Department on an individual well basis. The Department proposes to require, via permit condition and/or regulation, that for high-volume hydraulic fracturing the installation of intermediate casing in all wells covered under the SGEIS would be required. However, the Department may grant an exception to the intermediate casing requirement when technically justified. A request to waive the intermediate casing requirement would need to be made in writing with supporting documentation showing that environmental protection and public safety would not be compromised by omission of the intermediate string. An example of circumstances that may warrant consideration of the omission of the intermediate string and granting of the waiver could include: 1) deep set surface casing, 2) relatively shallow total depth of well and 3) absence of fluid and gas in the section between the surface casing and target interval. Such intermediate casing waiver request may also be supported by the inclusion of information on the subsurface and geologic conditions from offsetting wells, if available.

would impose specific construction windows within well construction permits in order to ensure that drilling activity and its cumulative adverse socioeconomic effects are not unduly concentrated in a specific geographic area.

Another way to mitigate the potential adverse impacts associated with in-migration to the region would be to actively encourage the hiring of local labor. Because natural gas exploration, drilling, and production activities typically require specialized skills, a jobs training program or apprentice program should be developed through the SUNY system (e.g., community colleges and agricultural and technical colleges) to increase the number of local residents with the requisite job skills for the natural gas industry, thereby reducing the number of workers that would need to be hired from outside the region. Such a program would also have the benefit of reducing unemployment in these regions. A jobs training program would not eliminate the need for in-migration of skilled labor, but the program could partially offset the in-migration of workers and thus partially offset the potential housing impact from such in-migration.

7.9 Visual Mitigation Measures[95]

As noted, in most cases high-volume hydraulic fracturing operations would not result in significant adverse impacts on visual resources. The most significant visual impacts would result from construction of the well pad and well, and those impacts would be of short duration. Nevertheless, this section describes generic measures to address temporary adverse impacts of well site construction, development, production, and reclamation on visual resources. These measures could be undertaken in cases where well construction takes place near visually sensitive areas identified within the area underlain by the Marcellus and Utica Shales in New York State. Measures to mitigate impacts on visual resources would be generally similar, regardless of the type of visual resource or its location, and despite the need for compliance with rules, regulations, and permits promulgated by other federal, state, and/or local (town, county or regional) agencies.

The development of measures to reduce impacts on visual resources or visually sensitive areas would follow the procedures identified in NYSDEC DEP-00-2, “Assessing and Mitigating

[95] Section 7.9, in its entirety, was provided by Ecology and Environment Engineering, P.C., August 2011 and was adapted by the Department.

Visual Impacts" (NYSDEC 2000). These measures can generally be divided into: design and siting measures that could be incorporated during the construction, development, and production phases; maintenance measures that could be incorporated into the development and production phases; and decommissioning measures that could be incorporated into the reclamation phase. Offsetting mitigation, as opposed to avoidance and direct mitigation measures, would typically be used only as a last resort for the resolution of significant impacts on visual resources or visually sensitive areas, as determined by Department staff. These measures are discussed in greater detail in the following subsections.

Generally, mitigation measures would be developed in consultation between Department staff and well operators and would be site-specific, or project-specific where multiple sites are a part of the project design. Depending on the location of the well pad and the resource potentially impacted, it may also be necessary to consult with additional state and federal regulatory agencies to develop measures to mitigate visual impacts on specific types of visual resources or visually sensitive areas, including but not limited to the New York State Historic Preservation Officer for NRHP-listed or -eligible historic properties; consultation with the National Park Service for National Historic Landmarks (NHLs) and National Natural Landmarks (NNLs); consultation with the U.S. Fish and Wildlife Service for National Wildlife Management Areas; consultation with the NYSDOT for state-designated Scenic Byways, etc.; and consultation with local (town, county, or regional) agencies for locally designated visual resources or visually sensitive areas that were identified on the EAF.

7.9.1 Design and Siting Measures

Design and siting measures, as described in NYSDEC DEP-00-2, would typically consist of screening, relocation, camouflage or disguise, maintaining low facility profiles, downsizing the scale of a project, using alternative technologies, using non-reflective materials, and controlling off-site migration of lighting (NYSDEC 2000). These various design and siting techniques are summarized below.

- **Screening**. Screening uses natural or man-made objects to conceal other objects from view; these objects may be constructed of any material that is opaque.

- **Relocation**. Relocation consists of moving facilities or equipment within a site to take advantage of the mitigating effects of topography and/or vegetation.

- **Camouflage or disguise**. Camouflage or disguise consists of using forms, colors, materials, and patterns to minimize or mitigate visual impacts.

- **Low profiles**. The use of low profiles consists of reducing the height of on-site objects to minimize their visibility from surrounding viewsheds.

- **Downsizing**. Downsizing consists of reducing the number, areas, or density of objects on a site to minimize their visibility from surrounding viewsheds.

- **Alternative technologies**. The use of alternative technologies consists of substituting one technology for another to reduce impacts.

- **Non-reflective materials**. The use of non-reflective, materials consists of using materials that do not shine or reflect light into surrounding viewsheds.

- **Lighting**. Lighting should be the minimum necessary for safe working conditions and for public safety, and should be sited to minimize off-site light migration, glare, and 'sky glow' light pollution.

Design and siting measures are the simplest and most effective methods for avoiding, minimizing, or mitigating direct and indirect impacts on visual resources or visually sensitive areas. For example, the state has determined that surface drilling would be prohibited on state-owned land, including reforestation areas and wildlife management areas, which would include many of the types of visual resources or visually sensitive areas discussed in Section 2.4. Implementing this siting measure would result in the exclusion from surface drilling of many resources and areas that may be designated or used, in part or in whole, for their scenic qualities, thereby decreasing the potential for direct visual impacts of surface drilling on such resources or areas. The implementation of design and siting measures would also minimize indirect impacts on visual resources or visually-sensitive areas that are outside of, but in close proximity to, areas where drilling is proposed.

Additional use of design and siting measures to avoid, reduce, or mitigate visual impacts would typically be implemented during the construction, development, and production phases of a well site. These measures could be used individually or in combination as determined appropriate and feasible by Department staff and well operators.

For example, the use of multi-well pads for horizontal drilling and hydraulic fracturing is a design and siting measure that incorporates both relocation and downsizing techniques by installing more than one well in one location. The benefit of the multi-well pad is that it decreases the overall number of pads in the surrounding landscapes, which would result in the decreased potential for impacts on visual resources or visually sensitive areas during the construction, development, production, and reclamation phases.

The use of horizontal drilling and high-volume hydraulic fracturing is a design and siting measure that incorporates the use of alternative technology to extract natural gas from the prospective Marcellus and Utica Shale region. The benefit of horizontal drilling and high-volume hydraulic fracturing is that it provides flexibility in pad location, such that well pads can be sited to avoid or minimize the potential for temporary, short-term, and long-term impacts on visual resources or visually sensitive areas during the construction, development, production, and reclamation phases (NTC 2011). Such considerations should be reflected in Department consideration of well pad applications.

The potential benefit of using camouflage or disguise as a design measure to minimize impacts on visual resources or visually sensitive areas is shown in Photo 7.1 below. This photo shows fracturing activities on a well site, a phase when well sites are almost entirely filled with on-site equipment, which represents new landscape features and results in an area that appears visually prominent in views from nearby vantage points. Although the fracturing phase of development is considered temporary and periodic (as described in Section 6.11), it would be possible to minimize visual impacts during fracturing activities that might occur in the spring, summer, or fall by requiring on-site water storage tanks (the red tanks in Photo 7.1) to be a green color to mimic surrounding conditions. This would reduce the prominence of the tanks in the surrounding landscape during seasons when visual resources or visually sensitive areas are typically visible to the greatest numbers of the viewing public.

Photo 7.1 - View of a well site during the fracturing phase of development, with maximum presence of on-site equipment. (New August 2011)

The 2010 visual impact assessment (Upadhyay and Bu 2010) evaluated the effectiveness of implementing certain design and siting techniques as measures to mitigate visual impacts. Using aerial photograph interpretation, the authors suggested that reducing the size of the well pad (downsizing) after drilling (the development phase) was complete could result in reduced site-specific visual impacts from surrounding vantage points and that reducing the density of multiple well pads in an area could result in reduced visual impacts within a larger area or region (e.g., within a county). Their study further suggested that the following design and siting measures would avoid or minimize visual impacts from surrounding vantage points: relocating well sites to avoid ridgelines or other areas where aboveground equipment and facilities breaks the skyline; and minimizing off-site light migration by using night lighting only when necessary and using the minimum amount of nighttime lighting necessary, directing lighting downward instead of horizontally, and using light fixtures that control light to minimize glare, light trespass (off-site light migration), and light pollution (sky glow) (Upadhyay and Bu 2010).

A tourism study (Rumbach 2011) prepared for the Southern Tier Central (STC) Regional Planning and Development Board suggests that visual impacts from horizontal drilling and hydraulic fracturing could be most effectively addressed during the siting and design phases by ensuring that well pads are designed and located in ways that minimize potential impacts on visual resources or visually sensitive areas to the extent practicable. The study also encourages the inclusion of visual impact mitigation conditions, developed in accordance with NYSDEC DEP-00-2, in permits when visual resources may be impacted. The study also recommends the development of a best practices manual for Department staff and the industry, which would provide information on what is expected by the Department in terms of well siting and visual mitigation, and the identification of instances where visual mitigation may be necessary. Additional recommendations included encouraging local agencies (towns, counties, and regions) to identify areas of high visual sensitivity, which may require additional visual mitigation, and to develop a feedback mechanism in the project review process to confirm the success of measures to avoid, minimize, or mitigate visual impacts, based on the analysis of results for prior projects (Rumbach 2011).

7.9.2 Maintenance Activities

The maintenance activities described in NYSDEC DEP-00-2 should be implemented to prevent project facilities from becoming "eyesores." Such measures would typically consist of appropriate mowing or other measures to control undesirable vegetation growth; erosion control measures to prevent migration of dust and/or water runoff from a site; measures to control the off-site migration of refuse; and measures to maintain facilities in good repair and as organized and clean as possible according to the type of project (NYSDEC 2000).

Maintenance activities to avoid, reduce, or mitigate visual impacts would typically be implemented during the development and production phases for well sites. Facilities should be maintained in good repair and as organized and clean as possible.

Upadhyay and Bu's visual impact assessment evaluated the effectiveness of site restoration to minimize visual impacts on surrounding landscapes. Their definition of site restoration as a mitigation measure, defined as restoring drilling pads to their original condition after drilling and hydraulic fracturing activities (i.e., the development phase) are completed, is similar in concept to the NYSDEC DEP-00-2 definition of maintenance activities as a mitigation measure. Their conclusion was that site restoration following drilling and hydraulic fracturing activities was an effective way to reduce adverse visual impacts of producing well sites within the existing landscape. With appropriate site restoration, well sites in the production phase, when activity is minimal and there are only a few relatively unobtrusive aboveground structures on site, are not prominent features within the surrounding landscape (Upadhyay and Bu 2010).

7.9.3 Decommissioning

The decommissioning activities described in NYSDEC DEP-00-2 should be implemented when the useful life of the project facilities is over; these activities would typically occur during the reclamation phase for well sites.[96] Such activities would typically consist of, at a minimum, the removal of aboveground structures at well sites. Additional decommissioning activities that may also be required include: the total removal of all facility components at a well site (aboveground and underground) and restoration of a well site to an acceptable condition, usually with attendant vegetation and possibly including recontouring to reestablish the original topographic contours; the partial removal of facility components, such as the removal or other elimination of structures or features that produce visual impacts (such as the restoration of water impoundment sites to original conditions); and the implementation of actions to maintain an abandoned facility and site in acceptable condition to prevent the well site from developing into an eyesore, or prevent site and structural deterioration (NYSDEC 2000).

The tourism study prepared for the STC (Rumbach 2011) discusses additional measures that could be implemented during the reclamation phase to mitigate visual impacts. These measures, which would be applied to all well pads, include the application of specific procedures identified in the 1992 GEIS for topsoil conservation and redistribution in agricultural districts. These procedures include stripping off and stockpiling topsoil during construction; protecting stockpiled topsoil from erosion and contamination; cutting well casings to a safe buffer depth of 4 feet below the ground surface; preparing areas before topsoil redistribution if compaction has

[96] Although substantial equipment and activity would be present at well sites during the construction and development phases, such equipment and activities are temporary. Once construction and well development is completed, some activities would cease and some equipment would be removed, and these are not considered to be decommissioning activities.

occurred on-site; and redistributing the topsoil over the disturbed area of the former well pads during reclamation (Rumbach 2011).

7.9.4 Offsetting Mitigation

The offsetting mitigation described in NYSDEC DEP-00-2 should be implemented when the impacts of well sites on visual resources or visually sensitive areas are significant and when such impacts cannot be avoided by locating the well pad in an alternate location. Per guidance in NYSDEC DEP-00-2, offsetting mitigation would consist of the correction of an existing aesthetic problem identified within the viewshed of a proposed well project. Thus, a decline in the landscape quality that would result from development of a proposed well site could, at least partially, be 'offset' by the correction. An example of offsetting mitigation might be the removal of an existing abandoned structure that is in disrepair (i.e., an 'eyesore') to offset impacts from the development of a well site within visual proximity to the same sensitive visual resource (NYSDEC 2000). Offsetting mitigation should be employed only when significant improvements in visually sensitive locations can be expected at a reasonable cost (NYSDEC 2000).

7.10 Noise Mitigation Measures[97]

Noise is best mitigated by increasing distance between the source and the receiver; the greater the distance the lower the noise impact. The second level of noise mitigation is direction. Directing noise-generating equipment away from receptors greatly reduces associated impacts. Timing also plays a key role in mitigating noise impacts. Scheduling the more significant noise-generating operations during daylight hours provides for tolerance that may not be achievable during the evening hours.

7.10.1 Pad Siting Equipment, Layout and Operation

Many of the potential negative impacts of gas development depend on the location chosen for the well pad and the techniques used in constructing the access road and well site. Before a drilling permit can be issued, Department staff must ensure that the proposed location of the well and access road complies with the Department's spacing regulations and siting restrictions. To assist

[97] Section 7.10, in its entirety, was provided by Ecology and Environment Engineering, P.C., August 2011 and was adapted by the Department.

sets forth a water well testing protocol using indicators that are independent of specific additive chemistry.

For every well permit application the Department would require, as part of the EAF Addendum, identification of additive products, by product name and purpose/type, and proposed percent by weight of water, proppants and each additive. This would allow the Department to determine whether the proposed fracturing fluid is water-based and generally similar to the fluid represented by Figures 5.3, 5.4, and 5.5. Additionally, the anticipated volume of each additive product proposed for use would be required as part of the EAF Addendum. Beyond providing information about the quantity of each additive product to be utilized, this requirement informs the Department of the approximate quantity of each additive product that would be on-site for each high-volume hydraulic fracturing operation.

The Department would also require the submittal of an MSDS for every additive product proposed for use, unless the MSDS for a particular product is already on file as a result of the disclosure provided during the preparation process of this SGEIS (as discussed in Chapter 5) or during the application process for a previous well permit. Submittal of product MSDSs would provide the Department with the identities, properties and effects of the hazardous chemical constituents within each additive proposed for use.

Finally, the Department proposes to require that the application materials (i) document the applicant's evaluation of available alternatives for the proposed additive products that are efficacious but which exhibit reduced aquatic toxicity and pose less risk to water resources and the environment and (ii) contain a statement that the applicant will utilize such alternatives, unless it demonstrates to DMN's satisfaction that they are not equally effective or feasible. The evaluation criteria should include (1) impact to the environment caused by the additive product if it remains in the environment, (2) the toxicity and mobility of the available alternatives, (3) persistence in the environment, (4) effectiveness of the available alternative to achieve desired results in the engineered fluid system and (5) feasibility of implementing the alternative.

In addition to the above requirements for well permit applications, the Department would continue its practice of requiring hydraulic fracturing information, including identification of

EXHIBIT L

Testimony of Paul V. Rush, P.E.
Deputy Commissioner, Bureau of Water Supply
New York City Department of Environmental Protection
at a Hearing of the Delaware River Basin Commission
Draft Natural Gas Development Regulations
Tuesday, February 22, 2011, 1 pm, Liberty, New York

Good afternoon, I am Paul Rush, Deputy Commissioner for the Bureau of Water Supply, at the New York City Department of Environmental Protection (DEP).

We commend the Delaware River Basin Commission (DRBC) for taking on the daunting task of updating the rules and procedures to address natural gas activities within the Delaware River Basin. Clearly this type of industrial activity has the potential to have a significant impact on the Delaware River and its tributaries and a strong regulatory framework is required. DRBC brings a much-needed regional perspective and consistency to this multi-jurisdictional issue. In particular, DRBC is in a unique position to address cumulative impacts of multiple water withdrawals and wastewater disposal sites. In the interest of time, I will confine my testimony to this issue; DEP will submit comprehensive comments by the March 16 deadline.

Any decisions about drilling for natural gas in the Marcellus Shale must be based on detailed scientific and technical reviews. DEP's 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. Decisions about drilling within the shared Delaware River Basin should be made on the same strong analytical foundation. We continue to urge DRBC to conduct a rigorous analysis of the potential cumulative impacts natural gas development could have on water quantity and water quality in the Delaware Basin. Given what is at stake and the estimates of natural gas wells in the Delaware River Basin numbering in the tens of thousands, it would be prudent to complete such a comprehensive analysis prior to the promulgation of final regulations, so that it can inform the rules and restriciton on natural gas exploration in the basin.

A cumulative impact assessment for the Delaware Basin must also include a depletive use budget for the basin, as recommended in the 1982 Good Faith Agreement. Depletive water use has a direct bearing on the basin's future development, its water quality, water quantity, ecological health, salinity intrusion, and drought management. This information is also critical for managing the effects of climate change, and must consider secondary impacts to other stakeholders as well. I urge DRBC to conduct and complete a cumulative impact assessment before issuing its natural gas regulations.

Thank you for the opportunity to comment. As always, New York City looks forward to working with our partners in the management of this common, precious resource.

EXHIBIT M

Environmental Protection

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April 7, 2011

Paula Schmitt, Commission Secretary
Delaware River Basin Commission
25 State Police Drive
PO Box 7360
West Trenton, NJ 08628

Re: Delaware River Basin Commission's Draft Natural Gas Extraction Regulations

Dear Ms. Schmitt:

The City of New York is very concerned with the prospect of natural gas drilling in the New York City (City) water supply watershed, much of which feeds the headwaters of the Delaware River. The City water supply provides high quality drinking water to nearly half the population of the State of New York – over eight million people in the City and one million people in upstate counties. The City has invested more than $1.5 billion in watershed protection programs that support sustainable farming, environmentally sensitive economic development, and local economic opportunity. These investments protect water quality for the 15 million people who rely on the Delaware River watershed for clean drinking water. The Delaware River is a shared resource and changes in its watershed's environment affect us all.

Overall, the draft regulations are a step in the right direction toward protecting the Delaware River from the potential impacts of gas drilling. They seek to strike a balance between deferring to state jurisdictions while still ensuring sufficient protection to the Delaware River and downstream stakeholders. However, the City continues to believe that it is premature for the Delaware River Basin Commission (DRBC) to adopt these regulations. Prior to issuing any regulations, DRBC should conduct a rigorous analysis of the potential cumulative impacts natural gas development could have on water quantity and water quality in the Delaware Basin. Second, in addition, DRBC should wait until the U.S. Environmental Protection Agency (EPA) completes its ongoing study of hydraulic fracturing's potential impacts on water quality. Only once those two critical analyses are complete can it be determined whether DRBC's proposed regulations will sufficiently protect the Delaware River.

The Department of Environmental Protection's (DEP) 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. Decisions about drilling within the shared Delaware River Basin should be made on the same strong scientific foundation. Given what is at stake and the estimates of natural gas wells in the Delaware River Basin numbering in the *tens of thousands*, we urge DRBC to wait for the completion of both a DRBC and EPA studies to inform the natural gas regulations.

Cumulative Impact Assessment

A cumulative impact assessment for the Delaware Basin is essential to developing a full understanding of the impacts of natural gas drilling. Such an assessment must include a depletive use budget for the basin as recommended in Section V, Depletive Water Use Budget, Recommendation 13, of the 1982 Good Faith Agreement. Depletive water use has a direct bearing on the basin's future development, its water quality, water quantity, ecological health, salinity intrusion, and drought management. This information is also critical for managing the effects of climate change.

Performing a cumulative impact assessment before adopting regulations is particularly important because the regulations do not provide for such an assessment to be prepared in connection with individual approvals. The City is particularly concerned about the cumulative impacts of consumptive uses in the basin. As Section 7.4(b)(2) of the draft regulations states, "*... the water uses associated with natural gas development are almost entirely consumptive in nature.*" The draft regulations would nonetheless allow Approval by Rule (ABR) to exploit previously approved water sources for supply of natural gas development. This is not consistent with the principles embodied in the regulations as a whole because it implies that consumptive use of water for natural gas development is similar to, and will have the same impacts as, whatever use had previously been approved. Particularly if a previously approved water source is not consumptive, allowing it to be utilized for natural gas development, which is consumptive, would represent a significant change from the original approval warranting thorough review. While we have concerns about ABR provisions, however, the City greatly appreciates DRBC's recognition that the ABR process should not be allowed within the City watershed.

Additionally, Section 7.4(e)(1)(i) of the draft regulations states that "*A new water source located within the physical boundaries of an approved NGDP [Natural Gas Development Plan] may be approved for uses within the NGDP by means of an ABR.*" A new withdrawal for natural gas development will have the same substantial effect, as indicated in the Preliminary Determination in section 7.4(b), regardless of whether it is within the boundaries of an approved natural gas development plan, and thus should only be approved by docket as other new water sources for natural gas development.

In order to address potential cumulative impacts associated with consumptive withdrawals, DRBC should develop river flow conditions under which withdrawals or wastewater discharges would be temporarily halted. For example, DRBC should mandate, as a condition of approval, that gas drilling companies take water only during times when the City is not required to make releases as directed by the Delaware River Master to meet the Montague flow objective. Consumptive withdrawals with low by-pass requirements will adversely impact downstream conditions, especially during periods of low flow, requiring increased compensating releases by the City to meet the Montague flow objective. A similar mandate can be placed on the Trenton flow objective in order to prevent natural gas withdrawals or wastewater discharges from adversely impacting existing uses in the lower Delaware Basin. Wastewater treatment plants discharging high salinity wastewaters from natural gas development should also be curtailed when the salt front nears the Philadelphia intake at Torresdale. A comprehensive basin-wide analysis would provide the data necessary to set appropriate restrictions on natural gas withdrawals and adequately protective pass-by flows.

EPA Drinking Water Study

Given that the Delaware River Basin is a critical source of drinking water for some 15 million people, and given the many open questions concerning the impact of hydrofracking on drinking water, we urge DRBC to wait to issue regulations until the EPA study is complete, and DRBC can evaluate whether EPA's findings dictate additional restrictions that should be imposed within such an important drinking water source. The City's own risk assessment identified substantial risks to water quality and water supply infrastructure associated with natural gas production in our watershed and in the vicinity of our water supply infrastructure. Accordingly, DRBC, as a steward of drinking water for such a substantial population, should approach this issue cautiously, and should wait to make decisions until it has the benefit of better information.

Other Concerns

Stormwater Controls. The required Natural Gas Development Plans will be valuable planning tools and will allow for more comprehensive reviews of natural gas development in the basin. We respectfully request, however, that the Non-point Source Pollution Control Plans (NPSPCP) be required to be submitted to the City in addition to New York State if the project is within the City watershed. The City has watershed rules and regulations governing stormwater that are based on New York State's regulatory program but which, in some situations, are more stringent. For the same reasons that the City has determined that rigorous stormwater controls are necessary to protect water quality, DRBC should add post-construction requirements covering items such as continuing maintenance of access roads or structural integrity of the well casing.

Reporting on Subsurface Conditions. Unusual subsurface conditions, if not properly mitigated, could result in migration of contaminants or gases away from the well bore. We recommend that conditions be added to the draft regulations requiring natural gas operators to submit a written report to the Commission in the event that any unexpected subsurface condition is encountered during drilling (e.g. blowout, borehole kick, lost circulation material, shallow methane or brine, etc.). The report should describe the event encountered and remedial action taken.

Spill Control Plans. The draft regulations do not mention the need for a spill control plan for natural gas development sites. Given the potential for spills and accidental releases from natural gas development utilizing hydraulic fracturing, DRBC regulations should require that a comprehensive spill control plan be submitted to the Commission for review as a condition of project approval. The spill control plan should be reviewed and updated annually to ensure it contains the most recent contact information for officials and first responders.

Setbacks from Water Supply Infrastructure. The setbacks provided for surface water intake (500 ft) and water supply reservoir (500 ft) are not sufficiently protective of water resources even given the prohibition of siting a well pad in the 100-year floodplain. The City urges DRBC to reconsider these distances and also to specify how the setback will be measured. Horizontal drilling adds a new complication to traditional regulatory setbacks. If the setback is measured from the well pad, then horizontal drilling may occur directly *beneath* the intake or reservoir. Instead we recommend that the setback be measured from the end of the nearest horizontal drill leg to the resource in question.

Invasive Species. The draft regulation indicates that an invasive species control plan is only required if determined by the Commission. Given the fact that natural gas development will be distributed throughout the Delaware Basin and surrounding regions, and that trucks and equipment will be moved frequently, it is recommended that invasive species control plans be required for all natural gas development projects.

Duration of Approvals. Given the rapid pace of natural gas development in this region and the constantly evolving technology, the duration of withdrawal approvals for natural gas extraction purposes must be reevaluated. Approvals lasting ten years may not give DRBC or other stakeholders an adequate opportunity to evaluate potential impacts in the context of current environmental conditions, recent technological advances or improved scientific understanding. The City therefore recommends that no withdrawal approval, whether through an original docket or through ABR, allow withdrawals for natural gas extraction purposes for longer than five years.

We commend DRBC for taking on the critical task of developing natural gas regulations and balancing a wide range of stakeholder needs. If you have any questions or comments, or if we can be of any further assistance in this matter, please feel free to contact me directly at (845) 340-7800, or prush@dep.nyc.gov.

Sincerely,

Paul V. Rush

Paul V. Rush, P.E.
Deputy Commissioner

c: James Tierney, Assistant Commissioner, NYS DEC

EXHIBIT N

New York City Department of
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December 22, 2009

Attn: dSGEIS Comments
Bureau of Oil & Gas Regulation
NYSDEC, Division of Mineral Resources
625 Broadway, Third Floor
Albany, NY 12233-6500

Re: Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program (dated 9/30/2009)

To Whom It May Concern:

The City of New York (City) submits the following comments on the New York State Department of Environmental Conservation's (DEC) September 30, 2009 Draft Supplemental Generic Environmental Impact Statement (dSGEIS) on the Oil, Gas and Solution Mining Regulatory Program – Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs.[1]

Overview

The City appreciates the opportunity to comment on DEC's plan to permit the development of natural gas in the Marcellus Shale formation, and the potential economic opportunity that this represents for the State. As promising as that opportunity may be, however, the City has concluded that based on the latest science and available technology, as well as the data and analysis presented in the State's dSGEIS, horizontal drilling and high-volume hydraulic fracturing (collectively, "hydro-fracking," or "gas drilling") 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.

As the detailed comments that follow explain, the up to 6,000 wells required to extract natural gas based on current technology, seven million truck trips, one million tons of concentrated chemicals, and millions of gallons of wastewater that are necessities and by-products of current extraction methods, pose a substantial threat to the water supply. Further, the activity is inconsistent with the principles of watershed protection and pollution prevention that are incorporated into its Filtration Avoidance Determination (FAD) under the federal Surface Water Treatment Rule.

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[1] These comments are informed by and incorporate the findings of the attached Final Impact Assessment Report (Report) and the attached Rapid Impact Assessment Report, both of which were undertaken by the City with the assistance of Hazen and Sawyer/Leggette, Brashears and Graham.

Hydro-fracking requires a high-degree of invasive industrial activity, with potential geologic and public health impacts that are not well understood. Given these realities, permitting gas drilling in the watershed would upset the balance between watershed protection and economic activities that the City, DEC, and our upstate partners have worked so hard to establish over the past 15 years.

When lands already owned or controlled by the City and State are taken into account, only six percent of potentially exploitable Marcellus shale is within the New York City watershed. Prohibiting gas drilling of six percent of the available reserves is a more than reasonable price to pay to safeguard the State's greatest natural resource—unfiltered drinking water for nine million state residents.

Background of the City's Filtration Avoidance Determination

The City's position is grounded in data and analysis. But some context is crucial to understanding what is at stake for nine million state residents who rely on the City's water supply. The federal Environmental Protection Agency (EPA) granted the City's first FAD in 1993 and, subsequently, five additional FADs. In 1997, New York City signed a Memorandum of Agreement (MOA) with EPA, various State agencies, 70 watershed municipalities and many environmental organizations to establish a land acquisition program, updated rules, and a set of partnership programs for the watershed's protection. Since that time, the City has since spent or committed approximately $1.5 billion, funded almost exclusively by rate paying customers, on the development and implementation of the watershed protection plan for the Catskills/Delaware watershed (the Cat-Del System).

A key component of these ongoing efforts is the City's Land Acquisition Program. Since its creation, the Land Acquisition Program has protected more than 103,000 acres in the Cat-Del watersheds. When combined with lands protected by the State and other entities, these acquisitions have raised the level of permanently protected land in the Cat-Del System from 24 percent in 1997, to 34 percent today.[2] Together with City-funded acquisitions by the Watershed Agricultural Council (WAC), the program has acquired or is under contract for lands with a value of $354 million.[3]

The New York City Department of Environmental Protection (DEP) also pays taxes on its upstate holdings, including system infrastructure and vacant land. For the current fiscal year, the City's total upstate tax bill is approximately $120 million (that includes properties east of Hudson). And other watershed protection efforts—like septic repairs, stormwater retrofits and stream restorations—result in quality-of-life improvements for watershed residents. Finally, DEP has made significant improvements in allowing recreational uses of City property in the watershed, which have been well received by local communities. The success of these protection efforts has been recognized by both the EPA and the State. A 2006 EPA report, evaluating the

[2] DEP, Long-Term Land Acquisition Plan 2012 to 2022 (September 30, 2009).

[3] Other key efforts as part of its watershed protection efforts include: upgrading plans that account for more than 98% of the wastewater flow in the Cat-Del System, at a cost of $355 million; spending $147 million since 1993 on the Watershed Agricultural Program (WAP), which aims to reduce pollutants leaving the farm through the implementation of best management practices; and a $60 million economic development fund for the West-of-Hudson watershed to support the economic vitality of the region.

City's performance, concluded that the City had "successfully satisfied the obligations specified in the 2002 FAD."[4]

DEC is a vital partner in these efforts. Through its Office of the New York City Watershed Program, the agency provides regulatory oversight and technical expertise, and administers State funding for watershed projects.[5] Praising the most recent FAD in 2007, DEC recognized that its extension strengthens protections for surrounding lands and reservoirs, and demonstrates a "tremendous fiduciary responsibility to the taxpayers."[6] That is because continuing to safeguard the watershed at its source will ensure the continued high quality of the water supply and save the minimum of $10 billion that would be required to build a filtration plant for Cat-Del water, and $100 million per year needed to operate it, if the FAD is ever discontinued or revoked.[7] That result is unacceptable because it is entirely unnecessary, and within the State's power to stop. The analysis that follows shows why hydro-fracking and horizontal drilling cannot safely be conducted in the watershed.

Analysis of the State's Gas-Drilling Proposal

The City's water supply provides high quality drinking water to nearly half the population of the State of New York – over eight million people in New York City and one million people in upstate counties. DEP is responsible for overseeing the operation, maintenance and management of the water supply, its infrastructure, and the protection of the 1,969 square mile watershed. The Marcellus shale underlies the entire West-of-Hudson portion of the New York City water supply, which typically supplies more than 90% of the City's drinking water. As noted above, the West-of-Hudson watershed supplies water of such high quality that the water does not require filtration.

Based on extensive analysis of the potential impacts of natural gas extraction, hydraulic fracturing threatens the water supply and the FAD in three principal ways:

1. Current extraction methods require a high degree of invasive industrialization that carries inherent short-term and cumulative environmental risks.

2. The chemicals currently used as part of the extraction process, and the significant volumes of wastewater produced can contaminate water supplies.

3. In their current anticipated form, the hydraulic fracturing process could damage water supply infrastructure located within and outside the New York City watershed.

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[4] EPA Region 2, Report on the City of New York's Progress in Implementing the Watershed Protection Program, and Complying with the Filtration Avoidance Determination (August 21, 2006), at 2, available at http://www.epa.gov/region02/water/nycshed/documents/epaeval_august2006.pdf.

[5] DEC's Role In The NYC Watershed, available at http://www.dec.ny.gov/lands/58529.html

[6] Press Release, State Health, Environmental Commissioners Applaud Agreement to Protect NYC Water Supply (July 30, 2007), available at http://www.dec.ny.gov/press/36767.html.

[7] The impacts of chemical contamination and other risks are, of course, environmental. However, the potential economic consequences of those environmental impacts are orders of magnitude greater than in other contexts.

These threats and other adverse impacts, including many known and emerging risks of hydraulic fracturing, are not adequately addressed (if at all) in the dSGEIS. Moreover, the dSGEIS does not fully analyze a range of reasonable alternatives to hydro-fracturing and horizontal drilling, and does not sufficiently mitigate known risks. The duty of the State is to take a hard look at the adverse environmental impacts of the action. A new SGEIS is required to adequately address the significant environmental impacts that would occur from the action, both at the local level and from a cumulative perspective. Site-specific environmental reviews to address the many discretionary elements of subsequent permit applications are also required.

We respectfully disagree with a fundamental assumption underlying many of the conclusions in the dSGEIS – that the combined technologies of horizontal drilling and high volume hydraulic fracturing are in large part similar to activities that have been conducted in New York State for decades. Rather, the extent and intensity of natural gas development that these new technologies make possible, together with the large volumes of water required, wastewater produced and associated industrial activities, raise serious concerns about a host of issues and potential impacts that was not previously anticipated or addressed in the 1992 Generic Environmental Impact Statement (GEIS) or in any existing regulatory program. Indeed, new information about spills from conventional gas wells in New York that have been unremediated calls into question the adequacy of the minimal requirements of the existing regulatory program to manage conventional pathways of harm and whether the scope of the dSGEIS has to be expanded to cover those issues.

If, notwithstanding the City's objections, DEC continues to pursue a plan to permit hydro-fracturing and/or horizontal drilling in the watershed, the current dSGEIS must be rescinded and these significant omissions and deficiencies must be addressed. The available knowledge of fractures in the watershed, seepages into DEP tunnels during construction, instances of contamination in other jurisdictions, and the sheer magnitude of truck trips, chemicals, and construction in the Watershed – much of it ignored in the dSGEIS – demonstrates that risks must be disclosed, analyzed, and mitigated on at least a site-specific basis for each well drilled.

The City's most serious concerns are summarized below:

Industrialization and the City's Filtration Avoidance Determination

The dSGEIS finds that "the possibility of high-volume hydraulic fracturing presents no realistic threat to the Filtration Avoidance Determination." This is simply not the case. The proposed action constitutes a significant and unacceptable threat to the FAD, and the integrity of the City's unfiltered water supply system.

The dSGEIS' erroneous finding is based, among other factors, on "New York City's control of a substantial amount of acreage surrounding the reservoirs through fee ownership or conservation easements ...." (dSGEIS, p. 7-63) In fact, DEP owns or has conservation easements on only 13% of watershed lands. Combined with the 21% of watershed lands protected by the State or other entities, a total of 34% of watershed land can be characterized as "protected" from natural gas drilling, though it should be noted that these areas are still subject to compulsory integration into a spacing unit under State law. According to our estimates, this would still allow 3,000 to 6,000 natural gas wells in the NYC watershed (see discussion under

Cumulative Impacts). The potential for this level of natural gas development under the terms and conditions presented in the dSGEIS can reasonably be anticipated to compromise the City's ability to comply with water quality regulations, and public confidence in our ability to adequately protect the water supply.

In the event that the FAD were revoked because of the impacts of natural gas exploration in the Catskill-Delaware watershed, the City would be required to construct a water filtration facility with a current estimated cost of $10 billion to build and $100 million per year to operate. This translates to a significant increase in the price of water and sewer service currently paid by NYC consumers. Additionally, the City expects that the current filtration plant design would be inadequate to remove the chemicals that are likely to be introduced into the watershed as a result of natural gas drilling activities. Additional technology such as advanced oxidation, granular activated carbon adsorption, and/or membrane filtration processes would likely be necessary. All of these advanced processes are significantly more expensive than those included in the current design. It is also important to note that it would take 10 years or more for the City to design and build a plant in the West-of-Hudson watershed capable of filtering the contaminants that would be introduced by hydraulic fracturing.

At a minimum, any regulatory framework for gas exploration, drilling, and development must protect against risks to public health and the environment. An appropriate regulatory framework would have to identify and address the remaining risks, such as the costs to build and operate the filtration plant in the event that drilling caused or contributed to the revocation of the City's Filtration Avoidance Determination. Failure to ensure that DEC's program to regulate and oversee natural gas production fully accounts for the potential costs of drilling in the City's watershed would impose a massive unfunded mandate on the City and its water rate payers, who are already bearing the cost of several billion-dollar projects that are driven by such mandates. In recognition of this growing problem, Governor Paterson recently stated in Executive Order 17 that "the fiscal impact of any legislative or regulatory proposal that imposes a mandate should be evaluated to the fullest extent possible to consider the cost to local governments." The significant potential costs of allowing drilling in the watershed cannot simply be passed on to New York City, and must not be ignored as this process moves forward. Yet the dSGEIS does not discuss or anticipate any regulatory, fiscal, or legal mechanism to make NYC whole should it suffer harm to its drinking water system or to the Filtration Avoidance Determination.

Cumulative Impacts of Gas Drilling in the Watershed

The City concurs with NYSDEC's premise that the "...<u>level of impact on a regional basis will be determined by the amount of development and the rate at which it occurs.</u>" (dSGEIS, p. 6-143) (emphasis added) However, the dSGEIS does not adequately evaluate cumulative impacts, as SEQRA clearly requires. Specifically, the dSGEIS does not rigorously evaluate the cumulative impacts of horizontal drilling and high-volume hydraulic fracturing under a reasonable worst-case development scenario, nor does it evaluate the extent to which the proposed mitigation measures address those impacts.

The City's expert analysis shows that at the rates and densities of natural gas well development recorded in comparable formations, 3,000 to 6,000 wells could be drilled in the NYC watershed, with annual well completion rates on the order of 100 to 500 wells per year in peak years. Delivery of the equipment, chemicals and water needed for well development will require many hundreds of truck trips per well, as will removal of equipment and hauling of flowback water. The proposed action will generate millions of truck trips, thousands of acres of site clearing and grading, millions of tons of fracking chemicals, and millions of tons of waste from produced water. Spills of hazardous materials will be inevitable, and can result in significant harm even if they are eventually remediated. As noted above, the track record of spill response and mitigation has been called into question, even without the substantially increased risks associated with the reasonably increased risks associated with the anticipated rate of drilling in the Marcellus shale.

Water Quality

Natural gas drilling has significant potential to adversely impact water quality through a variety of mechanisms, including but not limited to on-site spills, vehicle-related spills, and subsurface migration of contaminants. While we acknowledge that some safeguards are in place or proposed, we firmly believe that the risk to the water supply is significant and unacceptable, even with these safeguards.

<u>Fracking Chemicals</u>

The dSGEIS does not adequately analyze types and quantities of chemicals that will be used, stored and transported within the watershed; such chemicals are not well understood in any event. The oft-repeated statistic that fracking fluids comprise only 0.5 to 2 percent chemical additives is a better indication of the enormous water requirements involved in hydrofracturing than it is of the benign nature of the process. Even at 0.5 percent concentration, the additives in fracking fluid are an order of magnitude more concentrated than the dissolved pollutants in raw sewage. At 4 million gallons (mg) per job, a 1 percent concentration of chemical additives represents 160 tons of "chemistry" – much of it hazardous, unknown, and undisclosed.

The dSGEIS disclosure requirements are insufficiently protective of human health and the environment. First and foremost, disclosure is solely to DEC. The dSGEIS concludes that any chemical information disclosed in the permit submitted to DEC would be excluded from public disclosure under the trade secret exemption to the Freedom of Information Law. Without this information, the City, and other regulatory agencies, will be greatly hampered in the ability to conduct surveillance monitoring, protect inspection staff, safely and effectively respond to spills or other emergencies, and ultimately protect the public health of the water supply consumers. The City is ultimately faced with a scenario in which thousands of tons of <u>unknown hazardous chemicals</u> could be introduced into the watershed each year.

Second, the disclosure requirements to DEC are insufficient in that the proposed Environmental Assessment Form (EAF) Addendum requires that drillers would only be required to identify the additives to be used, but not necessarily their composition. This is a crucial distinction since many of the products contain undefined mixtures of chemicals; information about these mixtures would be necessary to effectively monitor these hazardous chemicals in the environment. For nearly one-quarter of the 197 products identified to DEC during the dSGEIS process, complete information on composition was not provided. Further, in addition to the 260 unique chemicals identified in the industry submission, there are "an additional 40 compounds which require further disclosure since many are mixtures." (dSGEIS, p. 5-34) The fact that DEC was unable to elicit complete chemical information from service companies during the environmental review process suggests the significant challenges associated with obtaining adequate data on chemical composition as fracking proceeds in New York State. It would also be unrealistic to assume that these submitted data cover all the products and chemicals that will be used in the future, and it is currently unclear whether the dSGEIS establishes a requirement for ongoing disclosure of chemical composition data.

Surface Spills

The dSGEIS dismisses the potential for serious adverse impacts to water quality as a result of surface spills. This finding is based on an analysis that is technically flawed and relies on several assumptions which are not at all conservative, such as complete and instantaneous mixing of chemicals and dilution of chemicals with the entire volume of upstream reservoirs (the latter assumption is also physically impossible) and absorption to the soil of all fracking chemicals. When the gross errors in the analysis are corrected, the likelihood of Maximum Contaminant Level (MCL) violations is significantly greater than predicted. Additionally, MCLs are likely to become more stringent as information on the effect of contaminants on public health continues to improve, rendering an assessment based strictly on current MCL levels inadequate.

The analysis ignores a number of spill scenarios that could realistically occur, such as a truckload of raw fracking chemicals or a tanker of flowback/produced water entering a NYC reservoir or headwater stream. Given the enormous volume of chemicals and wastewater that would be transported into and generated within the NYC watershed over a multi-decade development period, such acute spill scenarios merit more serious consideration.

In addition to acute spills, it is reasonable to expect – and data from DEC's own mining program and other states provide evidence – that a chronic level of minor spills will occur. This is an inevitable outcome of a complex mechanized industrial activity occurring hundreds of times per year across the watershed. The dSGEIS does not acknowledge or analyze the impacts from such chronic spills. Moreover, even if mitigated, the cumulative impact of chronic spills will be to compromise public and regulatory confidence in the integrity of NYC's unfiltered water supply.

Subsurface Contaminant Migration

The dSGEIS does not meaningfully consider the possibility of subsurface migration of methane or other gases, fracking fluids, or formation water or brine. The analysis ignores critical data and gives inadequate consideration to the possibility of error and long-term consequences. It focuses on the short-term impacts of hydrofracturing operations without giving due consideration to long-term subsurface changes, and underestimates the likelihood of vertical migration of contaminants. The dSGEIS' conclusion that subsurface migration is not a serious concern appears to be based on the bulk properties of the rock separating the fracking zone from shallow aquifers and DEP tunnels (see dSGEIS App. 11). While the intervening rock layers could in principle provide substantial protection against migration, the pre-existing fractures, and the fractures that will be created through the gas production process, substantially increase hydraulic conductivity by several orders of magnitude as compared with the conductivity of unbroken rock.

An equally disturbing omission is observed in the selective presentation and use of available geologic data. The dSGEIS presents only mapped faults and fails to present or evaluate the significance of hundreds of other brittle structures (e.g., shear zones and linear features) that indicate fracturing of the underlying bedrock and pathways for hydraulic contamination. The same data source reviewed in the dSGEIS indicates that extensive subsurface fracture systems and known "brittle" geological structures exist that commonly extend over a mile in length, and as far as seven miles in the vicinity of NYC infrastructure. These fracture systems have been demonstrated to transmit fluid and pressure, as evidenced by saline water and methane seeps encountered at grade and in shallow formations near NYC infrastructure during and since its construction.

The dSGEIS also discounts the risks from failure of well casings and grout designed to prevent vertical contamination between layers, despite the well-documented occurrence of such failure in conventional gas and oil wells in New York State and elsewhere.

Contrary to the findings in the dSGEIS, migration of fracking chemicals and/or poor quality formation water into overlying groundwater, watershed streams, reservoirs, and directly into tunnels is a reasonably foreseeable risk. This concern is further substantiated by similar events that have occurred in Pennsylvania over the past few years of drilling in the Marcellus shale and new information about contamination from conventional gas and oil wells in New York State. As the State has learned from its experience with MTBE and other pollutants, once groundwater is contaminated, chemicals are very hard if not impossible to remove.

Wastewater Disposal

The large volume and character of wastewater generated by hydraulic fracturing of horizontal wells is a direct result of the technology under evaluation in the dSGEIS, and raises issues and potential impacts, which are both quantitatively and qualitatively different from considerations addressed in the 1992 GEIS.

The dSGEIS does not provide a thorough evaluation of waste disposal issues, and instead describes existing permitting requirements. The absence of a thorough evaluation of waste disposal issues is a major deficiency in the dSGEIS analysis given the large volumes of concentrated waste streams generated by natural gas development. The elevated chlorides and total dissolved solids (TDS) concentrations (228,000 mg/l and 337,000 mg/l, respectively) documented in Section 5 of the dSGEIS clearly indicate the need for analysis of wastewater impacts.

Pennsylvania's recent experience is instructive. This past year, following water quality impacts in the Monongahela River that resulted from disposal of drilling wastes at municipal wastewater treatment plants, the Pennsylvania Department of Environmental Protection proposed effluent discharge limits of 500 mg/l for TDS. Gas industry technical papers indicate that there are no treatment plants currently in operation in Pennsylvania that can meet this standard. Furthermore, the only established technology that could meet this standard (evaporation/crystallization treatment) would generate 400 tons of salt waste for every 1 million gallons of treated waste.

The analysis of wastewater disposal issues is further deficient because of the absence of an analysis of cumulative impacts. Such an analysis would presumably address the insufficiency of regional waste disposal capacity, and the potential that this lack of capacity coupled with associated high disposal costs could lead to illegal dumping. Clearly, there is a need for a thorough waste stream analysis in order to fully evaluate potential impacts of the proposed action.

Radioactivity

The City initially raised concerns over naturally occurring radioactive material (NORM) in comments on the draft scope for the SGEIS (letter to DEC dated December 12, 2008) stating: "Drilling associated with the Marcellus and other geologic formations deposited in anoxic environments (e.g., Utica shale) will produce cuttings and waste fluids that contain radiological contaminants (such as radon and uranium), low pH (acidic) water and dissolved metals (e.g., iron), and dissolved salts." We commend DEC for obtaining Marcellus-specific monitoring data as part of the dSGEIS, but these data raise serious issues for public health, particularly with disposal of both solid waste (i.e., drill cuttings and equipment) and wastewater (flowback and/or produced water). DEC acknowledges in the dSGEIS that more analysis is needed, including an analysis of local capacity to handle the associated waste stream (both solid waste and wastewater). Such an analysis must be completed before any activity that is likely to generate radioactive waste can move forward. Proposing additional testing and evaluation in the future is not sufficiently protective of public health and does not meet the standard for an environmental review of potential impacts, which requires that such impacts be studied and disclosed prior to any decision on the proposed action.

Finally, all of these water quality risks would be heightened if the network of pads, roads, pipelines and other infrastructure induces exploitation of the deeper gas bearing shale layers (the Utica, Oriskany, or Trenton/Black River formations) that underlie the NYC watershed. Yet the dSGEIS does not analyze the likelihood of that induced exploration or its overall cumulative effects.

Water Supply Reliability and Infrastructure Integrity

Cumulative Water Withdrawal Impacts

The dSGEIS analysis does not evaluate the impacts that natural gas water withdrawals may have on pre-existing consumptive uses, despite highlighting withdrawals as a potential impact from natural gas development. As such, the mitigation measures proposed are flawed in that pre-existing consumptive uses are not required to be included in the interim passby flow calculations. The interim passby flow analysis, which is based on an outdated methodology, also lacks specific monitoring and enforcement requirements that would ensure compliance. These withdrawals could have significant impacts on the City's mandated release targets and water supply flexibility, but these impacts are not adequately disclosed or discussed in the dSGEIS.

Additionally, it is not clear that DEC has sufficient regulatory authority to mitigate adverse environmental impacts of cumulative surface water, since it lacks authority over groundwater withdrawals that are not intended for public water supplies. The dSGEIS relies heavily on the protections established by the Susquehanna River Basin Commission (SRBC) and Delaware River Basin Commission (DRBC) in their respective basins, and sidesteps the fact that DEC lacks the authority to regulate withdrawals and effectively mitigate cumulative water withdrawal impacts in the rest of the state, including the Catskill portion of the West-of-Hudson NYC watershed.

Stream/Reservoir Buffers

The setbacks established in the dSGEIS do not prevent drilling in any sensitive areas but instead require a site-specific SEQRA analysis, with no defined mechanism for DEP (or public) review, for a well pad within 300 feet of a reservoir or 150 feet of a stream. These setbacks are wholly insufficient to protect NYC drinking water quality based on the surface and subsurface contamination risks identified previously. First, the setbacks must be measured from the closest point of the natural gas spacing unit (which encompasses the full horizontal extent of well bores) and not just the well pad. As proposed, horizontal wells could be drilling below main tributaries or even the reservoirs themselves. Second, the closest part of spacing units should be excluded within a 1,000-foot buffer of streams and a 2,000-foot buffer around reservoirs. These proposed buffer zones are consistent with the setback distances required for public water supply wells established in the original 1992 GEIS. Surface water supplies deserve equivalent protections.

Infrastructure Integrity / Tunnel Buffer

The dSGEIS ignores numerous subsurface features (discussed previously under Subsurface Contaminant Migration) that could enhance mobility of drilling fluids and formation materials. These same pathways could expose the City water tunnels to elevated external pressures that they are not designed to withstand.

The dSGEIS requires a site-specific SEQRA review for issuance of a permit to drill any well whose location is determined by DEP to be within 1,000 feet of subsurface water supply infrastructure. The 1,000-foot infrastructure setback was developed in connection with vertical geothermal wells and was based on concerns associated with drilling through a City water tunnel. The concerns raised by horizontal drilling and hydraulic fracturing are entirely different for several reasons:

- Horizontal well laterals can extend for over a mile from the actual well pad (the dSGEIS would currently allow fracking to occur underneath a City water tunnel).
- The hydraulic fracturing process is specifically designed to fracture rock, which inevitably intercepts and enhances existing hydraulic pathways, and chemicals from such operations have traveled 7,000 feet or more through natural and induced subsurface fissures.
- The unreinforced linings of the City water tunnels were designed to keep water in, not to withstand external pressures. Fracking raises the distinct possibility that the unreinforced tunnel linings will be exposed to pressures in excess of their design strength. This could occur during fracturing, or it could occur after fracturing, when newly expanded fractures expose tunnel linings to naturally occurring formation pressures.
- Hydraulic fracturing operations adjacent to the naturally occurring fracture systems that intersect City water tunnels will increase the risk of (a) contaminating drinking water with fracking chemicals and poor quality formation water; (b) methane accumulation around and within DEP subsurface infrastructure; and (c) tunnel liner structural failure.
- The impact of repeatedly fracturing and expanding strata of rock underlying thousands of square miles as thoroughly and extensively as economically feasible, and then depressurizing it through the removal of compressed gas, is not addressed. Potential impacts can reasonably be anticipated to include movement at faults and fractures,

alteration of subsurface flow pathways, and vertical migration of gas, liquid and previously contained pressure.

To protect water quality and water supply reliability/infrastructure integrity, natural gas spacing units should be excluded within a buffer zone of at least seven miles from NYC subsurface water supply infrastructure. This distance is based on the lateral extent of known fractures that intersect DEP tunnels.

Failure to Comply with SEQRA

On the merits, gas drilling as proposed cannot safely be done in the watershed. And the omissions and deficiencies described above clearly show that the dSGEIS does not meet the requirements of the Environmental Conservation Law. The City's concerns with the SEQRA process are summarized below.

Segmentation

The dSGEIS has segmented the review of the proposed action by excluding certain critical elements (e.g., waste disposal, cumulative impacts, induced growth, air quality impacts, pipeline construction, and ancillary infrastructure). SEQRA requires that impacts associated with a "whole action" be evaluated and provides tests for segmentation based on timeframe, goals, geography, common planning/ownership, and functional dependence. All of the excluded actions violate one or more of these tests.

Inadequate Analysis

A number of the analyses in the dSGEIS are inadequate or incomplete and therefore do not satisfy SEQRA's requirement to identify all areas of environmental concern, and provide a reasoned elaboration of NYSDEC's conclusions.

Cumulative Impacts – The dSGEIS does not contain a comprehensive cumulative impact analysis. By neglecting to evaluate a reasonable worst-case scenario of natural gas wells in the New York City watershed, the dSGEIS does not adequately evaluate the potential adverse environmental impact from the proposed action. By focusing only on the impacts of single well development the dSGEIS does not fully disclose the potential adverse environmental impacts that could result from the proposed action under the reasonable worst-case scenario.

Induced Growth – The dSGEIS does not evaluate the potential adverse impacts of induced growth due to natural gas development. Induced growth and the resulting development would increase traffic, impervious surface areas, stormwater flows, wastewater flows, and water usage, each of which have the potential to adversely impact the region, especially without careful advance planning and analysis.

Waste Stream – The dSGEIS does not adequately evaluate the waste stream resulting from natural gas development. Many issues remain unaddressed, such as the amount of wastewater generated, treatment and disposal requirements for the wastewater, and the regional capacity for disposal. Given the large quantities of wastewater involved and the potential radioactivity of the waste stream, this must be comprehensively addressed prior to any permitting.

Public Health – The dSGEIS does not sufficiently address public health concerns. A separate impact assessment on public health is warranted given the hazardous chemicals that are proposed for use, the potential radioactivity of the waste products, the rate and scale of the drilling and accompanying activities, and, last but not least, the fact that one of the newly impacted areas supplies high quality drinking water to nearly half the State's population.

Alternatives – The dSGEIS does not address alternatives to natural gas development. Alternatives to hydraulic fracturing and waste disposal are described but not assessed. The alternatives chapter considers only potential economic and energy interests and does not acknowledge the evolving history of contamination in other states, particularly Pennsylvania, where hydraulic fracturing and horizontal drilling have occurred. Given that the potential impact on the NYC water supply was one driving force behind doing a supplemental analysis, consideration of a partial or full prohibition within the watershed would be consistent with the Environmental Conservation Law. Such a prohibition seems to have been dismissed on the basis of economic and energy interests, without a proper consideration of the full array of potential environmental impacts and costs, and without a proper balancing of environmental protection concerns.

State Administrative Procedures Act

The mitigation section of the dSGEIS relies on DEC's commitment to write permits that will impose requirements of general applicability, or requirements that would apply to all drilling applications meeting certain conditions (such as high-volume hydraulic fracturing, multi-well pads, or proximity to natural features), as a basis for its conclusions concerning the lack of impacts from these activities. Such requirements are, however, rules and therefore require promulgation pursuant to the State Administrative Procedures Act. In the absence of binding rules adopted pursuant to SAPA, the dSGEIS' statements concerning DEC's intention to impose any permit conditions are not binding. Accordingly, such statements cannot and do not militate against potential adverse impacts.

Conclusion

Balancing environmental and public health concerns with the need for adequate energy resources and economic development is a complex and challenging issue – not only in New York but throughout the nation. New York City's watershed is a unique resource and deserves special attention and consideration. Even without the benefit of the complete review mandated by SEQRA, it is clear from the technical information in the dSGEIS, and the City's own analysis, that horizontal drilling and hydraulic fracturing – using current extraction methods and based on the latest science – presents an unacceptable risk to the City's water supply, and the FAD.

If a less invasive process, using fully disclosed and better understood agents, is developed to extract natural gas in the future, the City will gladly evaluate whether it is or can be compatible with the control we are required to maintain in the watershed. But the State's proposal to permit hydro-fracking and horizontal drilling does not meet that standard.

Given the serious omissions in the supplemental analysis and the grave consequences of the proposed action, the City strongly urges DEC to rescind the dSGEIS. If DEC chooses to continue the pursuit of a plan to permit gas drilling in the New York City watershed, the deficiencies with the dSGEIS must be addressed, and a revised draft released for public review and comment. We look forward to continuing to work with DEC and NYSDOH on this important issue. If you have any questions please do not hesitate to contact me.

Sincerely,

Steven W. Lawitts

c: The Honorable Pete Grannis, Commissioner, DEC
The Honorable Judith Enck, Regional Administrator, EPA Region 2
The Honorable Richard Daines, Commissioner, New York State Department of Health
Mr. Phil Bein, New York City Watershed Inspector General

EXHIBIT O

CITY OF PHILADELPHIA

WATER DEPARTMENT
ARAMARK Tower
1101 Market Street
Philadelphia, PA 19107-2994

HOWARD M. NEUKRUG,P.E.
Water Commissioner

March 3, 2011

Commission Secretary
Delaware River Basin Commission
P.O. Box 7360
West Trenton, NJ 08628

Re: Comments on DRBC Natural Gas Development Regulations

Dear Commission Secretary:

One of the Philadelphia Water Department's (PWD) core missions is the provision of safe, high quality drinking water to our nearly two million customers in the Philadelphia region. Philadelphia's drinking water sources are the Delaware and Schuylkill Rivers, and our pledge to our customers extends to the stewardship of our region's water resources. To this end, PWD has embraced a watershed protection approach that tracks and evaluates events and practices that may cause immediate or long term impacts on water quality. It is with an eye towards potential long term repercussions that PWD is closely following the discussions surrounding natural gas drilling.

We believe that the current regulatory framework, if enforced, is adequate to protect our water supply from *immediate* threats. Support from DRBC through its new regulatory framework is needed, however, to help monitor and protect us from *long term* impacts. In light of this goal, DRBC's new regulations should be framed around complementing and strengthening state regulations. One such example already in the draft regulations is the requirement to store wastewater from hydraulic fracturing in closed tanks prior to treatment or transportation of the wastewater. This requirement helps supplement state regulations in Pennsylvania and helps protect Philadelphia's drinking water supply from the potential cumulative impacts of repeated spills and leaks from storing wastewater in open air pits. The following recommendations reflect other improvements to DRBC's regulations that would address key concerns for drinking water suppliers. Also included are recommendations that supplement changes to the draft regulations and that are critical to understanding and minimizing the potential impacts of natural gas development in the basin. Lastly, we request clarifications of the draft regulations to better understand their full impact.

RECOMMENDATIONS FOR DRBC'S DRAFT NATURAL GAS DEVELOPMENT REGULATIONS

1. **Increase Groundwater and Surface Water Monitoring Requirements**

A. Increase the Number of Samples Required

Prior to alteration of a well pad site, DRBÇ's regulations require one sample at a representative number of groundwater wells within 1,000 ft. For surface water, the regulations require one sample up gradient and one sample down gradient of the planned well pad site. Additionally, the draft DRBC regulations require annual monitoring at the same locations following well construction until the well is plugged. This sampling helps to supplement Pennsylvania regulations, which do not stipulate monitoring of this type. Yet the number of samples requested is not sufficient. Much more data is needed to effectively evaluate baseline conditions and to detect and track changes following drilling and hydraulic fracturing of a well. For groundwater, PWD recommends two samples prior to site alteration and one sample every three months thereafter. For surface water, PWD recommends sampling every two weeks beginning at least six months prior to site alteration. Sampling should occur on a fixed schedule and continue throughout the land clearing, drilling, hydraulic fracturing, and production phases of each well.

B. Specify the Parameters to be Analyzed

All samples – regardless of whether they are groundwater or surface water samples – should be analyzed for the parameters regulated under the Safe Drinking Water Act. Additionally, detection limits should be set to those established by EPA under the Safe Drinking Water Act.

C. Install Continuous Monitoring Probes at Priority Surface Water Locations

Natural gas companies operating in the Delaware River Basin should be required to fund continuous monitoring probes at priority locations selected by DRBC in collaboration with the Monitoring Advisory Committee. Parameters to be sampled for include, at a minimum, conductivity, pH and temperature. This continuous monitoring is critical for evaluating long-term data trends and detecting potential cumulative changes due to natural gas drilling in the basin. Monitoring units at these locations should be connected to the Delaware Valley Early Warning System, which is a secure notification and monitoring system designed to support downstream users and emergency responders in case of spills, accidents and other emergencies. This system already has much of the infrastructure necessary to accommodate multiple monitoring units. Additional monitoring locations could easily be incorporated.

2. **Do Not Allow Discharges of Treated Natural Gas Wastewater Upstream of Philadelphia's Intakes on the Schuylkill and Delaware Rivers**

The impacts of discharging treated wastewater from hydraulic fracturing on surface water and drinking water quality are unknown. Other states with similar shale formations use alternate methods of wastewater disposal, so data to evaluate the impact of discharging wastewater to surface waters are limited. Pre-treatment regulations in Pennsylvania established to address total dissolved solids do not directly deal with other parameters of concern found in natural gas wastewater, such as radionuclides. The ancillary effects of pre-treatment on these parameters, and ultimately on the quality of surface waters, have not been studied sufficiently. Additionally, no water quality criteria exist for many of the constituents found in natural gas wastewater, including certain metals. As a result, regulators are not able to develop permits that effectively protect water resources. Until more data and information are available, all discharges of treated natural gas wastewater upstream of the Philadelphia drinking water supply should be prohibited.

3. **Require Full Reforestation of Lands Cleared to Accommodate Drilling**
   Forests provide irreplaceable protection of drinking water supplies. Yet current regulations in Pennsylvania, while requiring site stabilization and vegetative restoration, do not require reclamation of a well pad site that was once forested back to its original state. PWD requests that DRBC's regulations be modified to supplement state law by requiring full restoration and reforestation of all lands that are impacted by gas drilling and related activities, including access roads, when drilling is complete. This is especially critical for the long-term viability of multi-use state owned forest lands where much of this drilling will occur.

4. **Expand Land Application Prohibitions**
   Page 59 of DRBC's draft regulations states that "wastewater, recovered flowback and or production water and brines from natural gas well pads may not be applied to any road or other surface within the Delaware River Basin." This prohibition should be expanded to include treated wastewater and solids produced from the treatment of brines from natural gas well pads.

OTHER RECOMMENDATIONS FOR ADDRESSING THE POTENTIAL IMPACTS OF NATURAL GAS DRILLING ON PHILADELPHIA'S DRINKING WATER SUPPLY

PWD recommends the following actions, in addition to the above changes to the draft regulations, that will help minimize the potential impacts of natural gas development in the basin. PWD encourages a commitment to these activities by DRBC and other regulating agencies before drilling occurs in the basin.

1. **Encourage Participation in the Delaware Valley Early Warning System**
   PWD requests that all entities dealing with hydraulic fracturing fluids or wastewater in the Delaware Basin – including haulers and treatment facilities – be encouraged to join the Delaware Valley Early Warning System to support advanced notification of downstream surface water users of spills and accidents.

2. **Support a Study that Evaluates the Long-Term Implications of Natural Gas Drilling on Drinking Water Supplies**
   A study of the long-term implications of natural gas drilling for Philadelphia's drinking water supply is needed. At a minimum, this study should include an evaluation of the cumulative impact on surface waters of improperly cased wells and on-site spills and accidents involving toxic substances. Additionally, the study should evaluate transportation pathways in the Delaware River Basin of hydraulic fracturing fluids and wastewater and determine the risk of spills and accidents in proximity to drinking water supplies. The study should also evaluate the potential impacts of disposing recovered wastewater from hydraulic fracturing upstream of PWD's intakes, should this activity be allowed.

3. **Participate in a Marcellus Shale Task Force**
   A task force committed to protecting Philadelphia's drinking water supply is needed. This task force should represent a diversity of stakeholders including, at a minimum, members of the gas industry, state agencies, DRBC, the environmental community and PWD. This task force would help direct the cumulative study described above, make recommendations for future regulatory changes, and help improve coordination among regulators and regulated entities for the benefit of drinking water supply protection.

4. **Commit to Future Regulatory Changes as Needed**
   DRBC should consider the recommendations from the cumulative impact study and Task Force and update its regulations accordingly. Permitting should cease if any contamination of drinking water supplies due to natural gas drilling or hydraulic fracturing is detected.

REQUESTED CLARIFICATIONS OF DRBC'S DRAFT REGULATIONS

PWD requests several clarifications of the draft regulations in order to improve our understanding of their full impact.

1. PWD has conducted an extensive analysis of both Pennsylvania's and DRBC's regulations for natural gas development. As a result of this analysis, we have identified significant overlap between the two sets of regulations in the areas of planning, permitting, reporting and bonding. In some cases, only minor differences exist within these areas of overlap. PWD recommends that guidance be developed to streamline both sets of regulations. This will help minimize confusion – and possible non-compliance – within the gas industry.

2. More explanation of DRBC's proposed Approval by Rule is needed. A chart demonstrating when an Approval by Rule is applicable would be helpful. An explanation of how, specifically, the Approval by Rule process works and its implications for public notification is also requested.

3. More information about DRBC's planned methods of inspections and enforcement at all stages of natural gas development is needed.

We look forward to continuing our longstanding partnership with the DRBC as we address the many challenges to water quality in the Delaware River Basin. Thank you for the opportunity to comment on the Draft Natural Gas Drilling regulations. Please do not hesitate to contact me with any questions.

Sincerely,

Howard Neukrug, P.E.
Commissioner

EXHIBIT P

Potential for Impairment of Freshwater Mussel Populations
in DRBC Special Protection Waters as a Consequence of
Natural Gas Exploratory Well Development

By

Robert M. Anderson, Fish & Wildlife Biologist, U.S. Fish & Wildlife Service
Expert in Freshwater Mussels and Mussel Habitat

and

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Partnership for the Delaware Estuary
Expert in Aquatic Ecology and Functional Ecology

November 23, 2010

Our testimony addresses the question of whether natural gas exploratory wells have the potential for a substantial effect on the quality of waters classified by the Delaware River Basin Commission (DRBC or “Commission”) as Special Protection Waters (SPW), for which the Commission has established a policy of “no measurable change except towards natural conditions . . . .” *DRBC Water Quality Regulations* § 3.10.3 A.2. We focus on the water quality value and susceptibility to impairment of freshwater mussel populations, which both depend upon and contribute to the exceptional water quality of the main stem upper and middle Delaware River. We also highlight characteristics of the dwarf wedgemussel, a federally listed endangered species found in portions of the main stem upper Delaware River and its tributaries underlain by the Marcellus shale. The dwarf wedgemussel is particularly susceptible to siltation, hydrologic changes, exposure to contaminants, and losses of population caused by invasive species, all of which are likely to accompany the development of natural gas in the region, including the construction of exploratory wells. We contend that in light of the potential for adverse effects on water quality and aquatic resources as a result of natural gas exploratory well development, regulation by the Delaware River Basin Commission is warranted. Such regulation may help to prevent impairment, ensure that any water resource impacts, should they occur, are measured, and require that those responsible for causing damage to water quality and aquatic resources have the means and legal obligation to perform restoration.

I. Freshwater Mussel Status and Trends in the Delaware Basin

Freshwater mussels include abundant species that are vital for ecosystem function. These are also the most imperiled of all animals and plants in the Delaware River Basin, as elsewhere in North America (Williams et al. 1993.) This otherwise highly successful and diverse group has specific life history characteristics that contribute to their apparent sensitivity and have resulted in substantial declines in range and abundance of some species. These characteristics include a dependence upon populations of an unrelated species of fish for successful reproduction, low annual recruitment balanced by a long reproductive life-span, relative immobility, and filtering of water to extract food.

II. Mussel Assemblages in the Delaware River System

Population Abundance and Biodiversity

As a result of being undammed and well managed, the upper mainstem Delaware River retains healthy numbers of several native species of freshwater mussels (Lellis 2001, Lellis 2002). Although there are numerous state and federal listed imperiled species in the basin (e.g. dwarf wedgemussels), the numerical health of the collective mussel assemblage is sizeable in the river itself, extending down even into the tidal areas of the Delaware River.

Approximately 60 species of bivalve mollusks live in headwater streams and lakes of the Delaware basin as well as in the non-tidal main stem and other large tributaries, freshwater tidal areas, and in the brackish and saline portions of the Estuary (Kreeger and Kraeuter 2010).

Approximately 12-14 species are native freshwater mussels (Unionidae, Table 1) based on historical accounts (e.g., Ortmann 1919.) Numerous species of special concern to PA and NJ are known to remain in portions of the basin (Table 1) including the Upper Delaware. Although the status terminology varies among states, nine of the twelve remaining native species are deemed imperiled by New York, New Jersey, Pennsylvania, and/or the Federal Government, or are deemed to be globally imperiled (Table 1.)

Scientific Name	**Common Name**	**Conservation Status**			
		NY Status	**NJ Status**	**PA Status**	**Global/ Federal Status**
Alasmidonta heterodon	Dwarf wedgemussel	Critically imperiled/ **Endangered**	Critically imperiled/ **Endangered**	Critically imperiled/ **Endangered**	Critically imperiled/ **Endangered**
Alasmidonta undulata	Triangle floater	Apparently secure	Imperiled/ **Threatened**	Vulnerable	Apparently secure
Alasmidonta varicosa	Brook floater	Critically imperiled/ **Threatened**	Critically imperiled/ **Endangered**	Imperiled	Vulnerable/ **Species of concern**
Anodonta implicata	Alewife floater	Critically imperiled	Secure	Not ranked	Secure
Elliptio complanata	Eastern Elliptio	Secure	Secure	Secure	Secure
Lampsilis cariosa	Yellow lampmussel	Vulnerable	Imperiled/ **Threatened**	Vulnerable	Vulnerable
Lampsilis radiata	Eastern lampmussel	Apparently secure	Imperiled/ **Threatened**	Critically imperiled	Secure
Leptodea ochracea	Tidewater mucket	Critically imperiled	Imperiled/ **Threatened**	Critically imperiled/ extirpated	Vulnerable
Ligumia nasuta	Eastern pondmussel	Vulnerable	Critically imperiled/ **Threatened**	Critically imperiled	Apparently secure
Maragatifera maragatifera	Eastern pearlshell	Imperiled	Not ranked Proposed	Critically imperiled/ **Endangered**	Apparently secure

			Endangered		
Pyganodon cataracta	Eastern floater	Apparently secure	Secure	Vulnerable	Secure
Strophitus undulatus	Creeper	Apparently secure	Vulnerable/ **Species of concern**	Apparently secure	Secure

Table 1. Conservation status of native freshwater mussel species of the Delaware River watershed. Bold text indicates legally protected species status by state. Natural Heritage status accessed on NatureServe (www.natureserve.org) on November 16, 2010.

Within the Delaware basin, colonies of dwarf wedgemussels, a federally listed endangered species, currently are found only in portions of the main stem upper Delaware River and in four tributaries – the Neversink River, within the drainage area of DRBC Special Protection Waters in New York State, and the Flat Brook/Little Flat Brook, Paulins Kill River and Pequest River in New Jersey. The distribution of dwarf wedgemussels was once much wider across the mid-Atlantic watersheds than it is today.

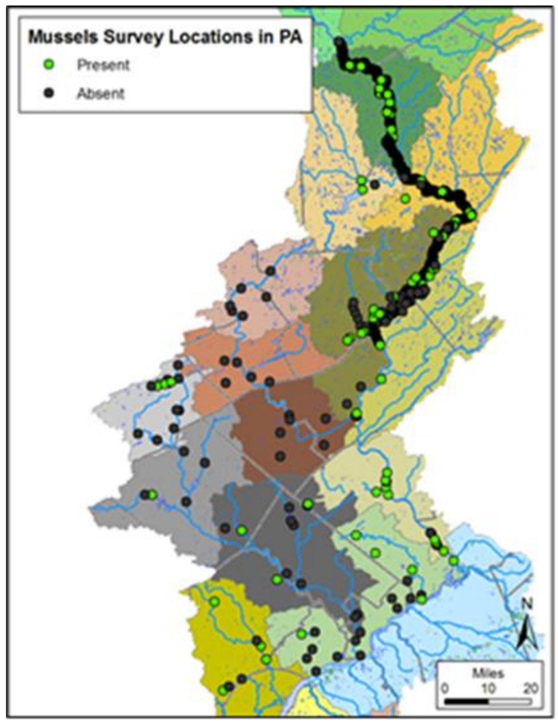

Figure 1. Presence and absence of freshwater mussels in Pennsylvania locations where they were historically reported as surveyed by various researchers since 1980.

The natural mixed-species assemblage of mussels would have consisted of aggregated populations of numerous species, occupying different niches (benthic habitats) within the stream, and collectively filtering a tremendous amount of water. Today, only one of our native 12+ mussel species can be readily found (*Elliptio complanata*). Unfortunately, mussel abundance appears greatly reduced in virtually all tributary streams and rivers in the Delaware River Basin. (PDE 2008.)

Based on the limited current distribution of mussels of any species in tributary streams (<10% in southeast PA, limited surveys elsewhere, Fig. 1), and the patchiness and low mussel abundance (<1 m^2) within streams where they are found (often only in wooded reaches), the healthy assemblages that exist in the main stem and tributaries of the Upper Delaware are particularly valuable and require protection.

Preservation of Existing Colonies is Critical to Stemming Mussel Declines

A number of factors make it critically important that existing colonies be preserved to serve as broodstock for restoring populations to streams from which they have been lost.

Mussels likely become extirpated from streams because of either: 1) general impaired water or habitat quality, 2) specific incidents (i.e. spills) that cause acute mortality in a single event, 3) overharvesting/predation, or 4) loss of fish host species to support larval growth and distribution.

Once extirpated from a stream or reach, mussels are not able to recolonize easily, particularly if there is no longer broodstock nearby. In some tributaries, dams and other impediments to fish passage may block dispersal of juveniles (via fish hosts, see life history below) back into the stream (McMahon 1991). Most mussels have a long lifespan (30-100 years) and don't reproduce until at least 8 years old. Therefore, even if conditions permit redistribution via fish hosts, recolonization and recovery can take decades.

Remaining mussel beds in the Delaware River are vulnerable to spills and land-based development. Protection of the existing metapopulation includes ensuring that it does not become further fragmented, less able to disperse and exchange genes, and as a result, less resilient.

III. Importance of Freshwater Mussels

There are societal and ecological reasons for maintaining large populations of filter feeders in aquatic ecosystems. Where abundant, they help to maintain water quality, stabilize substrates, decrease erosion, and create beneficial habitat complexity. Some species are also commercially and historically important. Filter-feeders are effective at accumulating many classes of contaminants and so are useful in assessing water and sediment contamination in specific areas and for specific time periods. The health of individual bivalves and assemblages of bivalves can directly indicate the health of the aquatic ecosystem.

Ecosystem Function Values

Freshwater mussels, like most bivalves, are considered “ecosystem engineers” because they modify habitat complexity and improve water quality, often dominating the ecology of rivers and streams where they are still abundant. Similar to oyster and coral reefs, these animals form dense assemblages that create habitat conditions beneficial for other organisms. The habitat benefits are myriad, including physical, chemical, and biological modifications. They help to stabilize stream channels and decrease bed transport during high flow events (physical). The vertical structure of large-bodied mussels also furnishes stable microhabitats for benthic macroinvertebrates and fish (physical). Mussel shells protruding from the bottom increase turbulent mixing in the benthic boundary layer and provide refugia for other fauna.

Through their biodeposits (agglutinated mussel feces and pseudofeces), mussels enrich sediments (Vanni 2002, Howard and Cuffey 2005) with organic materials and biochemical compounds (chemical) providing for enhanced benthic algal production and greater food resources for other benthic fauna (biological).

Although mussel beds provide many ecosystem services such as streambed stabilization and enrichment of sediments for other animals and plants, they are most valued for their water processing ability. Mussels improve water quality by removing suspended particulates through filter-feeding. Each adult mussel filters liters of water per day during the growing season, and the combined biofiltration by beds of mussels in healthy streams may exceed the system's downstream flushing volume. For instance, Dr. Kreeger estimated that a relic population of 500,000 mussels on the lower Brandywine River in Pennsylvania still filters more than 1 billion liters and removes 26 metric tons of dry total suspended solids (TSS) each summer season. This population is old, may not be reproducing, and represents a fraction of the system's carrying capacity for mussels. Approximately 4 billion *E. complanata* are estimated to reside in the Delaware River Basin today and they collectively filter about 10 billion liters of water per hour in the summer (Kreeger, unpublished).

Water quality and mussel abundance in the main stem and tributaries affect the ecosystem health of the Delaware Estuary. Kreeger and Kraeuter (2010) estimated that populations of all bivalve species in the Delaware Estuary watershed collectively filter more than 100 billion liters of water every hour during warmer seasons (10^8 m^3 hr^{-1}). If true, this represents about 2500 times the volume of freshwater entering the tidal estuary every hour (Kreeger and Kraeuter 2010.) Still, many streams contain no mussels at all, and others, such as the lower Brandywine, host older populations that may not be reproducing.

Biofiltration by mussels has direct implications for reduction of impacts of stormwater runoff and particulate nutrient control. Since much of the material filtered from the water column (e.g. particle bound nutrients, phytoplankton) is metabolized and then either used by the mussels or transformed into usable materials by other organisms, mussels facilitate nutrient control in streams and rivers.

Other important ecosystem functions include serving as prey for wildlife, biogeochemical cycling and remineralization, and in some areas facilitation of microbial denitrification. Freshwater mussels are eaten by many mammals and birds (van Tets 1994, Tyrrell and Hornbach 1998). Mussels therefore represent important links in aquatic food webs by feeding on microscopic matter at the base of the food chain and in turn being eaten by secondary consumers such as vertebrates.

In healthy rivers such as the main stem upper Delaware River where mussels are numerous, base-of–food-web conditions are richer and ecological turnover rates higher, compared to streams with few mussels.

In summary, healthy beds of mussels provide a multitude of structural and functional services including nutrient sequestration and cycling, substrate stabilization, suspended sediment removal, and the transfer of particulate matter from the water column and into easily assimilated foods for other aquatic species, including fish (Bauer and Wächtler 2001, Pusch et al. 2001, Kreeger 2004).

Bioindicator Value

Mussels are long-lived "sentinel bioindicators", meaning their abundance, biodiversity, and physiological health can tell us a great deal about overall environmental conditions (Kreeger et al. 2002; Martel et al. 2003, PDE 2008). Being relatively sessile, long-lived (up to 100 years), and sensitive to environmental conditions, freshwater mussels are excellent bioindicators of long-term changes in watershed condition. Due to their limited mobility that prohibits their movement to escape suboptimal environmental conditions, mussel fitness and population vigor is therefore directly indicative of local conditions. In addition, they are indicators of long-term habitat stability because their riverbed habitat is dependent on channel hydraulics and sediment transport.

Internationally, suspension-feeding bivalves have long been considered to be among the best bioindicators of aquatic ecosystems (Dame 1996). For example, in 1976 the U.S. instituted the "Mussel Watch Monitoring Program" to examine the environmental impact of pollution in aquatic ecosystems. Although initially conceived as including bivalves in marine, estuarine and freshwater habitats, the concept was embraced primarily by scientists and resource managers in marine habitats, and the program thereafter focused on marine species such as oysters and blue mussels. The program has been extended to the United Kingdom, France, Canada, Australia, Japan, Taiwan, India, South Africa and the Soviet Republic. In 1986, the U.S. program evolved into the National Status and Trends Mussel Watch Project. Today, a diverse array of chemical and biological contaminants is uniformly analyzed in bivalve tissue from more than 280 coastal sites in the U.S. Mussel Watch.

A comparable, bivalve-based biological monitoring program for freshwater systems is technically feasible but not yet developed, although many studies are now using caged mussels to monitor water quality (e.g., Kreeger et al. 2002).

Due to their unparalleled ability to filter water and improve water quality, suspension-feeding bivalves such as mussels are also perceived as top restoration targets, because enhanced mussel populations will promote positive feedbacks for water and habitat quality, which then benefit mussels. Again, where we are fortunate to have healthy mussel colonies, it is essential that they be preserved.

IV. Potential for Impairment of Freshwater Mussels as a Result of Activities Associated with Development of Natural Gas Exploratory Wells

The greatest diversity and abundance of mussels are associated with clean-swept sand and gravel substrates, but as largely sessile organisms, the complex life history traits of mussels make it possible for populations to thrive in a highly dynamic environment where rapid changes in flow and water quality can occur at each rain event. These same adaptations, however, limit the ability of freshwater mussels to withstand, or recover from, lethal and chronic impacts to which these animals are sensitive, such as increased siltation, water quality alteration, hydrologic alteration, and introduced species. These factors are discussed in greater detail below.

Sedimentation

Mortality, injury and stress to mussels from siltation and other types of sedimentation caused by onshore construction (*i.e.,* staging areas and access road use) is more likely to occur near the source, but erosion and siltation in tributaries at distant locations in the watershed can cause damage when this material is flushed downstream. Silt in the form of increased turbidity and suspended sediment transport is detrimental to mussel health and habitat because it reduces the depth of light penetration leading to alteration of primary productivity, decreases oxygen levels, increases water temperature, irritates or clogs mussel gills, and deposits silt on the substrate.

High turbidity may also interfere with sight lures, such as conglutinates, which attract host fish. Silt that settles from the water column can smother, bury and/or clog the gills of freshwater mussels unable to avoid these effects due to the extent of siltation or particular phase of the animals' annual life history (for example, gravid female mussels hold eggs and young within a specialized gill structure for weeks to months of a year).

Silt deposition also affects mussels by smothering the eggs or larvae of the fish host populations and by reducing food availability for either the fish or the mussels themselves. Siltation also may result in reduced dissolved oxygen and increased organic material at the substrate level (Ellis 1936, Harman 1974) even when it does not blanket the substrate due to quantity or local water velocity. Silt that settles between sand and gravel particles alters water flow, food and oxygen through the gravel. The interstitial space between sand and gravel is vital for spawning habitat and survival of young host fish and juvenile mussels. When this area becomes unsuitable for juvenile mussels, the population may be unable to reproduction even when the adults continue to survive. Finally, alteration of sediment grain size or excessive volumes of highly mobile soft sediments can increase the risk of scour and hinder the sediment-stabilization benefits of mussels

Excessive sedimentation reduces suitable bottom habitat for mussels, leading to reduced populations and reduced ecosystem services.

Excessive sedimentation can smother mussels, causing acute mortality, reduced populations and reduced ecosystem services.

<u>Suspended Sediments</u>

As filter feeders on microscopic food items, mussels are very susceptible to not only acute mortality due to smothering by silt but also high sediment loads in the water. High turbidity can directly hinder or prevent filter-feeding and respiration when mussels close their valves to avoid intake of silt. At sublethal levels, silt interferes with feeding and metabolism in general (Aldrige *et al*. 1987) because the mussels must divert more energy to sort silt particles from food, again resulting in starvation. Over time, this will reduce an animal's fitness through starvation and, at the population scale, decreases biofiltration services.

Finally, chemicals and compounds are often bound to, and mixed with, fine silts due to their high surface area-to -volume ratio and positive charge. While mussels have some ability to select particular particle sizes, they indiscriminately feed on vast numbers of these small particles, both organic and inorganic. Since particle capture is achieved on the soft tissue gills, which are also used for gas exchange (countercurrent), they have a high degree of exposure to any particle-associated chemicals. Furthermore, particle sorting is inefficient on the gills and labial palps prior to ingestion, so these animals unavoidably consume a variety of non-food particles. Although the chemical conditions in the digestive tract of the mussel can metabolize or mobilize some of the particle-associated contaminants, the high surface area-to -volume ratio of the very small particles exposes the animal to higher levels of toxic compounds than non-filter feeding species that consume larger prey.

In summary, filter feeding bivalves such as freshwater mussels are typically exposed to greater amounts of both waterborne dissolved contaminants and particle-associated contaminants than other aquatic organisms. Although some classes of contaminants can be broken down through metabolism, most tend to be bioaccumulated within the tissues of the animals, leading to either acute mortality, chronic stress, or mediation into the food web as other animals prey on mussels. For these reasons, bivalves are regarded as sentinel bioindicators around the world; e.g. by International Mussel Watch.

Excessive suspended sediments can impair feeding processes of mussels, leading to acute or chronic stress, reduced fitness and populations, and reduced ecosystem services.

Excessive suspended sediments that include contaminants can be efficiently captured and often efficiently bioaccumulated by mussels, leading to acute or chronic stress, reduced fitness and populations, and reduced ecosystem services, as well as facilitating contaminant entry to aquatic food webs.

<u>Brines, Contaminants, Water Quality</u>

Freshwater mussels are very sensitive to water quality and most classes of contaminants. Contaminant exposure can be particle-mediated (discussed above) or direct via dissolved compounds or attributes associated with the water (discussed here.) Because freshwater mussels feed and respire by filtering large volumes of water across many thin tissue layers (e.g., mantel, gills) they are highly exposed to changes in water quality. Therefore, dissolved toxins (e.g. heavy metals, TDS, biocides) are rapidly taken up by direct absorption (Russell and Gobas 1989, Metcalfe Smith et al. 1996, Riedel et al. 1998) and indirectly via the food (Wikfors et al. 1994).

Mussels can temporarily (hours to days) avoid some contaminants or poor water quality (e.g. low dissolved oxygen) by closing their shells, if the contaminant is of a type and at a concentration that the animal can detect.

Suboptimal water quality (e.g. high conductivity) or the presence of waterborne (dissolved) contaminants might cause acute toxicity and mortality by exceeding mussel tolerance levels.

Suboptimal water quality or the presence of contaminants will impart chronic toxicity to mussels, leading to decreased productivity or reproductive output due to stress or bioaccumulation of contaminants in soft tissues.

Stressed mussels consume more oxygen, especially at higher temperatures, potentially contributing to low DO in some deeper areas.

Physiological impairment due to acute or chronic toxicity from chemical or high solute exposure will reduce population-level ecosystem services, especially biofiltration services.

<u>Ecological Flows</u>

As aquatic organisms, freshwater mussels can survive only brief exposure to the atmosphere, particularly when high temperatures rapidly desiccate exposed mussels or when low air temperatures quickly freeze exposed mussels. Very low water can buffer temperature changes to some extent but low water velocity also allows for greater solar exposure in the summer and increased temperature (and decreases in dissolved oxygen) resulting in stress and mortality.

Similarly, low water during colder periods can result in the formation of ice, which in shallow water can reach the substrate, killing any mussels that freeze.

Riverine mussel species depend upon flow for not only food and oxygen but also to maintain water quality and shape the physical habitat. For example, reduced flow increases the likelihood of silt deposition in areas that may typically have velocity that precludes deposition, and contaminants in the water are increasingly concentrated during low flow events.

Sustained low flows, which could result from unregulated withdrawals from headwater streams, can alter quality and quantity of food, causing stress and reproductive failure for mussels.

Low flows can interfere with mussel reproduction if fish hosts are unavailable for mussel larvae, depending on seasonality.

Any physiological impairment due to extreme low or high temperatures associated with low flows or reduced habitable bottom will reduce population-level ecosystem services, especially biofiltration services.

Invasive Species

Activities that result in transfer of water between watersheds have also resulted in the transfer of exotic or invasive species that can cause direct mortality of freshwater mussels through predation, toxicity, and disease or through competition for food or habitat. Resource management agencies have taken great pains in recent years to educate the public and institute practices to prevent the accidental spread of invasive species by anglers, boaters and other recreationists.

Once established in a waterway, zebra mussel populations can become extremely abundant, directly competing with native mussels for food and rapidly covering any exposed surface of a mussel shell. In some locations, populations of native freshwater mussels have been severely reduced, or eliminated, after zebra mussel colonization that altered substrate, flow, and food availability.

In the fall of 2009, Dunkard Creek, a tributary of the Monongahela River located along the border of southwestern Pennsylvania and West Virginia experienced a massive aquatic kill affecting native freshwater mussels, fish and salamanders in a 43-mile reach of the Creek. The kill was associated with a spike in conductivity that may have caused direct mortality of freshwater mussels, but which also contributed to the bloom of an invasive marine alga *Prymnesium parvum* or "golden alga", a species that proliferates in saline waters more typical of coastal Texas than the Appalachian Mountains of Pennsylvania. Golden algae produce a toxin fatal to other aquatic organisms. The species had never been observed in Pennsylvania waters before the Dunkard Creek aquatic kill but is known to thrive at the higher TDS concentrations that are often associated with mining and drilling activity. Its presence in state waters makes spread of the species to other surface waters of the state highly likely. Transfer of water between basins increases the risk that invasive species like golden algae and zebra mussel will also be inadvertently introduced to the Delaware Basin. Once established, invasive species are very difficult or impossible to remove.

Loss of Forest Cover

Some mussel species depend on leaf litter inputs for their nutrition. Forest loss or fragmentation, especially in areas near streams and rivers, has the potential to significantly impair food quality and quantity as well as degrade stream habitats for mussels by altering nutritional conditions as well as physical and chemical habitat conditions. In streams of southeast Pennsylvania, for example, the only remaining mussel beds are found within heavily forested areas of watersheds such as the Brandywine and Ridley Creeks – mussel abundance decreases dramatically in stream reaches above and below forested segments.

Loss or fragmentation of forests near streams and rivers can impair mussels by altering nutrition support and degrading habitats, thereby reducing mussel populations and ecosystem services.

V. Special Considerations – Dwarf Wedgemussels

The federal endangered dwarf wedgemussel (*Alasmidonta heterodon*) is sensitive to many of the same threats described above for other native species of freshwater mussels. Siltation, hydrologic changes, and contaminants are among the threats to the species survival cited at the time it was listed in 1990 (55 FR 9447 9451; U.S. Fish and Wildlife Service 1993).

Dwarf wedgemussels have characteristics that likely increase their susceptibility to these factors. First, the species is small compared to most other freshwater mussel species, (in the range of about an inch in length); therefore, relatively minor siltation events can deposit a smothering silt layer that reaches a depth that animals cannot push above.

Second, although they require flowing water and occur in a diversity of habitats from small streams to large rivers, dwarf wedgemussel are a thin shelled species that could be easily transported during a scour event. Like many freshwater mussels, dwarf wedgemussel populations tend to occur in areas protected from high-flow events, such as side channels of larger rivers and lower gradient streams. These low to medium velocity areas tend to have finer particle size substrates. Infiltration of relatively smaller amounts of silt between sands and smaller gravel particles can quickly hinder interstitial flow.

In the Delaware River this microhabitat preferred by dwarf wedgemussels tends to be away from the main channel, and therefore it is very susceptible to low flow exposure and associated changes in temperature. The seasonality of low flow and temperature rise may also be critical for dwarf wedgemussel reproduction and nutrition since freshwater mussels require specific food conditions for reproductive conditioning.

Dwarf wedgemussels are sensitive to all of the factors listed in Sections I-IV and potentially more susceptible than other mussel species to sedimentation, low flow, and temperature extremes.

VI. Management Implications for Natural Gas Development

It is our opinion that natural gas drilling activities, including the construction of natural gas exploratory wells, pose a substantial risk to mussel populations in the Special Protection Waters of the Delaware River Basin but that this risk can be reduced through the mandatory use of protective management practices of the types set forth below:

A. Consistent use of avoidance and minimization measures across the supporting watershed in three states to reduce the risks that siltation, spills or other releases of contaminants, flow changes and the spread of invasive species could adversely affect mussel populations, including the federally listed dwarf wedgemussels that inhabit the upper Delaware River.

B. Implementation of stormwater management and erosion and sedimentation control practices to help minimize sources of sediment during and after construction of natural gas well pads, wells and impoundments.

C. Monitoring of water quality, flow conditions, and invasive species in potentially affected areas before, during and after project construction in order to identify where preventive measures may have failed, where they were effective, and where mitigation or restoration measures are warranted.

D. Monitoring of the diversity, fitness and abundance of freshwater mussel assemblages in potentially affected areas.

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Exhibit B (Part 2) to

New York Attorney General's

Comments dated March 30, 2018

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

--x

STATE OF NEW YORK,

Plaintiff,

v.

UNITED STATES ARMY CORPS OF ENGINEERS; et al.,

Defendants,

--x

DECLARATION OF WILLIAM RUDGE

CV-11-2599
(Garaufis, J.)
(Pollak, M.J.)

WILLIAM RUDGE states as follows:

1. I am the Natural Resource Supervisor for Region 3 of the New York State Department of Environmental Conservation ("New York DEC" or the "Department"), and submit this declaration in opposition to defendants' motions for dismissal and/or summary judgment and in support of plaintiff State of New York's cross-motion for summary judgment.

2. This declaration is based on my personal knowledge concerning the Upper Delaware River acquired in my position with the New York DEC and as the New York State representative to the Upper Delaware Council, a partnership of local, state, and federal governments and agencies which help manage and protect that waterbody.

3. The purpose of this declaration is to explain New York's concrete interests in the environment and natural resources of the Upper Delaware River within the Basin which are at risk of injury because of the federal agencies' failure to perform environmental review pursuant to the National Environmental Policy Act of 1969, 42 U.S.C. § 4321 et seq. ("NEPA").

A. Background and Qualifications

4. I have been employed by New York DEC since 1985 in positions of increasing responsibility within the field of natural resource management, after receiving a Bachelor of Science Degree in Natural Resources Management from Colorado State University. Since 2001, I have served as Natural Resources Supervisor for the Department's Region 3, a seven-county area that includes the Upper Delaware River and other portions of the Delaware River Basin in New York. In this position, I supervise eight program managers and a staff of fifty employees in programs designed to protect New York's wildlife, forests, fisheries, and habitat within Region 3. As part of my job, I act as New York's representative on the Upper Delaware Council.

B. The Upper Delaware River

5. The 78-mile Upper Delaware runs from Hancock to Port Jervis along the border between New York and Pennsylvania, with the portions of the River lying north and east of its midpoint lying within New York. The River is renowned for its scenic beauty, wildlife, and unique recreational opportunities. In 1978, a 73.4 mile portion of the River was designated by Congress as the "Upper Delaware Scenic and Recreational River" under the Wild and Scenic Rivers Act of 1968, 16 U.S.C. § 1271 et seq. ("the Act").

6. The exceptional nature of the River is underscored by the fact that of the 3.5 million miles of rivers within the Nation, only about 12,600 miles of rivers (or one-quarter of one percent) have been designated for protection under the Act. (See DRBC, "The Delaware River Basin," http://www.nj.gov/drbc/thedrb.htm, attached as Exhibit A.) The Superintendent of Defendant National Park Service ("NPS"), who administers the "Upper Delaware River Scenic and Recreational River" under the Act, described it as "one of the most beautiful places in the

world." (See Upper Delaware Council and NPS, "Partnering to Protect the River," October 2008, p.2., attached as Exhibit B)

7. The River is noted for its tranquil scenic beauty, with forested hills rising along its banks, along with hillside fields and pastures, and villages on the valley floors. The Delaware River Gorge, through which the River flows, has been identified as an outstanding scenic geologic feature by the Pennsylvania Geological Survey, and the New York Legislature has designated the highway which runs along the River within the State as a "New York Scenic Byway" because of the spectacular vistas it affords travelers.

8. The River is also unique for the habitat it provides for fish and other wildlife. The River's basin serves as home to diverse populations of reptiles, amphibians, mammals and birds, including the bald eagle and over 200 species of migratory birds.

9. Pursuant to the Act, during 1986 and 1987 NPS developed a River Management Plan for the Upper Delaware River and performed environmental review of that plan pursuant to NEPA. The River Management Plan noted that "the Upper Delaware's consistently high water quality provides habitat to diverse and well-balanced biological communities," including a cold water trout fishery in the 27-mile stretch of water from Hancock to Callicoon, and a warmwater fishery running south from Callicoon to Port Jervis that provides habitat for sunfish, eel, bass, and walleye, among other fish. (See "Final River Management Plan: Upper Delaware Scenic and Recreational River, New York and Pennsylvania" (November 1986), p.3, relevant portions attached as Exhibit C.)

10. The final environmental impact statement for the Management Plan concluded that:

> The Upper Delaware provides some of the most important fish habitat in the Northeast, because of its free-flowing nature, high water quality, and cold water releases (from

> reservoirs on tributaries). The northern segment of the river, between Hancock and Callicoon, is unique due to its cold water temperatures, and offers some of the finest trout fishing in the Northeast. The Upper Delaware is currently one of only two natural shad rivers (the Hudson River is the other) from Maine to West Virginia that is sufficiently free of man-made barriers and industrial pollution to allow passage of shad to their upper reach spawning habitats.

(See NPS, "Final Environmental Impact Statement, Upper Delaware Scenic and Recreational River, New York and Pennsylvania" (March 26, 1987), relevant portions attached as Exhibit D.) Those fish remain abundant in the Upper Delaware today, and in addition other fish are found there as well, including rainbow trout, brown trout, smallmouth bass, largemouth bass, rock bass, walleye, American eel, gizzard shad, brown bullhead, fallfish, shiners and minnow.

11. The River is also home to endangered or threatened species, including the dwarf wedge mussel and the bald eagle, our national bird. The dwarf wedge mussel is a freshwater mussel listed as endangered under federal, New York, and Pennsylvania laws. (See DEC, "Dwarf Wedge Mussel Fact Sheet" at http://www.dec.ny.gov/animals/42253.html, attached as Exhibit E; see Exh. B., p.9.) As noted by NPS, freshwater mussels, including the dwarf wedge mussel, make up the greatest animal biomass in the Delaware River and play an important role in maintaining water quality and water clarity because they can filter up to five gallons of water each day, thereby removing contamination from the River. (Id.)

12. While the dwarf wedge mussel was once found in numerous locations in 15 major Atlantic Coast drainages, its numbers have declined drastically, and most remaining populations number in the 100s. (See Exh. E.) In 2000, the United States Geological Survey (in work funded by NPS) documented the presence of the dwarf wedge mussel in three populations spread out over a 22-mile section of the Upper Delaware River. (Id.) New York DEC also collects data concerning the populations of aquatic species along the River through a variety of sources which include macro invertebrate surveys performed by the Department's Division of Water staff,

submissions from other agencies including NPS and the United States Geological Survey, as well as through the Department's regulatory process. Whenever there is a proposal to undertake a regulated activity in areas know to provide habitat for threatened or endangered species we require the applicant to undertake surveys and other studies to determine presence, abundance and potential impacts the project may have on that species. New York DEC's data confirms the presence of the dwarf wedge mussel at ten locations within the Upper Delaware between Cochecton and Frisbie Island, just upstream of Lordville.

13. Water pollution has been implicated as a major cause of the decline of the dwarf wedge mussel nationally and continues to present a threat to the endangered population of this mussel in the Upper Delaware. (See Exh. B; see "New York Natural Heritage Program: Dwarf Wedgemussel" at http://acris.nynhp.org/guide.php?id=8375), attached as Exhibit F.)

14. Bald eagles have established themselves on the Upper Delaware River because of the habitat provided by the River's clean water, food supply consisting largely of fish from the River, and the presence of protected stands of large deciduous and coniferous trees along its shores on which the eagles perch and nest. (See NPS, "Upper Delaware Scenic and Recreational River: Nature and Science" at www.nps.gov/upde/naturescience/index.htm, attached as Exhibit G.). Bald eagles rely on clean uncontaminated water and fish. Over 100 bald eagles winter along the River each year, and as observed by NPS, this is "the largest population of wintering bald eagles in the northeast, and a growing year-round population of eagles has made the area an ideal location for eagle watching." (See id; NPS, "Upper Delaware Scenic and Recreational River: Bald Eagles," at www.nps.gov/upde/photosmultimedia/Bald-Eagles.htm, attached as Exhibit G, and Map and Pamphlet, attached as Exhibit H.) Recent monitoring has disclosed at least 18 active bald eagle nests along the Upper Delaware River that produced 30 fledglings in

2010. (See NPS, "Upper Delaware Scenic and Recreational River: 2010 State of the Park Report," p. 8, attached as Exhibit I.) Nevertheless, the bald eagle remains classified as a threatened species under both New York and Pennsylvania law.

C. New York's Concrete Interests in the Upper Delaware River

15. The State has a strong interest in the surface waters located within its borders (including the portions of the Upper Delaware River in New York), and generally owns the fish and other wildlife found in water or on land in New York.

16. The River and its nearby areas provide important recreational opportunities for sightseeing, fishing, boating, bird watching, hiking, and camping because of the River's extraordinary scenic beauty, clean water, excellent fishery, bald eagles and other wildlife, and its proximity to large population centers in New York and elsewhere. According to NPS, the Upper Delaware River had over 300,000 recreational visitors in 2010 taking part in these activities, many of whom reside in New York. (See "National Park Service Statistics" at www.nature.nps.gov/stats/viewReport.cfm, attached as Exhibit J.) A recent study estimated that the economic output of recreational activities on the Upper Delaware River in 2010 exceeded $27 million. (See Gerald J. Kauffman, "Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania" (October 11, 2011), p. 30, at www.state.nj.us/drbc/thedrb.htm, relevant portions attached as Exhibit K.)

17. The State owns lands and other facilities along the River for the purpose of facilitating the public's recreational use of the River and to protect the State's forests, fish and wildlife. These facilities include New York DEC access sites for boating and fishing at the following locations: Hancock and Lordville Bridge (Town of Hancock), Kellams Bridge (Town of Fremont), Callicoon (Town of Delaware), Cochecton and Skinners Falls (Town of

Cochecton), Narrowsburg (Town of Tusten), Town of Highland, Mongaup (Town of Lumberland), and Sparrowbush (Town of Deerpark). These sites are the primary means for anglers, boaters, and hikers to obtain access to the Upper Delaware in New York.

18. In addition, DEC has constructed and maintains Eagle Observation Areas on State land along the River and within the adjacent Mongaup Valley Wildlife Management Area to enable the public to observe bald eagles without disrupting or harming them and to learn more about that species. (Attached as Exhibit L is a photograph of one of the observation facilities, located in Minisink Ford, and photographs of educational exhibits displayed in these facilities.)

19. The Mongaup Valley Wildlife Management Area consists of 11,855 acres of land adjacent to the Upper Delaware that are owned in fee or are subject to a conservation easement in favor of the State, and managed by the New York DEC. The Mongaup River, a major tributary of the Upper Delaware, runs through the Area, before emptying into the River. The Area provides recreational opportunities for hunting, trapping, fishing, boating, wildlife observation and wildlife photography. The Mongaup Valley Bird Conservation Area includes all of the Mongaup Valley Wildlife Management Area, and is managed by New York DEC to conserve the diversity of bird and wildlife species using the area, particularly bald eagles. As noted above, the State owns these wild animals. In addition to Mongaup, the State owns State Forest Preserve lands in the Town of Hancock, including Bouchoux Trail, along the River.

20. The State also owns Route 97, designated in 1992 by the State Legislature as the Upper Delaware Scenic Byway pursuant to New York Highway Law § 349-dd. This 70-mile stretch of road was built into steep hillside hugging the River for most of its length, offering to motorists spectacular views both of the River below and of lands in Pennsylvania to the south and west. Because of its breathtaking setting, leading car manufacturers (such as BMW, Honda,

Mercedes-Benz, Saab and Cadillac) have used the road for television commercials. In addition to providing such views, the road offers picnic areas on its River side for motorists to enjoy.

D. Environmental Review of Potential Impacts of Natural Gas Development on the River

21. The New York DEC has been engaged in a two-year environmental review process of evaluating horizontal drilling and high volume hydraulic fracturing ("HVHF") under the State Environmental Quality Review Act (New York Environmental Conservation Law, Article 8) involving the drafting of successive environmental impact statements based on review of thousands of public comments by the Department, the input from its staff, and consultation with outside experts. As part of that review, New York DEC is presently evaluating a suite of potential mitigation measures to address any adverse environmental impacts of HVHF in New York.

22. Portions of Pennsylvania within the Delaware River Basin drain to the Upper Delaware River. If the Upper Delaware River were polluted by natural gas development activity from Pennsylvania there is a potential for harm to the State's portion of that River and its fish and other wildlife; impairment of State lands along the River, and reduced public participation in recreational and educational activities on those lands. If there were adverse visual impacts associated with natural gas development in Pennsylvania they have the potential to adversely impact the State's scenic byway along the River.

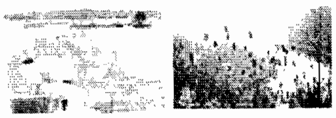
Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on January 30, 2012.

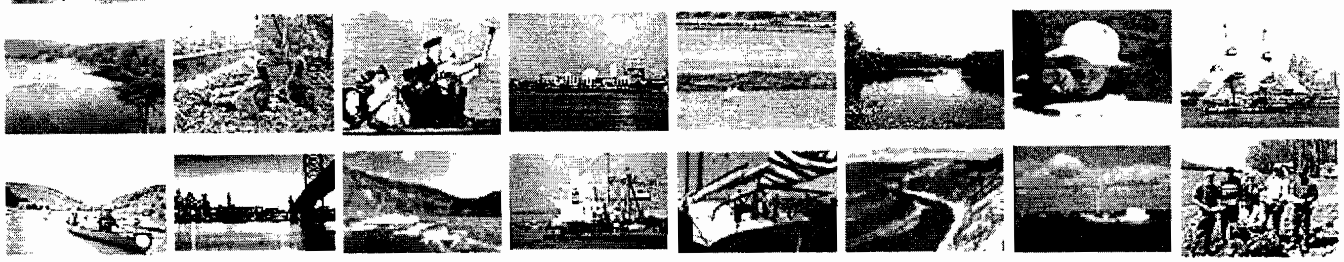
William Rudge

EXHIBIT A

Delaware River Basin Commission



The Delaware River Basin



Download "Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania" Final Report (2.695 MB) and Executive Summary prepared by Gerald Kauffman, Director, Water Resources Agency, Institute for Public Administration, University of Delaware (October 2011). *(Free Adobe reader required to view both documents)*

***

The Delaware is the longest un-dammed river in the United States east of the Mississippi, extending 330 miles from the confluence of its East and West branches at Hancock, N.Y. to the mouth of the Delaware Bay where it meets the Atlantic Ocean. The river is fed by 216 tributaries, the largest being the Schuylkill and Lehigh Rivers in Pennsylvania. In all, the basin contains 13,539 square miles, draining parts of Pennsylvania (6,422 square miles or 50.3 percent of the basin's total land area); New Jersey (2,969 square miles, or 23.3%); New York (2,362 square miles, 18.5%); and Delaware (1,004 square miles, 7.9%). Included in the total area number is the 782 square-mile Delaware Bay, which lies roughly half in New Jersey and half in Delaware.

***

Over 15 million people (approximately five percent of the nation's population) rely on the waters of the Delaware River Basin for drinking, agricultural, and industrial use, but the watershed drains only four-tenths of one percent of the total continental U.S. land area. The 15 million figure includes about seven million people in New York City and northern New Jersey who live outside the basin. New York City gets roughly half its water from three large reservoirs located on tributaries to the Delaware. The Delaware Bay is only a gas tank away for about 23 percent of the people living in the U.S.

***

Three reaches of the Delaware have been included in the National Wild and Scenic Rivers System. One section extends 73 miles from the confluence of the river's East and West branches at Hancock, N.Y. downstream to Milrift, Pa.; the second is a 40-mile stretch from just south of Port Jervis, N.Y. downstream to the Delaware Water Gap near Stroudsburg, Pa. Combined, these two river corridors take in 124,929 acres. The Lower Delaware Wild and Scenic Rivers Act, signed into law on November 1, 2000, added a 38.9-mile section of the main stem Delaware (and about 28 miles of selected tributaries) to the national system, linking the Delaware Water Gap and Washington Crossing, Pa., just upstream of Trenton, N.J. *Three-quarters of the non-tidal Delaware River is now included in the National Wild and Scenic Rivers System.* Sections of the Maurice River in New Jersey (a Delaware Bay tributary) and the Musconetcong River in New Jersey (a Delaware River tributary), as well as the White Clay Creek in Pennsylvania and Delaware (which flows into the Christina River, a tributary to the Delaware) also have been included in the national system. According to the National Park Service's web site, the U.S. has 3.5 million miles of rivers, but only about 12,600 river miles (just over one-quarter of one percent) are included in the National Wild and Scenic Rivers System.

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As a result of clean-up efforts in the Delaware River, shad and other fish species, as well as bald eagles, are increasing in number.

***

The Delaware Estuary -- the Delaware Bay and tidal reach of the Delaware River -- has been included in the National Estuary Program, a project set up to protect estuarine systems of national significance.

***

There are numerous economic benefits from the river. The Delaware River Port Complex (including docking facilities in Pennsylvania, New Jersey, and Delaware) is the largest freshwater port in the world. According to testimony submitted to a U.S. House of Representatives subcommittee in 2005, the port complex generates $19 billion in annual economic activity. It is one of only 14 strategic ports in the nation transporting military supplies and equipment by vessel to support our troops overseas. The Delaware River and Bay is home to the third largest petrochemical port as well as five of the largest east coast refineries. Nearly 42 million gallons of crude oil are moved on the Delaware River on a daily basis. There are approximately 3,000 deep draft vessel arrivals each year and it is the largest receiving port in the United States for Very Large Crude Carriers (tank ships greater than 125,000 deadweight tons). It is the largest North American port for steel, paper, and meat imports as well as the largest importer of cocoa beans and fruit on the east coast. Over 65% of Chilean and other South American fruits imported into the United States arrive at terminal facilities in the tri-state port complex. Wilmington, Delaware is home to the largest U.S. banana importing port, handling over one million tons of this cargo annually from Central America. According to Rear Admiral Sally Brice-O'Hara, District Commander of the Fifth Coast Guard District, "The port is critical not only to the region, but also to the nation."

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The Delaware: A National Treasure
(free Adobe reader required to view)

Map Gallery

Municipalities in the Basin

EXHIBIT B

Celebrating the 30th Anniversary of the

Upper Delaware Scenic and Recreational River

Partnering to protect the river

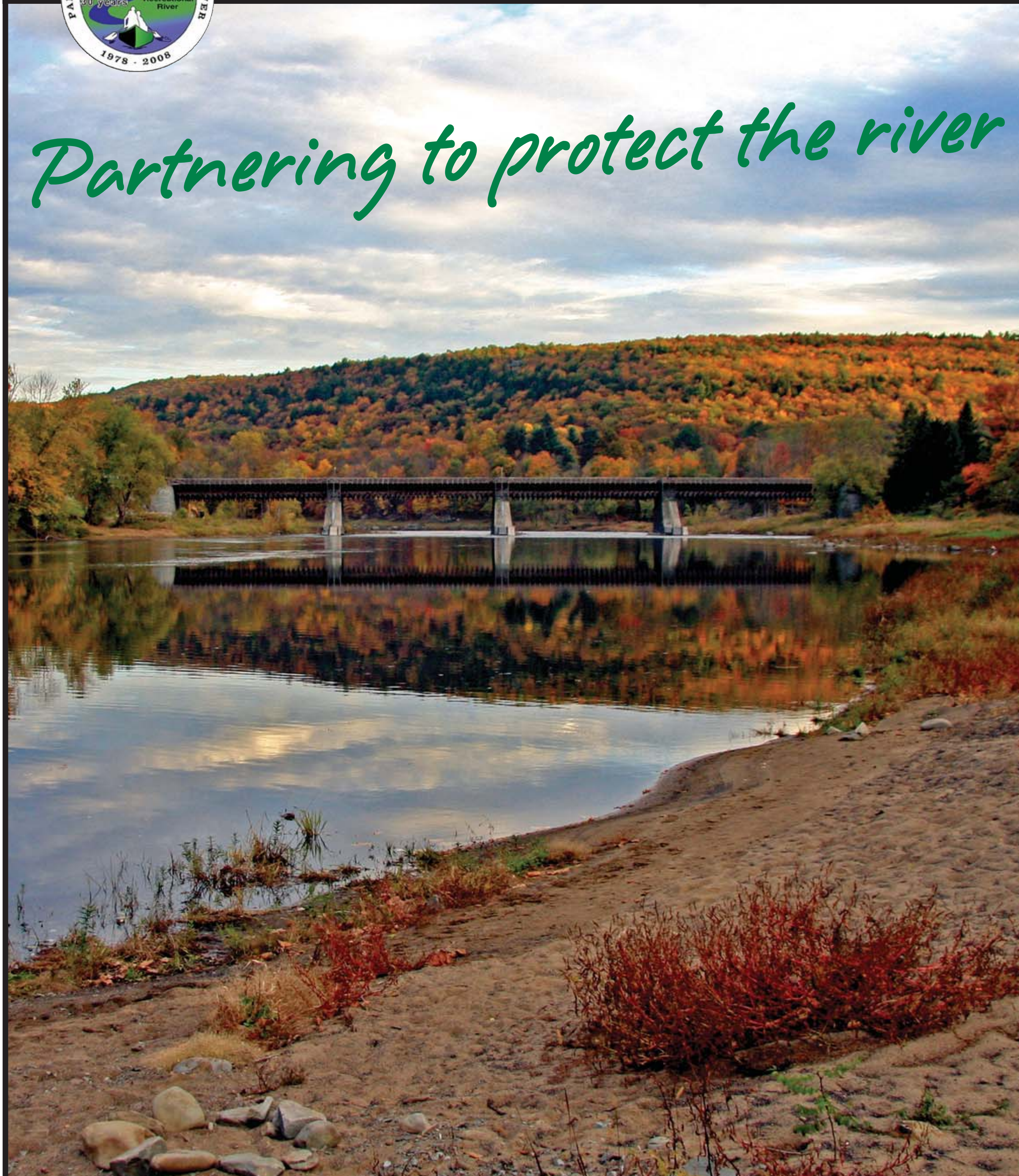
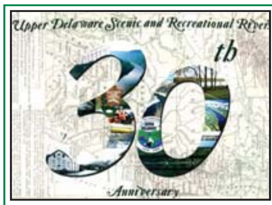


Photo by David B. Soete©

Celebrating the 30th Anniversary of the Upper Delaware Scenic and Recreational River

contents



page 10

Over 50 area high school students submitted original artwork depicting the rich natural resources and cultural history of the Upper Delaware River Valley in the 30th anniversary poster contest. A Delaware Valley Arts Alliance jury selected the winners.

United States Department of the Interior

NATIONAL PARK SERVICE
Upper Delaware
Scenic and Recreational River
274 River Road, Beach Lake PA 18405

In Reply Refer to:

October 23, 2008

Dear Friends of the River,

I recently had the pleasure of driving up the Upper Delaware Scenic Byway, and as I broke over a hilltop, the valley opened before me in full autumn regalia. The setting sun bounced off of the bright yellows, oranges and reds before it landed as diamonds on the water's surface. It was breathtaking. It is my first autumn on the Upper Delaware, and that memory will never be forgotten. The Upper Delaware Scenic and Recreational River is one of the most beautiful places in the world.

It gives me pause, as we are inclined to do at this time of year, to be thankful for what we have at the Upper Delaware. The law that established the Upper Delaware Scenic and Recreational River as a unit of the Wild and Scenic Rivers System is 30 years old, and as we mature together, we consider our nearly 400 partner agencies and organizations who work tirelessly together to *keep* this one of the most beautiful places in the world. Who are our partners? The list begins with the Upper Delaware Council, and it extends through the 15 towns and townships, five counties and two states with their agencies who play a role. It includes the Delaware River Basin Commission and federal agencies such as the U.S. Geological Survey and U.S. Fish and Wildlife Service. It includes Scouts and 4-H Clubs, historical groups and community organizers.There are scores of volunteer organizations who pitch in wherever they are needed…and when a new need arises, a new organization forms to help.

But it is obvious that unsung heroes contribute also. Last year at the National Park Service alone, we logged over 10,000 hours of volunteer service, a new record. Residents volunteer for community cleanups, spruce ups and fundraisers. Ambulance Corps and Fire Departments volunteer to help in emergencies. Families volunteer to "adopt a highway."

Thank you. All of you. Each of you. Each hour contributes to the overwhelming beauty of the Upper Delaware. I am humbled to be in your service.

Sincerely,

Vidal Martinez
Superintendent

How to Contact Us

National Park Service
Upper Delaware Scenic and Recreational River
274 River Road
Beach Lake, PA 18405
www.nps.gov/upde

Office of the Superintendent
570/729-8251

Natural Resources Management
570/729-7842

Cultural Resources Management
570/685-4871

Interpretation
570/685-4871

Protection
Call 911 in emergencies
Chief of Protection
570/729-7134
Milanville Ranger Office
570/729-7862
Barryville Ranger Office & Dispatch
845/557-0222

Maintenance
570/729-7137

Administration
570/729-7136

The Upper Delaware Council
845/252-3022
PO Box 192
211 Bridge Street
Narrowsburg, NY 12724
www.upperdelawarecouncil.org

Islands punctuate the Upper Delaware North of the Callicoon Bridge. *Photo by David B. Soete©*

River of Compromise

With eight New York towns, four Pennsylvania townships, and numerous agencies of the two states, as well as the National Park Service (NPS), the Upper Delaware Council (UDC) and the Delaware River Basin Commission (DRBC) involved in its management, the Upper Delaware National Scenic and Recreational River is truly a unique creation.

The current NPS Superintendent of the river corridor, Vidal Martinez, who has 32 years of federal government service, discovered the difference from other NPS areas as soon as he arrived on the job in February of 2008.

He said, "The difference is significant in that the whole concept of this style of management has to do with working with the townships in helping to conserve and protect the scenic and recreational values of the river corridor and the Upper Delaware River."

When a situation arises that might threaten the river, the UDC and NPS voice their concerns to the appropriate officials.

One recent example of working together to try to prevent a direct threat to the river valley is the effort mounted against the New York Regional Interconnect (NYRI). This project originally proposed to run a High-Voltage, Direct-Current electrical transmission line on a 190-mile path that would parallel the Upper Delaware River corridor on the railroad right-of-way.

Strong objections raised by the NPS and UDC, among other organizations and individuals, resulted in the private investment company moving its nominated route slightly east of the corridor boundaries in its application before the New York State Public Service Commission.

"This fight isn't over yet but we remain committed to urging compliance with the River Management Plan, which characterizes a project of this scope as an incompatible use," said William Douglass, Executive Director of the UDC.

With the changing demographics of the river valley, the role of the NPS and the UDC has shifted slightly. Sandy Schultz, the NPS Assistant Superintendent, said the emergence of more environmental organizations in the area has allowed the NPS to remain more in the center of the dialogue among various groups in the river valley with different points of view. She said that with the advent of active citizen groups such as the Upper Delaware Preservation Coalition and Catskill Mountainkeeper, the NPS is no longer viewed by many as being extreme in its role of protecting the river. Now that the UDC has been in business for 20 years, and the NPS has been in the valley for 30 years, much of the initial suspicion about the federal effort has been abated.

Douglass said, "The skepticism is not completely gone, but over the years there have been fewer and fewer problems. There are still issues out there, but in general, things have calmed down. The River Management Plan is working; nobody's property has been taken. Those who were really afraid of it, I think, have realized that the Park Service is not here to take their land—that's just not going to happen, and that's the real success story here."

Photo by David B. Soete©

The river at Narrowsburg: Serene and welcoming at the deepest point.

The River Runs Through It

In the post-World War II era, the economy was booming and new construction was underway across the nation. It was national policy to promote construction of dams on some rivers. But by the 1960s, many felt that some rivers in the country should be protected from development to ensure that they remain "free-flowing." In 1968, Congress passed the Wild and Scenic Rivers Act, to protect selected rivers from dams and other construction projects. The act noted that the selected rivers "possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values," and these rivers and their immediate environs "shall be protected for the benefit and enjoyment of future generations." The Upper Delaware River was one of the initial Study Rivers for the National Wild and Scenic Rivers System.

This led to a lengthy period of study that involved input from governments and organizations and residents because the river means many things to many people, and there were many stakeholders to be consulted and considered during the study…

- the towns and local residents have interests related to the river in terms of earning a living, pursuing recreation, or enjoying its scenic beauty.
- the Upper Delaware receives releases from two reservoirs that serve New York City.
- the Delaware River Basin Commission (DRBC), representing the four states through which the Delaware flows, has jurisdiction over certain aspects of the river.

Some property owners were suspicious of the federal government because in the '60s, the U.S. Army Corps of Engineers began acquiring land, some by eminent domain, for the Tocks Island Dam, to be built upstream from Delaware Water Gap. Many former residents complained bitterly that the government had taken their land without adequate compensation. Some of those people who were moved off their land settled upstream in the Upper Delaware River valley (Ultimately, the proposed dam was never built, and the project was abandoned. The land is now the Delaware Water Gap National Recreation Area, managed by the National Park Service (NPS). Fearing a repeat of that kind of land acquisition, residents organized and petitioned their representatives in Washington to become heavily involved in shaping the future of the Upper Delaware River valley. They also urged very limited government land acquisition.

In July 1976, the Bureau of Outdoor Recreation, an agency of the U.S. Department of the Interior, released an exhaustive study identifying the resources of the Upper Delaware. The report documented the "outstandingly remarkable scenic, recreational and cultural values" of the Upper Delaware:

- **Scenic Values:** Rich variety of riparian vegetative screening of development, fields and pastures add variety to an already interesting landscape, and overall tranquil scenic beauty.
- **Recreational Values:** Developed recreation resources; camps and campgrounds; hunting and fishing preserves; public recreation—state parks, forests and game lands; opportunities for canoeing, fishing, swimming and sightseeing; and related river activities.
- **Fish and Wildlife:** Outstanding habitat for both a cold and warm water fishery; anadromous species such as shad and the American eel; large and small wildlife species; waterfowl and upland game populations; reptiles and amphibians.
- **Cultural Values:** Including archeological sites of the early Native Americans, and historic sites depicting the timber industry with rafting of logs, farming of cleared land, and the Delaware and Hudson Canal.

Photo by David B. Soete©

The Upper Delaware begins at regal Point Mountain, where the East and West Branches meet.

Place your postal cancellation here.

Clearly, there were many natural and cultural resources worthy of protection in the river valley.

In 1978, Congress designated "The Upper Delaware Scenic and Recreational River." The legislation assigned administration to the U.S. Secretary of the Interior through the National Park Service and directed that the NPS should work with representatives of both states, local governments in both states, the DRBC and the Upper Delaware Citizens Advisory Council—which was comprised of concerned citizens—to create a river management plan. Land the federal government could acquire was limited to a total of 450 acres of "land and interests in land for access, development sites, the preservation of scenic qualities or for any other purpose..." with the exception that the federal government could acquire an additional 1,000 acres if it were so designated in the river management plan. That language guaranteed that the river area would not be owned by the federal government as is the usual case for national parks, but instead would be a ground-breaking partnership with NPS and many other interested stakeholders.

Photo by David B. Soete©

The Upper Delaware River valley is home to a great variety of aquatic birds, including this great blue heron.

Photo by David B. Soete©

The Upper Delaware Scenic Byway follows the river along New York State Route 97.

When John Hutzky was appointed as the first National Park Service (NPS) Superintendent of the Upper Delaware Scenic and Recreational River in November 1979, he was tasked with overseeing the formation of the Upper Delaware River Management Plan (RPM). He was entering uncharted territory.

The process for creating this plan was far different. Normally, the NPS would buy the land required for a natural park. In this case NPS was ordered by Congress to work with state and local governments, other agencies and community groups to develop a plan in which federal jurisdiction would be limited to the river surface and a small amount of property, while the vast majority of land remained privately owned.

Many residents along the river were extremely skeptical about the intentions of government officials regarding the acquisition of land. In the '60s, thousands of acres of land had been acquired, some of it by eminent domain from unwilling sellers, for a planned "Tocks Island Dam" in the Middle Delaware River. In earlier decades New York City condemmed thousands of acres of land to create the Neversink, Cannonsville and Pepacton Reservoirs, which ended with many homesteads forever covered by water.

With that historical backdrop, the challenge for the NPS was to convince residents of the Upper Delaware Valley that their primary mission was to protect the natural resources of the area, and not take land by condemnation. This was especially difficult because a 1970s Bureau of Outdoor Recreation report recommended federal acquisition of land for a quarter mile on either side of the river (This recommendation, however, was not included in the enabling legislation for the Upper Delaware). On the other hand, not all residents and local officials were opposed to the NPS. Some were pleased that the NPS brought policing services to the river to help enforce local laws. At the time, many people from outside the area would travel to the river for recreation, and behave badly. Visitors would litter and relieve themselves on private property, and there is a story repeated by residents that one woman came home to find a naked man using her phone.

The NPS helped to quell that sort of activity and some residents were grateful that the NPS had "cleaned up the mess in the river." Additionally, the NPS was responsible for cutting the number of drownings on the river. The year before the National Park Service arrived, there were ten drownings on the Upper Delaware.

In 1980, the creation of the RMP began. NPS personnel from the NPS Denver office, working with local officials from the five counties, the Citizens Advisory Council (CAC), and with input from a group of local county planning professionals called the Upper Delaware Clearinghouse, drafted two river management plans, both of which were soundly rejected by local residents. The general consensus was that the Denver planners did not understand the importance of the concept of home rule. Major concerns of the residents included over-regulation, the use of eminent domain, loss of local control, and issues such as the right to fish, hunt and use the river corridor as families had for generations.

With the third attempt at drafting the plan, the Denver planning people withdrew from the process. Many local residents and politicians were brought into the process more deeply, and the group of seven Pennsylvania townships and eight New York towns along the river formed the Conference of Upper Delaware Townships (COUP) in 1981, which became involved to a very important degree.

Several community groups were pushing various agendas for the plan at the time. At least two influential groups were pushing for "de-authorization" of the Upper Delaware, a scenario under which the NPS would simply leave the valley.

A California land rights activist, Charles Cushman, had come to the area, and promoted showings of the film "For the Good of All." The film told the story of the actions of the Army Corps of Engineers and the NPS regarding the Cuyahoga Valley National Recreation Area in Ohio in the late '70s and early '80s. According to testimony Cushman later gave to Congress, the number of homes purchased by the federal government to create the area was well over 300. He said, "The small community was destroyed, schools closed, their tax base eroded by unnecessary land acquisition." The film gave support to those calling for "de-authorization."

There were also other concerns. The owners of the various canoe livery services along the river were resistant to the NPS requiring the liveries to operate under licenses. Smaller liveries feared they would be squeezed out.

And there was vandalism aimed at the NPS. In February 1984, five vehicles in the NPS motor pool were painted with black swastikas.

By July of 1984, five towns and townships had endorsed de-authorization, while other towns came out in support of the Upper Delaware legislation. COUP hired a consulting firm at NPS expense to assist them in re-writing the plan.

Foresight Consulting Group conducted a survey and found that "of those who responded, large majorities state preferences for 'zero' or 'slower than current rates of growth' rates of development along the river, and management of land by town governments."

Rewriting the plan was contentious, dealing with such complex and thorny issues as the rights of towns or townships choosing not to participate in the plan. On August 9, 1985, the new draft plan was submitted to the towns and townships for review. Several towns voted to withdraw from COUP and thus future participation in the plan.

The first public hearing on the plan was scheduled for June 4, 1986, at the Damascus School. More than 300 people attended, with a large majority of them opposed to the plan. As the meeting was called to

Contributed photo

The National Park Service was met with skepticism and outright opposition by some in the Upper Delaware River Valley.

The Final River Management Plan for the Upper Delaware Scenic and Recreational River, adopted in 1986, includes the following Goals and Objectives which are still adhered to today:

1. Protect and maintain the unique scenic, cultural, and natural qualities of the Upper Delaware River corridor, including its rare and endangered plant and animal species and rare natural habitats.

2. Maintain and enhance the corridor's social and economic vitality and its diversity, consistent with efforts to protect the recognized values of the river corridor.

3. Conserve the resources of the Upper Delaware primarily through the use of existing local and state land use controls and voluntary private landowner actions consistent with local land use ordinances.

4. Protect private property rights, and allow for the use and enjoyment of the river corridor by both year-round and seasonal residents.

5. Provide for planned growth, consistent with local ordinances, to ensure optimum use of existing public services, while maintaining and conserving the essential character of the river valley.

6. Maintain and improve fisheries and wildlife habitat to ensure the continued public enjoyment of hunting, fishing and trapping, consistent with state laws.

7. Foster a public recognition of the Upper Delaware River Valley as a place with its own identity, continuing history, and a destiny to be shaped by its residents.

8. Provide for the continued public use and enjoyment of a full range of recreational activities, as is compatible with the other goals.

9. Encourage maximum local government official, private landowner, private group, and citizen involvement in the management of the Upper Delaware.

10. Develop and implement an interim plan for the protection of public health and safety due to the presence of a toxic landfill located adjacent to the river in the Town of Tusten, and advocate the prompt cleanup and removal of its contents.

(In the Upper Delaware Council's second Five-Year Operating Program Cooperative Agreement with the National Park Service covering 2002-2007, four new goals were added to this list):

11. Ensure that no new landfills are located within the Upper Delaware corridor, and that existing landfills either within or beyond the corridor boundaries do not threaten the corridor's ecological health and integrity.

12. Carefully manage the transport of hazardous materials and toxic substances through the river corridor to minimize the risks to human health and the river corridor's ecology. Emergency services and communication, especially for hazard warnings to recreational users, should be elevated to the highest level of preparedness.

13. Protect and enhance the Upper Delaware River's outstanding values: its free-flowing nature, excellent water quality, and aquatic ecosystem.

14. Provide for the effective and continued operation of the Upper Delaware Council as a community-based, non-profit organization working in close contact with its members and the property owners of and visitors to the river valley.

order, an organized disruption began and cowbells and other noisemakers were sounded, and chants of "No park, no plan, no way," broke out. The noise continued for 90 minutes, preventing anyone from speaking. Eventually representatives of CAC, COUP and NPS left the podium.

A second meeting ended the same way.

Meetings on June 6 and 7, however, were brought to order, and testimony from 74 individuals was taken, with 256 written comments received. Later that month, COUP sent a letter inviting the 15 eligible towns to participate in a new Plan Revision Committee. Nine of the fifteen towns and townships chose to participate, and the committee held several hearings through October 23.

Some of the early meetings were disrupted by anti-plan activists, but the NPS requested assistance from the Tusten Town Police, and the disruptions ceased.

It was during this period that tensions ran highest in the community. The River Reporter newspaper had been supporting the NPS and the adoption of a River Management Plan, drawing the ire of groups and individuals who favored de-authorization. In August of 1986, the home of the publisher and editor of the paper was burned to the ground. While no one was ever charged with setting the fire, many residents remain convinced to this day that the fire was connected to the paper's support of the NPS.

An anti-plan resident also lost a building to fire at about the same time, but there is some ambiguity about whether that fire was connected to the NPS controversy.

The Plan Revision C committee made some 400 changes to the plan over the next year to try to strike a balance among all of the entities involved.

Among the most important clauses in the revised plan were:

- An imperative to local government to retain control through the establishment of the Upper Delaware Council, which would have primary responsibility for coordinating and overseeing the plan.
- Protection against over regulation by using only existing local, state and federal laws to protect the river.
- Providing landowners with protections against the use of eminent domain by implementing a multi-step process that would be followed before eminent domain could be used.
- Emphasizing the need to maintain the local economy through the use of alternatives to fee title land acquisition.
- Limiting the total amount of NPS land acquisition for management purposes to not more than 124 acres on a willing-seller, willing-buyer basis only.
- Revision of the plan and guidelines to ensure continuation of such traditional activities as recreation, hunting, fishing, trapping, timbering and agriculture.
- Providing towns with alternatives and flexibility that allowed them to meet the plan guidelines in their own way.

The River Management Plan also includes a Land and Water Use Guidelines supplemental section based on management principles and objectives set forth in the 1968 U.S. Wild and Scenic Rivers Act.

The Guidelines provide direction for all cooperating governments—local, state and federal—to determine those land and water uses which: are clearly appropriate in the Upper Delaware River Valley; those uses which might, with conditions, be deemed appropriate; and those which might pose a threat to its resources and therefore are considered incompatible.

Local governments that adopt land use regulations based on these Guidelines are deemed to be in "substantial conformance" with them. Implementation of these Guidelines is accomplished through the use of existing legal authorities, with maximum flexibility allowed.

The overarching purpose of the Land and Water Use Guidelines is to assure that actions on all levels of government contribute to a true, partnership-based management of the Upper Delaware by protecting the health, safety and welfare of river corridor residents, while also protecting and enhancing the unique characteristics of the Upper Delaware River Valley.

The plan was adopted in November 1986, and the UDC was officially incorporated on February 18, 1988. Eligible for membership were the eight New York towns and seven Pennsylvania townships bordering the river, the State of New York, the Commonwealth of Pennsylvania, the Delaware River Basin Commission and the Upper Delaware Citizens Advisory Council.

The voting membership includes representatives of eight New York towns: Hancock, Fremont, Delaware, Cochecton, Tusten, Highland, Lumberland and Deerpark; four Pennsylvania townships: Damascus, Lackawaxen, Shohola and Westfall; and the two states. The Delaware River Basin Commission and the National Park Service are non-voting members.

As of this writing, three townships in Wayne County, PA—Berlin, Buckingham and Manchester—remain eligible for membership in the UDC but have not yet chosen to join.

The CAC, which was established in 1978 to advise the U.S. Secretary of the Interior and NPS about issues pertaining to the management of the Upper Delaware Scenic and Recreational River, expired on February 6, 1999.

For more information on the River Management Plan and its Land and Water Use Guidelines, contact the Upper Delaware Council at P.O. Box 192, 211 Bridge St., Narrowsburg, NY 12764; phone (845) 252-3022; or on-line at www.upperdelawarecouncil.org.

The Rare and the Overabundant: Endangered and Invasive Species

The Upper Delaware River region is rich with varied flora and fauna that exist in a delicate balance affected by many factors. While some species are able to thrive and out-compete native species, others struggle to meet precarious habitat needs. Learn more about several of the endangered and invasive species of the region here.

Contributed photo

Japanese knotweed

Invasive Species

The U.S. Fish and Wildlife Service (FWS) defines invasive species as organisms introduced into a non-native ecosystem and which are likely to cause harm to the economy, environment or human health. Invasive plants and animals have many impacts and can degrade, change or displace native habitats in their competition for various resources.

According to the FWS, when non-native species are introduced into an ecosystem in which they did not evolve, their populations sometimes explode. Normally, species evolve together into an ecosystem with checks and balances—such as predators, herbivores, diseases, parasites, other competing organisms and environmental factors—that limit the population growth of any one species.

However, when an organism is introduced into an ecosystem in which it did not evolve naturally, it no longer has those limits. The resulting unnaturally large population can then have severe impacts because it disrupts natural communities and ecological processes. Suddenly, native species must compete for favorable habitat and resources like food, water and shelter. The invasive species can decrease the diversity of the ecosystem, making it more susceptible to diseases and natural disasters and can even cause extinction of other species. Following are several examples of invasive species affecting the Upper Delaware River region.

Japanese knotweed *(Polygonum cuspidatum)*

This herbaceous perennial plant can be seen throughout the region. It begins to emerge each growing season as "asparagus-like" stalks in late April or early May. The hollow, bamboo-like, reddish-brown stalks typically reach their full height of 10 feet by the end of July. The whitish and fragrant flowers are often in full bloom by late August. The leaves of the plant are broadly egg-shaped with pointed tips and square bases. This plant is typically found in degraded habitats such as roadsides and riverbanks. Japanese knotweed produces roots called rhizomes, which allow a single plant to colonize a large area in little time. It spreads very easily to new locations when tiny pieces of stem fragment or rhizomes get washed downstream after being cut or uprooted by flooding. As a result of knotweed's ability to regenerate from stem and root fragments and its astounding growth rate (young shoots can grow as much as three to four inches a day), it quickly colonizes scoured shores and river islands after flooding, and forms extremely persistent and dense thickets, known as monocultures, which exclude almost all other types of native vegetation from growing.

Native to eastern Asia, Japanese knotweed was introduced to England in 1825 for use as an ornamental plant. Today it can be found in 38 states across the U.S. Historical records show Japanese knotweed arriving in the Upper Delaware River Region sometime around 1979.

Asian longhorn beetle *(Anoplpphora glabripennis)*

This beetle, which made its way to the United States as larvae inside wood packing material from China, attacks many different species of hardwood trees in the United States, including maples, horse chestnut, poplar, willow, elm, mulberry and black locust. It kills the trees by boring into the trunks and branches. Trees damaged by this pest have round entry and exit holes about half an inch in diameter and may have sawdust piled up at the base. Sap may flow out of these holes.

The adult beetle can be up to one inch long with a glossy black body with white spots. The very long antennae are black with distinctive white bands. Adults can be seen from May through November. Adults should not be confused with the Whitespotted sawyer, which is native to North America.

The Asian longhorn beetle was confirmed in New York State in 1996 and has been found at several locations in New York City and Long Island, though it is not currently found in the Upper Delaware River region. To prevent its transmission to other areas, the New York Department of Environmental Conservation (DEC) imposed an emergency regulation in September 2008 against importing firewood into New York unless it has been treated (kiln-dried) to eliminate pests. The ban also prohibits the movement of untreated firewood within New York more than 50 miles from its source. To protect the trees of the Upper Delaware, leave firewood at home. Do not transport it to campgrounds or parks. Only buy firewood that has been harvested locally or treated for pests. Burn all firewood brought to the campsite.

Northern snakehead *(Channa argus)*

This aggressive fish is native to China, Russia and Korea, and one we hope never to see get established in the Upper Delaware River watershed. They are voracious predators, feeding on a variety of other fish, frogs, crayfish and aquatic insects and can grow to over 30 inches in length.

Snakeheads have the potential to greatly harm native fish populations. They are highly invasive, and could inhabit any of our streams and lakes. They can tolerate water with lower levels of dissolved oxygen than our native fish species, can breathe air, and may survive for days out of water in damp conditions.

Northern snakeheads were found this past summer as close as Orange County, NY. In its early stages, it was eradicated this past August in a concerted effort by DEC biologists, who isolated and poisoned sections of the treatment area. These fish likely appeared as the result of illegal introductions. Importation and interstate transport of snakeheads is prohibited under the federal Lacey Act, and New York and Pennsylvania also prohibit the possession, sale and live transport of snakehead fish (genus Channa and Parachanna) and their viable eggs.

If you see or catch a snakehead, report it to DEC's Region 3 fisheries office at 845/256-3161 or the Pennsylvania Fish and Boat Commission at 570/588-6388 or the National Park Service at 570/729-7842. If caught, do not release the fish. Kill, freeze and report your catch. Take a digital photo if possible.

Didymo algae *(Didymosphenia geminata)*

Didymo is a freshwater microscopic diatom found in streams and rivers in much of North America. Commonly called "rock snot," this aquatic nuisance algae increasingly poses a threat to aquatic ecosystems because it forms extensive mats on streambeds. Didymo attaches to the streambed by stalks which have a rough texture similar to wet wool and mimic strands of toilet paper, as opposed to other algal species which feel "slimy."

Contributed photo

Transmitter fitting on bald eagle

In August 2007, Didymo was confirmed to be present in the East Branch of the Delaware River. There are no feasible methods of eradication known, but efforts have been made to educate the public about practices such as cleaning waders and equipment between outings in hopes of minimizing chances of its spread.

Hemlock woolly adelgid *(Adelges tsuga)*

A small aphid-like non-native invasive insect, the Hemlock wooly adelgid (HWA) was introduced in the United States in 1951 and appeared regionally after destroying hemlock forests from Virginia to New Jersey. Adelgids feed at the bases of hemlock needles causing the needles to die. Defoliation and mortality of hemlocks can follow, sometimes in as little as four years, with a heavy infestation. Believed to be native to Japan and China, experts think that hemlock woolly adelgid (HWA) probably came to the United States on imported ornamental hemlocks. The adelgid was not a serious problem in its native lands because of an abundance of predatory beetles that kept it in check.

Hemlocks dominate most ravines of tributaries that flow into the Upper Delaware River, providing shade and cooler water inputs, and stabilizing these streams' hydrologic regimes while making them less likely to dry up during the summer months. Research and monitoring conducted at Delaware Water Gap National Recreation Area since 1993 has indicated that hemlock-shaded streams are three times more likely to have native brook trout than drainages with deciduous tree canopies. Along with this species are entire natural communities of birds, mammals, amphibians and invertebrates linked to these environments for thousands of years with evolved interdependencies.

The potential for controlling HWA is thought to lie in the introduction of predatory beetles, which have been released at Delaware Water Gap National Recreation Area and other places in the Eastern United States. Besides biological controls, spraying individual trees with insecticidal soaps and oils, or injecting them with a systemic insecticide that kills the adelgid, may be feasible options. Aerial applications of pesticides to kill HWA are not appropriate, because hemlocks often grow near sensitive stream areas.

Endangered Species

In 1973, the United States Congress created the Endangered Species Act, one of the world's strongest and most effective wildlife conservation laws, in order to reverse the trend of human-caused extinctions threatening shared ecosystems. The Act has continued to evolve, and today protects many species of fish, wildlife and plants. It declares that these species possess aesthetic, ecological, educational, historical, recreational and scientific value and pledges to conserve them.

Individual states also protect such species. Their classifications as endangered or threatened help to prevent further population declines.

Listed below are a few species whose populations are at risk in the Upper Delaware River region.

Miner's lettuce *(Montia chamissoi)*

This very small and rare herbaceous perennial plant is classified as an endangered species in Pennsylvania. It sends out long slender runners and produces two- to five-centimeter pink petals on two to seven flowers in May through August each year. Miner's lettuce can be found on moist, rocky ledges, riverbanks and streamsides from low to high elevations of coastal valleys and mountains.

Dwarf sand cherry *(Prunus pumila)*

Considered a threatened species in New York, dwarf sand cherry is a colonial shrub that produces creeping stems radiating outward from the original plant. The stems may be three-to-five meters long, and they root prolifically where they contact the ground. The simple leaves are four to 10 centimeter long and narrow, finely toothed and whitish on the undersides. This plant may be identified in any season, though it might easily be overlooked in winter when the leaves are gone.

In New York, dwarf sand cherry is most often found on the islands and banks of large rivers, where scouring ice prevents trees and large shrubs from persisting. The prostrate, ground-hugging stems of this subspecies appear well adapted to these unique habitats.

Quillwort *(Isoetes riparia)*

This grass-like, emergent aquatic plant with dark green stiff leaves can be found in lakes, ponds, streams and river shores. Quillwort is classified as an endangered species in New York and is infrequently found in shallow water and shores of slow-moving rivers and streams, and intertidal mud flats. This plant ranges from southern Quebec and Ontario, south through Eastern New York and Western New England, down to the coastal plain of North Carolina. The best time to find quillwort is in late June through early October when the vegetative stems are present. Certain populations of this plant have been negatively impacted by pollutants, run-off, boat traffic and other changes to their associated waterways.

Dwarf wedge mussel *(Alasmidonta heterodon)*

The dwarf wedge mussel is a small freshwater mussel that rarely exceeds one and a half inches (38 mm) in length. Once found at 70 locations in 15 major Atlantic Coast drainages, its numbers have declined drastically, and it is now found at only about 20 sites in seven Atlantic Coast drainages. Its Federal status, as well as its status in Pennsylvania and New York, is endangered.

In 2000, a United States Geological Survey team, funded by the NPS, documented their presence here in three populations spread out over

Contributed photo

This thriving eaglet is part of an Upper Delaware River valley success story.

a 22-mile section of the Upper Delaware River. The Delaware River has nine species of freshwater mussels, or 64 percent of the 14 species known to the Atlantic slope. Historically, North America was home to 297 species of freshwater mussels, by far the highest diversity in the world. Today, they are the most rapidly declining animal group in the United States, with 70 percent of their species either extinct, endangered, threatened or potentially justifying federal protection.

While not very charismatic animals, freshwater mussels are not insignificant. They make up the greatest animal biomass in the Delaware River, and play an important, integral role in its ecosystem. A freshwater mussel can filter up to five gallons of water a day, and collectively they act as a filtration system for the river, contributing to water quality and clarity. Estimates are that the mussels found in the Delaware River filter its water volume several times over before it reaches Delaware Bay.

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Photo by David B. Soete©

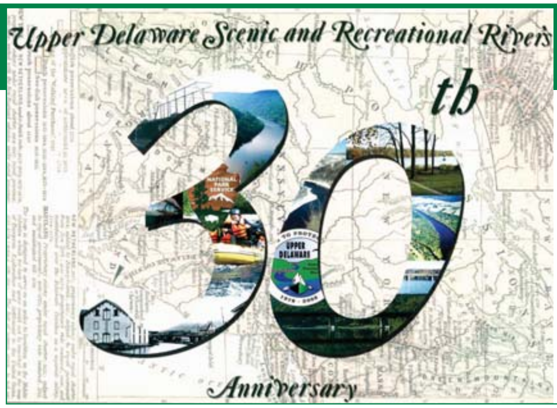
The deceptively beautiful purple loosestrife and a common egret make for a striking riparian scene.

Did You Know?

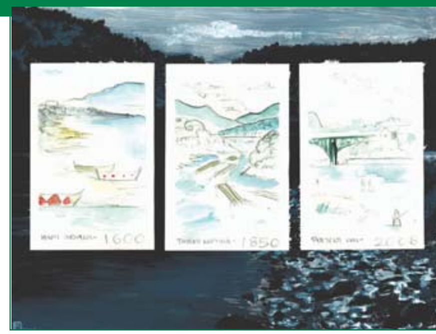
Known as "The Gateway to the Delaware River," Hancock, New York, is famous for its bluestone and timber industries. Louisville Slugger baseball bats were made from Hancock timber for over 85 years and its bluestone was used in building the Empire State Building and the Statue of Liberty.

Spawned in the Sargasso Sea in the Atlantic Ocean, the American eel migrates as a juvenile to fresh water where they grow into adults. As a traditional food source for Native Americans, smoked eels are still a local delicacy.

Art Poster Contest Winners, 30th Anniversary Upper Delaware Scenic & Recreational River



GRAND PRIZE-$200—Annelise Babula, Eldred Jr-Sr HS, Grade 12

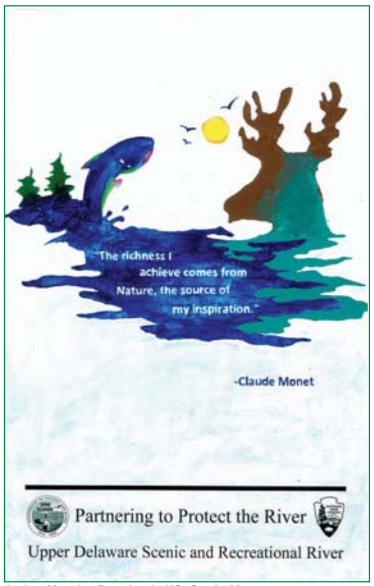


1ST PLACE-$100—Hannah Garrison, Delaware Valley HS, Grade 12

2ND PLACE-$75—Alexa Vogel, Delaware Valley HS, Grade 11

3RD PLACE-$50—Jenna Gangel, Sullivan West HS, Grade 12

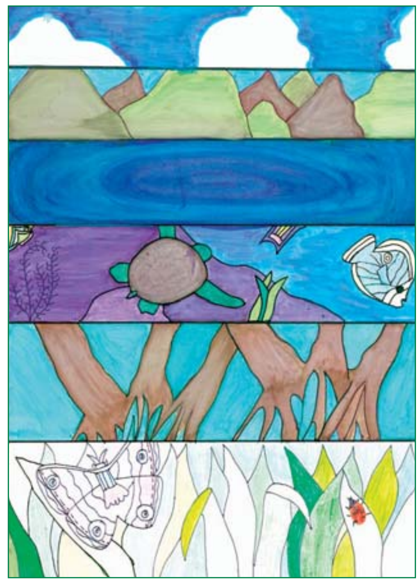
HONORABLE MENTIONS—$25 each



Amber Murphy, Port Jervis HS, Grade 12

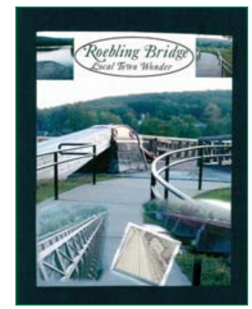
Heather McGinley, Delaware Valley HS, Grade 12

Ariana Wagner, Delaware Valley HS, Grade 11

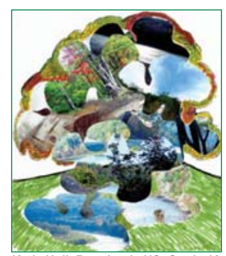


Jamie Rivera, Port Jervis HS, Grade 11

Sharyn Beodeker, Delaware Valley HS, Grade 11



Nick Mehedin, Eldred Jr-Sr HS, Grade 10



Katie Hull, Port Jervis HS, Grade 10

Jessica Van Orden, Delaware Valley HS, Grade 11

POSTER CONTEST SPONSORS:

First National Community Bank
Dunmore, PA

Narrowsburg Inn
Narrowsburg, NY

Rasmussen Home Furnishings
Narrowsburg, NY

Carriage House
Barryville, NY

Kittatinny Canoes
Dingmans Ferry, PA

Catskill Hudson Bank
Narrowsburg, NY

Il Castello
Barryville, NY

Alice's Wonderland
Greeley, PA

JoAnne Merritt
In Memory of Angus Ross, NPS Natural Resource Specialist

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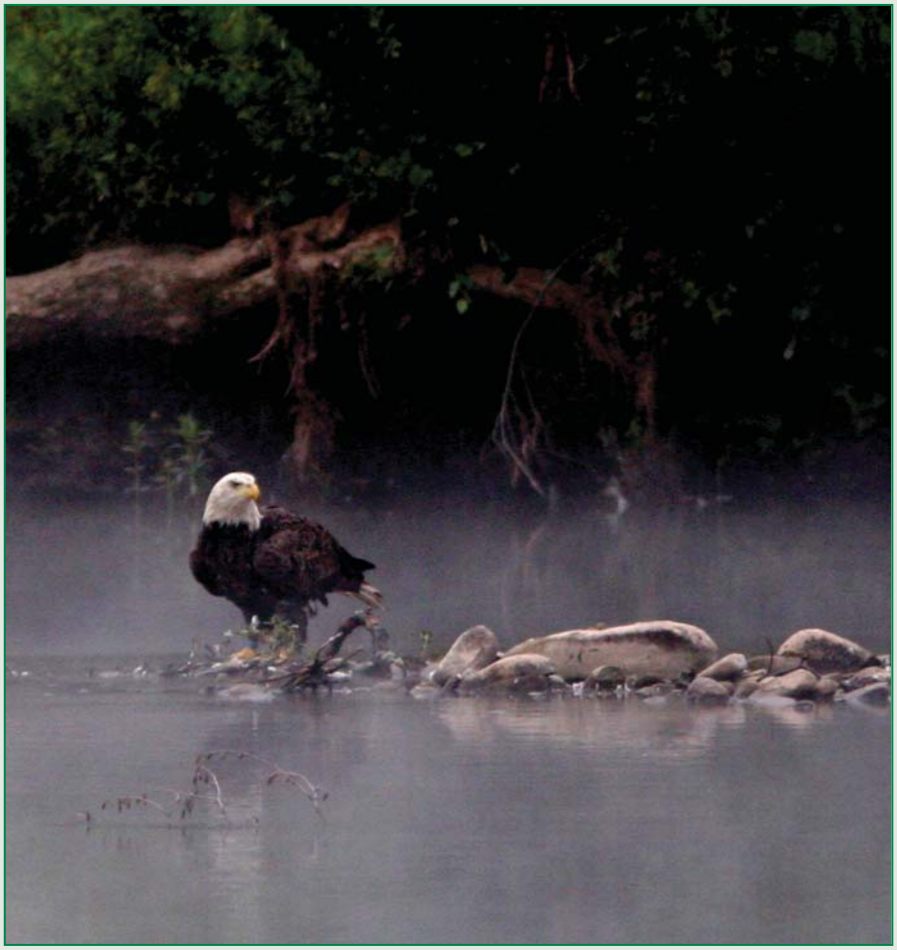


Photo by David B. Soete©

The magnificent bald eagle has made a comeback in the valley, with 16 breeding pairs in 2008.

American Bald Eagles: A Success Story

After nearly disappearing from the United States, the bald eagle is now considered to be flourishing and was removed from the federal threatened and endangered species list, though it continues to be protected under both New York and Pennsylvania law. The bald eagle, native only to North America, was one of the original species protected since 1973 by the Endangered Species Act after widespread use of the pesticide DDT nearly caused the majestic bird's extinction.

The legal protections given the species, along with a decision by the Environmental Protection Agency to ban the general use of DDT in 1972, accelerated eagle recovery through captive breeding programs, reintroductions, law enforcement efforts, protection of habitat around nest sites and land purchase and preservation activities.

The U.S. Department of the Interior's decision to delist the bald eagle was based on the bird's dramatic recovery. In 1963, the lower 48 states were home to barely 400 nesting pairs of bald eagles. After decades of conservation effort, they are home to some 10,000 nesting pairs, a 25-fold increase in the last 40 years.

Bald eagles will continue to be protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Both federal laws prohibit "taking"—killing, selling or otherwise harming eagles, their nests or eggs.

Eagle populations will be monitored for at least five years, as required by the Endangered Species Act. If at any time it appears that the bald eagle again needs the Act's protection, the U.S. Fish and Wildlife Service can propose to relist the species.

Did You Know?

In addition to "Partnering to Protect the River", the National Park Service offers many programs and services, including

- Providing information and education to the public about the Upper Delaware River, including programs about river safety, boating, fishing, Zane Grey, Roebling Bridge, the Delaware and Hudson Canal, Upper Delaware Native Americans, plants, animals and birds, among many others
- Assisting visitors in emergencies and providing law enforcement on the Upper Delaware Scenic and Recreational River, at 16 accesses along the river, and at NPS-owned sites throughout the corridor

As part of the National Wild and Scenic Rivers System, Upper Delaware Scenic and Recreational River stretches 73.4 miles along the New York – Pennsylvania border. The Upper Delaware is the longest free flowing (undammed) river in the Northeast, and one of the longest and cleanest free flowing rivers in the Eastern United States.

The American Shad are a saltwater fish that migrate from the Atlantic Ocean up the Delaware River to spawn in the spring. Fish reach the upper portions of the river by early to mid May. After spawning many of the weakened adult Shad die, usually in late June and into July.

Volunteer Programs at National Park Service

Over the years, the National Park Service has been assisted by volunteers made up of groups and individuals. These people have assisted the Service to do things that its limited budget could not cover.

National canoe safety patrol volunteers.

There at two main volunteer programs:

- The Park Ranger Internship Program enlists college students during the summer to the NPS Division of Interpretation. Duties include staffing river access sites, presenting river safety talks, providing area information to river users, performing river patrols and presenting educational programs to park visitors.
- The second volunteer program occurs at the Zane Grey Museum where volunteers present tours and talks, answer questions and operate the sales outlet, work with the museum collection, historic properties, archival collections and various other efforts.

For information about the NPS Volunteer Program, contact Ingrid Peterec at 570/685-4871.

Q&A

Photo by David B. Soete©

Canoeing on the West Branch of the Delaware River.

A Conversation with the Superintendent

Vidal Martinez stepped into the role of the National Park Service (NPS) Superintendent of the Upper Delaware Scenic and Recreational River in February 2008.

Question: What challenges did you face when you arrived?

Answer: When I arrived at the beginning of February, I was immediately faced with weather and closure issues. I quickly realized that the honeymoon period was over, as I was rudely awakened by the sheer number of complex issues facing the Upper Delaware.

I knew about the non-federal lands concept of the Upper Delaware, and the extensive work with partners. I also knew about power lines, and how that project could affect the river, and that one of the challenges that faced the NPS was the need to communicate the importance of wearing life jackets while on the river.

However, when I walked in that door, it seemed that the floodgates opened with development issues that could have a profound impact on the river itself, as well as the overall complexity of protecting the river through the use of local land use controls. So these are the kinds of issues that I was immediately confronted with.

Question: How is the NPS dealing with the possibility of natural gas drilling in the region?

Answer: Gas drilling has emerged as an activity that could greatly change the character of the river valley and the surrounding region. We're still uncertain as to what the long-term impacts will be on the river corridor. We know that it is spreading into the region, and there are several areas outside the river corridor that are starting to concern us.

We need to find out the impacts, and that's where we need to work with the Delaware River Basin Commission (DRBC) to ensure that the regulatory requirements, through their permit process, will protect the river. The DRBC will address issues of water extraction on surface water, groundwater and tributaries that will affect the river corridor.

So, we are relying on the DRBC. That's totally different from a traditional or typical park setting where a NPS manager would have more control because of park-owned land.

Question: Working with so many partners: the UDC, DRBC, seven townships in Pennsylvania and the state government, eight towns in New York and that state government, the DEP in Pennsylvania and the DEC in New York, is it frustrating because it can take a rather long time to get things accomplished?

Answer: It can be challenging. The fact remains that we have home-rule governments here. That's what we signed up for, and that's what the idea was with the River Management Plan: that the towns and other partners would collectively support the goal of protecting and preserving the scenic and recreational values of the river corridor. And so those were the key points, that there are appropriate practices and compatible land uses that won't compromise the river corridor. Many partners now feel that it's a plus that the Park Service is here. In the past, that wasn't so. But as time goes on, it appears that there has been a change in perspective to believing that the NPS and the Upper Delaware Council are meaningful organizations trying to do the right thing.

Question: This past spring, you got your first chance to go out and paddle on the river. How did you like it?

Answer: The experience is breathtaking. It presents a different perspective, and shows the reason why we're doing what we're doing. It really becomes pretty apparent as you're seeing the beautiful scenery, the untouched areas, the bald eagles soaring through the air and the different types of landscapes. And the experience of being on the river—it's not a beach, or a lake—it's a moving body of water and each different part of the river that you go through is a new experience.

It's not like seeing it from the road. When you're on the river, you're getting worthwhile experience, and I think the young people today need to divorce themselves from the TV and the electronic games for a while and step out with their moms and dads and get outdoors. And the Upper Delaware Scenic and Recreational River is a great place to do that.

Did You Know?

The Delaware River's deepest point is in Narrowsburg, New York, at an astounding 113 feet deep. It was once thought to be a long - drowned "plunge pool" from a glacial waterfall or possibly even a pothole scoured out by erosion with the smooth rocks at the bottom being the tools that did the job.

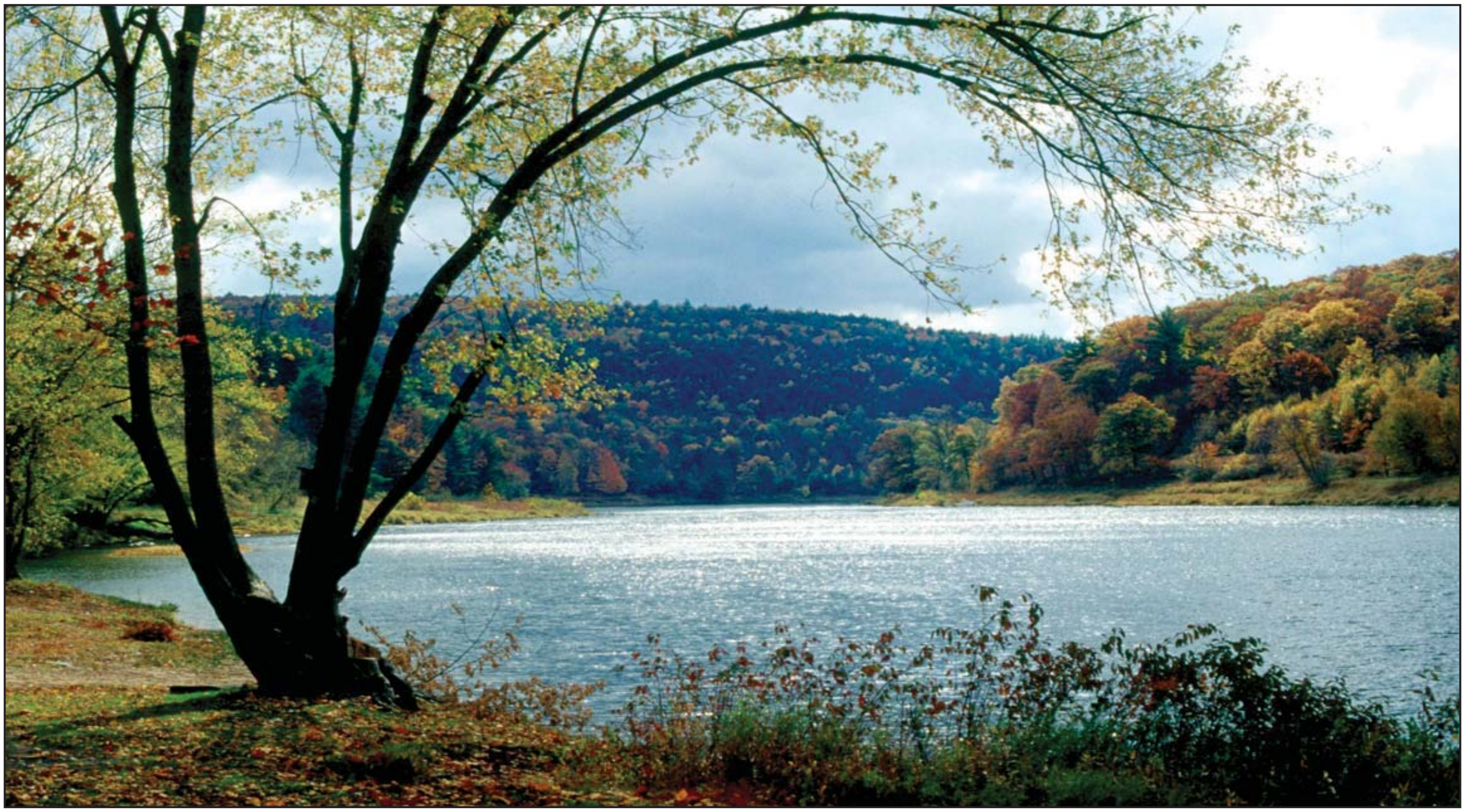


Photo by David B. Soete©

Ten Mile River Access along the Upper Delaware.

Partnerships – The Secret of the Upper Delaware Scenic and Recreational River's Success

Forming productive partnerships among the many groups that cherish the river has been the secret to the success of the Upper Delaware Scenic and Recreational River, according to Sandy Schultz, Assistant Superintendent of the National Park Service (NPS).

"These organizations and individuals have built trusting relationships because they have a common purpose—protecting and improving the Delaware River," Schultz said.

The NPS and the Upper Delaware Council (UDC) comprise the epicenter of these partnerships, encouraging and enlisting the services of various groups in fulfilling the mandates of the River Management Plan, a document whose purpose is to conserve, protect, maintain and enhance the river corridor's resource values and social and economic vitality.

"When we asked our staff to name the organizations and groups that are our partners, they came up with 400 names," said Carla Hauser Hahn, NPS Program Specialist. Though it would be impossible to name all these in this article, we can highlight a few groups that contribute to these unique relationships.

Besides the obvious partners, NPS, the UDC, the New York State Department of Environmental Conservation (DEC), the Pennsylvania Department of Environmental Protection (DEP), Delaware River Basin Commission (DRBC), the Pennsylvania Department of Conservation and Natural Resources (DCNR), and the local municipalities along both sides of the river, others are briefly highlighed here.

The National Canoe Safety Patrol (NCSP)

This group pre-dates even the federal designation of the river in 1978. "Back before we had learned about the designation, a group of canoe clubs in Pennsylvania, New York and New Jersey, saw the need to lessen the deaths that had been occurring along the river," said Richard Rhodes of the NCSP. "So we began to organize and train rescue teams and have continued to do so in cooperation with the NPS. Since our beginnings, we have lessened the deaths of those using canoes to zero or near zero."

The volunteer group will focus next year on educating swimmers about river safety.

The Delaware Highlands Conservancy (DHC)

DHC is a land trust whose purpose is to conserve the forests, farms and waters of the Upper Delaware River region by acquiring conservation easements, or land, from willing landowners. Founded in 1994, DHC met its goal of protecting 10,000 acres in 2007, and has set a new goal to protect an additional 10,000 acres across the region by 2012.

The Kittatinny Canoes River Cleanup

An annual volunteer effort organized by Kittatinny Canoe Livery owner Ruth Jones, this cleanup enlists volunteers who search the river and remove trash and debris that mars the beauty of the river.

The Delaware and Hudson Transportation Heritage Council (DHTHC)

This partnership includes public, private and non-profit organizations committed to promoting the appreciation, preservation and restoration of the historic resources of the Delaware and Hudson Canal and Gravity Railroad. Many sections of the D&H Canal towpath, once used by mules for pulling canal boats, have been transformed into unique recreational trails.

The partnership includes Wayne County Historical Society and Museum, the Neversink Valley Area Museum, the Waymart Area Historical Society, the Ellenville Public Library and Museum, the Sullivan County Historical Society, the Century House Historical Society and the Hudson River Maritime Museum, the D&H Canal and Gravity Railroad Conservancy, the Upper Delaware Council, and the National Park Service.

The Eagle Institute

One of the cherished resources of the Upper Delaware River are the bald eagles, who draw large crowds of viewers. The Eagle Institute is a volunteer, non-profit organization dedicated to protecting the eagle and its habitat. The Institute is uniquely located near the largest wintering eagle habitat in the northeast, encompassing the Upper Delaware

Photo by David B. Soete©

Hancock, NY fishing access.

Photo by Sandra Schultz©

Erica Benoit zipping her life jacket before entering the river at Narrowsburg.

Providing Public Access

"Please Respect Private Property Rights." This message appears at every opportunity, both in publications and signage throughout the valley. National Park Service (NPS) staff must explain that the Upper Delaware Scenic and Recreational River is different from many other NPS sites. Of the 56,000 acres comprising the "cooperative" management area, NPS is limited by the River Management Plan to acquiring no more than 124 acres. After 30 years, NPS owns 30.6.

Yet, nearly 250,000 visitors come to National Park Service-managed facilities at the Upper Delaware Scenic and Recreational River each year, and river users at 16 public accesses are introduced to the experience of fishing or boating via agreements. It is impossible to enjoy the Upper Delaware River without experiencing Upper Delaware partnership success first-hand.

The New York State Department of Environmental Conservation or the Pennsylvania Fish and Boat Commission, both agencies with complimentary missions to the National Park Service, provide 14 accesses that allow visitors to use the river. The Town of Hancock, NY and the Boy Scouts of America at Ten Mile River, NY, provide the other critical two.

The National Park Service stepped in to fill the need for adequate amenities, law enforcement, education and information. Three-panel bulletin boards inform and educate, while National Park Service Interpretive rangers talk to visitors at accesses with higher visitation. Law Enforcement Rangers educate visitors about safe and appropriate river use. And in the background, our maintenance and administrative staff sees to our visitors' comfort and the river's cleanliness by providing trash pickup and toilet facilities, either directly or through separate agreements with the local municipalities.

Providing a seamless experience to our guests, together we are "Partnering to Protect the River," orchestrating the best the incomparable Upper Delaware has to offer.

For more, please see http://www.nps.gov/upde/planyourvisit/

River watershed in New York and Pennsylvania and the lower Hudson Valley of New York. The group fulfills its purpose through education, research and public awareness.

The Upper Delaware Scenic Byway

The Byway was established in 2002 to enhance the economic vitality and preserve the scenic values of the communities along New York State Route 97. The designation involved three counties and 8 municipalities. Signs identify the route that traverses the valley from Port Jervis in Orange County, NY, through six towns of Sullivan County to Hancock, NY, in Delaware County. Research and data collection along Route 97 indicates that significant historic, cultural, natural, recreational, scenic and archeological qualities exist within the byway corridor.

The Delaware River Sojourn

"This event, like no other, symbolizes the true life and charm of the river," says NPS Assistant Superintendent Sandra Schultz. Since 1995, the annual Sojourn takes people—from children to seniors—on an organized, seven-day canoe journey with camping in established campgrounds on the banks of the river.

"Being on the river changes your view of its importance," she said. "You fall in love with the river the more time you spend on it, in a boat and sleeping on its banks. It's so important that we bring decision-makers on the river to experience it, not intellectually, but emotionally and spiritually."

Zane Grey's West Society

Fulfilling their mission to "promote interest in and knowledge of the eminent American author, Zane Grey and his works..." the Zane Grey's West Society collaborates with the National Park Service at the Zane Grey Museum in Lackawaxen, PA. Contributions to the museum have, among other things, helped restore the "summer kitchen." Members volunteer during "Zane Grey Days" where visitors—children in particular—are introduced to the stories of the Old West through programs and hands-on projects. Other members contribute their extensive knowledge about the author and his life and prepare for new exhibits at the museum.

The Cochecton Preservation Society

The 1850s-era train station, originally located at the site of Cochecton Mills, is being restored by the Cochecton Preservation Society and will serve as a companion to the proposed Upper Delaware Scenic Byway Visitor Center on New York State Route 97. The visitor center will be owned and operated by Sullivan County in a similar fashion as they operate the Fort Delaware Museum of Colonial History in Narrowsburg. In addition to rest rooms and tourist literature, the visitor center will contain office space for the Byway organization and the Preservation Society.

The Upper DelAWARE River Roundtable

The Roundtable is a network initiative to foster communication and collaboration between regional partners and stakeholders in the Upper Delaware River Valley and provide tools and educational activities for governmental entities. An early accomplishment of this initiative, which began September 2007, was the creation and continual updating of a regional map of the river valley which shows existing development, proposed subdivisions over 20 units and preserved lands from the Delaware Water Gap, PA to the headwaters of the Upper Delaware in Delaware County, NY

Catskill Regional Invasive Species Partnership (CRISP)

A volunteer partnership of diverse stakeholders with an interest in invasive species management in the Catskill and Delaware region, CRISP promotes prevention, early detection and rapid response, and limited broader control of invasive species to protect natural resources. In addition to conducting public outreach and management activities, CRISP supports research about ecological impact and effective controls of invasive species.

These groups and many others will be celebrating the river's anniversaries at the Upper Delaware EXPO to be held on Saturday, October 25, 2008 at the Damascus School on Route 371 in Damascus, PA. Admission is free.

John Hart interpreting traditional woodworking used on the Roebling Bridge.

Contributed photos

Canal remnants can be observed along NYS Route 97 south of Minisink Ford.

The Upper Delaware River – Rich in History

The history of the Upper Delaware River is a saga of singular ventures, new inventions, disappointments and positive regeneration.

The singular events and new inventions were the building of the Delaware and Hudson Canal and Gravity Railroad, and the construction of the nation's first railroads, initiating a daring precedent for entrepreneurs across this nation to follow, building a nation that would become the economic and ideological model for the rest of the world. It all started here.

The disappointments came as the nation developed in new directions, away from dependence on rivers for transportation, on wood and forests, on tanneries, acid factories and blue stone, leaving the communities along the Delaware River to wither until the construction of the Greater New York and Erie Railway, transforming the area in later years into a tourist area, attracting people because of its unspoiled beauty.

The regeneration has come in recent years with the designation of the Upper Delaware Scenic and Recreational River, the arrival of the National Park Service, and the establishment of the Upper Delaware Council with a management plan for the future.

It is this history and regeneration that we are commemorating during this year when we celebrate not one, but three significant anniversaries: 40 years of the Wild and Scenic Rivers Act, 30 years of the Upper Delaware Scenic and Recreational River, and 20 years of incorporation of the Upper Delaware Council.

"It wasn't always beautiful in the area," said Mary Curtis, Town of Delaware historian and former NPS Historian. "If you could have seen the denuding of the wonderful pine forests that happened during the rafting period, the bodies of the hemlocks stripped of their bark and strewn all around, and the smell of the tanneries and the acid factories, you wouldn't want to live here."

Despite all this, the history of the Upper Delaware is rich.

The Lenape Tribes

The Native American Lenape, also known as "the Delaware," who inhabited the Delaware and Hudson River valleys in the 17th century when the European settlers arrived, were a loosely organized band of indigenous people sharing the same culture and language. They were hunters, fishers and farmers who stayed close to their lands. Their homes were sturdy structures of saplings and bark, and dugout canoes were their principle means of travel. They were largely a peaceful people.

At the time of the European settlement, their numbers are estimated to have been about 15,000. By the mid-1700s diseases such as measles and smallpox, for which the Lenape had no immunity, dwindled their numbers, and pressure by the Iroquois Confederacy and the more educated and venturous colonists forced the tribe to move away.

The early white settlers

"The roads in those early days were mud ways," Curtis said. "When the railroad came in, it created the towns along the river that we have now."

The first settlers came from Connecticut. "One of the British kings gave the Yankees claim to the land going west—overstepping New York and beginning again in Pennsylvania," Curtis said. "The main families had names like Skinner, Tyler, Calkins and Thomas. They set up a settlement they called Cushetunk, meaning place of the red rocks. The place was present day Cochecton."

Another group of settlers came from the south and settled in Tusten. "They were massacred by a group of marauding braves from the Susquehanna Valley and their settlement didn't last," she said.

The German immigrants of the 19th century brought much of the architecture of the valley; they expanded farming and the boarding house industry, the tourism of the 1800s.

Zane Grey

Born in Zanesville, Ohio, Zane Grey (1872-1939) came East to attend the Dental School at the University of Pennsylvania on a baseball scholarship. Following graduation, he played semi-pro baseball while he practiced dentistry.

Zane Grey began his writing career relating stories of his experiences fishing along the Upper Delaware River. On one of these outings in 1900 he met his future wife, Lina Elise "Dolly" Roth, who persuaded him to leave both baseball and dentistry to write full-time, which he did by fall of 1904, when he purchased property on the confluence of the Delaware and Lackawaxen Rivers where he lived and wrote until 1918. Zane and Dolly's three children were born during the Lackawaxen era.

Early in his marriage, Grey traveled to the American West. The harsh landscapes and determined people Grey encountered on these expeditions and in the many that followed would color his descriptions of people and landscapes for the rest of his life.

Grey's first successful novel, *The Heritage of the Desert,* was followed by his most noted work, *Riders of the Purple Sage*, which launched his stellar career writing the classical novel of the "Old West." Ultimately the prolific author's books would become the inspiration for over 100 classic black-and-white films of the "Old West."

Though he moved his family to California in 1918, the family retained the house in Lackawaxen, visiting when they were on the East Coast. The ashes of both Zane and Dolly Grey were interred in the cemetery near their home in Lackawaxen, fulfilling their wishes to rest together along the Delaware River where it all had begun for them.

The Delaware and Hudson Canal

This canal was the first in this nation built as a private venture. Constructed from 1825 to 1829 by immigrant Irish and German laborers, it gave the area a unique mix of ethnicities. The canal was used to transport anthracite coal from the mines of northeast Pennsylvania to Kingston, New

Contributed photo

Zane Grey

York, where it was then transported along the Hudson River to New York City, depending first on the Gravity Railroad that carried the coal from Carbondale over the Moosic Mountains to Honesdale where the railroad ended and the canal began. As part of the effort, what is considered the first steam locomotive engine, the Stourbridge Lion, began operating.

The Roebling Bridge – Delaware Aqueduct

As the canal wended its way toward the Hudson River, its operators realized the necessity of carrying the coal barges over the rapidly flowing Rivers, so they commissioned a German immigrant engineer, John Roebling, to construct four suspension aqueducts in 1845 (the other three aqueducts were abandoned and succumbed to the elements over the years). The aqueduct operated for 50 years until the canal was closed in 1898 and it was converted to a roadway bridge.

Although not the first suspension bridge built in America, the Roebling Bridge is now the oldest surviving suspension bridge in the country. It was purchased by the National Park Service in 1978 and restored over succeeding years.

The Railroad

The fast-paced Industrial Era brought with it the Steam Locomotive, an equally fast-moving transportation system. Supplies and materials of ever increasing quantities were needed throughout the world, and people were again broadening their horizons. The Upper Delaware valley was a crossroads for that new system. Many railroads crisscrossed the Catskills and Poconos. Each of the quaint hamlets along the river once hosted a railroad station. Among the cargo carried were travelers, most of whom escaped the cities to spend their summers on family farms here during the heyday of the railroad and the budding tourism industry. Only the Norfolk Southern and Central New York railroads still traverse the Upper Delaware today.

Tourism

Since the advent of the railroad, tourism has been a major industry in the Upper Delaware region. More recently, however, nearly 250,000 visitors come to experience the natural beauty of the Upper Delaware Scenic and Recreational River in particular, while thousands more tour the Upper Delaware Scenic Byway and the shops, trails and cultural stops throughout the valley. Ecotourism is a burgeoning industry. "Everything old is new again."

Places to go

Photo contributed by National Park Service

Zane Grey Museum

Photo contributed by National Park Service

D&H Canal

Photo by David B. Soete©

Tusten Mountain Trail

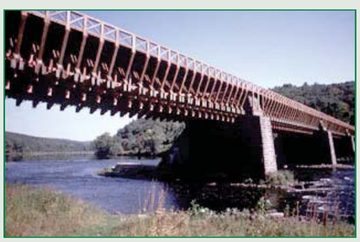


Photo contributed by National Park Service

Roebling Bridge

Photo by David B. Soete©

Upper Delaware Scenic Byway

Photo by David B. Soete©

Recreation on Upper Delaware

A Handy Guide to Safely Enjoying the Natural Resources of the Upper Delaware River Region

Contributed photo

National Park Service personnel demonstrate water safety for young boaters.

Enjoying the Delaware River

A river trip should be exciting, but it can also be a dangerous experience. To avoid problems or injuries, it is important to prepare carefully for a safe trip.

The Delaware River does not have particularly hazardous rapids. At average water levels, the Upper Delaware has only a few Class II or II+ rapids. However, moving water can be deceptive and potentially treacherous, even for non-paddlers. More drownings on the Delaware River have been swimming-related than boating-related. In almost all cases, the victims were not wearing a properly fitted life jacket.

Follow the steps and information listed here to learn how to safely and comfortably enjoy the river.

Be Prepared

- Wear a life jacket and river shoes.
- Bring a spare paddle, a throw line and a first aid kit.
- Bring adequate drinking water.
- Protect yourself from heat-related illnesses.
- Heat cramps are the warning sign that the body is having trouble with the heat.
- Resting and drinking water will help prevent more serious illnesses like heat exhaustion or heat stroke. Do not drink river or stream water.

Be Aware of River Conditions

Call the Upper Delaware River Hotline at 845/252-7100. This recorded message is available 24 hours a day and is updated daily during the boating season. It provides the river height, air and water temperatures, boating conditions and general river safety information. Be aware of upstream releases and sudden changes in water depth and speed. River information is also available at www.nps.gov/upde.

Be Ready for Changing Weather and Cold Water

Bring raingear. To protect against hypothermia, have clothing made of wool, polypropylene, high-performance fleece or a wet suit. Immersion hypothermia is the numbing effect that cold water has on the body. Hypothermia is possible whenever the water temperature falls below 70° F. Loss of body heat is 25 times greater in cold water than in air of the same temperature.

Always Tell Someone Where You Are Going And When You Expect to Return

Arrange drop-off and pick-up points before you leave. Leave emergency phone numbers and vehicle description and tag numbers with someone who can report that you are overdue.

Avoid Mind-Altering Substances

Avoid alcohol and other drugs while on the river. Alcohol makes you more susceptible to heat-related illness. In an emergency, it slows your response. Never impair your judgment while on the river.

Laws on underage drinking, possession of illegal drugs, disorderly conduct and littering are strictly enforced.

Guard against sunburn

It's easy to get burned before you realize it on a cool, refreshing river. Knees, backs of hands, neck and tops of feet are most susceptible to burns. Be sure to apply waterproof sunscreen or keep your skin covered. Wear UV-protecting eye wear. Eyes can be sunburned too!

YOUR SAFETY IS YOUR RESPONSIBILITY

Always Wear Your Life Jacket

It's smart to wear a life jacket—while boating, tubing, fishing, wading or swimming on the river. By law, all children 12 and under must wear a life jacket while on the river in any vessel, including inner tubes. Every person in a boat or using an inner tube must have a life jacket within reach.

Use Proper Boating Techniques

- Kneel when canoeing in rapids to keep your weight low. This helps avoid capsizing. In rapids, aim for the downstream "V."
- When boating with a partner, paddle on opposite sides of the canoe. Hold on to your paddle, not the boat.
- Paddle around eel weirs. Avoid these large, V-shaped wooden and rock traps, usually constructed by late summer.
- Always be courteous on the river. You may encounter a variety of river users on your trip. Please respect their rights and act responsibly and ethically.

If You Capsize...

Don't panic. Stay upstream of the boat so it does not pin you against a rock.

Don't attempt to stand in rapids. Get on your back and keep your feet up and pointed downstream to push off obstacles.

Never swim against the current. Backstroke and let the current assist you to shore.

Don't Become a Statistic

Since 1980, when the National Park Service

Photo by David B. Soete©

Proper use of life jackets saves lives on the Delaware.

Photo by David B. Soete©

This mature buck is one of the magnificent animals sharing space in the forests and fields of the Upper Delaware River valley.

began river operations here, 56 drownings have been recorded on the Upper Delaware Scenic and Recreational River. Fifty-three were male. The average age is just 28. At least 20 percent of the deaths were drug- or alcohol-related fatalities.

- Over 65 percent of the drownings occurred while victims were swimming or wading. The number wearing a life jacket? Zero!
- The Upper Delaware includes swift currents, rapids, eddies, sudden dropoffs, slippery rocks and floating or submerged debris.
- There are no designated or life-guarded swimming areas on the Upper Delaware River.
- Wear a life jacket and appropriate footwear while swimming, wading or floating.
- Never try to stand in rapids. Your foot could get trapped between submerged rocks. The current could push you over and hold you under even if you are wearing a life jacket.
- Do not jump or dive from cliffs, rocks or bridges into the river; the water may be shallow and objects may be submerged.
- Never attempt to swim across the river.

Protect the River and Others around You

- Obey all regulations and respect all resources.
- Observe fishing limits and seasons.
- Display your fishing license properly; fishing regulations are enforced.
- Do not fish from any bridge.
- Respect private property. More than 85 percent of the land along the river is privately owned.
- Do not remove or deface cultural artifacts or natural features.
- Don't litter. Be sure to tie all gear—except life jackets—to your boat. Carry in, carry out. No glass containers on or near the river.
- If you have questions or need assistance look for National Park Service rangers or volunteers, who are there to help.

Angling Etiquette

- Keep only the fish you plan to use.
- Handle fish carefully to avoid injury.
- Follow fishing regulations.
- Observe safe angling and safe boating.
- Never stock fish or plants in public waters.
- Do not disturb nesting birds.
- Remove all mud and drain all water from boats before departing access site.
- Do not release live bait into the water.
- Dispose of water from bait bucket on land.
- Do not transport fish or aquatic plants from one body of water to another.
- Do not dispose of fish carcasses or by-products in the water.
- Properly dispose of used fishing line.
- Leave the area as clean as (or cleaner!) as you found it.

Eagle Etiquette

American bald eagles are not very tolerant of human activity and may be easily disturbed. Human presence can stress the birds and affect their overall health, feeding, roosting and nesting. Eagle watchers are asked to cooperate by not attempting to approach any eagle and by following the preferred eagle etiquette:

- Use binoculars instead of trying to get a little closer."
- Don't try to make a bird fly, as it will waste precious energy it needs to survive.
- Persons on foot are the mostdisturbing to bald eagles.
- It is illegal under federal and state laws to kill, trap, injure, take, annoy, harass, worry, or pursue (approach) a bald eagle.

For the least intrusive and most successful eagle viewing, please:

- Remain in your vehicle.
- Remain quiet. No loud music, yelling, door slamming, etc.
- Respect private property and restricted areas.
- Get out early in the day, between sun-up and 11:00 a.m., when eagles are most active.

Outdoor Etiquette

Practice the following Leave No Trace principles:

- Be prepared. Select gear and make plans by thinking about how it will impact the environment.
- Keep to existing roads, trails and footpaths.
- Carry in and carry out all your belongings, including trash.
- Leave what you find. Don't disturb natural features such as rocks and plants, nor alter campsites by digging,chopping or hammering.
- Minimize use of fire with lightweight camp stoves.
- Practice "Negative Trace." Clean up trash left behind by others.

Wildlife Viewing Etiquette

Opportunity abounds for observing wildlife throughout the region. Outdoor enthusiasts may encounter black bears, white-tailed deer, eagles, wild turkeys, porcupines, coyotes and much more. Care should be taken to avoid disturbing any wild creature. The following measures should be practiced:

- Approach wildlife slowly and maintain an appropriate distance.
- Use binoculars and telephoto lenses to get a closer view.
- Turn off headlights, car engines and alarms and cell phones.
- Don't chase wildlife whether on foot or in a motorized vehicle.
- Don't touch, swim with or feed wild animals.
- Talk quietly; don't make loud noises or imitate animal sounds.
- Sit still and move slowly. Sudden moves can alarm wildlife.
- Do not move or remove any creature from its habitat.
- One of the best ways you can assist wildlife is by protecting its habitat.

Emergency Contact Numbers for the Upper Delaware:

911
National Park Service: 845/557-0222

New York State Police:
Delaware County: 607/467-3215
Sullivan County: 845/292-6600
Orange County: 845/856-6500

Pennsylvania State Police
Honesdale: 570/253-7126
Blooming Grove: 570/226-5718

Cell phones may not work along the river.

Upper Delaware EXPO

Celebrate the 30th Anniversary of the Upper Delaware Scenic and Recreational River

Join the National Park Service and Our Partners in Celebrating 30 Years of "Partnering To Protect The River"

Upper Delaware EXPO
Damascus Elementary School, Route 371 & High School Road, Damascus, PA
Saturday, October 25, 2008
10 am to 4 pm

Opening Ceremony at 10:30 am
Winners of the 9th-12th Grade Art Contest will be Announced

Educational Programs Include:

Birds of Prey by the Delaware Valley Raptor Center at 11 am & 1 pm

Resource Management through the Years at 12:30 pm

Reptiles and Amphibians by the Pennsylvania Fish & Boat Commission at 2 pm

K-9 Search and Rescue Unit by New York State Environmental Conservation will have a demonstration at 3 pm

Outside, throughout the day, river safety and rescue demonstrations will take place

A photographic and art exhibition by well-known photographer Dave Soete & award-winning students will be on display

Exhibits by Upper Delaware partners will highlight their collaborative contributions to the "partnering to protect the river" philosophy

Boy Scout Troop #122 will have food available for sale throughout the day

PROUD MEDIA SPONSORS PARTNERING TO PROTECT THE RIVER

THE RIVER REPORTER

THUNDER 102 The New Home of Country

Stuart Communications Creative Services FULL-SERVICE MARKETING SOLUTIONS

PIKE COUNTY DISPATCH

To learn more about the Upper Delaware EXPO, visit the park's web page at www.nps.gov/upde or call Education Specialist Ingrid Peterec at 570/685-4871

EXHIBIT C

Final River Management Plan

UPPER DELAWARE
SCENIC AND RECREATIONAL RIVER

New York and Pennsylvania

Prepare by the Conference of Upper Delaware Townships
in cooperation with the National Park Service

November 1986

Final River Management Plan

UPPER DELAWARE
SCENIC AND RECREATIONAL RIVER

New York and Pennsylvania

Prepared by the

Conference of Upper Delaware Townships

In Cooperation with the

**Commonwealth of Pennsylvania;
State of New York;
Delaware River Basin Commission;
National Park Service;
and the
Upper Delaware Citizens Advisory Council**

November, 1986

Water Quality

High water quality, the presence of cold water releases and its free-flowing character all give the Upper Delaware some of the most important fisheries habitat in the Northeast. The Upper Delaware's consistently high water quality provides habitat to diverse and well-balanced biological communities. The upper segment of the river is also unique among large rivers in the East due to its relatively cold temperatures. Since 1967, when large volumes of cold water were first released from the Cannonsville Reservoir, the New York State Department of Environmental Conservation reclassified approximately 27 miles of river between Hancock and Callicoon as a coldwater fishery. This stretch supports an abundant population of rainbow trout and brown trout, offering some of the finest trout fishing in the Northeast. The 50 miles of warmwater fishery between Callicoon and Port Jervis offers habitat to many species including sunfish, eel, bass, and walleye.

Certain tributaries to the river are vitally important fishery areas. These tributaries, although not specifically recognized in the Upper Delaware legislation or included within the proposed river boundary area, are biologically important to the fishery values of the main stream of the river. Specifically, many of these streams, which have been legislatively or administratively recognized by the State of New York or the Commonwealth of Pennsylvania, provide spawning habitat for trout and other species.

New York Tributaries

A number of tributary streams of the Upper Delaware River have been determined by New York's Department of Environmental Conservation to be fishery areas which have a direct relationship to the values of the designated river area. All New York tributaries that are currently classified C(t) or higher, or are so reclassified in the future, are recognized as having this direct relationship. The major tributaries now in this category are:

1. Basket Creek - upstream to the confluence of the East and North Branches

2. Hankins Creek - upstream to the impassable barrier at Mileses

3. Callicoon Creek - upstream to the confluence of the East and North Branches

4. Mongaup River - upstream to the impassable barrier at the Rio Dam

Pennsylvania Tributaries

All tributaries on the Pennsylvania side of the river have been designated as "exceptional value," "high quality," or "coldwater fishery" by the Commonwealth of Pennsylvania under the state Clean Streams Law. This designation, designed to improve water quality and habitat, permits no degradation of exceptional value streams. It also permits no degradation of high quality, coldwater fishery streams, unless overriding social and economic justification/benefits exist.

Wildlife

The Upper Delaware River corridor contains diverse habitats that support abundant wildlife populations. In addition to the dense forest cover (from 50% to 75% of the corridor), farming practices have introduced new pioneer plant species and have provided pasture grasses and crops that enhance the wildlife food supply. Of the fifty species of mammals observed in the corridor, the white-tailed deer is a principal wildlife resource. The valley provides habitat for the river otter, once abundant throughout Pennsylvania. About 70% of the state's remaining otter population is now though: to reside in the basin. Wildlife biologists believe that Pike County, Pennsylvania, has one of the highest Eastern Black Bear populations in the state. Other animals of note in the corridor include bobcats, coyotes, and wild turkey.

As part of the Atlantic Flyway, the corridor hosts large numbers of waterfowl and waterbirds in the wooded riverside habitats. Approximately 200 species of birds have been identified within the corridor, including the federally endangered bald eagle, which winters in the Delaware watershed. According to wildlife biologists, the highest concentration of eagle wintering areas in New York is found in this watershed.

Threatened and Endangered Species

The Upper Delaware River corridor is habitat to several threatened and endangered species, including the bald eagle which winters in the area. The Pennsylvania office of The Nature Conservancy has identified several rare plant species along the Pennsylvania side of the river. These species are considered potential candidates for state designation, a register that will be officially released in 1986. The plants proposed for designation as rare are the sand cherry *(Prunus pumila),* the thread rush *(Juncusfiliformus),* and the roseroot stonecrop *(Seedum rosea).* The roseroot stonecrop has only been observed on one additional site in the state. The plant proposed for designation as an endangered species is the miner's lettuce *(Montia chamissio).* The river corridor is the only location in the state of Pennsylvania where this plant has been observed.

The New York Natural Heritage Program is conducting a two year study of rare plants and exemplary natural communities within the proposed river corridor boundaries on the New York side of the Upper Delaware River. The final report for this study will be available in February 1987. Preliminary findings indicate the presence of four species considered rare in New York: Great Saint John's wort *(Hypericum pyramidatum),* prostrate sand cherry *(Prunus pumila* var. *depressa),* river birch *(Betula nigra),* and sand plain gerardia *(Agalinis setacea).* The study will identify human use impacts within the proposed river corridor boundaries.

Recreational Resources

Hunting and Trapping

The Upper Delaware Valley offers some of the best hunting and trapping opportunities in Pennsylvania and New York. Wildlife biologists recognize the river valley as an excellent hunting area because its combination of diverse habitats produces abundant wildlife populations. Large tracts owned by hunting clubs contribute to this healthy population. New York's Delaware County had the second highest deer harvest in the state in 1983, and the highest turkey harvest in the spring of 1984. Hunting and trapping also substantially contribute to the economy of the area.

Fishing

The Upper Delaware is recognized by sportsmen and fisheries biologists as one of the finest fishing rivers in the northeastern United States. The Upper Delaware offers opportunities for both cold and warmwater fishing and provides a high quality fishing experience in close proximity to major metropolitan areas. According to the 1976 New York Angler Survey, the Upper Delaware is one of the five most heavily fished river areas in the state. In 1982, it was estimated that there were nearly 60,000 angler days for the river area between Hancock and Port Jervis. (Sheppard, 1983) Since 1978, the estimated fishing days in the 27 mile reach between Hancock and Calicoon have increased by ninety percent, while the 36 mile reach between Narrowsburg and Port Jervis has experienced an increase of 205 percent. The annual economic value of recreational fishing to the Upper Delaware area has been estimated at nearly 5,000,000. (Sheppard. 1983).

Fisheries biologists from Pennsylvania and New York recognize the upper segment of the river as one of the foremost trophy trout streams in the Northeast. Depending on the time of year and volume of cold water releases from tributary reservoirs, this significant trout fishery ranges between the hamlets of Hancock and Callicoon. Trout and other fish have been subjected periodically to extreme changes in flows and water temperature due to sudden changes in the release schedules of the upstream reservoirs. American eels are found throughout the corridor, sustaining one of the finest commercial eel fisheries in the world during the fall, when mature eels return to the sea to spawn.

The Upper Delaware also provides key spawning and nursery habitat for the American shad along its entire length. The Delaware is the only natural shad river in the Northeast (from Maine to West Virginia) that is sufficiently free of man-made barriers and industrial pollution to allow passage of these migratory fish to their upper reach spawning habitats. Up to 500,000 shad migrate to the upper reaches annually. This number is expected to increase substantially upon completion of several new sewage treatment plants in the Philadelphia area. The most important spawning occurs above the Delaware Water Gap, with nursery areas at or downstream of spawning grounds due to the downstream dispersal of young shad. The most important nursery areas are located from Belvedere to Hancock and up into the East Branch, and centered near Tusten and Lordville. The shad spawning period runs from mid-April through June. From Port Jervis up into the East Branch the peak of the spawning period usually occurs in June due to the slower warming waters.

Canoeing and Rafting

The Upper Delaware is one of the most outstanding canoeing rivers in the Northeast. The designated river section is canoeable throughout its entire length and boasts a total elevation differential of 460 feet, better than six feet per mile, although it is much steeper in some reaches. Boating experts have stated that the combination of proximity to major metropolitan areas, high visual quality, and consistent flows due to upstream dam releases make the Upper Delaware one of the finest recreational canoeing rivers in the Northeast. The number of rafting trips on the river has been increasing in recent years.

Data on river use throughout the United States is incomplete, but many boating experts agree that the Upper Delaware receives more recreational canoeing use than any other river in the Northeast, and that it is certainly one of the most popular canoeing rivers in the country. The New York State Department of Environmental Conservation estimated that for the period from 1978 to 1982, the annual number of boating trips on the Upper Delaware ranged between a low of 20,500 trips in 1979, and a high of over 59,000 trips in 1980. In 1982, the economic value of recreational boating activities on the river was estimated to be $12.7 million.

Cultural, Historical and Archeological Resources

The Upper Delaware Valley is rich in structures and sites that reflect its history and cultural development, although the full potential of many of these structures has yet to be explored. Prehistoric archeological sites, historic architecture, and historic engineering and industrial sites are all abundant in the valley.

The Roebling Bridge, formerly an aqueduct that was part of the Delaware and Hudson Canal, was designated a component of the Delaware and Hudson Canal National Historic Landmark in 1968, the highest designation of national significance that a structure can receive. Designed by John Roebling, creator of the Brooklyn Bridge, the aqueduct is his earliest surviving suspension bridge and may be the oldest cable suspension bridge in the world that survives intact. The aqueduct was also designated by the American Society of Civil Engineers as a national historic civil engineering landmark in 1973.

Much of the Delaware and Hudson Canal corridor is lined with the remains of structures related to canal operations--bridges, locks, aqueducts, dams and related buildings, which provide a record of the complex infrastructure of nineteenth century canal transport. Several canal segments outside the river corridor have been listed on the National Register of Historic Places, and two segments within the corridor, between Sparrow Bush and Mongaup and between Pond Eddy and Barryville, are also considered eligible for nomination.

Three historic buildings in the river corridor, the Arlington Hotel and the Kirk House in Narrowsburg, and the Zane Grey House in Lackawaxen, were recently listed on the National Register of Historic Places. The Zane Grey House is a large "eclectic style" home occupied by the popular author of Western novels between 1905 and 1918. It now contains a private museum and is leased in part for office space by the National Park Service. The Arlington Hotel, built in 1894, is the focal point of Narrowsburg's commercial district and is considered significant for its association with the early economic and social history of the river valley. It is currently being restored by its present owners, the Delaware Valley Arts Alliance.

The Kirk House is a small "high style" Greek Revival house originally built around 1840, and "modernized" with a stucco exterior around 1920. This exterior is considered an exceptional example of vernacular architectural design in stucco.

EXHIBIT D

Final Environmental Impact Statement

UPPER DELAWARE SCENIC AND RECREATIONAL RIVER

New York and Pennsylvania

FES 87-13
RELEASED
March 26, 1987

Prepared by National Park Service, Mid-Atlantic Regional Office, Division of Park and Resource Planning; in consultation with the State of New York, Commonwealth of Pennsylvania, Conference of Upper Delaware Townships, Delaware River Basin Commission, Citizens Advisory Council, and other public and private interests.

CHAPTER I - PURPOSE AND NEED

A. Purpose

The Upper Delaware legislation (P.L. 95-625) Section 704 requires that the Secretary of the Interior in cooperation with the Delaware River Basin Commission, the Citizen's Advisory Council, the Commonwealth of Pennsylvania, the State of New York and their concerned political subdivisions develop and approve a river management plan. The purpose of the proposed Upper Delaware River Management Plan is to set forth how the resources of the Upper Delaware River corridor will be managed, through cooperative federal, state, local and private efforts, and to provide as broad a range of land and water uses as is compatible with conserving outstanding resource values. If approved, this plan will guide the future actions of the National Park Service (NPS) and other agencies and units of government in the management of the river and adjacent land resources for the next 20 years.

B. Need

The Upper Delaware River is one of only four river segments in the Northeastern U.S. to have been designated as a component of the National Wild and Scenic Rivers System. To receive such recognition, a river and its surrounding environment must be free-flowing and relatively undeveloped, and must possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic and cultural resources, or other similar values. Designated rivers, by law, are to be preserved in free-flowing condition and protected for the benefit and enjoyment of present and future generations. The Delaware River is the only major river in the Northeastern United States that remains undammed along its main stem, although its flow is controlled, in part, by several tributary dams.

The high water quality of the Upper Delaware, in part attributable to the rural, sparsely settled nature of the region, is also an important resource, which has prompted the Pennsylvania Department of Environmental Resources to designate the watershed as a special protection area.

The landscape of the Upper Delaware area is a visually diverse one, characterized by the contrast of farmland and villages on the valley floors with the forested hills that surround the valley. The Delaware River Gorge, which extends north from Matamoras, Pennsylvania, for much of the corridor's length, has been identified by the Pennsylvania Geological Survey as an outstanding scenic geologic feature.

The Upper Delaware provides some of the most important fish habitat in the Northeast, because of its free-flowing nature, high water quality, and cold water releases (from reservoirs on tributaries). The northern segment of the river, between Hancock and Callicoon, is unique due to its cold water temperatures, and offers some of the finest trout fishing in the Northeast. The Upper Delaware is currently one of only two natural shad rivers (the Hudson River is the other) from Maine to West Virginia that is sufficiently free of man-made barriers and industrial pollution to allow passage of shad to their upper reach spawning habitats.

Recreational opportunities are abundant in the Upper Delaware area. The river is one of the most outstanding canoeing rivers in the Northeast, combining consistent water flows, high scenic quality, and proximity to metropolitan areas. Because of its combination of diverse habitats, the area also offers excellent recreational fishing and hunting opportunities. Many also visit the area for sightseeing, swimming, and other activities.

This rural area is readily accessible to approximately 31,750,000 people who live within a 150-mile radius of the river. These outstanding resource values, and the steadily increasing recreational use of the river, are among the reasons the U.S. Congress designated 73.4 miles of the Upper Delaware River as part of the National Wild and Scenic Rivers System through the National Parks and Recreation Act of 1978 (P.L. 95-625). The Upper Delaware legislation requires that the river management plan shall set forth:

(A) a map showing detailed final landward boundaries, the upper and lower termini of the corridor, and the specific segments of the river classified as scenic and recreational, to be administered in accordance with such classifications;

(B) a program for the management of existing and future land and water use, including the application of available management techniques;

(C) an analysis of the economic and environmental costs and benefits of implementing the management plan, including any impact of the plan upon the revenues and costs of local government;

(D) a program providing for coordinated implementation and administration of the plan with proposed assignment of responsibilities to the appropriate governmental unit at the Federal, regional, State and local levels; and

(E) such other recommendations or provisions as shall be deemed appropriate to carry out the purposes of Section 704(c)(2) of the Act.

C. Legislative and Planning History

The Upper Delaware River was one of the original twenty-seven rivers designated for study upon passage of the Wild and Scenic Rivers Act by Congress in 1968 (P.L. 90-542, 16 U.S.C. 1271). A federal study team led by the Bureau of Outdoor Recreation (BOR) began its evaluations in 1969, and a draft river qualification study and draft environmental impact statement was released in February 1974. Concern over the level of federal land acquisition arose during this time, which resulted in a substantial redefinition of the study's recommendations concerning the boundary, land acquisition, and local involvement in the river's management. Further drafts were produced in October 1974, before a river study and a final environmental impact statement were released in July 1976. The final study and statement attempted to resolve these concerns by recommending a wider

EXHIBIT E

NEW YORK STATE
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION

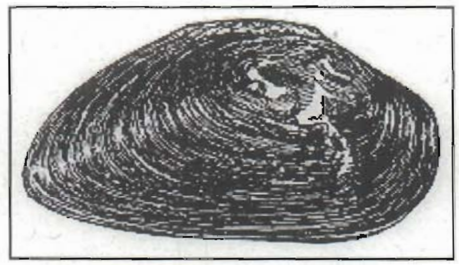
Dwarf Wedge Mussel Fact Sheet

Dwarf Wedge Mussel
Alasmidonta heterodon

New York Status: **Endangered**
Federal Status: Endangered

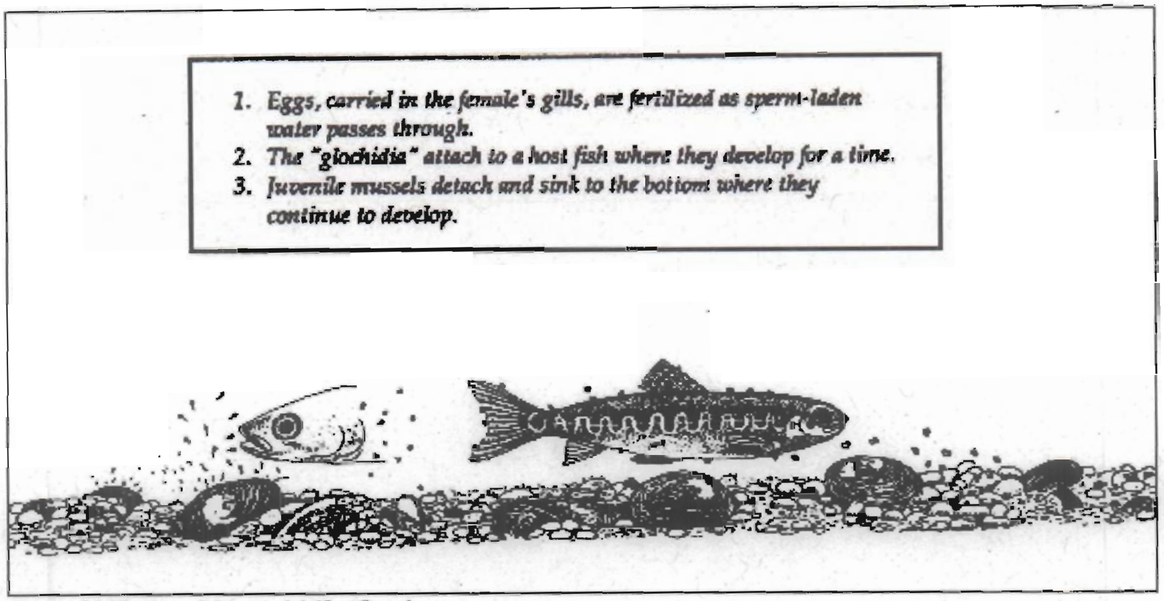
Description

The dwarf wedge mussel is a small freshwater mussel that rarely exceeds 1.5 inches (38 mm) in length. It is brown or yellowish-brown in color. Adult mussels are filter-feeders, feeding on algae and other small suspended particles. They spend most of their time buried almost completely in the bottom of streams and rivers.



Life History

The dwarf wedge mussel is sexually dimorphic, with separate sexes, unlike some mussels which are hermaphroditic, with individuals having both male and female reproductive organs. Even so, the dimorphism is very subtle; routine determination of sex in dwarf wedge mussels is at best difficult. Male dwarf wedge mussels release sperm into the water column during the mid-summer or fall. Females collect the sperm while siphoning water for food; the eggs are then fertilized and kept within the female until they are released the following spring. By then, each egg has developed into a parasitic larvae called a glochidium. After release from the female, the glochidium attaches itself to a fish with the aid of a small hook-like appendage. Mussel glochidia are generally species-specific and will only live if they find the correct host. With dwarf wedge mussels, the right hosts are small bottom-dwelling fish, the tessellated darter (*Etheostoma olmstedi*) and the mottled sculpin (*Cottus bairdi*). It appears that the glochidium receives little nutrition from the fish, but uses it only as a means of dispersal. After several weeks, the glochidium detaches itself from the unharmed fish and drops to the river bottom. It is then a juvenile mussel.



Dwarf Wedge Mussel Life Cycle

Many mussels have lifespans that range upwards of 20, 30 or even 100 years. The dwarf wedge mussel is considerably different in this regard, though, as it appears to only live about 10 years. Adults must therefore be constantly replaced to maintain a viable population.

Distribution and Habitat

The dwarf wedge mussel is found at 17 sites in seven Atlantic Coast drainages. These are located in New Hampshire, Vermont, Connecticut, New York, Maryland, Virginia and North Carolina.

Typical habitat for this mussel includes running waters of all sizes, from small brooks to large rivers. Bottom substrates include silt, sand and gravel, which may be distributed in relatively small patches behind larger cobbles and boulders. The river velocity is usually slow to moderate. Dwarf wedge mussels appear to select or are at least tolerant of relatively low levels of calcium in the water.

Status

This mussel was once found at 70 locations in 15 major Atlantic Coast drainages. Its numbers have declined drastically; most populations that remain number in the 100's. The two exceptions are the lower Neversink River in Orange County, where there appears to be at least ten thousand if not tens of thousands of dwarf wedge mussels, and the Tar River in North Carolina.

Water pollution, including sediments and chemicals from agriculture and other development projects such as golf courses, have been implicated in the mussel's decline. Also, impoundments and channelization may have eliminated the mussel from former habitat.

Management and Research Needs

Studies by the Institute of Ecosystem Studies at Millbrook, New York and the Nature Conservancy are presently underway to better understand the habitat requirements of the dwarf wedge mussel. It is still largely unknown what determines the location of mussel beds on the river bottom. More detailed population surveys in the Neversink River will be done to determine the age structure, distribution and size of the New York population. Research will focus on potential threats to the mussels such as the effects of dams and agricultural practices.

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EXHIBIT F

Dwarf Wedgemussel

Alasmidonta heterodon

Photo credits: *Kathryn J. Schneider*

Scientific Name *Alasmidonta heterodon* (I. Lea, 1830)

Family Name Unionidae
Unionid Mussels

Did you know?
The Neversink River population, estimated at 20,000 individuals is one of the largest known populations in the U.S. (Strayer and Jirka, 1997).

Summary

Protection Endangered Species in New York State, listed as Endangered federally.

This level of state protection means: any species which meet one of the following criteria: 1) Any native species in imminent danger of extirpation or extinction in New York. 2) Any species listed as endangered by the United States Department of the Interior.

This level of federal protection means: this species is formally listed as endangered.

Rarity G1G2, S1

A global rarity rank of G1G2 means: Critically Imperiled or Imperiled globally - At very high or high risk of extinction due to rarity or other factors; typically 20 or fewer populations or locations in the world, very few individuals, very restricted range, few remaining acres (or miles of stream), and/or steep declines. More information is needed to assign a single conservation status.
A state rarity rank of S1 means: Typically 5 or fewer occurrences, very few remaining individuals, acres, or miles of stream, or some factor of its biology makes it especially vulnerable in New York State.

Conservation Status in New York

The extent of this species in New York is limited to a small area within the Delaware River watershed. The Neversink River population, a tributary of the Delaware, dropped by an estimated 60,000 individuals between 1990 to 1994 and continues to be vulnerable to a myraid of stressors that affect aquatic systems, including non-point pollution and existing impoundments (Strayer et al. 1996).

Short-term Trends

The Neversink River population has apparently declined by 75% since it was first located in 1990 when it dropped from an estimated 80,000 individuals to 50,000 in 1991, then to 20,000 in 1994 (Strayer et al., 1996). It is not known if the population still numbers in the tens of thousands since the last survey over a decade ago. Since these population estimates are based on the direct capture of only a small number of individuals and standardized monitoring methods have only recently been adopted for Unionids (Strayer and Smith 2003) the estimates may not be accurate, nor directly comparable. The short-term trend for the Delaware River (meta)population is not known at this time because the sites have not been monitored since they were first located by U.S. Geological Survey researchers in 2000 (Lellis, 2001).

Long-term Trends

All 13 major populations studied rangewide, including the Neversink River in New York, had low densities, similar to earlier 20th century observations. About 100 years ago the species was known from about 70 Atlantic seaboard river systems, but now from only 25-30 (USFWS, 1993). Similar declines in the distribution of dwarf wedgemussels have undoubtedly occurred in New York. However, since the Recovery Plan was published in 1993, increased survey effort has led to the discovery of 40 new locations where the species had been presumed extirpated, or in rivers where it had never been found (Nedeau 2005). Of the 70- 80 known locales in 2004 only 16 were believed to support reprodcuing populations, while 31 were based on observations of of five or fewer individuals, or solely on spent shells.

Conservation and Management

Threats

Water pollution and impoundments are the primary threats. This species requires a low silt environment with a slow to moderate current, a situation that dams alter both upstream and downstream of the impoundment. A wide array of industrial, agricultural and domestic pollutants have been responsible for the dwarf wedgemussel's disappearance from much of its historical range and continues to be a problem in most aquatic systems (USFWS 1993). The darter and sculpin glocidial host fish species are generally pollutant sensitive taxa and a healthy fish assemblage is critical to viable mussel populations (Pinkney et al. 1997). The low densities (< 0.5 per square meter) in which this species occurs is problematical since successful reproduction is density dependent. Females need to be in close proximity to a sperm- releasing male to be successfully fertilized (Strayer et al. 1996). Competition with exotic bivalves, both the Asian clam (Corbicula fluminea) and zebra mussel (Dreissena polymorpha) could pose a threat because they are expected to eventually invade all of New York's watersheds, although neither has yet invaded the upper Delaware system (Strayer and Ralley 1991). The majority of 45 individuals collected from the Neversink population were 4 and 5 year old specimens, and none were older than 8 years (Michaelson and Neves 1995). This indicates recent successful reproduction. However, since this species can live at least 20 years, and perhaps much longer, the lack of older individuals in the popualtion could indicate high rates of mortality of older animals, possibly from pollution. Ageing Unionids by counting growth rings has recently been shown to vastly underestimate the true age of individuals, so the ages cited above may be too low by up to an order of magnitude (Strayer 2004).

Conservation Strategies and Management Practices

When feasible, the removal of impoundments in order to restore rivers to their natural flow would be benefical. The Nature Conservancy negotiated with the Army Corps of Engineers for the removal of the Cuddebackville Dam in the summer of 2003 in order to restore natural flow patterns to the lower Neversink and is working to reduce alterations to the natural flow caused by the upstream Neversink Reservoir Dam. The outcome of this management strategy on the mussel populations has not been evaluated. The U.S. Fish and Wildlife Service has suggested that reintroductions may need to be undertaken to bring low- density populations back up to viable levels and re-establish populations extirpated from certain rivers (USFWS 1993).

Research Needs

There is still much to learn about this species, including confirmation of host fish(es) in the Delaware and the Neversink rivers, diet, age and growth, and mortality factors. Details about habitat requirements (current speed, water depth, substrate grain size, substrate stability, water temperature, and water quality factors) also need work. However, Strayer and Ralley (1993) found that the distribution of this species was not related to these typical physical habitat qualities, but instead to long term stability of the substrate (i.e., flow refuges). Both large and smaller scale forces promoting the patchy occurrence of Unionid mussel beds is an active area of research (Strayer 2004).

Habitat

In New York, dwarf wedgemussels live embedded in the fine sediment that has accumulated between cobbles in slow to moderate current and relatively shallow water (40 cm) in small cool water rivers and similar habitat in larger rivers (Strayer and Jirka 1997).

Associated Ecological Communities

Confined River
The aquatic community of relatively large, fast flowing sections of streams with a moderate to gentle gradient.

Associated Species

Triangle Floater (*Alasmidonta undulata*)
Brook Floater (*Alasmidonta varicosa*)
Alewife Floater (*Anodonta implicata*)
Eastern Elliptio (*Elliptio complanata*)

Identification Comments

Alasmidonta heterodon is a small freshwater mussel, usually less than 55 mm long. Its shell is subrhomboidal to suntriangular, with a prominent posterior ridge. The beak sculpture consists of two concentric ridges surrounded by two to three trapezoidal ridges along the posterior slope. The periostracum is greenish to brownish, usually with many fine green color rays. Pseudocardinal and lateral teeth are both present and the nacre is white (Strayer and Jirka 1997).

Identifying Characteristics

The small size, roundly pointed posterio-basal margin, and reversed lateral hinge teeth readily distinguish this species (Strayer and Jirka 1997).

Best Life Stage for Identifying This Species

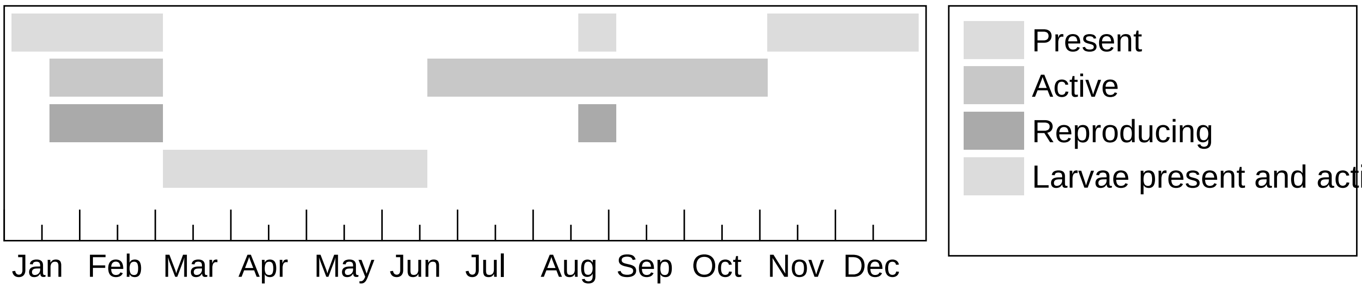
Adults

Behavior

Adults of this species are sessile with only limited movement in the substrate. Passive downstream movement may occur when they are displaced from the substrate during floods. More major dispersal occurs while glochidia are encysted on their darter and sculpin hosts, although McLain and Ross (2005) showed that tesselated darters move very little which promotes a patchy distribution of mussel beds. Being ectothermic, activity levels are reduced greatly during colder months of the year. This is a long- term brooder that spawns in late summer, becomes gravid in the fall and the larvae become active the following spring (Michaelson and Neves, 1995).

The Best Time to See

Little is known about the activity periods of Unionid mussels but they are presumed to be greatly reduced during cold times of the year. Freshwater mussels are most often easiest to locate during late summer when water levels are lowest. This species is a long-term breeder (winter- early spring) (Clarke 1981) and larvae (glochidia) are released into the water from early March to June (Wicklow 2004).



The time of year you would expect to find Dwarf Wedgemussel in New York.

Similar Species

Brook Floater(Alasmidonta varicosa): Alasmidonta heterodon can be distinguished from A. varicosa by its reversed lateral teeth. Two occur in the right valve and one in the left, opposite of what is normally found in other unionoids.

Taxonomy

Kingdom Animalia

└─ **Phylum** Mollusks (Mollusca)

└─

Class Bivalves (Bivalvia)
└ **Order** Freshwater Mussels (Unionoida)
  └ **Family** Unionidae (Unionid Mussels)

Additional Resources

Links

Unio Gallery
http://unionid.missouristate.edu/
The Ohio State Division of Molluscs
http://www.biosci.ohio-state.edu/~molluscs/OSUM2/
NatureServe Explorer
http://natureserve.org/explorer/servlet/NatureServe?searchName=ALASMIDONTA+HETERODON
Google Images
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- New York State Department of Environmental Conservation Hudson River Estuary Program
- Division of Lands & Forests, Department of Environmental Conservation
- New York State Office of Parks, Recreation and Historic Preservation

Information for this guide was last updated on Oct 04, 2011
This guide was authored by

EXHIBIT G

National Park Service
U.S. Department of the Interior

Upper Delaware Scenic and Recreational River

Nature & Science

The Upper Delaware River Valley and its watershed provides an ideal habitat for the bald eagle. This includes clean water, ample food, and undisturbed stands of large deciduous and coniferous trees for perching and nesting. But until recently, your chances of actually seeing an eagle along the Upper Delaware were slim. That is changing, thanks to recent cooperative efforts to improve environmental conditions and to re-establish the bald eagle in the eastern United States. During the winter, when lakes and rivers freeze, bald eagles from the northern portions of the United States and Canada leave their nests and move southward to areas, like the Upper Delaware, with open water and reliable food supplies. Well over 100 bald eagles visit this area each winter.

Did You Know?
Upper Delaware is the home of the oldest existing wire cable suspension bridge in the nation - the Delaware Aqueduct. Built in 1847 for the Delaware and Hudson Canal, it was designed by and constructed under the supervision of John A. Roebling, future engineer of the Brooklyn Bridge.

Last Updated: August 01, 2006 at 13:02 MST

National Park Service
U.S. Department of the Interior

Upper Delaware Scenic and Recreational River

Bald Eagles

Bald Eagles

Gallery Description: A selection of photographs of Upper Delaware's bald eagles, including chicks, hunting and feeding eagles, and birds at rest.

Immature eagle

Photo by Jason Farmer

Eagle Eye

Photo by Scott Rando

Female and young

Photo by Scott Rando

Eaglets

Photo by Peter Nye

Adult eagle approaching immature eagle

Photo by Scott Rando

Immature Eagle

Photo by Scott Rando

[Download 87 kb]

Immature Eagles

Photo by Scott Rando

Adult and young

Photo by Scott Rando

Immature doing a half roll

Photo by Scott Rando

Eaglet

Photo by Scott VanArsdale

Juvinile with a headache

Photo by Scott Rando

Eagles in nest

Photo by PA Fish & Boat Commission

Eaglets stretching their wings

Mature eagle in flight

Male eagle with a squirrel

Mature eagle fishing


Photo by Scott Rando


Photo by Scott Rando


Photo by Scott Rando


Photo by Scott Rando

Female with prey

Female eagle on nest


Photo by Scott Rando


Photo by Scott Rando

Female and young

Female


Photo by Scott Rando


Photo by Scott Rando

Feeding an eaglet

Mature and immature eating an eel


Photo by Scott Rando


Photo by Scott Rando

Mature and immature eating an eel

Eaglet

Photo by Scott Rando

Photo by Peter Nye

Did You Know?
The Upper Delaware watershed hosts the largest inhabitants of wintering bald eagles in the northeast, and a growing year round population of eagles has made the area an ideal location for eagle watching.

Last Updated: July 16, 2010 at 00:13 MST

EXHIBIT H

Welcome to the River

Welcome to the Upper Delaware Scenic and Recreational River, a component of the National Wild and Scenic Rivers System. This designated, 73.4-mile section of the Delaware River flows freely from Hancock, NY to Mill Rift, PA. The Upper Delaware Council is proud of our river valley's unique management structure, natural beauty, rich history, and recreational opportunities.

Why This Guide?

The purpose of this guide is to provide information that will help to make your visit enjoyable and safe. Please keep in mind that, unlike most units within the National Park System, the majority of land in the Upper Delaware Scenic and Recreational River is privately owned.

A list of public access areas, river rest stops, and state-owned lands appears on the reverse side of this brochure. To avoid trespassing on private land, plan ahead to use available public and commercial recreational facilities.

The Upper Delaware River forms the boundary of two states. As you travel downstream, New York is on your left and Pennsylvania is on your right.

Conserve the Resource

The Upper Delaware Scenic and Recreational River is a working partnership of local, state, and federal governments, as well as individuals, organizations, and businesses, dedicated to conserving this precious resource while providing for the public's enjoyment and preserving private property rights.

While visiting, please leave habitat intact, properly dispose of litter, and respect the wishes of private property owners. Be a part of this cooperative stewardship for current and future generations.

Upper Delaware Council

The Upper Delaware Council (UDC) was incorporated in 1988 as the oversight body responsible for the coordinated implementation of the River Management Plan for the Upper Delaware Scenic and Recreational River.

As the driving force behind the River Management Plan, the UDC provides a mechanism to address actions by local, state, and federal agencies which affect the river valley. Services to members include reviews of development projects, ordinances, and governmental initiatives. The Council also administers a Technical Assistance Grants program, publishes *The Upper Delaware* quarterly newsletter, sponsors educational programs, and holds an annual awards ceremony to honor river valley contributors.

The Council's voting members are the two states and presently 11 of the 15 local governments which border on the Upper Delaware River. The Delaware River Basin Commission is a non-voting member. The UDC, a registered 501(c)(3) non-for-profit organization, operates under a Cooperative Agreement with the National Park Service.

The UDC's business office is in Narrowsburg, NY. The full Council meets on the first Thursday of every month. Three standing committees - Water Use/Resource Management, Project Review, and Operations - also convene monthly. All meetings of the Council are open to the public.

For further information, contact:

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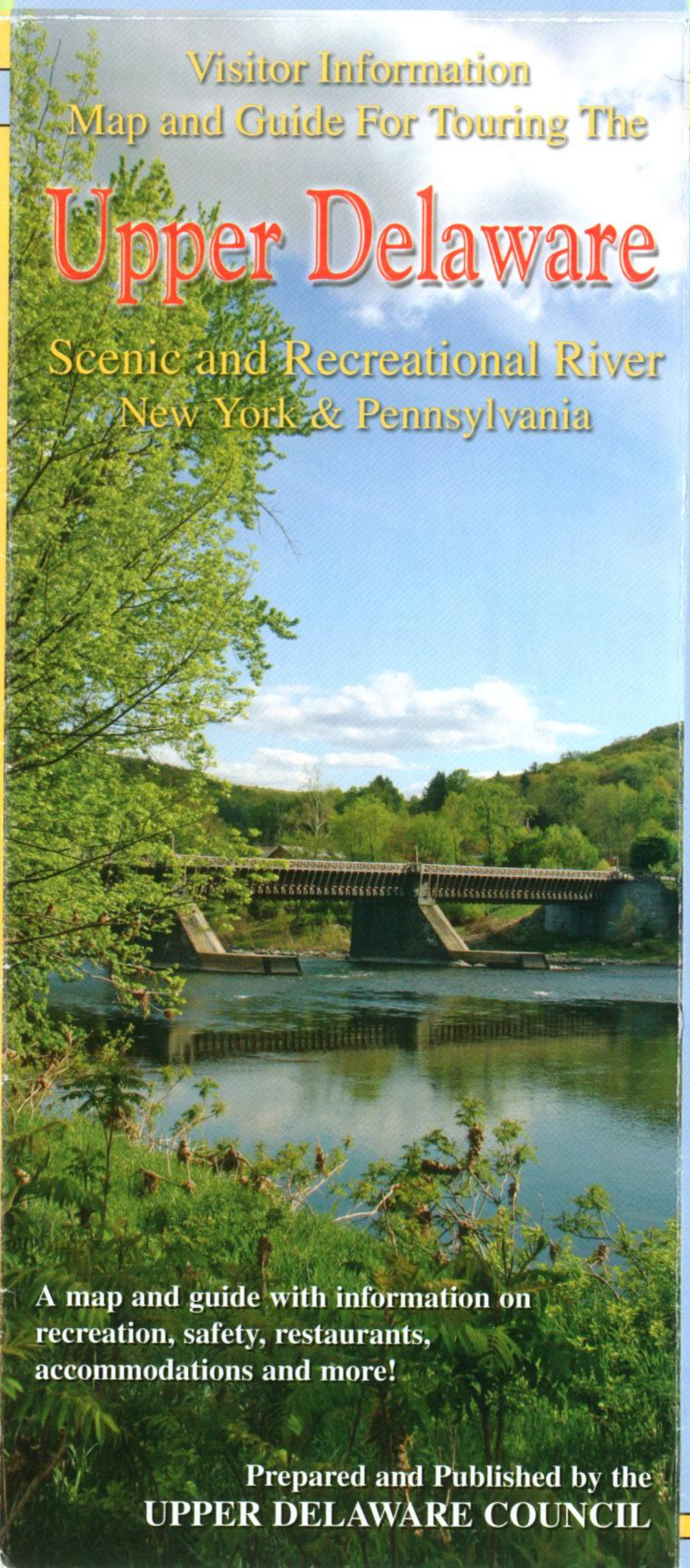
Narrowsburg, NY 12764-0192
Tel.: (845) 252-3022 Fax: (845) 252-3359
E-mail: udcramie@hvc.rr.com
www.upperdelawarecouncil.org

Cover Photo Courtesy of David B. Soete
Visitor Information Map and Guide, © 2008, UDC

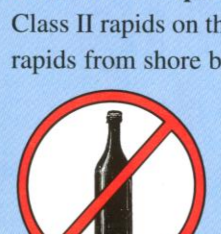


Before Getting on the River

Like any large river, the Upper Delaware is potentially dangerous and must be treated with respect. Tragic drownings teach a lesson of supreme importance: while boating, swimming, or tubing on the river, it is mandatory for each person to have a life vest, also known as a personal flotation device (PFD), and you are strongly advised to wear it. Children 12 years of age and under are required to wear a PFD at all times in any vessel. Because of reservoir releases or heavy rains, the Upper Delaware can run cold enough to stun even during the summer months. A person may also be incapacitated by striking the rocky river bottom. In such situations a PFD is often the only chance for survival. Before getting in a boat, make certain that everyone has a PFD and is wearing it properly. Almost all Upper Delaware drowning victims did not wear their PFDs.

If Boating or Tubing …

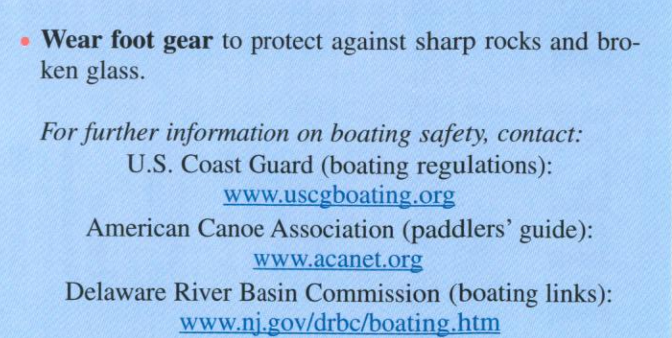
- **Wear a securely-fastened, USCG-approved Personal Flotation Device!**
- **Don't drink alcohol.** Alcohol impairs your judgment and increases the effect of cold. Many boating accidents and drownings are alcohol-related.
- **Know how to swim.** If you are in a boat, assume that sooner or later you will be in the water.
- **Scout the rapids.** There are seven relatively difficult Class II rapids on the river (see map). It is wise to scout the rapids from shore before attempting to run them.



- **Carry out** what you carry in. No glass containers, please.
- **Beware of eel weirs.** In the river there are a number of V-shaped rock walls in the channel designed to catch eels which can trap and swamp your boat. Watch for the signs, and ask National Park Service rangers or livery personnel for information on how to locate and avoid them.
- **Hypothermia** is a danger whenever the water temperature is below 70 degrees. You should know how to prevent, recognize, and treat hypothermia. For a report on temperature conditions, call NPS at (845) 252-7100.
- **Wear warm clothing** when boating in cold water. If the sum of the water temperature plus air temperature is less than 100 degrees, wear a wet suit.
- **Do not overload your boat.** Keep weight evenly distributed.
- **Wear protective foot gear.**
- **Avoid boating alone.** The American Red Cross recommends traveling with a minimum of three craft. Use the buddy system and keep other boats in sight.
- **Be courteous.** Extend courtesy to anglers and other river users. Respect natural resources.
- **Don't litter or trespass.** Almost all land along the river is privately owned and should be treated with due respect.
- **River conditions are ever-changing.** High water or cold weather can increase the danger for boaters. For a report on river conditions, call NPS at (845) 252-7100.

If You Are Swamped …

- **Even a swamped boat will float.** Stay with the boat unless you are in rapids where your safety will be increased by leaving the boat.
- **Hold on** to the upstream end of the boat in order to avoid being pinned between the boat and a rock. Float on your back with your feet pointed downstream and near the water surface (see diagram). Do not attempt to stand in fast water unless it is too shallow to float because if your foot is caught in the rocks, the current can pin you under water.



Viewed from above.

- **Save people first.** Save equipment later only if it can be done safely.

If Swimming …

- **Wear a securely-fastened, USCG-approved Personal Flotation Device!**
- **Never attempt to swim across the river.**
- **Be aware of sudden drop-offs and swift currents.**
- **Wear foot gear** to protect against sharp rocks and broken glass.

For further information on boating safety, contact:
U.S. Coast Guard (boating regulations): www.uscgboating.org
American Canoe Association (paddlers' guide): www.acanet.org
Delaware River Basin Commission (boating links): www.nj.gov/drbc/boating.htm
American Red Cross (water safety): www.redcross.org
National Park Service Upper Delaware (conditions): (845) 252-7100 hotline or www.nps.gov/upde

Recreation

The Upper Delaware offers some of the finest recreational opportunities in the northeastern United States. In particular, sightseeing, boating, camping, hunting, fishing, hiking, birdwatching, and cycling along state-established bike routes are popular activities in the river area.

The river corridor's 55,575 acres of mostly private property traverse five counties, eight New York towns, and seven Pennsylvania townships.

Portions of NYS Route 97, the river valley's main transportation artery, were designated in 2002 as the "Upper Delaware Scenic Byway" by New York State. The road's 71-mile length provides outstanding views. Particularly impressive is the rock cut at the Hawks Nest in the Town of Deerpark, which features winding S-curves and panoramic vistas from river bluffs hundreds of feet high.

Many historic sites are easily visited from Rt. 97. Of note are the Zane Grey Museum in Lackawaxen, PA, former home of the famous western novelist; Minisink Battleground, the site of a bloody 1779 Indian and Tory victory over Colonials; Roebling's 1848 Delaware Aqueduct, the nation's oldest existing wire suspension bridge built by Brooklyn Bridge designer John A. Roebling to accommodate the Delaware & Hudson Canal, remnants of which can still be seen; and Fort Delaware in Narrowsburg, a living re-enactment of regional frontier life.

Upper Delaware communities offer year-round sporting activities, fairs, festivals, parades, ethnic celebrations, and arts programs to appeal to people of all ages. Browse museums, go antiquing, observe the Upper Delaware's bald eagles and other birds and wildlife, hike, and take historic walking tours.

The valley boasts many fine restaurants, specialty shops, and choices of lodging. A listing of visitor-oriented businesses *located within the river corridor* is provided on the reverse side.

Boating and Camping

The Upper Delaware is navigable by a wide variety of watercraft throughout its entire length and boasts a total elevation differential of 460 feet, better than six feet per mile, although it is much steeper in some reaches. Boating experts have said that the combination of proximity to major metropolitan areas, high visual quality, and consistent flows due to upstream reservoir releases, makes the Upper Delaware one of the finest recreational canoeing rivers in the Northeast.

Canoes, rafts, tubes, and kayaks are the most popular watercraft on the Upper Delaware. If you don't have your own, vessels are available to rent from the many licensed commercial outfitters that operate on the river. Please note that Personal Watercraft or PWCs (i.e. jet skis) are prohibited. To ensure safety, National Park Service rangers and volunteers, as well as members of the National Canoe Safety Patrol, may be present to assist boaters in need.

Those using their own boats should locate the public access points that are indicated on the inside map. Of course, every boater should bring along a bag for trash and pack out what he or she carries in.

Camping is available only at private or commercial campsites. Keep in mind that most land in the river valley is privately owned and should not be used without permission. Primitive camping is available on Pennsylvania State Forest land with a permit, which may be obtained free of charge by stopping by the National Park Service's Barryville Office located on NY Route 97 or calling (845) 557-0222.

Hunting and Eagle Watching

Hunting and trapping within the river valley are managed by the states in accordance with state and federal laws. In Pennsylvania, state game lands and state forest lands in Pike County are provided for public hunting. In New York, state forest preserve lands are available. The map on the reverse side of this guide shows the locations of these and other public lands. All other land in the river valley is privately owned. Always ask permission before crossing private land. Please don't trespass.

A state license is required for hunting and trapping. Licenses may be obtained from local municipal offices, authorized commercial agents, or online via the Internet. The license year in New York State is October 1 to September 30. The hunting license year in Pennsylvania is July 1 to June 30.

The Mongaup Valley Wildlife Management Area, with property in the Towns of Lumberland, Deerpark, Highland, and Forestburgh, offers opportunities for eagle watching, fishing, hunting, hiking, nature study, and photography. Restricted to all use from December 1 to March 31 to protect the wintering bald eagle population, after April 1 most of the lands are open to the public.

Bald eagles are easily disturbed by human activity that alters their use of feeding and roosting areas. Please follow proper viewing etiquette and all posted regulations.

The Eagle Institute, which maintains a winter field office at the Roebling Bridge Information Center in Lackawaxen, Pa., offers year-round information on these majestic birds, as well as wintertime updates on area viewing locations, eagle sightings, ice cover, road conditions, and visitation numbers, through its web site at www.eagleinstitute.org or call (570) 685-5960 in PA and (845) 557-6162 in NY.

Fishing

The Upper Delaware is recognized by anglers and fishery biologists as one of the finest fishing rivers in the northeastern United States.

Smallmouth bass, walleye, and a growing number of striped bass are present in the warmwater section below Callicoon. Coldwater releases from upstream reservoirs provide conditions suitable for trout at least to Hankins, and large wild browns and rainbows support a quality fishery. Migrating American shad are plentiful in May and June as they swim upstream to spawn. The entire river offers abundant white-suckers, American eels, and fallfish.

A valid New York or Pennsylvania fishing license is required for all anglers, age 16 and older, when fishing from a boat or from either shore on the Upper Delaware. Licenses may be purchased from local sporting goods stores or other state license issuing agents. A list of bait and tackle shops located in the river corridor is available on the reverse side.

Variable flows can affect the angling experience on the Upper Delaware Scenic and Recreational River. The United States Geological Survey has established a number of gaging stations along the Delaware River to measure the quantity and temperature of its surface water. Real-time data on river flows can be obtained prior to setting out for a fishing trip by consulting the gage station links provided on the Delaware River Basin Commission's web site at www.nj.gov/drbc/streamfl.htm.

Approximately 40 commercial fishing guides are licensed by the National Park Service to operate on the Upper Delaware Scenic and Recreational River. To obtain a complete list of these fishing guides, access the National Park Service unit's web site at www.nps.gov/upde/planyourvisit/fishingguides.htm or request a copy from the Upper Delaware Council office by calling (845) 252-3022.

Keep in mind that private property dominates both sides of the Upper Delaware River and its islands. Please respect the rights of local landowners when accessing the river to fish. The New York State Department of Environmental Conservation and Pennsylvania Fish and Boat Commission offer several public fishing accesses along the river.

For Further Information

Upper Delaware Council, Inc.
P.O. Box 192, 211 Bridge St.
Narrowsburg, NY 12764-0192
(845) 252-3022
www.upperdelawarecouncil.org

National Park Service
Upper Delaware Scenic and Recreational River
274 River Rd.
Beach Lake, PA 18405-4046
(570) 685-4871
River Conditions Hotline: (845) 252-7100
www.nps.gov/upde

NYS Department of Environmental Conservation
Region 3: for Sullivan and Orange Counties
21 South Putt Corners Rd., New Paltz, NY 12561
(845) 256-3000
Region 4: for Delaware County
1130 North Westcott Rd., Schenectady, NY 12306
(518) 357-2068
www.dec.ny.gov

PA Fish and Boat Commission, Northeast Region
P.O. Box 88, Sweet Valley, PA 18656-0088
(570) 477-2206 (Educ.) or (570) 477-5717 (Law Enf.)
www.fish.state.pa.us

PA Game Commission, Northeast Region
P.O. Box 220, Dallas, PA 18612-0220
(570) 675-1143 or 1144
www.pgc.state.pa.us

PA Bureau of Forestry, #19 Delaware District
HC 1 Box 95A, Swiftwater, PA 18370-9723
(570) 895-4000 or 4001
www.dcnr.state.pa.us

Delaware River Basin Commission
P.O. Box 7360, West Trenton, NJ 08628-0360
(609) 883-9500
www.state.nj.us/drbc

How to Get Here

The Upper Delaware valley is located between the Catskill and Pocono regions, where the river forms the border between Pennsylvania and New York, and is easily reached by major highways.

The southern terminus of the river above Port Jervis, NY may be reached by I-84 and U.S. Routes 6 & 209 to NY Route 97. The northern terminus of the river below Hancock, NY is accessed via NY Route 17 (future I-86) to NY Route 97 and PA Route 191. Middle sections of the river may be reached by a variety of state, county, and local roads. Please refer to the map on the reverse side.

Tourism Information

Delaware County, NY: www.delawarecounty.org
Sullivan County, NY: www.scva.net
Orange County, NY: www.orangetourism.org
Wayne County, PA: www.waynecountycc.com
Pike County, PA: www.DiscoverPikePA.com
PA Regional: www.poconos.org
NY Regional: www.upperdelawarescenicbyway.org

Emergency Contacts

River Emergency in NY or PA	**Dial 911**
National Park Service Dispatch	(845) 557-0222
New York State Police	
Delaware County (Deposit)	(607) 467-3215
Sullivan County (Narrowsburg)	(845) 252-3212
Orange County (Middletown)	(845) 344-5300
Pennsylvania State Police	
Wayne County (Honesdale)	(570) 253-7126
Pike County (Blooming Grove)	(570) 226-5718

Emergency Preparedness and Assistance
American Red Cross
Orange/Sullivan Chapter: (845) 294-9785
www.nyredcross.org
Wayne/Pike Chapter: (570) 253-2310 or 296-5229
www.redcrossonline.org

EXHIBIT I

Upper Delaware Scenic and Recreational River

2010 State of the Park Report

Photo by David B. Soete

"It is hereby declared to be the policy of the United States that certain selected rivers of the Nation which, with their immediate environments possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values shall be preserved in a free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations." (Public Law 90-542)

Congress forged an uncharacteristic "new" mission for the National Park Service (NPS) when designating the upper 73.4-mile section of the main-stem Delaware River as a unit of the Wild and Scenic Rivers System. We are charged with protecting our "Outstandingly Remarkable" values-- overall tranquil scenic beauty of the valley; camping, hunting, fishing, swimming, sightseeing and river related recreational opportunities; outstanding habitat for both a cold and warm water fishery; large and small wildlife species; history and archeological sites. The twist is that we must do so with and through many partners, on land that we do not own.

For over 30 years, compliance with the *Secretary of the Interior's Guidelines for Land and Water Use Management* through the *Upper Delaware River Management* Plan which guides municipalities was sufficient to protect the significant resources that comprise our "outstandingly remarkable" values through local planning and land use regulation. Since 2003, however, the pressure of energy resource development at an industrial magnitude never anticipated challenges our staff, governmental management partners, and the community: How it will be possible to preserve and protect our outstanding resource values in view of our metropolitan New York City and Philadelphia neighbors' increasing need for both high quality water and energy consumption.

Natural Gas Drilling

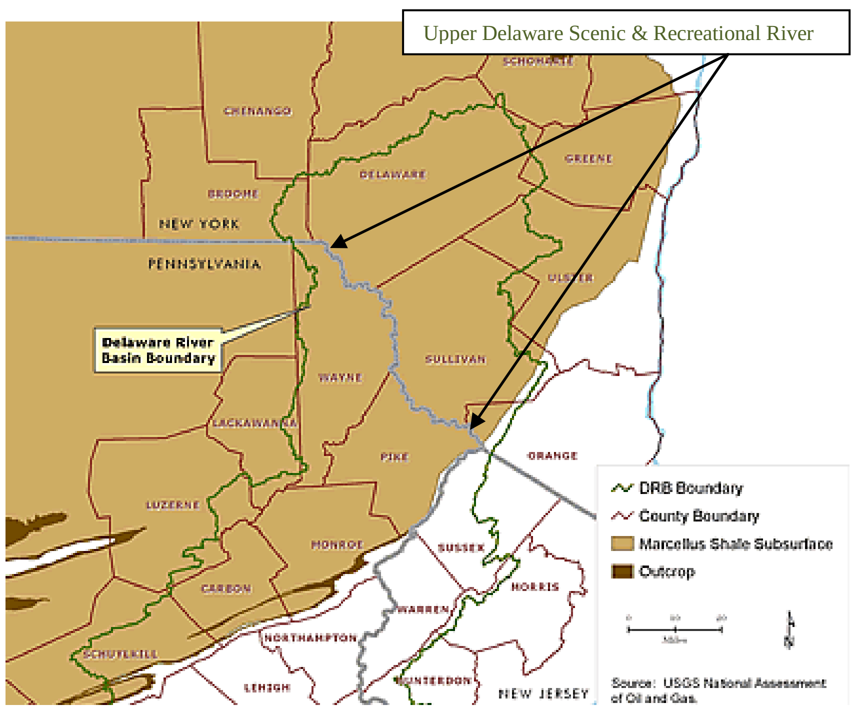
Recognizing the pressure placed on the resources of the Delaware River basin by placement of an estimated 10,000 natural gas wells (currently five test wells have been drilled near the Upper Delaware Scenic and Recreational River [UPDE] boundary) and well infrastructure in the Delaware River basin, an interdisciplinary team convened for monthly teleconferences to address the impacts anticipated within NPS areas. The team includes NPS staff from UPDE and other parks, NPS Geologic Resources Division, NPS Water Resources Division, Northeast Regional Office, the DOI Northeast Region Solicitor's Office, and Upper Delaware Council. A more geographically-broad federal interagency team includes NPS representation to concentrate on overall resource management issues.

A key management partner, the Delaware River Basin Commission (DRBC) is a federal-interstate compact government agency formed by 1961 concurrent legislation enacted by the United States, Pennsylvania, New York, New Jersey, and Delaware (which includes the Middle and Lower Delaware units of the Wild and Scenic Rivers System). DRBC hash legal authority over both water quality and water quantity-related issues throughout the basin, including water quality protection, water supply allocation, regulatory review (permitting), water conservation initiatives, watershed planning, drought management, flood loss reduction, and recreation.

DRBC regulates Special Protection Waters (SPW) for point source (or "end-of-pipe") discharges and for non-point source pollutant loadings carried by runoff to protect existing high water quality in areas of the Delaware River Basin deemed "to have exceptionally high scenic, recreational, ecological and/or water supply values."

In connection with natural gas drilling, the Commission has identified three major areas of concern:

1. Gas drilling projects in the Marcellus Shale or other formations may have a substantial effect on the water resources of the basin by reducing the flow in streams and/or aquifers used to supply the significant amounts of fresh water needed in the natural gas mining process.



Extent of Marcellus Shale Formation in the Delaware River Basin

2. On-site drilling operations may potentially add, discharge or cause the release of pollutants into the ground water or surface water.

3. The recovered "frac water" must be treated and disposed of properly.[1]

With NPS support, DRBC's Executive Director expanded on a 2009 determination, concluding that "all natural gas well sponsors, *including the sponsors of natural*

[1] From Delaware River Basin Commission website www.drbc.net, used with permission

gas well projects intended solely for exploratory purposes, must first apply for and obtain commission approval before commencing any natural gas well project for the production from or exploration of shale formations within the drainage area of Special Protection Waters in the Delaware River Basin."

DRBC is developing natural gas regulations to ensure protection of basin waters while minimizing regulatory duplication. The draft regulations will likely be published in December 2010, and will be accompanied by a public rulemaking process. This process will entail two public hearings and a written comment period.[2]

See Natural Resources Section for more information on this issue.

Changing of the Guard

"There is nothing permanent except change".[3] During Fiscal Year 2010, Superintendent Vidal Martinez accepted a Superintendent position at Prince William Forest Park after nearly 2 years at UPDE; Assistant Superintendent Sandra Schultz retired after 36 years with the NPS (Sandy worked on the Legislative Support Data Package for UPDE, as a Regional Planner assigned to UPDE, as UPDE's Chief of Planning, Management Assistant and then Assistant Superintendent during her career, as well as several long-term Acting Superintendent assignments), and Acting Chief of Protection Joe Nicholson retired after over 30 years with NPS, two of them at UPDE.

Sean McGuinness assumed the Superintendency on February 3, 2010, one month before the Assistant Superintendent departed; and, Natural Gas Drilling began to pervade nearly every aspect of the partner building process. UPDE's partners have come to recognize him as an outspoken and reliable consensus builder.

Administration

Assistance to Other Sites is in the fabric of UPDE's Administrative Staff, who: Provided mentoring to new Administrative Officers at WORI and FOST and closeout assistance to MAVA; managed GovTrip and Timekeeping for FOST and MAVA; provides assistance and management for the NPS Property Management system for the Upstate NY sub-cluster and UPDE. Our AO provides PCS support to several parks in upstate NY, PA and NJ, as well as UPDE. And she and the team of IPPM instructors re-wrote the IPPM course. She also taught two IPPM classes at the beginning of FY-2010.

Five permanent employees were hired at UPDE in FY-2010: Four 4 subject to furlough WG-05 positions in Maintenance and 1 part-time GS-05 Office Automation Assistant in the Superintendent's Office. 14 seasonal positions were shared among three divisions.

Purchasing overall took a lot longer to accomplish because of learning new requirements of the MABO. The park provided training in IDEAS and Agreements.

Construction on HQ buildings disrupted network and internet use for a few weeks and electrical storms caused feedback into systems at two other locations also disrupting network and internet use. The necessary services and equipment were purchased to repair damaged equipment. Radio system coverage was reviewed to provide information to assist in determining requirements for improvement.

[2] DRBC Webpage http://www.state.nj.us/drbc/naturalgas.htm

[3] Greek philospher Heraclatus

Maintenance

Removed 500 linear feet of chain link fence and installed a secure, automatic sliding gate at headquarters complex.

Completed an ARRA-funded weatherization project for three Headquarters buildings to replace deteriorated log siding and roofing. New thermal windows, insulation and a vapor barrier were installed on the main headquarters building.



Removed and installed new concrete sidewalks and steps and hand railings at the Headquarters complex.

Prepared the Zane Grey Museum for installation of new exhibitory by removing old exhibits, painting, and installing electrical wiring and devices.

Supervised replacement of the Zane Grey Museum roof with 35 Squares of Cedar shake shingles on the roof and dormers, replaced flashing, and re-pointed, cleaned and repaired the chimneys.

Painted the exterior of the Margold house adjacent to Roebling Bridge.

Completed UPDE Integrated Solid Waste Alternatives Plan.

The maintenance staff, Safety Officer and Safety committee chair attended the EPA training for Lead Safety for Renovation, Repair and Painting. All are certified for this new regulation.

UPDE Protection Division

In the wake of Chief Ranger Joe Nicholson's retirement one year after that of the former Chief Ranger, several protection employees have served as Acting Supervisory Park Ranger and Chief of Protection. Hot dry weather kept visitation high and our patrol function was altered to areas with the highest visitation. This flexibility, combined with an expanded boating and river safety program, resulted in no visitor fatalities in 2010.

The new joint NCSP/NPS Training curriculum allows both NCSP and NPS to advance through swift water recue and motorboat operator certification

In partnership with the National Canoe Safety Patrol (NCSP), we developed a 4-tier curriculum which allows NCSP and UPDE employees to document training and advance through swift water rescue and MOCC (motorboat operator certification course). We co-instruct sessions during the NCSP training weekend and weekly skill drills (tailgate safety sessions).

Our staff assisted Delaware Water Gap (DEWA) with a wildfire at Sunfish pond by providing Firefighters, squad boss, and a FALB (class B faller). We also assisted DEWA in a multi-day search for a missing person in the spring of 2010, and with prescribed fire burns in fall of 2009.

We have merged our dispatch operation with DEWA, resulting in 24-hour coverage as required by DO/RM-9. As part of this merger, we worked with GIS staff to develop "duff" maps for use by dispatch personnel.

Protection staff also:

- Represents UPDE on the Delaware River Water Trail's signage and rivers and trails subcommittee.
- Participated in DRBC flexible flows, floods and other committees.
- Assisted Women's Rights NHP for a 3 week protection detail.

During the 2010 visitor season, 6 UPDE rangers closed 345 cases. We issued 115 citations, 105 verbal warnings, 95 case cards, 30 written warnings, and 343 case incident reports. A high percentage of these statistics were for violations pertaining to visitor safety, boating and PFD violations.

Interpretation

UPDE staff made nearly 81,000 visitor contacts in 2010. The greatest number of visitor contacts occurred at riverside kiosks and on roving patrols as the interpretive staff concentrated on providing safety information to river users. Water Safety was a major thrust in our curriculum-based education program with over 1,800 students participating. The *Delaware and Hudson Canal Days* off- and on-site programs, a partnership among divisions, involved eight schools and 718 4th grade students. Interpretive and Natural Resources staff collaborated to expand the *Water Snapshot* Program with 382 students participating in both classroom and the on-site water testing. Overall education programming increased by 20% this year as UPDE exceeded our GPRA goals for Visitor Satisfaction, Visitor Satisfaction with Facilitated Programs, Visitor Understanding, Visitors Attending Facilitated Programs, Visitor Safety, and Visitor Fatalities.

Centennial Initiative funding provided two Seasonal Interpretive Rangers, allowing UPDE to provide additional interpretive river safety patrols, increase our assistance to the cultural and natural resource management divisions, and to open the Zane Grey Museum daily from Memorial Day Weekend through the end of September.

We continue to support local partners by participating in numerous festivals, sponsoring river clean-up events with area high schools, conducting in-service training for teachers, and providing river safety training to public safety agencies and livery staff. In celebration of Public Lands Day, UPDE partnered with Kittatinny Canoes and Woodloch Resort to host a river clean-up event.

The Zane Grey House was open Memorial Day through mid-October. The annual Zane Grey Festival was presented in partnership with Zane Grey's West Society.

Eastern National sales at the Zane Grey House and the Narrowsburg Information Center totaled $12,483.50, a 19% increase.

Volunteers – 409 Volunteers, including six interns, the National Canoe Safety Patrol, the Zane Grey's West Society, the Eagle Institute, and the annual summer River-Clean-Up in partnership with Kittatinny Canoes, contributed 11,977 hours.

Natural Resources

Tracking Marcellus Shale Natural Gas Development Issues near UPDE

On June 2, 2010, the Upper Delaware Scenic and Recreational River gained the dubious distinction of being named "America's Most Endangered River" by the conservation organization *American Rivers*, due to impending natural gas development in the region. We are at the intersection of the largest and most rapidly developing natural gas field in the U.S., the Marcellus Shale, and the longest reach of Special Protection Waters in the country, the upper 197 miles of the main stem of the Delaware River.

We continue to spend a great deal of time focused on natural gas development issues, attending meetings, reading reports, participating in conference calls, keeping abreast of developments, and reviewing and commenting on proposed regulations in an effort to best protect UPDE resources and values. We continue to get a great deal of help with this issue from the NPS Geologic Resources Division, and the Air and Water Resources Division staff.

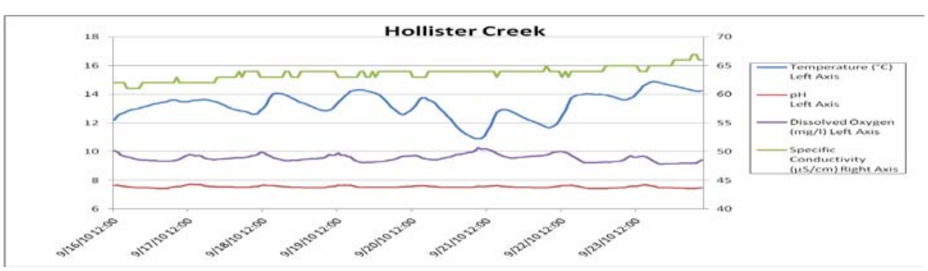
New York State Department of Environmental Conservation released an 809-page Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas, and Solution Mining Regulatory Program. UPDE, the NPS Northeast Region, the Geologic Resources Division, the Water Resources Division, the North Country Trail, and the DOI Solicitor's Office collaborated to review and comment on this document.

In mid-December, we reviewed and provided comments on DRBC draft dockets for a water withdrawal on the West Branch of the Lackawaxen River, and further development of the Matoushek well in Clinton Township, Wayne County, PA.

A submerged sonde, temporarily out of its protective, camouflaging PVC sleeve.

Continuous Water Quality Monitoring

UPDE instituted continuous water quality monitoring of Delaware River tributaries. Multi-probe instruments, or "sondes", are placed directly in the water flow to measure water quality parameters such as dissolved oxygen, pH, conductivity, temperature, and turbidity. The results are downloaded for analysis. Funds were provided by the NPS Northeast Regional Office for 7 additional instruments, four of which will be equipped with telemetry to allow off-site real-time monitoring, thus enabling rapid detection of significant water quality changes.

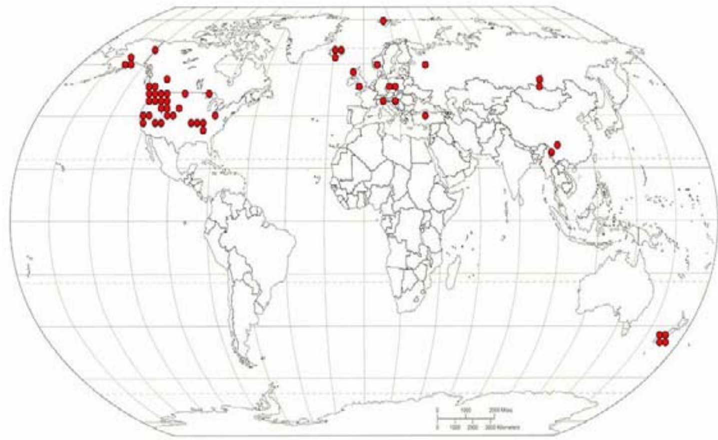


Hourly data collected for a one week period in Hollister Creek clearly shows the diurnal cycle of the water temperature and the corresponding changes in dissolved oxygen levels (mg/L). A lesser diurnal variation was also exhibited by pH. Conductivity remained relatively constant.

Scenic Rivers Monitoring Program

With the addition of a new site on the West Branch, 20 locations on tributaries and the main stem Delaware River were sampled bi-weekly from May through September. Fecal coliform, E.coli and enterococcus bacteria, and a host of chemical parameters including nutrient levels, total chloride, total alkalinity, and total hardness data is maintained in the national EPA STORET database by the Delaware River Basin Commission, as well as at UPDE.

The Lackawaxen Township, Pennsylvania, Sewage Enforcement Officer requested our assistance to collect and test water samples at an effluent "outfall" believed to be contributing point source pollution into the Delaware River.



Confirmed presence and portion of published records of D.geminata from around the world. Dots show rough geographic area of populations (From Spaulding and Elwell 2007; Map by Sarah Spaulding, USGS.

Addressing identified research needs for the nuisance freshwater diatom *Didymosphenia geminata*

D. geminata (a.k.a. Didymo or "rock snot") is expanding, emerging as an organism with extraordinary capacity to impact stream ecosystems on a global scale.

UPDE Resource Management Specialist Don Hamilton sought out and collaborated with a USGS scientist to develop a joint research request to better understand this organism in the Delaware and other river systems. The proposal, *"Determining the ecological and evolutionary processes associated with distribution and behavior of the nuisance freshwater diatom Didymosphenia geminata"*, was funded for FY2011-13.

Samples of *D. geminata* collected in 2010 from locations on the Delaware River mainstem were sent to the Academy of Natural Sciences in Philadelphia (ANSP) for confirmation. Dr. Marina Potapova, a world-renowned phycologist at ANSP and a Co-Principal Investigator in our study, is attempting to culture *D. geminata* in her lab using these samples (something that no researcher has been able to do so far). This would be an important step in further studying the species and better understanding factors linked to the vegetative stalk growth.

Biological Monitoring of Benthic Macroinvertebrates

Freshwater BMI are a very important part of stream food webs because they form the primary source of nutrition for many aquatic and terrestrial animals. UPDE is partnering with two entities to monitor benthic macroinvertebrates (BMI) as a means of assessing the health of stream ecosystems:

Biologists from the Delaware River Basin Commission have had a structured study and sampling program for BMI at UPDE and DEWA for the past 7 years. A local newspaper article covered this program recently, helping the public to develop an understanding and appreciation of this component of the Delaware River's ecosystem.

We are also partnering with the NPS Eastern Rivers and Mountains Network (ERMN) in a long-term BMI sampling effort on 12 UPDE tributaries as part of the Vital Signs program. The second season of monitoring UPDE tributaries was completed in fall 2009, and we recently received the 2008 Summary Report.

We continue to advise and share data with the Equinunk Watershed Alliance in stewardship of Equinunk Creek, which has the highest water quality of the UPDE tributaries sampled by ERMN staff.

Bald Eagle Essential Habitat Study

In cooperation with the *New York State Department of Environmental Conservation and The Eagle Institute*, a local organization dedicated to bald eagle conservation and education, a multi-year study to determine the most important habitats for bald eagles along the Upper Delaware River is in the data analysis and report writing phase. Sixteen birds fitted with satellite and radio transmitters provide information about their habitat use. The Data Manager/GIS Specialist from the Eastern Rivers and Mountains Network is assisting to model some of the habitat use data.

Photo © Scott Rando. Used with permission.

Study bird R27 (lower, photographed in January 2010, carries a backpack transmitter from a 2008 capture

From a total of 18 active nests (that we know of) within the UPDE corridor, the successful nests produced about 30 fledglings in 2010.

Thousands of school children follow the migrations and movements of UPDE-tagged bald and golden eagles every year, and learn about their habits and habitat needs at http://www.learner.org/jnorth/eagle/.

Targeted Mammal Inventory

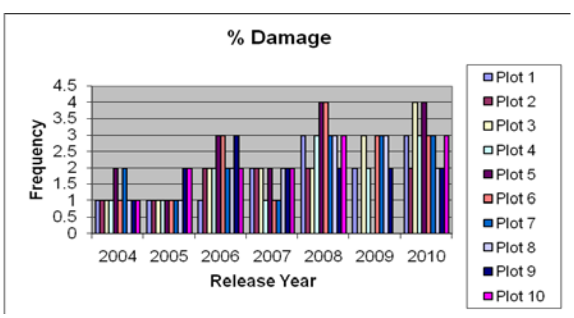
Fieldwork and review of the draft final Targeted Mammal Inventory (TMI) report was conducted under the direction of Dr. Howard Whidden of East Stroudsburg University (ESU). The three-part study of mammals supports a broader effort to catalogue the nation's natural resources throughout our national parks.

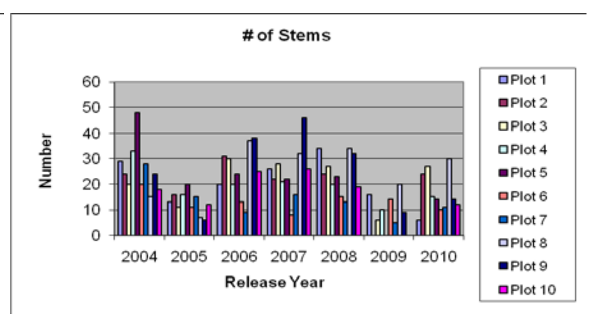
NPS Biological Resource Division provided $2500 for ESU students to do a third year of acoustic monitoring to document declines in local bat populations as a result of white-nose syndrome (WNS), a cold-loving virus contributing to the deaths of over 100,000 hibernating bats in the northeastern United States.

Invasive Species

The NPS Northeast Region Exotic Plant Management Team (NER EPMT) came three times this season to treat and assist with removal of non-native invasive plants, targeting Japanese knotweed, Japanese barberry and multiflora rose at NPS-owned Towpath Trail in Minisink Ford, NY, and the D&H Canal site at Corwin Farm.

Monitoring shows a definite decline in the loosestrife population at Pond Eddy. This is our seventh year of releasing *Galerucella pusilla* beetles, which feed exclusively on the leaves, stems and shoot tips of purple loosestrife, preventing seed production and distribution.





Both Galerucella beetles and eggs of the Galerucella beetles were documented in 2010 in our study area

Thanks to local Boy Scout Troop 122 and their leader, NPS volunteer Rich Egan, four years of eradication resulted in no new infestations of the invasive plant, water chestnut (*Trapa natans*) in the Upper Delaware River in 2010.

We assisted the Pennsylvania Chapter of The Nature Conservancy to remove Japanese knotweed from Butternut Island, a critical link between the Delaware River's headwaters in New York's Catskill Mountains and the unique heaths and mountains of Pennsylvania's Pocono Mountains.

Study on Age Structure of Spawning Stock of American Shad in the Delaware River
UPDE, the U. S. Fish and Wildlife Service (FWS), Pennsylvania Fish & Boat Commission (PFBC) and New York State Department of Environmental Conservation cooperated on a NPS-funded project to describe the age structure of the spawning stock of American shad (AMS) in the Upper Delaware River.

From May 1 through June 19, 2010, UPDE staff contacted fishermen at twelve access points in a joint study. Using a FWS-designed creel survey valuable information was gathered from AMS anglers regarding 1) total length, 2) sex, and 3) scale samples. PFBC will study the scale samples to help provide a good sampling of the ages of AMS in the Upper Delaware basin. Data gathered in 2009 and 2010 will help to formulate the age range and obtain the percent of repeat spawning for the AMS in the Delaware River.

NPS volunteer Rich Egan reviewing Water Snapshot results with Damascus Elementary students.

Environmental Education
The *Water Snapshot* program was presented to over 400 local elementary school students, the biggest year to date. UPDE staff visited fourth through eighth grade students in two states, four school districts, six schools and twenty classrooms to explain concepts and principles of water quality and environmental stewardship. This basin-wide event helps students to look at water quality of the streams and rivers in their own backyards. The "Upper Delaware Snapshot 2010" Water Snapshot booklet is posted for students' and teachers' use. Students' posters were displayed at our Information Center for the month of July.

In its third year, *Trout in the Classroom* provides resources to teachers and helps students make the connection between Trout and local water quality issues.

UPDE Cultural Resources

Building on the existing National Register listing for Zane Grey's residence, a nomination for the Zane Grey site, (including Zane Grey's mother's house and ancillary buildings, the orchard and garden) was completed. A Historic Structures Report for the Alice Grey House and Ancillary Buildings (coal house, barn, cottage-kitchen) and a structural assessment and report of the Zane Grey house were also completed.

Installation of new exhibits at the Zane Grey Museum was completed with the assistance of Harpers Ferry Center.

Historic furnishings in Zane Grey's office completed the Zane Grey Museum exhibit.

Congressman Chris Carney was a speaker at the Zane Grey Exhibit Grand Opening , along with keynote speaker Henry Nardi from the Zane Grey's West Society. Collette Fulton from the Zane Grey's West Society presented the park with a book, The Young Lion Hunter, the first in a series of books for young people that the society is having printed.

Zane Grey Museum Exhibit Ribbon Cutting L-R: Museum Curator Dorothy Moon, former UPDE Superintendent John T. Hutzky, Carolyn Weidner, Collette Fulton, Congressman Chris Carney, Henry Nardi, and Superintendent Sean J. McGuinness.

With the addition of a Seasonal Museum Technician, we were able to improve documentation and care of museum collections. All new objects received were accessioned and cataloged. Monitoring environmental conditions allowed us to establish baseline data for the new museum exhibits. All GPRA goals for FY 2010 were met, and goal 1a6 (NPS preservation and protection standards) was exceeded.

Upper Delaware Council

Our key management partner, The Upper Delaware Council, Inc. (UDC), continued assessing potential impacts from the proposed development of natural gas in the Marcellus Shale play. Activities included gathering and disseminating information, attending meetings and hearings, submitting comment letters, and monitoring the status of regulatory programs by both states and the Delaware River Basin Commission.

Starting in March 2010, UDC's Water Use/Resource Management Committee devoted a portion of every monthly meeting to reviewing studies, hearing presentations, and discussing modifications of the Flexible Flows Management Program (FFMP). UDC is preparing recommendations for management of releases from New York City's Delaware River Basin reservoirs in advance of the FFMP's expiration date of September 30, 2011.

One hundred guests attended the UDC's 22nd Annual Awards Ceremony on April 25, 2010, with New York State Assemblywoman Aileen M. Gunther (98th District) as keynote speaker. Awards were presented to individuals, organizations, and projects (including the NPS Roebling Bridge and Towpath Trail Storm Damage Repair), that have enhanced the quality of life or protected the resources of the Upper Delaware River Valley.

Conclusion

In FY2010, we worked with 137 formal and informal partners to further the mission of the NPS in the Upper Delaware Scenic and Recreational River Corridor, on issues as diverse as The joint Upper Delaware Council & Common Waters Natural Gas Drilling Stakeholders' forums, Delaware and Hudson Canal Transportation Heritage Council, Penn State Science programs, Upper Delaware Visioning, Delaware River Flows, safety of river visitors with the National Canoe Safety Patrol and Upper Delaware liveries, camps and guides, and meetings with each of the 15 township Supervisors, as well as Delaware River Champion, Congressman Maurice Hinchey; to name a few.

FY 2010 has been a year of considerable change, with significant commitment by both our staff and partners to protect The Upper Delaware Scenic and Recreational River. The balance lies in constant vigilance while considering the increased need for sustainability and reason.

EXHIBIT J

Upper Delaware S&RR

Year	Recreational Visitors
1980	77,764
1981	156,437
1982	106,502
1983	223,096
1984	159,854
1985	154,799
1986	162,598
1987	157,753
1988	207,465
1989	226,125
1990	215,924
1991	222,637
1992	207,751
1993	258,994
1994	270,922
1995	492,256
1996	494,267
1997	308,215
1998	292,245
1999	354,356
2000	276,178
2001	306,639
2002	296,095
2003	256,987
2004	225,565
2005	248,953
2006	200,338
2007	248,284
2008	284,347
2009	258,311
2010	306,468
Total	**7,658,125**

EXHIBIT K

Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania

The Delaware River Basin, an economic engine for over 400 years

October 11, 2011

Prepared by:

Gerald J. Kauffman
University of Delaware
Newark, Del.
302-831-4929
jerryk@udel.edu

Executive Summary

What do the Guggenheim Museum, New York Yankees, Boeing, Sunoco, Campbell's Soup, DuPont, Wawa, Starbucks, Iron Hill Brewery, Philadelphia Phillies, Camelback Ski Area, Pt. Pleasant Canoe Livery, Salem Nuclear Power Plant, and United States Navy all have in common? They all depend on the waters of the Delaware River Basin to sustain their businesses.

The Delaware River Basin is an economic engine that supplies drinking water to the 1st (New York City) and 7th (Philadelphia) largest metropolitan economies in the United States and supports the largest freshwater port in the world. The Delaware Basin's water supplies, natural resources, and ecosystems in Delaware, New Jersey, New York, Pennsylvania and a small sliver of Maryland:

- Contribute $25 billion in annual economic activity from recreation, water quality, water supply, hunting/fishing, ecotourism, forest, agriculture, open space, potential Marcellus Shale natural gas, and port benefits.

- Provide ecosystem goods and services (natural capital) of $21 billion per year in 2010 dollars with net present value (NPV) of $683 billion discounted over 100 years.

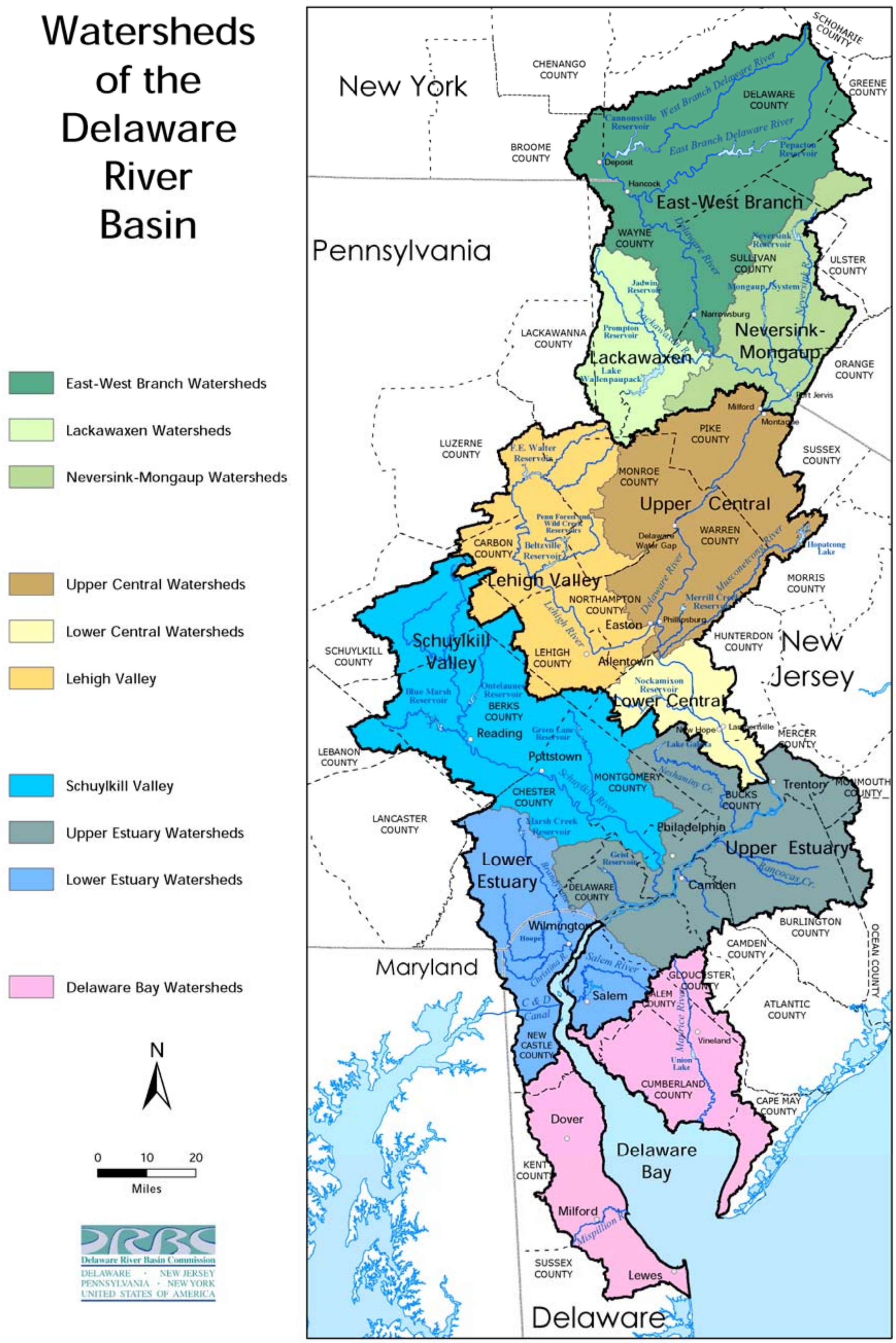
- Are directly/indirectly responsible for 600,000 jobs with $10 billion in annual wages.

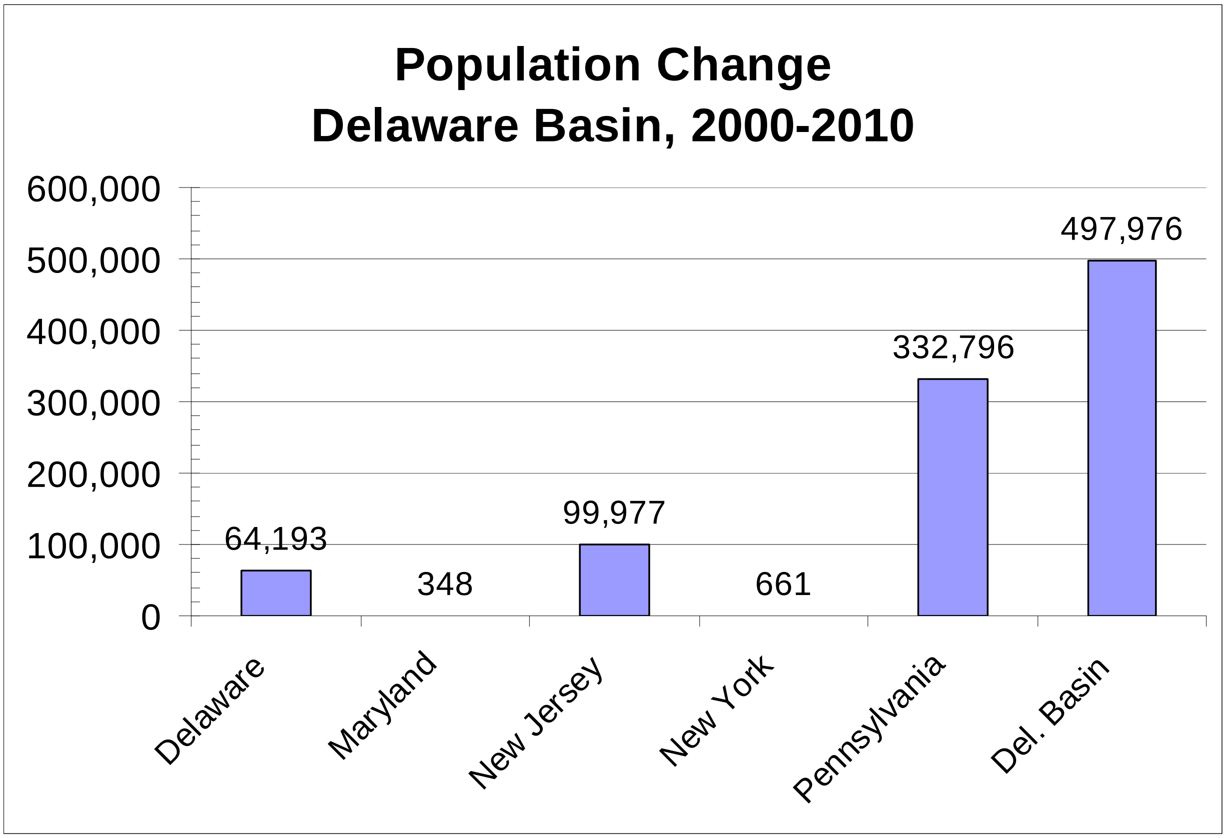
The Basin

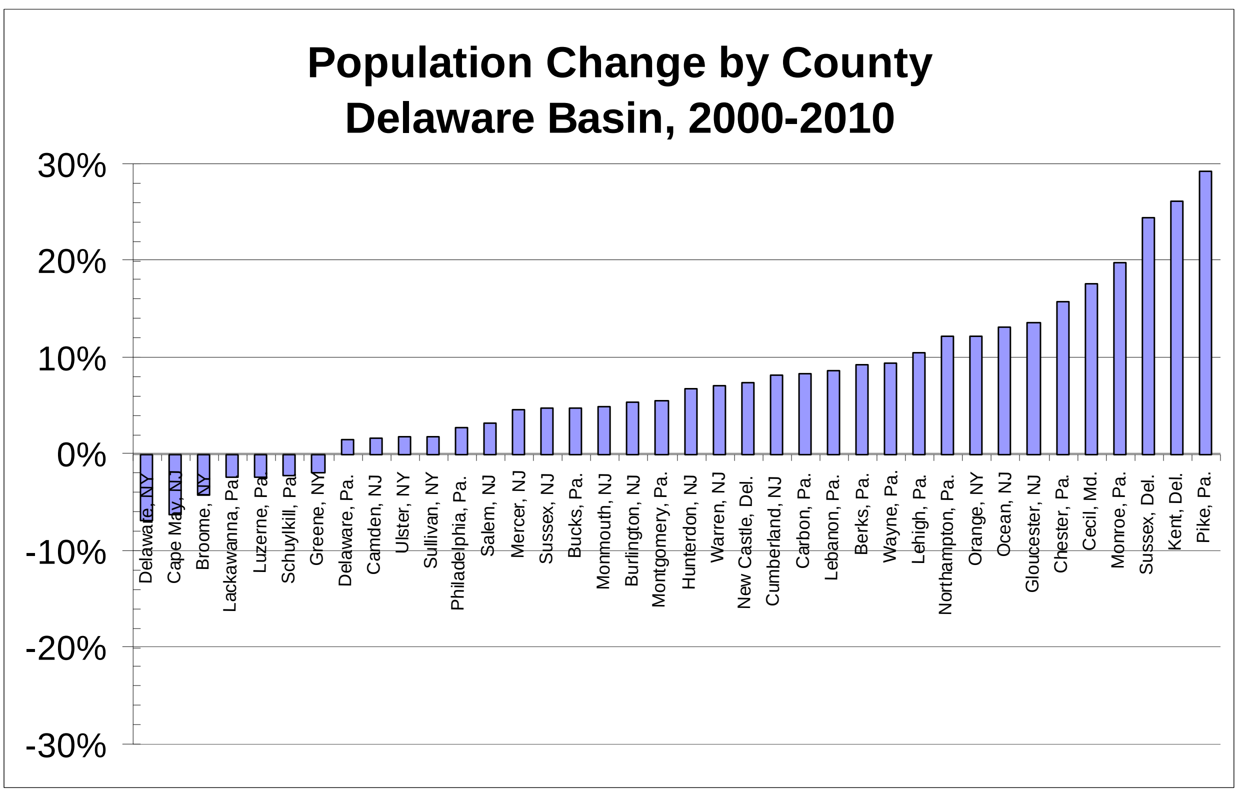
The Delaware River Basin occupies almost 13,000 sq mi (not including the river and bay) in Delaware, Maryland, New Jersey, New York, and Pennsylvania. In 2010, over 8.2 million residents lived in the basin including 654,000 people in Delaware, 2,300 in Maryland, 1,964,000 in New Jersey, 131,000 in New York, and 5,469,000 in Pennsylvania. Nearly 3,500,000 people work in the basin with 316,000 jobs in Delaware, 823,000 jobs in New Jersey, 70,000 jobs in New York, and 2,271,000 jobs in Pennsylvania. An additional 8 million people in New York City and northern New Jersey receive drinking water from the Delaware River via interbasin transfers. The Delaware Basin occupies just 0.4% of the continental U.S. yet supplies drinking water to 5% of the U.S. population.

The Delaware Basin population exceeds 8.2 million which if counted together would be the 12th most populous state after New Jersey but ahead of Virginia. The Delaware Basin occupies:
- Delaware (50% of the State's area and 74% of the First State's population)
- New Jersey (40% of the State's area and 22% of the Garden State's population)
- New York (5% of the State's area and 0.7% of the Empire State's population)
- Pennsylvania (14% of the State's area and 43% of the Keystone State's population.

Between 2000 and 2010, the population in the Delaware Basin increased by 6.1% or 472,066 people. Over the last decade, the population increased by 30% in Pike County, Pa.; by over 20% in Kent and Sussex counties, Del. and Monroe County, Pa.; and by over 10% in Gloucester and Ocean counties, NJ, Orange County, NY, and Chester, Lehigh, and Northampton counties, Pa. For the first time in two generations, Philadelphia gained population. Several counties in the basin lost population since 2000: Cape May, NJ; Broome, Delaware, and Greene counties, NY; and Lackawanna, Luzerne, and Schuylkill counties, Pa.


Watersheds of the Delaware River Basin
East-West Branch Watersheds
Lackawaxen Watersheds
Neversink-Mongaup Watersheds
Upper Central Watersheds
Lower Central Watersheds
Lehigh Valley
Schuylkill Valley
Upper Estuary Watersheds
Lower Estuary Watersheds
Delaware Bay Watersheds
N
0 10 20
Miles
DRBC
Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA
New York
Pennsylvania
New Jersey
Maryland
Delaware
East-West Branch
Neversink-Mongaup
Lackawaxen
Upper Central
Lehigh Valley
Schuylkill Valley
Lower Central
Upper Estuary
Lower Estuary
Delaware Bay
CHENANGO COUNTY
DELAWARE COUNTY
SCHOHARIE COUNTY
GREENE COUNTY
BROOME COUNTY
WAYNE COUNTY
SULLIVAN COUNTY
ULSTER COUNTY
LACKAWANNA COUNTY
ORANGE COUNTY
LUZERNE COUNTY
PIKE COUNTY
SUSSEX COUNTY
MONROE COUNTY
WARREN COUNTY
CARBON COUNTY
MORRIS COUNTY
NORTHAMPTON COUNTY
SCHUYLKILL COUNTY
LEHIGH COUNTY
HUNTERDON COUNTY
BERKS COUNTY
MERCER COUNTY
LEBANON COUNTY
MONTGOMERY COUNTY
BUCKS COUNTY
MONMOUTH COUNTY
CHESTER COUNTY
LANCASTER COUNTY
DELAWARE COUNTY
BURLINGTON COUNTY
CAMDEN COUNTY
OCEAN COUNTY
GLOUCESTER COUNTY
SALEM COUNTY
ATLANTIC COUNTY
NEW CASTLE COUNTY
CUMBERLAND COUNTY
CAPE MAY COUNTY
KENT COUNTY
SUSSEX COUNTY
Cannonsville Reservoir
West Branch Delaware River
East Branch Delaware River
Pepacton Reservoir
Deposit
Hancock
Delaware River
Neversink Reservoir
Mongaup System
Neversink R.
Jadwin Reservoir
Prompton Reservoir
Lackawaxen R.
Narrowsburg
Lake Wallenpaupack
Port Jervis
Milford
Montague
F.E. Walter Reservoir
Penn Forest and Wild Creek Reservoirs
Beltzville Reservoir
Delaware Water Gap
Musconetcong River
Hopatcong Lake
Merrill Creek Reservoir
Phillipsburg
Easton
Lehigh River
Allentown
Nockamixon Reservoir
Blue Marsh Reservoir
Ontelaunee Reservoir
Reading
Green Lane Reservoir
New Hope
Lambertville
Lake Galena
Pottstown
Neshaminy Cr.
Trenton
Schuylkill River
Marsh Creek Reservoir
Philadelphia
Geist Reservoir
Rancocas Cr.
Camden
Brandywine
Wilmington
Hoopes
Christina R.
Salem River
Salem
C & D Canal
Maurice River
Vineland
Union Lake
Dover
Milford
Mispillion R.
Lewes


Population Change
Delaware Basin, 2000-2010
600,000
500,000
400,000
300,000
200,000
100,000
0
64,193
348
99,977
661
332,796
497,976
Delaware
Maryland
New Jersey
New York
Pennsylvania
Del. Basin


Population Change by County
Delaware Basin, 2000-2010
30%
20%
10%
0%
-10%
-20%
-30%
Delaware, NY
Cape May, NJ
Broome, NY
Lackawanna, Pa.
Luzerne, Pa.
Schuylkill, Pa.
Greene, NY
Delaware, Pa.
Camden, NJ
Ulster, NY
Sullivan, NY
Philadelphia, Pa.
Salem, NJ
Mercer, NJ
Sussex, NJ
Bucks, Pa.
Monmouth, NJ
Burlington, NJ
Montgomery, Pa.
Hunterdon, NJ
Warren, NJ
New Castle, Del.
Cumberland, NJ
Carbon, Pa.
Lebanon, Pa.
Berks, Pa.
Wayne, Pa.
Lehigh, Pa.
Northampton, Pa.
Orange, NY
Ocean, NJ
Gloucester, NJ
Chester, Pa.
Cecil, Md.
Monroe, Pa.
Sussex, Del.
Kent, Del.
Pike, Pa.

Annual Economic Activity

The Delaware Basin contributes over $25 billion in annual market/non-market value to the regional economy from the following activities:

• Recreation	$1.22 billion
• Fish and Wildlife	$1.55 billion
• Public Parks	$1.83 billion
• Water Quality	$2.46 billion
• Navigation/Ports	$2.62 billion
• Marcellus Shale Natural Gas (potential)	$3.30 billion
• Agriculture	$3.37 billion
• Water Supply	$3.82 billion
• Forests	$5.13 billion

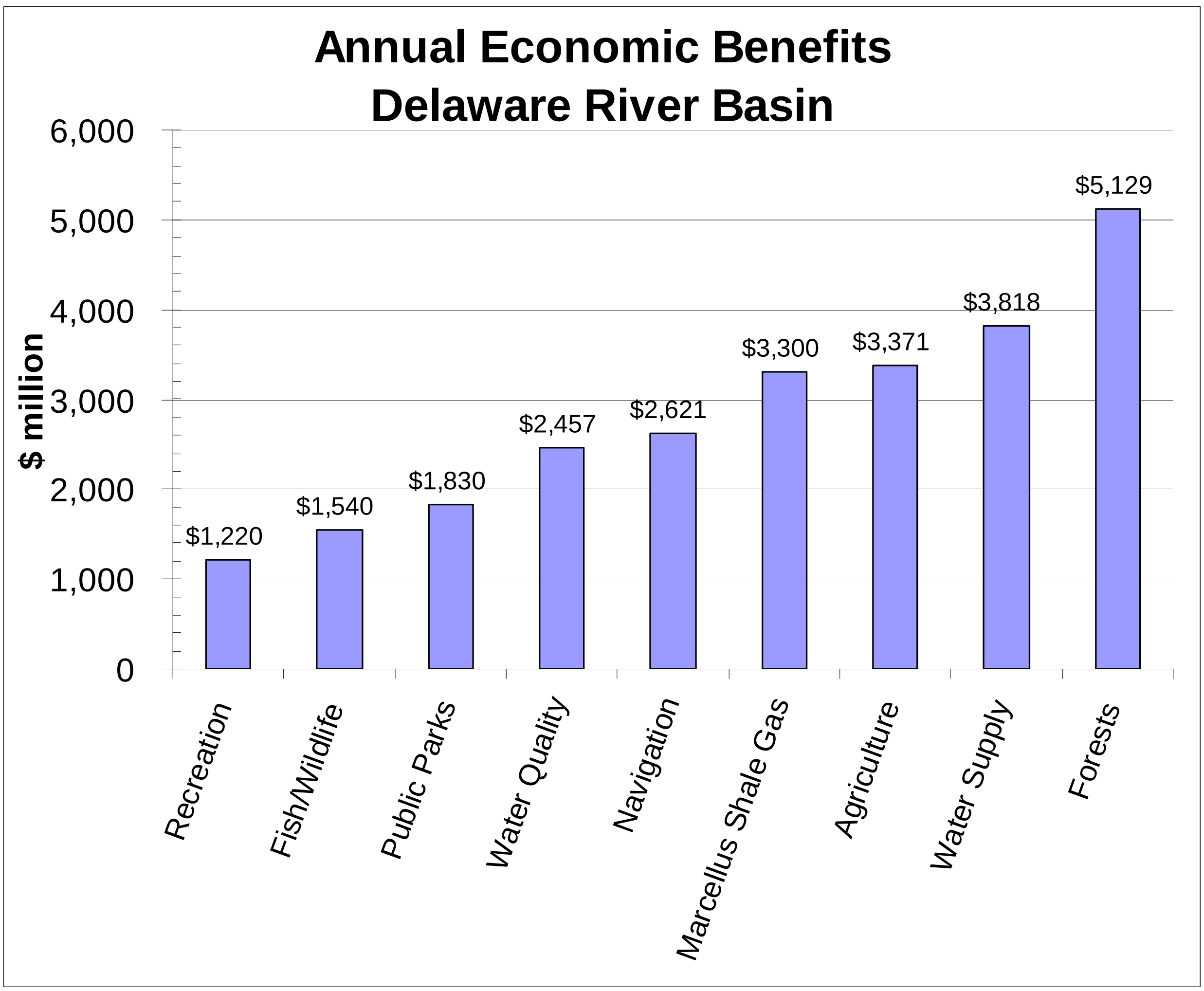


Table E1. Annual economic value supported by the Delaware River Basin.

Market Value	2010 ($ million)	Sources
Recreation (Boating, Fishing, Swimming)		
Skiing (1.9 million ski-days @ $45/day)	325	Penna Ski Areas Association (2010
Paddling-based Recreation (620,860 paddlers)	362	Outdoor Industry Association (2006)
Del. Water Gap River Recreation (267,000 visits)	41	U.S. Forest Service, Nat'l Park Service (1990)
Canoe/Kayak/Rafting (225,000 visits)	9	Canoe and Kayak Liveries (2010)
Powerboating (232,000 boat registrations)	395	National Marine Manufacturers Assoc. (2010)
Water Quality		
Water Treatment by Forests ($96/mgd)	63	Trust for Public Land, AWWA (2004)
Wastewater Treatment ($4.00/1000 gal)	1,722	DRBC and USEPA
Increased Property Value (+8%, 2000 ft of river)	13	EPA (1973), Brookings Institute (2010)
Water Supply		
Drinking Water Supply ($4.78/1000 gal)	3,145	UDWRA and DRBC (2010)
Reservoir Storage ($0.394/1000 gal)	145	UDWRA and DRBC (2010)
Irrigation Water Supply ($300/ac-ft)	32	Resources for Future (1996), USDA (2007)
Thermoelectric Power Water Supply ($44/ac-ft)	297	EIA (2002), NETL (2009)
Industrial Water Supply ($200/ac-ft)	179	Resources for Future (1996), DRBC (2010)
Hydropower Water Supply ($32/ac-ft)	20	Resources for Future (1996), DRBC (2010)
Fish/Wildlife		
Commercial Fish Landings ($0.60/lb)	34	NMFS, Nat'l. Ocean Econ. Program (2007)
Fishing (11-18 trips/angler, $53/trip)	576	U. S. Fish and Wildlife Service (2001)
Hunting (16 trips/hunter, $50/trip)	340	U. S. Fish and Wildlife Service (2001)
Wildlife/Bird-watching (8-13 trips/yr, $27/trip)	561	U. S. Fish and Wildlife Service (2001)
Shad Fishing (63,000 trips, $102/trip)	6	Pennsylvania Fish & Boat Comm. (2011)
Wild Trout Fishing	29	Sportfishing Assn./Trout Unlimited (1998)
Agriculture		
Crop, poultry, livestock value ($1,180/ac)	3,371	USDA Census of Agriculture 2007 (2009)
Public Parks		
Del. Water Gap Natl. Rec. Area (4.9 million visits)	100	U.S. National Park Service (2002)
Marcellus Shale		
Natural Gas (potential)	3,300	USGS (2011), EIA (2011)
Maritime Transportation		
Navigation ($15/ac-ft)	220	Resources for the Future (1996)
Port Activity	2,400	Economy League of Greater Phila. (2008)
Delaware Basin Market Value	**≈ $17.7 billion**	
Non-Market Value		
Recreation (Boating, Fishing, Swimming)		
Clean Water Act Restoration		
Viewing/Aesthetics ($0.58/person)	5	University of Delaware (2003)
Boating ($0.76/person)	6	University of Delaware (2003)
Fishing ($2.95/person)	24	University of Delaware (2003)
Swimming ($6.88/person)	57	University of Delaware (2003)
Water Quality		
WTP for Clean Water ($38/nonuser-$121/user)	659	University of Maryland (1989)
Forests		
Carbon Storage ($827/ac)	3,592	U.S. Forest Service, Del. Center Hort. (2008)
Carbon Sequestration ($29/ac)	126	U.S. Forest Service, Del. Center Hort. (2008)
Air Pollution Removal ($266/ac)	1,155	U.S. Forest Service, Del. Center Hort. (2008)
Building Energy Savings ($56/ac)	243	U.S. Forest Service, Del. Center Hort. (2008)
Avoided Carbon Emissions ($3/ac)	13	U.S. Forest Service, Del. Center Hort. (2008)
Public Parks		
Health Benefits ($9,734/ac)	1,283	Trust for Public Land (2009)
Community Cohesion ($2,383/ac)	314	Trust for Public Land (2009)
Stormwater Benefit ($921/ac)	121	Trust for Public Land (2009)
Air Pollution ($88/ac)	12	Trust for Public Land (2009)
Delaware Basin Non-Market Value	**≈ $7.6 billion**	

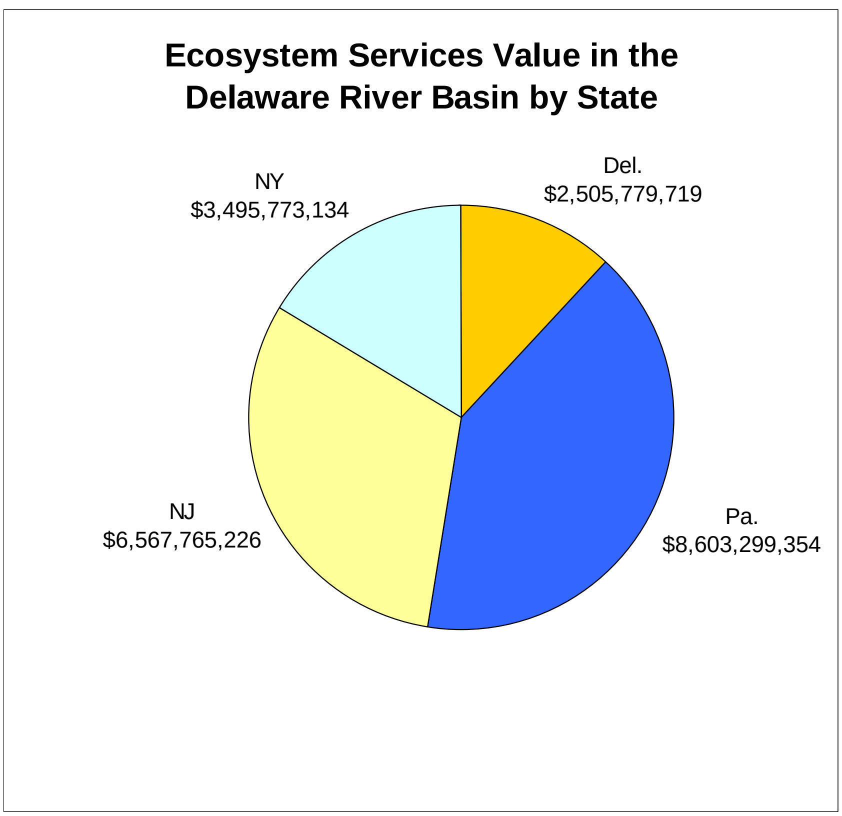
Ecosystem Services

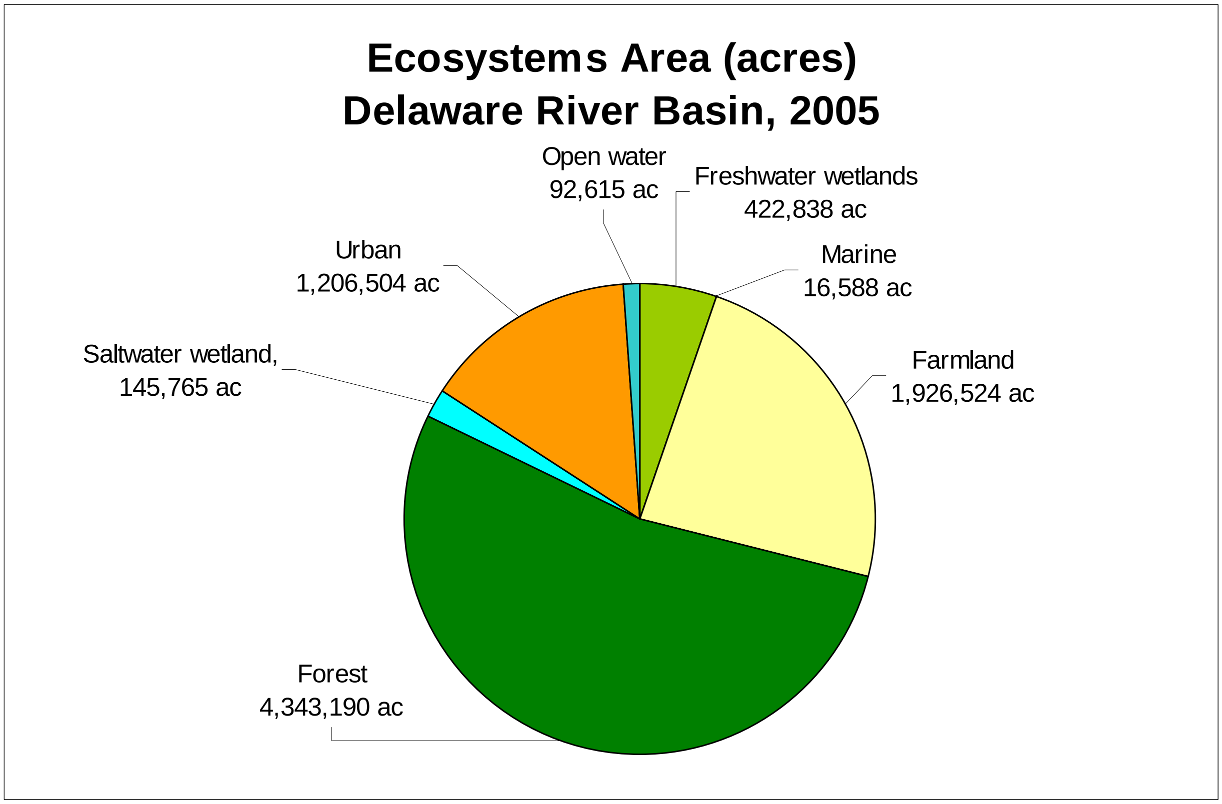
The value of natural goods and services from ecosystems in the Delaware Basin is $21 billion ($2010) with net present value (NPV) of $683 billion using a discount of 3% over 100 years. The contributions of ecosystem services by state include:

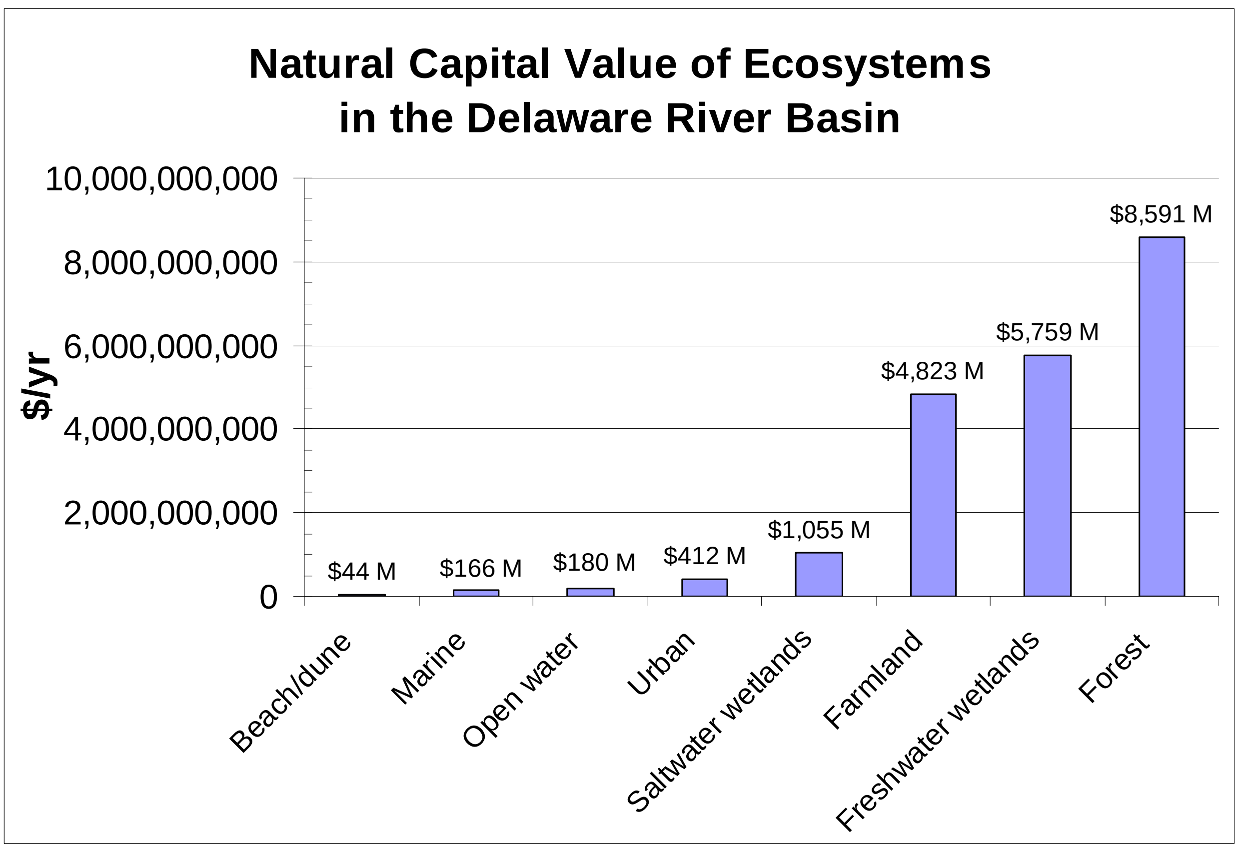
- Delaware ($2.5 billion, NPV $81.4 billion)
- New Jersey ($6.6 billion, NPV $213.4 billion)
- New York ($3.5 billion, NPV $113.6 billion)
- Pennsylvania ($8.6 billion, NPV $279.6 billion)

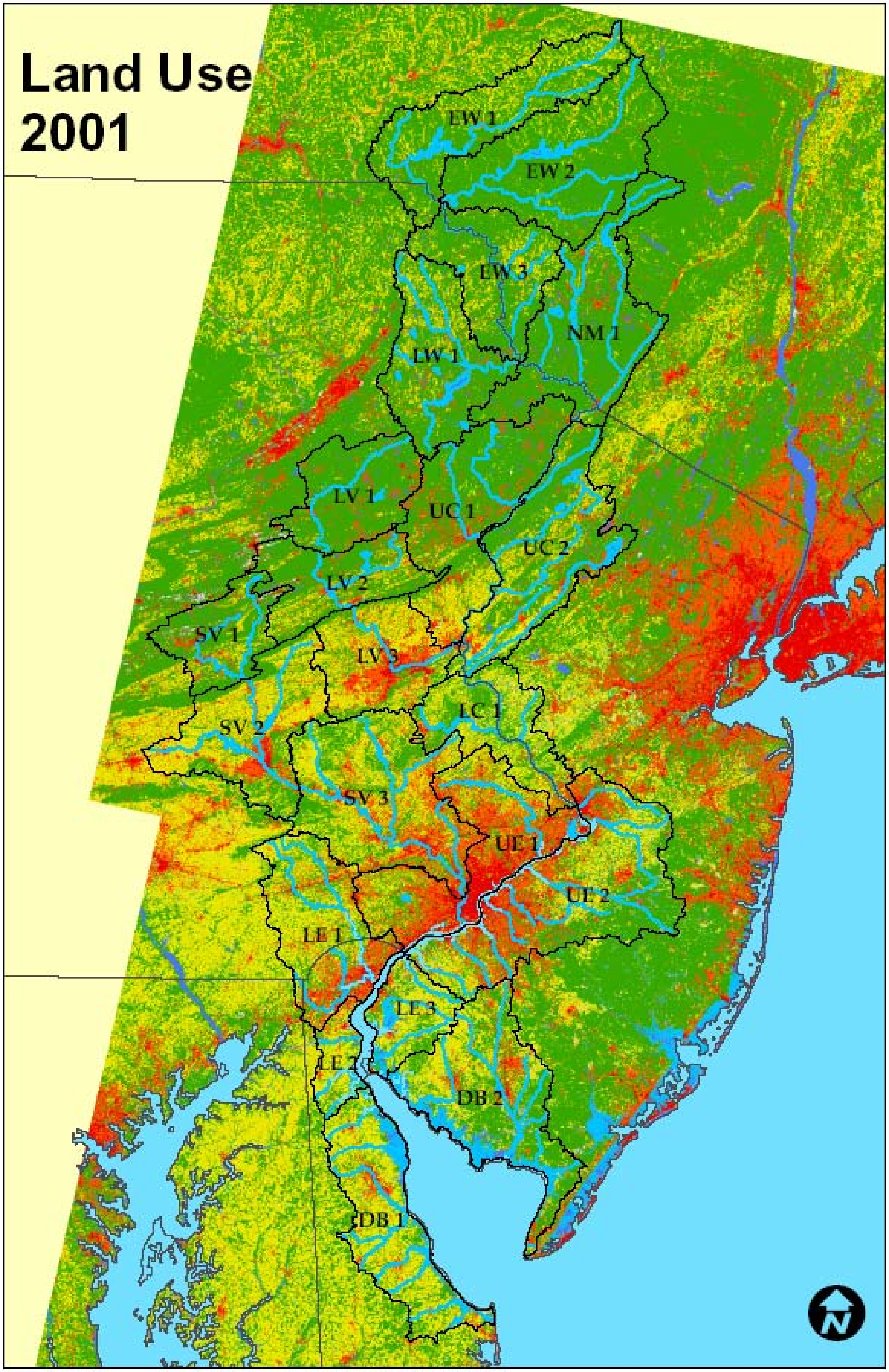
Table E2. Ecosystem goods and services provided by the Delaware River Basin

Ecosystem	Area (ac)	$/ac/yr 2010	$/yr 2010	NPV $
Freshwater wetlands	422,838	13,621	5,759,329,048	187,178,194,067
Marine	16,588	10,006	165,982,947	5,394,445,767
Farmland	1,926,524	2,503	4,823,030,404	156,748,488,136
Forest land	4,343,190	1,978	8,591,367,360	279,219,439,184
Saltwater wetland	145,765	7,235	1,054,617,851	34,275,080,170
Urban	1,206,504	342	412,157,579	13,395,121,322
Beach/dune	900	48,644	43,758,633	1,422,155,566
Open water	92,615	1,946	180,210,703	5,856,847,857
Total	**8,154,924**		**$21,030,454,525**	**$683,489,772,069**




Ecosystems Area (acres)
Delaware River Basin, 2005
Open water
92,615 ac
Freshwater wetlands
422,838 ac
Urban
1,206,504 ac
Marine
16,588 ac
Saltwater wetland,
145,765 ac
Farmland
1,926,524 ac
Forest
4,343,190 ac


Natural Capital Value of Ecosystems
in the Delaware River Basin
$/yr
10,000,000,000
8,000,000,000
6,000,000,000
4,000,000,000
2,000,000,000
0
$44 M
$166 M
$180 M
$412 M
$1,055 M
$4,823 M
$5,759 M
$8,591 M
Beach/dune
Marine
Open water
Urban
Saltwater wetlands
Farmland
Freshwater wetlands
Forest


Land Use
2001
EW 1
EW 2
EW 3
NM 1
LW 1
LV 1
UC 1
UC 2
LV 2
SV 1
LV 3
LC 1
SV 2
SV 3
UE 1
UE 2
LE 1
LE 3
LE 2
DB 2
DB 1

Jobs and Wages

The Delaware River Basin is a jobs engine that supports 600,000 direct/indirect jobs with $10 billion in annual wages in the coastal, farm, ecotourism, water/wastewater, ports, and recreation industries.

Table E3. Jobs and wages directly and indirectly supported by the Delaware River Basin

Sector	Jobs	Wages ($ million)	Source
Direct Basin Related	240,621	4,900	U.S. Bureau of Labor Statistics, 2009
Indirect Basin Related	288,745	4,000	U.S. Census Bureau, 2009
Coastal	44,658	947	National Coastal Economics Program, 2009
Farm	45,865	1,376	USDA Census of Agriculture, 2007
Fishing/Hunting/Birding	44,941	1,476	U.S. Fish and Wildlife Service, 2008
Water Supply Utilities	8,750	485	UDWRA and DRBC, 2010
Wastewater Utilities	1,298	61	UDWRA and DRBC, 2010
Watershed Organizations	201	10	UDWRA and DRBC, 2010
Ski Area Jobs	1,753	88	Penna. Ski Areas Association
Paddling-based Recreation	4,226		Outdoor Industry Association (2006
River Recreation	448	9	U. S. Forest Service/Nat'l. Park Service, 1990
Canoe/Kayak/Rafting	225		Canoe Liveries and UDWRA, 2010
Wild Trout Fishing	350	4	Maharaj, McGurrin, and Carpenter, 1998
Del. Water Gap Nat'l. Rec. Area	7,563	101	Stynes and Sun, 2002
Port Jobs	12,121	772	Economy League of Greater Phila., 2008
Delaware Basin Total	**> 600,000**	**>$10 billion**	

Within the Delaware Basin are 3,480,483 jobs earning $172.6 billion in wages including:

- Delaware (316,014 jobs earning $16.5 billion in wages)
- New Jersey (823,294 jobs, $38.1 billion in wages)
- New York (69,858 jobs earning $2.5 billion in wages)
- Pennsylvania (2,271,317 jobs earning $115.5 billion in wages)

Jobs directly associated with the Delaware River Basin (such as water/sewer construction, water utilities, fishing, recreation, tourism, and ports) employ 240,621 with $4.9 billion in wages including:

- Delaware (15,737 jobs earning $340 million in wages)
- New Jersey (62,349 jobs earning $1.3 billion in wages)
- New York (32,171 jobs earning $550 million in wages)
- Pennsylvania (130,364 jobs earning $2.8 billion in wages)

Jobs indirectly related to the waters of the Delaware Basin (based on multipliers of 2.2 for jobs and 1.8 for salaries) employ 288,745 people with $4.0 billion in wages including:

- Delaware (18,884 jobs earning $270 million in wages)
- New Jersey (74,819 jobs earning $1.0 billion in wages)
- New York (38,605 jobs earning $400 million in wages)
- Pennsylvania (156,437 jobs earning $2.2 billion in wages)

According to the National Coastal Economy Report (2009), coastal employment sectors within the Delaware River Basin are responsible for 44,658 jobs earning $947 million in wages with contributions of $1.8 billion toward the GDP including:

- Delaware (12,139 jobs, $214 million in wages, $392 million toward the GDP)
- New Jersey (4,423 jobs, $140 million in wages, $235 million toward the GDP).
- Pennsylvania (28,096 jobs, $593 million in wages, $1.2 billion toward the GDP.

Over 21,800 farms provide 45,865 jobs with $1.9 billion in wages in the Delaware Basin including:

- Delaware (3,140 farm jobs earning $129 million in wages)
- New Jersey (14,305 farm jobs earning $587 million in wages)
- New York (2,410 farm jobs earning $99 million in wages)
- Pennsylvania (26,010 farm jobs earning $1.1 billion in wages)

Fishing, hunting, and bird watching/wildlife associated recreation employ 44,941 jobs with $1.5 billion in wages in the Delaware Basin including:

- Delaware (4,080 jobs earning $134 million in wages)
- New Jersey (17,477 jobs earning $574 million in wages)
- New York (4,872 jobs earning $160 million in wages)
- Pennsylvania (18,512 jobs earning $608 million in wages)
-

Public and private water utilities that withdraw drinking water from the Delaware River Basin employ 8,750 people with wages of $485 million including:

- Delaware (141 jobs earning $7.8 million in wages)
- New Jersey (823 jobs earning $46 million in wages)
- New York (5,600 jobs earning $310 million in wages)
- Pennsylvania (2,186 jobs earning $121 million in wages)

Wastewater utilities that treat and discharge wastewater to the Delaware River Basin employ 1,298 people with wages of $61 million including:

- Delaware (108 jobs earning $5 million in wages)
- New Jersey (257 jobs earning $12 million in wages)
- New York (20 jobs earning $1 million in wages)
- Pennsylvania (913 jobs earning $43 million in wages)

Over 100 nonprofit watershed and environmental organizations employ at least 200 staff who earn at least $9.5 million in wages to restore the watersheds in the Delaware River Basin.

In the Pocono Mountains of Pennsylvania, 9 ski resorts support 1,753 direct jobs in the Delaware Basin from aggregate annual revenues of $87,655,063 from 1,908,228 skier visits.

Paddling-based recreation in the Delaware Basin is responsible for 620,860 participants and 4,226 jobs according to data prorated from the Outdoor Industry Association (2006).

The U. S. Forest Service and U.S. National Park Service estimated river recreation along the Upper Delaware River and Delaware Water Gap was responsible for 448 jobs with wages of $8.8 million in $1986.

The 37 canoe/kayak liveries along the Delaware, Lehigh, and Schuylkill, and Brandywine Rivers have earnings of $9 million per year and employ 225 people to lease watercraft to 225,000 visitors.

Along the Beaverkill, East Branch, West Branch, and upper main stem of the Delaware River in New York, wild trout fishing provides for 350 jobs with $3.6 million in wages.

The Delaware Water Gap National Recreation Area recorded 4,867,272 recreation visits in 2001 that generated $106 million in sales and 7,563 direct/indirect jobs with $100 million in wages.

Delaware River ports from Wilmington to Philadelphia to Trenton are collectively the 5th largest port in the U.S. based on imports and the 20 largest U.S. port based on exports. These ports:

- Employ 4,056 workers who earn $326 million in wages.
- Provide port jobs that support an additional two jobs each in port activity and employee spending for a total of 12,121 port related jobs with $772 million in wages.
- Most of the 4,056 direct port jobs are in cargo handling and warehousing with petroleum port jobs adding up to less than 10% of employment
- Provides good jobs, the average salary of a port employee (with benefits) is over $80,000.

River Recreation

Cordel et al. (1990) from the U. S. Forest Service and U.S. National Park Service estimated river recreation along the Upper Delaware River and Delaware Water Gap was responsible for $13.3 million and $6.9 million in total economic output, respectively, in $1986 (Table 11). Adjusting for 3% annually, river recreation economic output along the Upper Delaware River and Delaware Water Gap is roughly $27.1 million and $14.1 million, respectively, or $41.2 million total in $2010.

Table 11. Economic impacts of river recreation along Upper Delaware and Delaware Water Gap

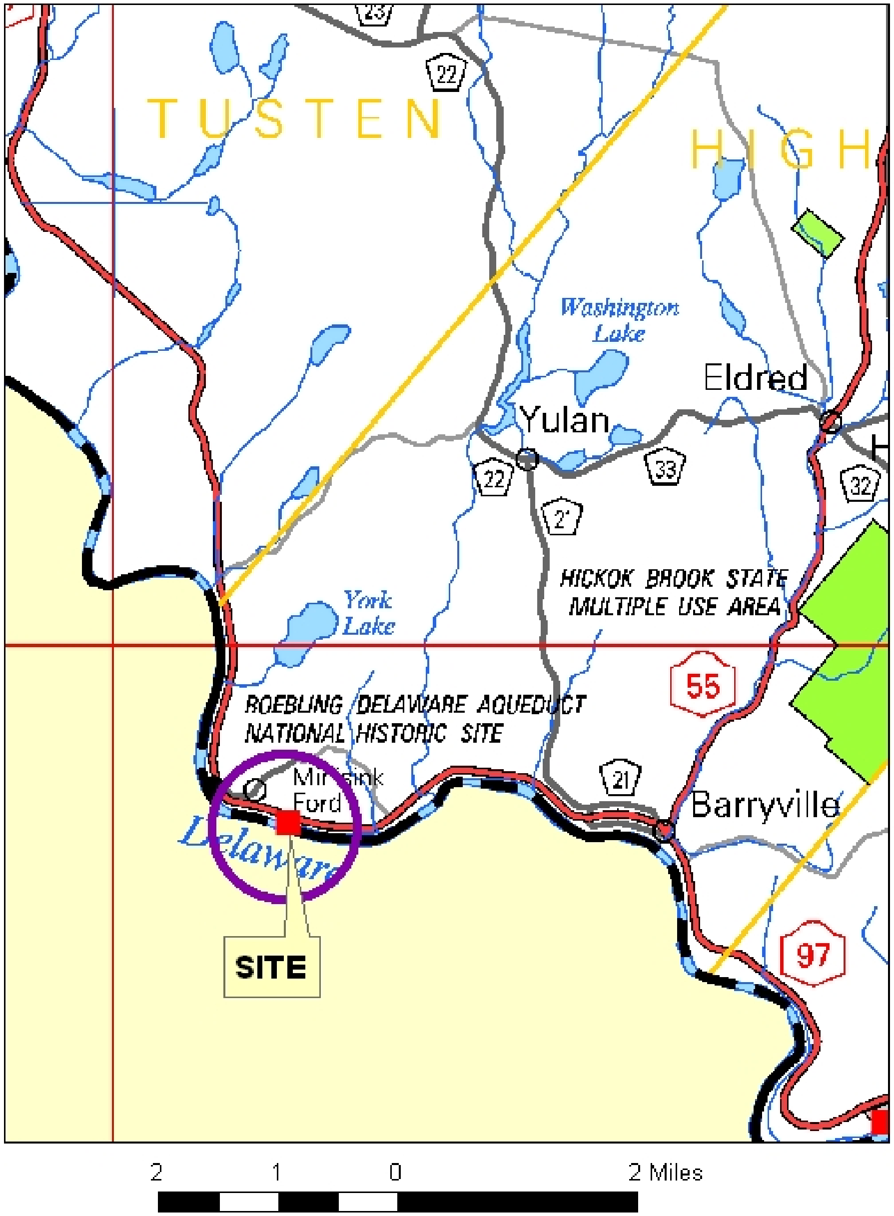
River	Participants	Jobs	Wages ($1986)	Economic Output ($1986)	Wages ($2010)	Economic Output ($2010)
Upper Delaware	232,000	292	5,582,800	13,351,000	11,408,000	$27,100,000
Del. Water Gap	135,400	156	3,246,300	6,929,000	6,633,743	$14,100,000
Total	**367,400**	**448**	**8,829,100**	**20,280,000**	**18,041,743**	**41,200,000**

1. Cordel et al. 1990. 2. Adjusted to $2010 at 3% annually.

Canoe/Kayak/Rafting

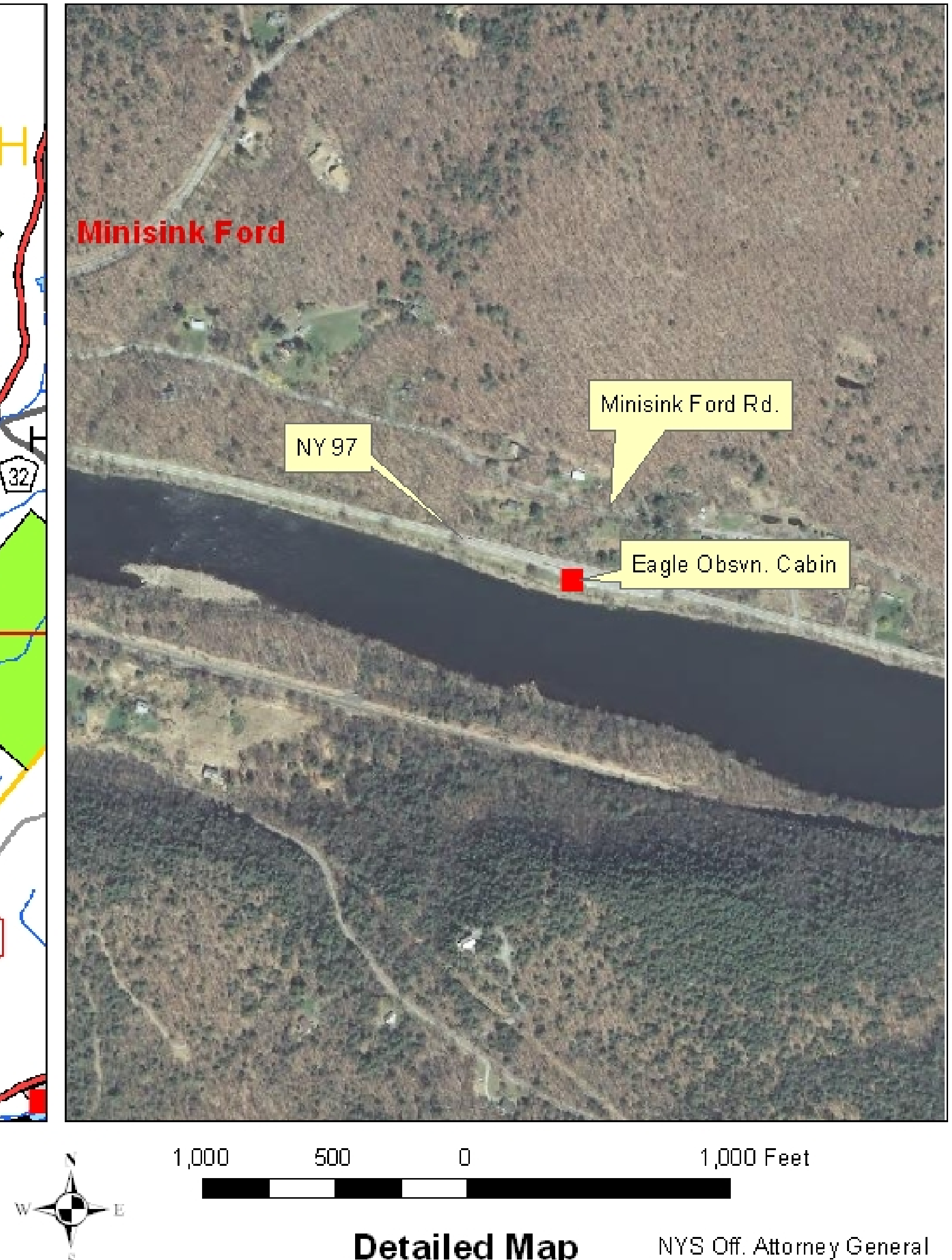
Thirty seven (37) canoe and kayak liveries along the Delaware, Lehigh, and Schuylkill, and Brandywine Rivers lease watercraft to approximately 225,000 visitors with earnings of $9 million per year assuming a daily rental fee of $40 per person (Table 12).

EXHIBIT L



General Map

■ Eagle Observation Blind



Detailed Map

NYS Off. Attorney General
Envrl. Protection Bureau
October 2011

Delaware River and NY 97 Eagle Observation Blind


Eagle Observation Area
QUIET PLEASE
TURN OFF ENGINES
NO MUSIC
LOW VOICES ONLY
Is it an Eagle?
Eagle Etiquette
Human presence and disturbances can stress the eagles and affect their overall health. Whether a winter visitor or year-round breeder, the eagles should not be disturbed or harmed in any way.
Practice Eagle Etiquette for the least intrusive experience:
- Remain in or near your vehicle, or move quickly and quietly into this observation blind.
- Avoid loud noises. Yelling, car horns, slamming doors, and any unnecessary movements.
- Use binoculars or spotting scopes to view eagles. Window-mounted scopes in your vehicle work well.
- Keep your distance. Don't try to approach any eagles or try to get a little bit closer.
- Don't do anything to try to make the eagle fly.
- Obey the law! There are serious consequences (high fines and/or imprisonment) for disturbing, harming or killing eagles.
Because most eagle watching is done in winter, for your own safety:
- Be prepared for snow, ice, mud and frigid temperatures.
- Dress for extreme cold and avoid hypothermia.
- Limit exposure to the cold and wind; return to your vehicle often for warmth.
The Eagle Institute

Mongaup Valley Wildlife Management Area

One of North America's largest birds of prey (raptors), bald eagles stand about 30 inches high, have a wingspan of 72-84 inches and weigh between 8 and 14 pounds. Their life span in the wild is more than 30 years. Their call has been described as a harsh cackle, kleek-kik-ik-ik-ik or a lower kak-kak-kak.

Bald Eagle Restoration, Research and Management

During the 1800s and early 1900s, New York State was home to as many as 80 nesting pairs of bald eagles and served as wintering grounds for several hundred. By 1960, however, the state had only one known, active bald eagle nest remaining, and the number of wintering visitors had been reduced to only a few dozen.

About 20 years later, bald eagle populations experienced a dramatic turnaround thanks to a national ban on DDT, the federal Endangered Species Act, New York State's Endangered Species Program and the state's listing of eagles as endangered. Nationally, eagles are still protected under the Migratory Bird Treaty Act (MBTA) and the National Bald and Golden Eagle Act.

Successful bald eagle restoration in New York has resulted from DEC programs that:

- Restricted the use of toxic substances that interfere with their breeding
- Protected and restored their species in the wild
- Protected critical eagle habitat

Destruction of habitat is the most damaging activity to eagle populations. Therefore, we must secure sufficient, suitable eagle habitat and limit human disturbance within it.

This majestic bird is unmistakable in adult plumage, its brown body set off by a white head and tail and a bright yellow bill. Male and female bald eagles look identical except that the female is usually about one-third larger and heavier, as is typical in birds of prey. Sexual maturity and the characteristic white head and tail are achieved around five years of age. Bald eagles are found throughout Canada and in every state except Hawaii. Historically, they nested in forests along the shorelines of waterbodies throughout most of North America, often moving south in winter to areas where water remained open.

Immature bald eagles lack the characteristic white head and tail of adults. They are mostly chocolate brown, with varying amounts of white on the body, tail and under-wings, and their bills are grey. Juvenile bald eagles are often mistaken for golden eagles, which are much rarer in New York State.

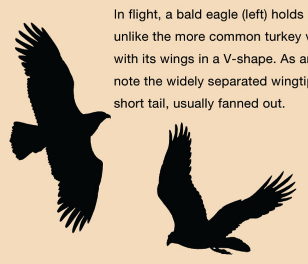
Bald eagles mate for life. Reaching sexual maturity around age 5, they return to nest in the general area (within 250 miles) from which they fledged. Once a pair selects a nesting territory, they use it for life. Bald eagles breed throughout New York State, usually in areas with large bodies of water that support high fish populations. Currently, breeding bald eagles are absent from Long Island, where they historically nested.

Nesting: The nesting season begins in late February and March. Males and females build nests together and continue to add sticks each breeding season. A bald eagle's nest is a large, flat-topped mass of sticks lined with fine vegetation such as rushes, grasses and mosses. Usually located high in a tall, live, white pine tree near water, nests are reused and enlarged each year, often becoming eight or more feet deep, six feet across and weighing hundreds of pounds.

Eggs and young: Female bald eagles lay one or two eggs, occasionally three, in March. They are slightly smaller than domestic goose eggs and are dull white. Only one eagle egg is laid per day, although not always on successive days. The adults incubate and care for their young together; however, the female is primarily responsible for them. In New York State, the young fledge by mid- to late summer at about 12 weeks of age. By 20 weeks, they are largely independent.

The New York State Bald Eagle Restoration Project began in 1976 in an attempt to reestablish a breeding population through hacking (hand rearing to independence). During a 13-year period, 198 nestlings were collected (most from Alaska), transported and released in New York. The hacking project ended in 1989 after accomplishing its goal of establishing ten breeding pairs.

New York State has been enjoying a long-term, consistent annual increase in the breeding bald eagle population of 10-15% per year. In 2009, there were approximately 201 occupied bald eagle nest sites in New York. Of these, 123 nests fledged 223 young.



In flight, a bald eagle (left) holds its wings straight out, unlike the more common turkey vulture, which soars with its wings in a V-shape. As an eagle passes overhead, note the widely separated wingtip feathers and the relatively short tail, usually fanned out.

New York State Department of Environmental Conservation www.dec.ny.gov

Eagle Viewing Tips

Harassing, disturbing or injuring a bald eagle is a federal offense and carries a penalty of up to $20,000 and/or one year in jail. Remember that eagles should remain undisturbed, and they must conserve energy during winter.

The following tips for eagle viewing will ensure the best possible experience:

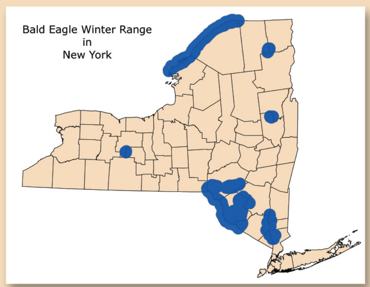
•Arrive early (7 AM - 9 AM), or stay late (4 PM - 5 PM), when eagles are most active.
•Use a designated bald eagle viewing site.
•Scan the tree line for eagles that are perched in tree tops.
•Look overhead for eagles soaring high in the sky.
•Check ice floes or river islands for eagles sunning themselves or enjoying a meal.
•Be patient; it's the key to successful viewing.

For the safest and least intrusive bald eagle viewing, we recommend the following:

•Leave pets at home.
•Refrain from making loud noises, such as yelling, etc.
•Don't attempt to make an eagle fly.
•Use binoculars or spotting scopes instead of trying to get closer.
•Respect private property, and avoid restricted areas.

Winter is the best time to observe bald eagles in New York State. They begin arriving in December, with peak concentrations in January and February. During the non-breeding season, bald eagles tend to concentrate at wintering areas and roosts at four open-water sites: the upper Delaware River, the Saint Lawrence River, the lower Hudson River and the Sacandaga River. Many hydroelectric plants, such as in Mongaup Valley, provide suitable wintering habitat for bald eagles. Although their primary prey is fish, bald eagles will eat mammals, waterfowl, seabirds and carrion, especially in winter.

Bald eagles breed throughout New York State, usually in areas with large bodies of water that support high fish populations. Currently, breeding bald eagles are absent from Long Island, where they historically nested.

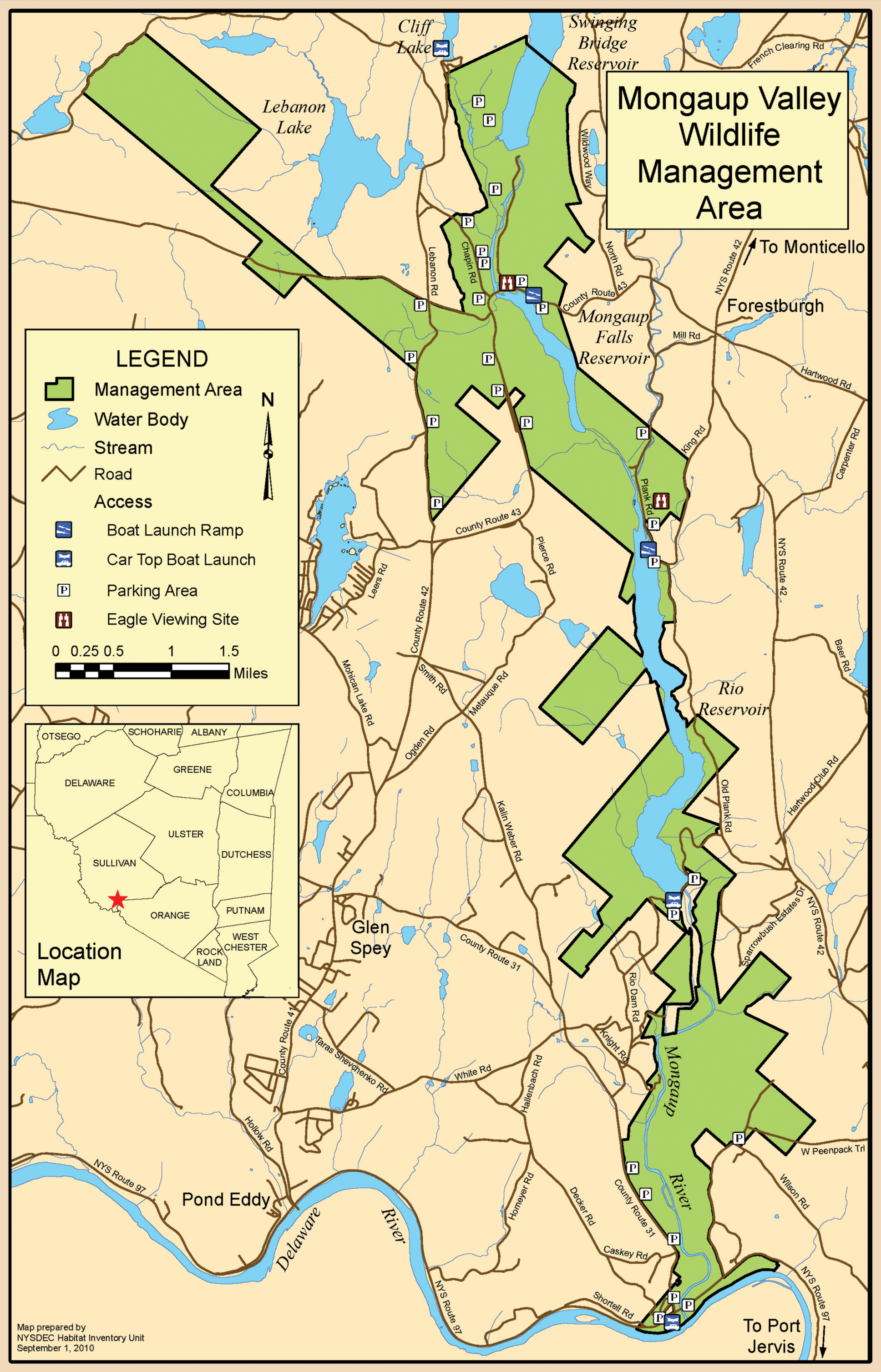


Sound the Alarm–Support the Eagles

•If you see someone harassing or injuring an eagle, or if you spot destruction of eagle habitat or find an injured or dead eagle, report it at once to DEC Law Enforcement at 1-800-TIPP-DEC.
•Support legislation that helps protect the eagle and its habitat.
•Participate in local planning and development.
•Support organizations that work toward conservation of eagles and all wildlife.

New York State Department of Environmental Conservation www.dec.ny.gov

Mongaup Valley Wildlife Management Area



Mongaup Valley Wildlife Management Area

Early Settlement

Mongaup Valley was initially settled by members of the Leni-Lanapes or the Algonkian Nation who were then conquered by the Mengwe of the Iroquois Confederacy. In 1768, the Mengwe sold the lands, including all of the ancient territory of the Leni-Lenape, to European settlers–mostly trappers, hunters and lumbermen.

In 1798, the New York State Legislature created the Town of Lumberland. The early to mid-1800s saw the height of the lumber industry in the town due to tremendous resources of virgin forests, which were harvested for timber and bark used in the tanning industry.

The Delaware and Hudson (D&H) Canal, used for transporting coal from the mines of Pennsylvania to Kingston, opened in 1828 and brought increased settlement and growth to the area. By 1898, the canal had closed due to competition from railroads.

In 1891, Chester W. Chapin, Jr. began buying land in the area, eventually accruing 18,000 acres that became known as Chapin Park. After Chapin's death, most of his estate was purchased by the Atlantic Utilities Corporation and the Catskill Power Corporation. It was then sold to the Tenney Corporation, which held the title for Rockland Light and Power Company, predecessors of today's Orange and Rockland Utilities (O&R). By the 1920s, much of the Mongaup Valley had reverted to forest.

Hydroelectric Power

The era of hydroelectric power generation began in 1922. By the 1940s, the former Chapin estate and other lands in the lower Mongaup Valley totaled more than 20,000 acres, with a system of seven reservoirs. Until 1999, the reservoirs were owned and operated by O&R.

Monitoring of this area in the 1970s showed that bald eagles wintered in the valley due to the rivers, reservoirs, extensive forests and low human population density found here.

During 1984, O&R announced plans to develop their holdings within the area, and, in August 1985, O&R presented their Mongaup Lands Master Plan to DEC. With the exception of a narrow "green belt" along the river, almost all of their holdings were to be developed to include golf courses, houses, apartments and a shopping center.

Land Acquisition by DEC

DEC acquired the property in 1990 from O&R and Clove Development Corporation and formed the Mongaup Valley Wildlife Management Area (WMA). This area includes 6,315 acres of state-owned land and an additional 5,542 acres of privately owned land managed as a conservation easement to the WMA totaling 11,857 acres. Mongaup Valley encompasses the Mongaup River Valley, several reservoirs, and adjacent uplands in the towns of Lumberland, Highland, Forestburgh, and Bethel in Sullivan County and the town of Deer Park in Orange County. The land was acquired with funding provided by the 1986 Environmental Quality Bond Act, primarily to protect the wetlands and bald eagle breeding and wintering habitat.

Eagle Management at Mongaup Valley WMA

This area is managed primarily as habitat for wintering bald eagles. Several decisions concerning fisheries management and recreational uses of the WMA have been made based on potentially negative impacts on eagle use or eagle habitat. For this reason, all access to the reservoirs, the river corridor and the associated uplands is restricted from December 1 through March 31 to minimize stressing the eagles.

Typically in winter, bald eagles search for food, eat and perch or roost. It is imperative that the birds conserve energy during the winter by spending much of their time perching or roosting. Access to a reliable food supply is critical to the continued use of the WMA by bald eagles. It has been documented that the primary food for eagles wintering within the area is alewives. The alewife (*Alosa pseudoharengus*) is a species of herring. Without such prey available, bald eagles would simply stop using the WMA.

Frequent hydroelectric generation in the winter maintains areas of open water in the reservoirs, thus enabling eagles to take alewives. Limited water resources must be budgeted for this need against other competing water uses.

Active bald eagle nests are usually found along or near the shorelines of quiet lakes or reservoirs. Only electric outboard motors are allowed in the WMAlakes and reservoirs.

In Addition to Eagles...

In addition to bald eagles, Mongaup Valley is also home to many other species of wildlife and a few rare ecological communities. The NYS-threatened timber rattlesnake and red-shouldered hawk, black bears, deer, neo-tropical migrant birds, perched bog and pitch pine-oak-heath woodland are just a few examples. Today, in addition to eagle observers, the property is used by hunters, trappers, fishers, hikers, kayakers and other outdoor enthusiasts.

New York State Department of Environmental Conservation www.dec.ny.gov

The two end panels are 39 x60 inches. The middle panela ares 39 x 54.

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF NEW YORK

STATE OF NEW YORK,	)	
	)	
Plaintiff,	)	No. 11-Civ.-02599 (NGG) (CLP)
	)	
v.	)	ECF Case
	)	
UNITED STATES ARMY CORPS	)	
OF ENGINEERS, ET AL.,	)	
	)	
Defendants.	)	

DECLARATION OF LYLE CHINKIN

Pursuant to 28 U.S.C. § 1746, I, Lyle Chinkin, declare as follows:

1. I am the President of Sonoma Technology, Inc. ("STI"), which specializes in air quality and meteorological research and services. I joined STI in 1992 and have worked on projects for federal, state, and local government agencies; universities; public and private research consortiums; and major corporations.

2. I submit this declaration in opposition to defendants' motions to dismiss and for summary judgment, and in support of plaintiff New York's motion for summary judgment. The purpose of this declaration is to evaluate the impacts of natural gas development in the Pennsylvania portion of the Delaware River Basin (DRB) on ozone levels in New York State.

3. In brief, as explained in more detail below, I conclude that natural gas development in the Pennsylvania portion of the DRB would likely increase ozone levels in New York State, and in particular in the New York City metropolitan area and other downstate areas close to Pennsylvania.

I. Personal Background and Qualifications

4. I received Master of Science (1984) and Bachelor of Science (1981) degrees in Atmospheric Sciences from the University of California at Davis.

5. I have over 25 years of experience in professional consulting regarding air quality and over five years of experience at the California Air Resources Board working on air pollution issues. I have been appointed to and served on the National Research Council (NRC) of the National Academy of Sciences Committee on the Effects of Changes in New Source Review Programs for Stationary Sources of Air Pollutants. I have been appointed to and served on a NRC panel to review "Improving Emission Inventories for Effective Air Quality Management Across North America, a NARSTO Assessment." I have also served as a United States Environmental Protection Agency (EPA) invited peer-reviewer of the EPA Particulate Matter (PM) National Ambient Air Quality Standards (NAAQS) Criteria Document, as an expert panel member for the Prince William Sound Regional Citizens' Advisory Council's review of the Valdez Air Health Study, and as an expert witness for the United States Department of Justice in environmental enforcement actions in various federal courts. My resume is Appendix A to this declaration and a list of my publications is found at Appendix B

II. Summary of Conclusions

6. At the request of the New York State Office of the Attorney General (NYSOAG), I performed an analysis of the potential for emissions from natural gas development in the Pennsylvania portion of the DRB to impact ozone levels in New York State.

7. Based on the analysis below, I have concluded, with a high degree of certainty, that such activities will result in increased ozone levels in New York State. A list of documents considered in forming these opinions is provided at Appendix C to this declaration.

III. Background Information

8. The DRB covers parts of New York, Pennsylvania, New Jersey, and Delaware. Water resources in the region are managed by the Delaware River Basin Commission (DRBC), which consists of the governors of the four basin states and a federal representative from the U.S. Army Corps of Engineers.

9. As part of its role, the DRBC has proposed draft regulations for natural gas drilling operations in the DRB, including portions of northeastern Pennsylvania and southern New York. This drilling would occur in portions of the DRB that overlay the Marcellus Shale formation, a large natural gas play[1] in the Appalachian Basin extending from New York southward through Pennsylvania, West Virginia, and eastern Ohio (see **Figure 1**). Because the Marcellus Shale is a deep, low-permeability gas reservoir, horizontal drilling and hydraulic fracturing techniques must in many cases be used to extract the natural gas.

10. The DRBC has given some indication that drilling in the Pennsylvania portion of the DRB will largely occur in Wayne County, which lies across the Delaware River from New York State (see **Figure 1**). For example, the DRBC Natural Gas Well Estimate Summary (DRBC, 2012), which was provided to the NYSOAG on January 29, 2012, indicates that portion of the DRB in Pennsylvania that the DRBC has asserted is "economically viable" for gas development may be a 180 square mile area in northeastern Pennsylvania that primarily falls within Wayne County (see **Figure 2**).

[1] A play is a set of known or postulated oil and/or natural gas accumulations sharing similar geographic, geologic, and temporal properties.

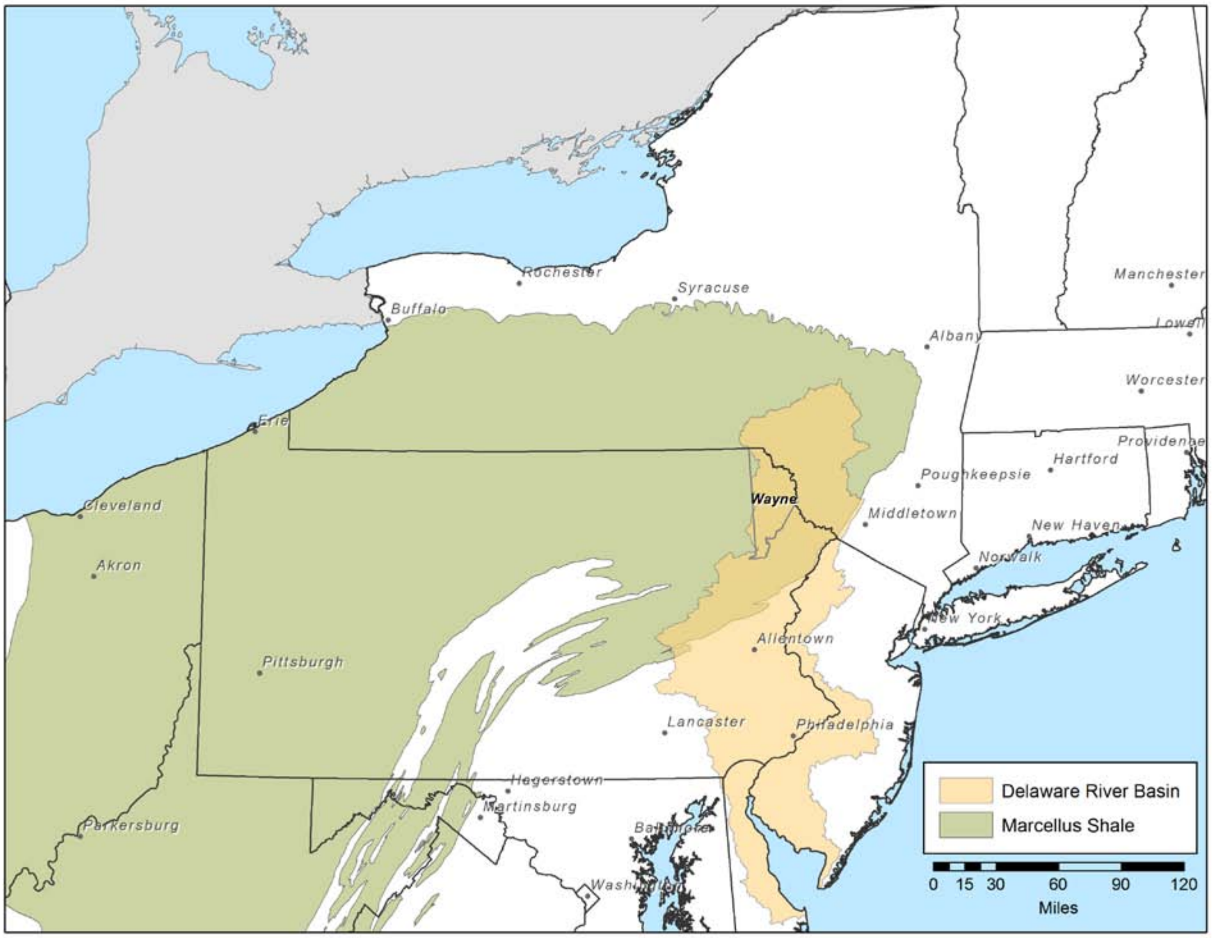


Figure 1. Map showing the extent of the Marcellus Shale and the Delaware River Basin.[2]

[2] This map was developed from geographic information systems (GIS) shapefiles for the DRB from the DRBC (http://www.state.nj.us/drbc/basin/map/GIS.html) and for the Marcellus Shale from the U.S. Geological Survey (http://certmapper.cr.usgs.gov/noga/servlet/NogaNewGISResultsSubServ?page=gis&tps=506704).

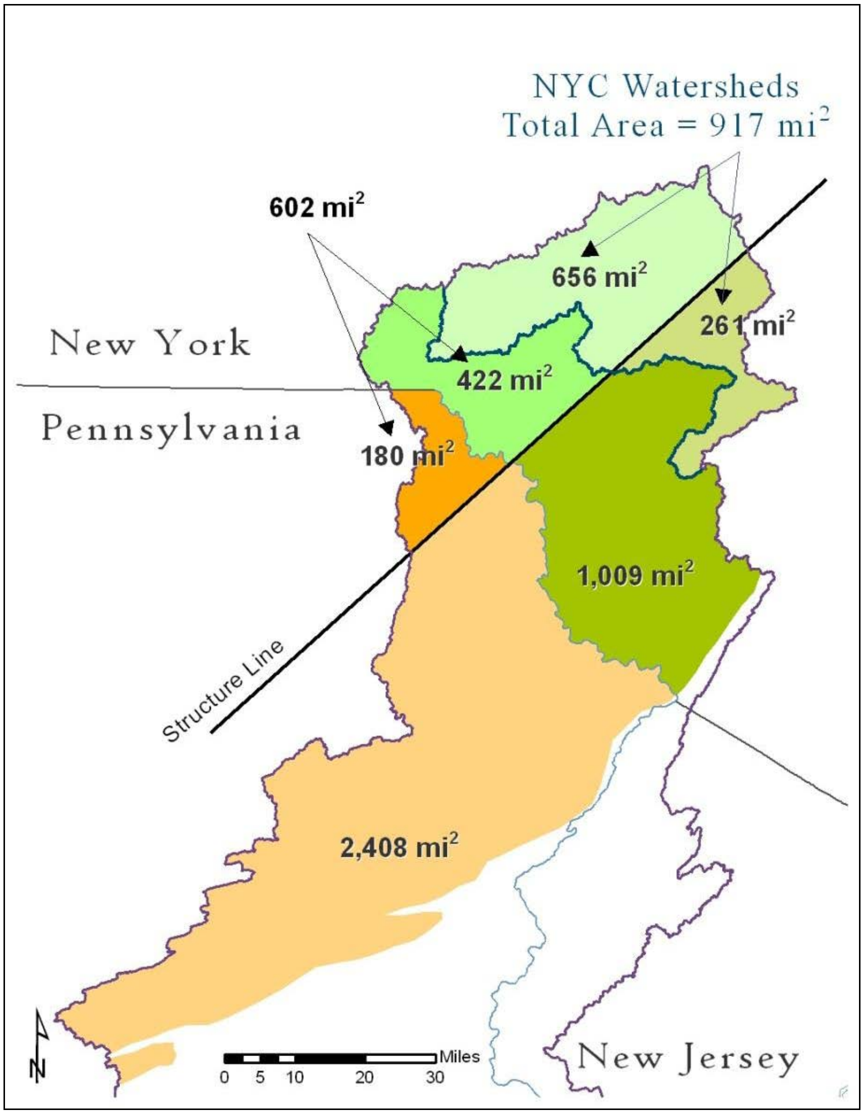


Figure 2. DRBC map of potential well development areas (DRBC, 2012).

11. Wayne County, Pennsylvania is immediately adjacent to New York State and is in the vicinity of several areas in New York that exceed the U.S. Environmental Protection Agency's (EPA) National Ambient Air Quality Standards (NAAQS) for ozone. The NAAQS are the maximum pollutant concentrations allowed under federal law, and as the name indicates, these standards apply nationwide. Under the Clean Air Act, EPA has established NAAQS for six pollutants, including ozone, that are considered harmful to public health and the environment.

12. In 2008, EPA promulgated the current 8-hour NAAQS for ozone of 75 parts per billion (ppb). Subsequently, EPA's Clean Air Scientific Advisory Committee proposed lowering the ozone NAAQS to between 60 and 70 ppb (CASAC, 2007), though reconsideration of the standard has been delayed until 2013.

13. **Figure 3** below shows that, based on the most recent three years of monitoring data (2008-2010)[3], multiple Metropolitan Statistical Areas in New York State have ozone levels that exceed the current 75 ppb standard, including much of New York City and its suburbs. Other areas are at or near the 75 ppb standard and would exceed a lower standard. Such areas include Orange County, partially located within the DRB. (NYSDEC, 2011a).

[3] It should be noted that the 2008-2010 monitored ozone levels reflect an economic downturn and two years of cooler, wetter weather that was not conducive to ozone formation (Ozone Transport Commission, 2011); therefore, the 2008-2010 numbers may not be representative of future trends in ozone levels.

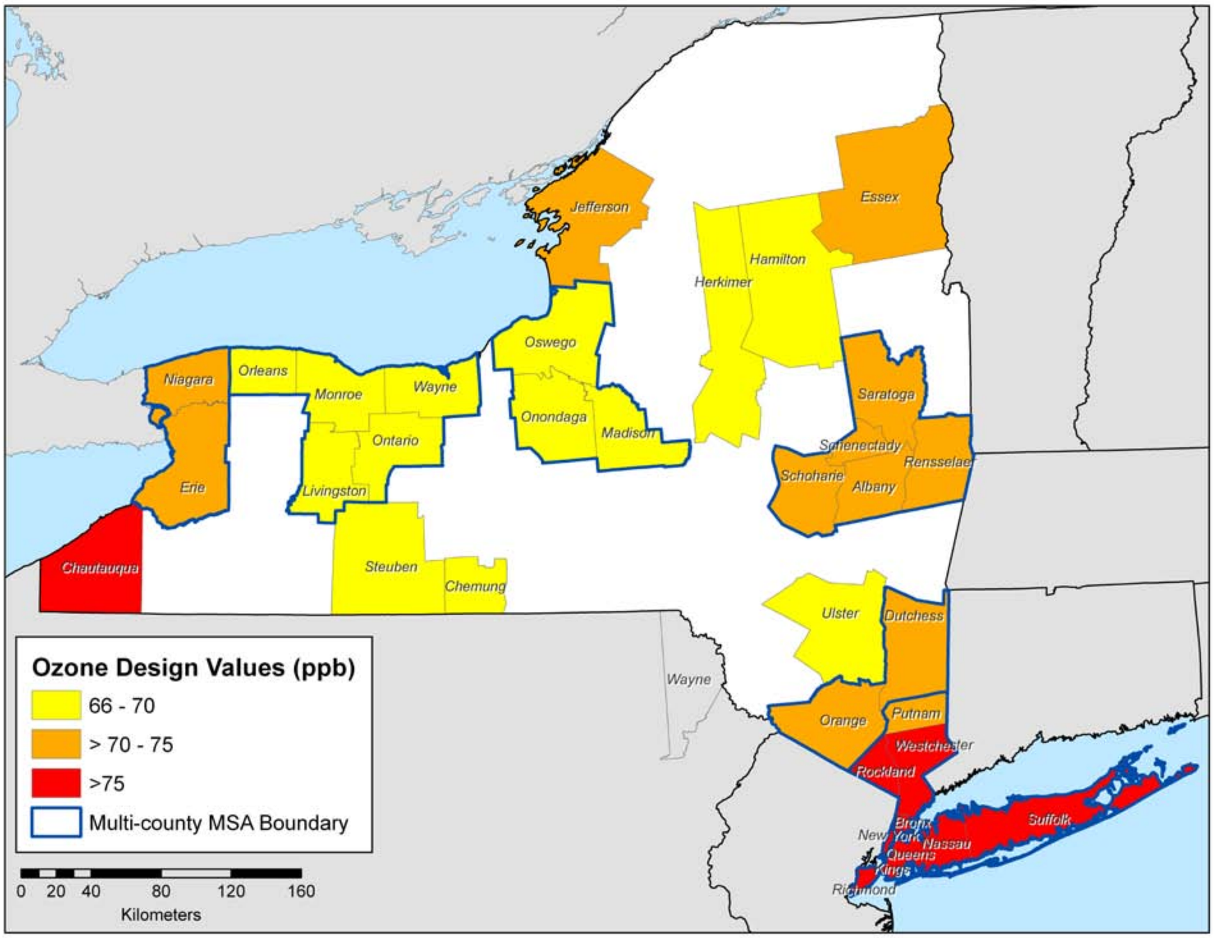


Figure 3. 2008-2010 ozone design values[4] for New York State.

14. Ozone (O_3) is a secondary pollutant formed through the photochemical reactions of nitrogen oxides (NO_x), volatile organic carbons (VOCs), and sunlight in the atmosphere. The precursors to ozone (VOC and NO_x) are emitted into the atmosphere by both anthropogenic (man-made) and biogenic (naturally occurring) sources. In areas with high VOC-to-NO_x ratios (e.g., rural areas with significant VOC emissions from biogenic sources), ozone production is limited by the supply of NO_x emissions, and these areas are called "NO_x-limited." Similarly,

[4] Design values are statistical calculations based on measured data that are used to represent the ozone level in a given area. They are calculated as the 3-year average of the fourth-highest daily maximum 8-hour ozone concentration at a given monitoring site. Monitors are sited to be representative of a metropolitan area and are not necessarily located in each individual county.

"VOC-limited" areas have relatively low VOC-to-NO_x ratios, and the supply of VOCs limits the ozone production rate.

IV. Analysis

15. My evaluation of the potential for emissions from natural gas development activities in the Pennsylvania portion of the DRB to impact air quality in New York State required several steps. First, I evaluated the trajectory of air parcels originating in Wayne County, Pennsylvania and determined that air emissions from the Pennsylvania portion of the DRB would be frequently transported into New York State. Second, I evaluated several scenarios regarding the number of wells that would be developed in the Pennsylvania portion of the DRB and estimated the magnitude of emissions resulting from each of those scenarios. Lastly, I evaluated the likelihood that these emissions from the Pennsylvania portion of the DRB would result in increased ozone concentrations in New York State.

A. Evaluating Whether Pennsylvania Emissions Reach New York

16. To examine the potential for emissions from natural gas development activities in the Pennsylvania portion of the DRB to impact air quality in New York State, I first evaluated the likelihood and extent to which air parcels from natural gas extraction areas would reach New York State. I did so by performing wind trajectory analyses using the National Oceanic and Atmospheric Administration (NOAA) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model (Draxler and Hess, 1997).

17. HYSPLIT is a widely used, peer-reviewed tool that can calculate air parcel trajectories from one region to another and, therefore, demonstrate the likelihood of potential air pollution transport between two regions. Gridded, hourly meteorological data from the National Weather Service's Eta Data Assimilation System (EDAS) are used as inputs to HYSPLIT, which

calculates trajectories by the time integration of the position of an air parcel as it is transported by three-dimensional wind fields. My firm, STI, has developed geographic information systems-based procedures for aggregating these trajectories and calculating spatial probability density (SPD) values that identify where air parcels have spent the most time under the conditions of interest.[5]

18. **Figures 4 and 5** show maps of SPD values produced by running HYSPLIT with 2006-2010 meteorological data,[6] a start height of 7 meters,[7] and using the centroid, or geographic center, of Wayne County, PA as a starting point. These results indicate that air parcels from Wayne County reach metropolitan New York during 10% to 20% of total hours each year, and on one-third of all days on average. Similarly, air parcels from Wayne County reach other regions in New York State (e.g., Orange County) during 20% to 40% of total hours each year, and on about half of all days on average. These results are consistent for HYSPLIT runs using data from complete years (Figure 4) and from the summer season months only (Figure 5).

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[5] These techniques were developed to assist the Central Regional Air Planning Association (CENRAP) in determining causes of regional haze in national parks and Class I areas (Sullivan et al., 2005). Subsequently these techniques have been used for a wide variety of analyses, including helping EPA to evaluate the potential impact of off-shore shipping emissions in Puerto Rico and the U.S. Virgin Islands (Reid et al., 2010).

[6] HYSPLIT was run with five years of meteorological data to develop representative results that are not unduly influenced by a single year with unusual meteorological conditions.

[7] This start height was selected as representative of an emissions release height for a typical well drilling rig.

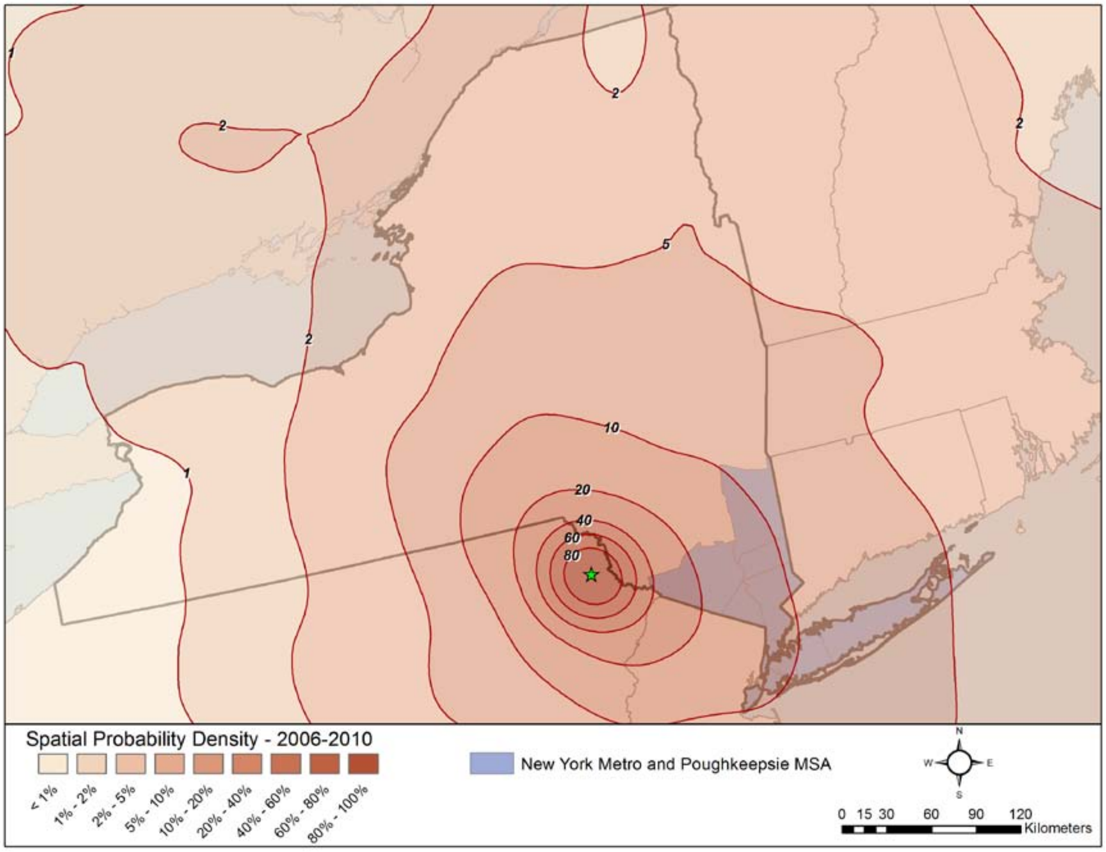

Figure 4. Spatial probability density plot for transport from Wayne County, PA for 2006-2010 (darker colors represent increased transport probability).

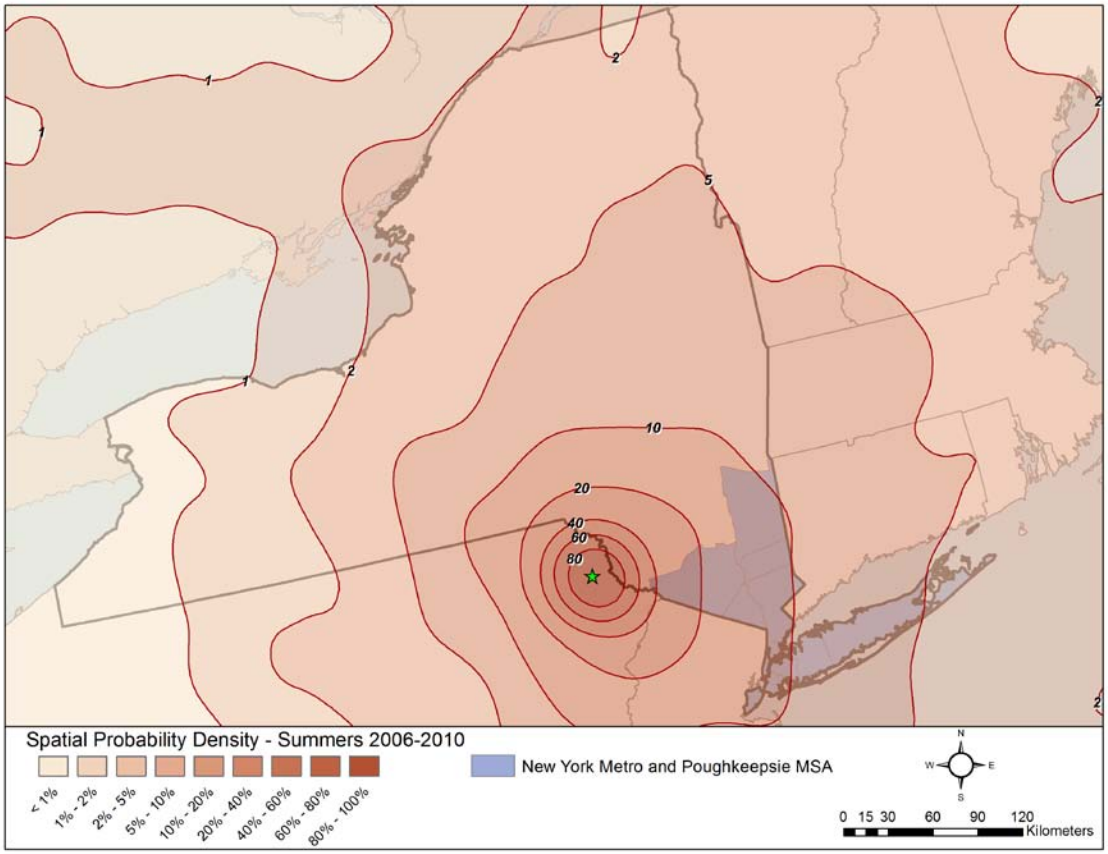

Figure 5. Spatial probability density plot for transport from Wayne County, PA for summer months, 2006-2010 (darker colors represent increased transport probability).

B. Evaluating the Emissions Impact in New York

19. Having established that emissions from natural gas development in Wayne County, PA are likely to reach areas in New York State on a significant number of days each year, I then evaluated the potential magnitude of those emissions.

1. Estimating Emissions from Pennsylvania DRB Well Development

20. To calculate the magnitude of emissions that might be released from well drilling activities in the Pennsylvania portion of the DRB, I relied on New York State Department of Environmental Conservation (NYSDEC) estimates of air emissions associated with various stages of natural gas development at individual wells, including well drilling, well development

(including hydraulic fracturing) and natural gas production. These per-well air emission estimates were then multiplied by the average and peak amount of well drilling activity (e.g., number of wells drilled per year), associated with three different well development scenarios to estimate total annual emissions for each scenario. The three average year well development scenarios are described below.

1.1 Well Development Scenarios

21. I developed annual air emissions estimates for the following three natural gas well development scenarios for the Pennsylvania portion of the DRB based on information provided to me by the NYSOAG.

22. **Scenario 1** is an estimate of 214 wells per year. This estimate was presented in industry comments on DRBC's Proposed Natural Gas Development Regulations submitted by ALL Consulting, on behalf of the Marcellus Shale Coalition and the American Petroleum Institute (ALL Consulting, 2011).

23. **Scenario 2** is an estimate of 58 wells per year. This estimate is based upon the following assumptions: (a) a DRBC estimate that 4,816 wells may be drilled in the 602 square mile “economically viable” portion of the DRB that overlies the Marcellus shale and excludes the New York City Watershed (DRBC, 2012); (b) a calculation that 29.9% of this "economically viable" DRB land area is within the Pennsylvania portion of the DRB (180 square miles out of 602 square miles, as shown in **Figure 2**); and (c) a 25-year period for natural gas development in the DRB, which is the high end of a 20- to 25-year development timeframe given by DRBC staff (Muszynski, 2011).

24. **Scenario 3** is an estimate of 828 wells per year. This estimate is based upon the following assumptions: (a) a DRBC estimate that 32,152 wells may be drilled in the entire

portion of the DRB that overlie the Marcellus shale, excluding the New York City Watershed but including areas south of the "Structure Line" shown in Figure 2 (DRBC, 2012); (b) a calculation that 64.4% of this DRB land area is within the Pennsylvania portion of the DRB (2,588 square miles out of 4,019 square miles); and (c) the 25-year period for natural gas development in the DRB cited in paragraph 23 above.

25. Based on these three average year well development scenarios, I then developed three peak year well development scenarios (i.e., worst-case estimates). I calculated the peak year well scenarios by multiplying each average year scenario by 1.5. This 1.5 multiplier was used by industry to estimate peak year natural gas development in New York State (ALL Consulting, 2010).

26. These average year and peak year well development scenarios are summarized in **Table 1**. Across the three scenarios, peak year well development estimates range from 87 wells to 1,242 wells.

Table 1. Estimates of average and peak year well development in the Pennsylvania portion of the DRB.

Scenario	Average Year Well Development (Number of wells)	Peak Year Well Development (Number of wells)
1	214	321
2	58	87
3	828	1,242
Range	58 to 828	87 to 1,242

1.2 Estimates of Air Emissions Per Well

27. To develop per-well air emission rates I reviewed estimates documented in the NYSDEC draft Supplemental Generic Environmental Impact Statement (draft SGEIS) on well permit issuance for horizontal drilling and hydraulic fracturing in the Marcellus Shale. This

document was prepared to satisfy New York State Environmental Quality Review Act (SEQRA) requirements by evaluating potential adverse impacts of natural gas development associated with hydraulic fracturing activities (NYSDEC, 2011b). Projections of air emissions set out by NYSDEC in the draft SGEIS are based on industry estimates (ALL Consulting, 2009, 2010) of per-well emission rates associated with the various stages of natural gas development activities at individual wells, including well drilling, well development (including hydraulic fracturing) and natural gas production. These per-well emission rates were combined with estimates of peak well development to calculate the annual emissions estimates shown in **Table 2**.

Table 2. NYSDEC estimates of peak annual emissions (tons/year) from natural gas development activities in the Marcellus Shale.

Activity	NO_x	VOC
Drilling	8,785	369
Completion	6,248	927
Production	9,274	5,974
Truck traffic[a]	687	70
Total	24,994	7,340

[a] Truck traffic emissions were not included in the industry reports but were calculated by NYSDEC for the SGEIS.

28. The total emissions in Table 2 were calculated based on peak well estimates of 2,462 wells per year (2,216 horizontal wells and 246 vertical wells). Therefore, per-well emission rates derived from Table 2 amount to 10 tons per year (tpy) of NO_x and 3 tpy of VOC. For ozone formation in the region, the NO_x emissions are of the greatest concern, due to their magnitude and the fact that Wayne County, Pennsylvania is a rural area with significant pre-existing VOC emissions from biogenic sources (see previous discussion of ozone formation in Paragraph 14).

1.3 Calculating Peak Year NO_x Emissions for the Pennsylvania Portion of the DRB

29. Peak year NO_x emissions for the various well development scenarios were then calculated by multiplying the number of wells to be drilled in the Pennsylvania portion of the DRB by the per-well emission rates calculated in paragraph 28 above. The results range from 870 to 12,420 tons of NO_x per year, as shown in **Table 3**.

Table 3. Peak year NOx emissions estimates from natural gas development activities in the Pennsylvania portion of the DRB.

Scenario	Peak Year Well Development (Number of Wells)	Peak Year NO_x Emissions (Tons per year)
1	321	3,210
2	87	870
3	1,242	12,420

30. These emissions levels are significant on a regional basis. For comparison purposes, data from EPA's 2008 National Emissions Inventory (NEI) show that the two largest point sources of NO_x in New York State are the AES Somerset coal-fired power plant in Niagara County and John F. Kennedy International Airport in New York City, both of which emitted about 4,900 tons of NO_x in 2008.[8] Therefore, NO_x emissions from the maximum peak-year estimate for drilling activities in the Pennsylvania portion of the DRB would be the equivalent of adding 2.5 major airports or coal-fired power plants similar to the AES plant to an area adjacent to New York State and less than 30 miles from areas of New York that do not meet the ozone NAAQS.

31. In addition, EPA's MOVES mobile source model (EPA, 2010) indicates that the average passenger car in the U.S. emits 36 lb of NO_x per year. Therefore, NO_x emissions from

[8] EPA's 2008 National Emissions Inventory is available online at http://www.epa.gov/ttnchie1/net/2008inventory.html.

the maximum peak-year estimate for drilling activities in the Pennsylvania portion of the DRB would be the equivalent of adding 690,000 cars to the roads of Wayne County, Pennsylvania. And even for the lowest emissions scenario (Scenario 2, with 870 tons of NO_x), the NOx emissions are equivalent to those of more than 48,000 cars.

32. To further place emissions from the proposed drilling activities in context, I also evaluated the most recent NYSDEC State Implementation Plan for ozone submitted to EPA (2008). This plan documents ozone modeling conducted by NYSDEC to evaluate current and future year ozone concentrations in the New York metropolitan area. To improve air quality in the region, a variety of control measures were evaluated for inclusion in the New York SIP to reduce ozone precursor emissions of NO_x in the region, some of which were initially identified and evaluated by the Ozone Transport Commission (OTC), a multi-state organization created to develop and implement regional solutions to elevated ozone concentrations in the Northeast and Mid-Atlantic regions. In 2007, the OTC recommended that states consider control measures that would reduce ozone precursor emissions from several source categories, including consumer products, diesel engines, asphalt paving, cement kilns, and glass furnaces (MACTEC, 2007). For New York and Pennsylvania, these measures were estimated to result in 2009 NO_x reductions of 0.2 to 40.8 tons per day (tpd) and total reductions of 80.1 tpd in New York and 73.9 tpd in Pennsylvania.

33. By comparison, peak year daily estimated emissions from natural gas development activities in the Pennsylvania portion of the DRB range from 2.4 to 34.0 tpd of NO_x (calculated by dividing Table 3 annual NOx estimates by 365 days). Therefore, the additional emissions estimated from natural gas development in the Pennsylvania portion of the DRB are comparable

to statewide reductions in New York State from control measures recommended by OTC for New York's state implementation plan (SIP) (see **Figure 6**).

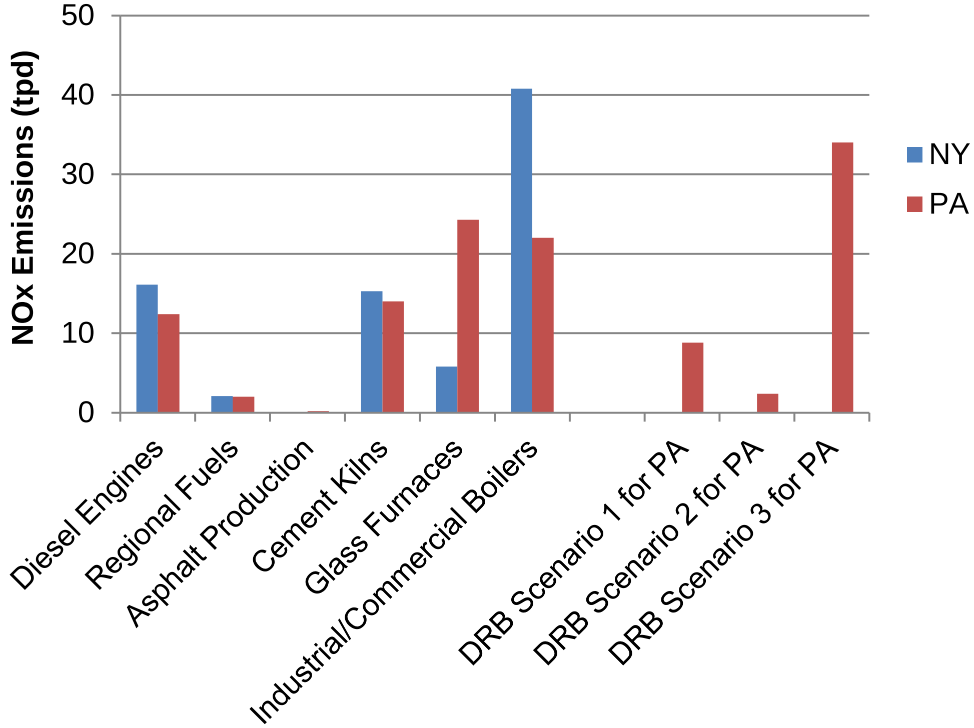

Figure 6. Comparison of NO_x emissions from DRB gas development in PA with 2009 statewide emission reductions for control measures recommended by the OTC (OTC recommendations from MACTEC, 2007).

1.4. Evaluating the Impact of Emissions from the Pennsylvania Portion of the DRB on Ozone Concentrations in New York

34. It is my opinion that, with a high degree of scientific certainty, the NO_x emissions associated with natural gas development in the Pennsylvania portion of the DRB would result in ozone formation in the region, and some portion of that ozone will be transported to New York State, resulting in increased ozone concentrations in that state. This conclusion is based on my knowledge of ozone formation mechanisms and my analysis of meteorological data (i.e., wind trajectories) for the region. The magnitude of the air quality impacts is dependent upon the annual number of wells drilled in the Pennsylvania portion of the DRB, but even at the lowest

projected drilling levels (i.e., Scenario 2 from Table 3), additional ozone formation and transport would occur.

35. This conclusion is supported by previously completed air quality studies of ozone transport in the northeastern U.S. For example, I reviewed results of air quality modeling performed by EPA in support of the Cross-State Air Pollution Rule (CSAPR), which requires states in the eastern U.S. to reduce NO_x emissions that contribute to ozone in other states.[9]

36. In developing CSAPR, EPA used the Comprehensive Air Quality Model with Extensions (CAMx) software to (1) identify locations expected to be in nonattainment or have maintenance problems in 2012 for the 8-hour ozone, annual $PM_{2.5}$, and/or 24-hour $PM_{2.5}$ NAAQS; (2) quantify the contributions of state-level NO_x emissions on 8-hour ozone concentrations in downwind states; and (3) quantify the contributions of state-level NO_x and SO_2 emissions on annual and 24-hour $PM_{2.5}$ concentrations in downwind states (EPA, 2011).

37. EPA's CSAPR modeling results for 2012[10] show that total anthropogenic NO_x emissions from Pennsylvania contribute from 6.1 to 8.4 ppb of ozone to ozone concentrations observed by monitors in the metropolitan New York area. These results demonstrate that emissions from Pennsylvania have impacts on ozone concentrations in New York State.

38. In addition, analyses by the Ozone Transport Assessment Group (OTAG), a partnership between EPA, states, and industrial and environmental groups in the northeastern U.S., showed that during periods when New York experiences high ozone concentrations, the average range of ozone transport is from 30 to 150 miles. This transport associated with high

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[9] Information on the CSAPR is available online at http://epa.gov/airtransport/.

[10] These results are available online at http://www.epa.gov/airtransport/pdfs/CSAPR_Ozone%20and%20PM2.5_Contributions.xls (Tab "CSAPR Ozone Contributions," lines 217-218, 226-231, 233).

ozone events results from the fact that such events require the sunlight of daylight hours and are associated with light winds and conditions that suppress vertical mixing in the atmosphere.

39. Given these considerations, it is reasonable to conclude that elevated ozone concentrations in the metropolitan New York area are primarily impacted by Pennsylvania emission sources that lie within 150 miles. **Figure 7** shows that Wayne County, Pennsylvania lies within a 150-mile radius of both nearby Orange County, New York, and New York City and its suburbs. Therefore, any additional NOx emissions resulting from natural gas development in Wayne County would be occurring in a geographic area that has demonstrable impacts on ozone concentrations in New York.

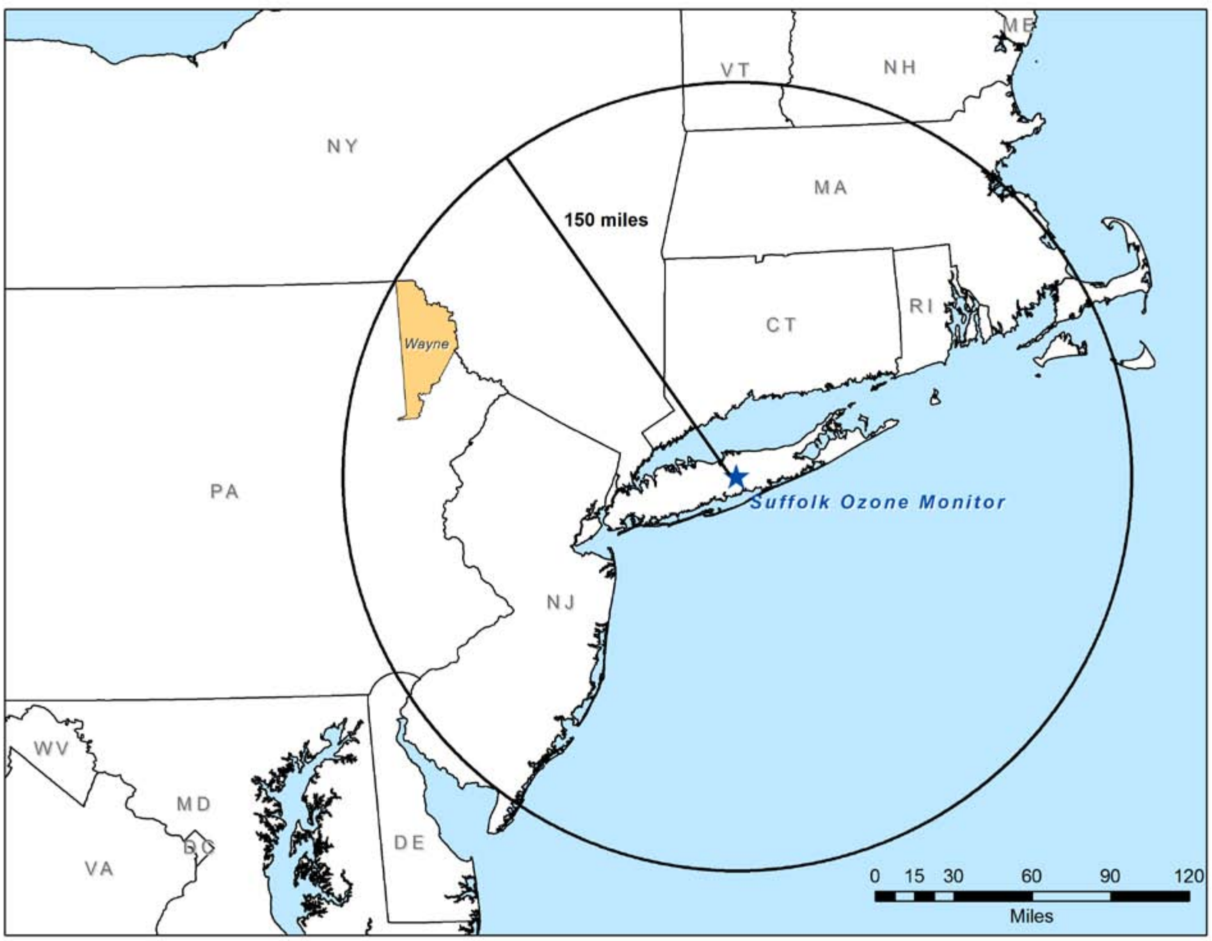

Figure 7. Map showing a 150-mile radius around a Suffolk County ozone monitoring site in the New York City metropolitan area.

V. Conclusions

40. In summary, I conclude that emissions from proposed natural gas drilling operations in the Pennsylvania portion of the DRB are likely to be significant and increase ozone concentrations in New York State, particularly the New York metropolitan area and surrounding counties. This conclusion is based on a number of considerations, including:

- The proximity of Wayne County, Pennsylvania (where DRBC states that most of the natural gas development in the Pennsylvania portion of the DRB is expected to occur) to New York State and areas within New York that exceed or approach the NAAQS for ozone;

- The results of trajectory analyses indicating that air parcels from Wayne County reach metropolitan New York 10% to 20% of the time and impact other regions in the state (e.g., Orange County) 20% to 40% of the time;

- The substantial NO_x emissions expected to result from natural gas development in the Pennsylvania portion of the DRB, which I have estimated could be equivalent to adding 2.5 coal-fired power plants, 2.5 major airports, or over 690,000 passenger cars to an area that is adjacent to New York State and less than 30 miles from areas in New York where ozone levels exceed the NAAQS;

- The additional emissions expected to result from such natural gas development are comparable to statewide NO_x reductions from controls measures recommended for state implementation plan (SIP) development in the region; and

- The potential increase in ozone pollution in New York resulting from emissions from such natural gas development; this increase in ozone is based on a well-established scientific understanding of the role of NO_x emissions on ozone formation and is further supported by results from EPA modeling and transport analyses for the region.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on February 8, 2012, at Petaluma, California.

Lyle R Chinkin

Lyle R. Chinkin

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ALL Consulting (2009) NY DEC SGEIS information requests and industry responses. Prepared for the Independent Oil & Gas Association of New York, October 14, 2009.

ALL Consulting (2010) NY DEC SGEIS information requests. Prepared for the Independent Oil & Gas Association of New York, September 16, 2010.

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CASAC (2007) Clean Air Scientific Advisory Committee's Review of the Agency's Final Ozone Staff Paper, EPA-CASAC-07-002, March 26.

Draxler R.R. and Hess G.D. (1997) Description of the HYSPLIT 4 modeling system. Technical memorandum by the National Oceanic and Atmospheric Administration, Silver Spring, MD, ERL ARL-224, December 24.

DRBC (2012) DRBC Natural Gas Well Estimate Summary, January 27.

EPA (2011) Air quality modeling – final rule technical support document. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, June.

EPA (2010) Motor vehicle emission simulator (MOVES) user guide for MOVES2010a, EPA-420-B-10-036, August.

NYSDEC (2011b) Supplemental generic environmental impact statement on the oil, gas, and solution mining regulatory program, September 7, 2011.

NYSDEC (2008) New York state implementation plan for ozone – final proposed revision, February, 2008.

Ozone Transport Commission (2011) Modeling committee update. Presented to the Ozone Transport Commission Annual Caucus, Washington, DC, June 15, 2011.

MACTEC (2007) Identification and evaluation of candidate control measures – final technical support document. Prepared for the Ozone Transport Commission, Washington, DC, February 28, 2007.

MARC (2005) A clean air action plan for the Kansas City region. Prepared by the Mid-America Regional Council with support from Sonoma Technology, Inc., May, 2005.

Muszynski, W. (2011) Statement by William Muszynski, DRBC Special Projects Coordinator, from the transcript of a DRBC public hearing at Honesdale, Pennsylvania, February 22.

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Sullivan D.C., Hafner H.R., Brown S.G., MacDonald C.P., Raffuse S.M., Penfold B.M., and Roberts P.T. (2005) Analyses of the causes of haze for the Central States (Phase II) summary of findings. Executive summary prepared for the Central States Regional Air Planning Association by Sonoma Technology, Inc., Petaluma, CA, STI-904780.08-2754-ES, August.

APPENDIX A

Lyle R. Chinkin Resume

LYLE R. CHINKIN
President

Sonoma Technology, Inc.

Educational Background

B.S. Atmospheric Science, summa cum laude, University of California at Davis
M.S. Atmospheric Science, University of California at Davis

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Professional Experience

Mr. Chinkin joined Sonoma Technology, Inc. (STI) in 1992 and is STI's President. He has over 25 years of professional consulting experience in air quality and over 5 years of experience at the California Air Resources Board.

Mr. Chinkin is a nationally recognized expert in emissions inventory preparation and assessment and air quality analysis. He has worked on projects for federal, state, and local government agencies; universities; public and private research consortiums; and major corporations. Mr. Chinkin's areas of expertise include (1) developing and improving regional emission inventories; (2) providing independent assessments of emissions inventories using bottom-up and top-down evaluation techniques; (3) conducting field studies to obtain real-world data and improve activity estimates and emission factors; (4) conducting scoping studies to develop conceptual models of community-scale air quality; (5) assisting with State Implementation Plan (SIP) development; and (6) providing expert testimony and presentations to public boards. He has been appointed to the National Research Council of the National Academy of Sciences Committee on the Effects of Changes in New Source Review Programs for Stationary Sources of Air Pollutants and to a panel to review "Improving Emission Inventories for Effective Air Quality Management Across North America, a NARSTO Assessment".

Mr. Chinkin served as (1) an EPA-invited peer-reviewer of the EPA particulate matter (PM) National Ambient Air Quality Standards Criteria Document and the draft EPA Report on the Environment (ROE) 2006; (2) an expert panel member for the review of the Valdez Air Health Study; and (3) an expert witness for U.S. Department of Justice environmental enforcement actions. Mr. Chinkin was the project manager and co-author of the EPA national guidance document on the preparation of emissions inputs for photochemical air quality simulation models. In addition, his projects have included improving estimates of PM and ammonia emissions, evaluating internal combustion engine activity profiles and emissions, determining emissions from propane use and distribution systems, determining air toxic emissions from wood-preservation activities, and improving biogenic emission estimation tools. He frequently directs studies that combine public- and private-sector participation (e.g., an assessment and ground-truth study of industrial emissions in the Houston Ship Channel under the joint direction of the Texas Natural Resource Conservation Commission [now Texas Commission on Environmental Quality] and local industry). Mr. Chinkin has also assisted numerous industrial clients with projects such as development of emission-estimation tools for the American Petroleum Institute and top-down evaluations of emissions inventories for the Coordinating Research Council.

Mr. Chinkin is frequently called upon by clients to explain complicated technical information to other air quality professionals, advisory boards, and members of the public. He presented research findings to public advisory committees in Ohio, Kansas, and Missouri and to senior federal and state government officials in Minnesota and at numerous scientific conferences. EPA selected Mr. Chinkin to help prepare a summary of the proceedings of the 2003 NARSTO air quality research conference, and to help an audience of air quality officials from four western U.S. states understand technical air toxics assessment techniques.

Chronology of Education and Work Experience

- 1978-1979: Assistant Weather Producer, KCRA-TV Channel 3, Sacramento, CA
  - Decoded weather data and prepared in-studio weather displays for broadcast
- 1979-1981: Student Assistant, Meteorology Section, California Air Resources Board
  - Evaluated meteorological data
  - Analyzed isobaric pressure charts and wind flow patterns
- 1980: Weather Reporter, KDVS Radio Station, Davis, CA
  - Prepared and presented weather broadcasts for California
- 1980: Instrument Technician, Air Quality Group, University of California, Davis
  - Maintained and calibrated particulate samplers in remote areas of the western U.S.
- 1981: B.S. Atmospheric Science, *summa cum laude*, University of California at Davis
- 1981-1982: Air Pollution Specialist, Analysis and Projects Section, California Air Resources Board
  - Prepared comprehensive technical reports requiring computer programming and statistical analyses
  - Produced the "California Air Quality Data Report"
- 1982-1984: Assistant Meteorologist, Meteorology Section, California Air Resources Board
  - Conducted climatological studies relating to air pollution in California
  - Applied meteorological principles to engineering evaluations and statistical analyses
  - Developed guidelines for agricultural burning
- 1984: M.S. Atmospheric Science, University of California at Davis
- 1984-1989: Senior Atmospheric Scientist, Systems Applications, Inc., San Rafael, CA
  - Conducted emissions inventory studies relating to air pollution in various regions of the U.S.
  - Developed software to process emissions inventory data into model-ready inputs for comprehensive 3-dimensional photochemical models

- 1989-1992: Manager of Emissions Modeling Group, Systems Applications, Inc., San Rafael, CA
  - Managed emissions inventory studies relating to air pollution throughout the U.S. and Asia
  - Conducted air quality studies for government and private industry
- 1992-1998: Manager of Emissions Modeling, Sonoma Technology, Inc., Petaluma, CA
  - Managed emissions inventory studies relating to air pollution worldwide
  - Managed air quality studies for government and private industry
  - Managed a multi-million dollar level-of-effort contract with the U.S. Environmental Protection Agency for air quality modeling assistance
- 1998: Vice President, Sonoma Technology, Inc., Petaluma, CA
  - Managed emissions modeling group and meteorological programs group
- 1999: Vice President and General Manager, Sonoma Technology, Inc., Petaluma, CA
  - Managed emissions modeling group and meteorological programs group
  - Responsible for financial oversight of company operations including financial performance (e.g., cash flow, profit and loss, backlog, and overhead rates)
- 2000: Appointed to the Board of Directors, Sonoma Technology, Inc., Petaluma, CA
- 2002: Senior Vice-President, Sonoma Technology, Inc., Petaluma, CA
- 2004: Appointed to the National Research Council of the National Academy of Sciences Committee on the Effects of Changes in New Source Review Programs for Stationary Sources of Air Pollutants
- 2005: Selected as peer-reviewer for NARSTO report “Improving Emission Inventories for Effective Air Quality Management Across North America”
- 2006-Present: President, Sonoma Technology, Inc., Petaluma, CA

Professional Memberships

Air & Waste Management Association

American Meteorological Society (1979-1984)

California Registered Environmental Assessor (REA-00715) (1984–1989)

Professional Development

1982: Statistics for Decision Makers

1982: Air Pollution Enforcement Symposium, California Air Resources Board

2001: Understanding Finance and Accounting

Peer Reviewer

U.S. Environmental Protection Agency

Journal of the Air and Waste Management Association

International Journal of Environmental Studies

North American Research Strategy for Tropospheric Ozone (NARSTO)

APPENDIX B

List of Publications

This appendix contains the list of publications by Lyle R. Chinkin

LYLE R. CHINKIN

Book Chapter

Magliano K.L. and Chinkin L.R. (1994) Emissions inventory planning and development. In *Planning and Managing Regional Air Quality Modeling and Measurement Studies: A Perspective Through the San Joaquin Valley Air Quality Study and AUSPEX*, Solomon P.A. and Silver T.A., eds., CRC Press, Inc., Boca Raton, FL, pp. 545-560.

Journal Articles

McCarthy M.C., Hafner H.R., Chinkin L.R., and Charrier J.G. (2007) Temporal variability of selected air toxics in the United States. *Atmos. Environ*., doi:10.1016/j.atmosenv.2007.1005.1037 (STI-2894).

McCarthy M.C., Eisinger D.S., Hafner H.R., Chinkin L.R., Roberts P.T., Black K.N., Clark N.N., McMurry P.H., and Winer A.M. (2006) Particulate matter: a strategic vision for transportation-related research. *Environ. Sci. Technol.* **40** (18), 5593-5599 (STI-904750-2843). Available on the Internet at http://pubs.acs.org/doi/abs/10.1021/es062767i.

Chinkin L.R., Coe D.L., Funk T.H., Hafner H.R., Roberts P.T., Ryan P.A., and Lawson D.R. (2003) Weekday versus weekend emissions activity patterns for ozone precursor emissions in California's South Coast Air Basin. *J. Air & Waste Manag. Assoc*. **53**, pp. 829-843 (STI-999679-2225).

Funk T.H., Chinkin L.R., Roberts P.T., Saeger M., Mulligan S., Figeroa V.H.P., and Yarbrough J. (2001) Compilation and evaluation of a Paso del Norte emission inventory. *Sci. Total Environ*. (Special Issue: U.S.-Mexico Transboundary Air Pollution Studies) **276, Nos. 1-3**, 135-151 (STI-1942).

Magliano K.L., Hughes V.M., Chinkin L.R., Coe D.L., Haste T.L., Kumar N., and Lurmann F.W. (1999) Spatial and temporal variations in PM_{10} and $PM_{2.5}$ source contributions and comparison to emissions during the 1995 Integrated Monitoring Study. *Atmos. Environ*. **33**, 4757-4774.

Chinkin L.R., Chang D.P.Y., and Floccini R.G. (1986) Relationships among the coefficient of haze, scattering coefficient, and visibility during an agricultural burn season. *J. Air Pollut. Control Assoc.* **36**, 173-178.

Meeting Presentations and Conference Proceedings

Raffuse S.M., Larkin N.K., Strand T.T., Drury S.A., Solomon R.C., Sullivan D.C., Wheeler N.J.M., and Chinkin L.R. (2010) Developing an improved wildland fire emissions inventory for the United States. Poster presented at the *International Workshop on Air Quality Forecasting Research, Quebec City, Canada, November 16-18* (STI-4034).

Wheeler N., Funk T., Raffuse S., Drury S., Nuss P., Unger K., Yahdav L., Pryden D., Healy A., Haderman M., Chinkin L., Cissel J., and Rauscher H.M. (2010) A new decision support system based on a service-oriented architecture. Paper presented at the *9th Annual CMAS Conference, Chapel Hill, NC, October 11* by Sonoma Technology, Inc., Petaluma, CA, Joint Fire Science Program, Boise, ID, and Rauscher Enterprises LLC, Leicester, NC (STI 3896).

Raffuse S., Gilliland E., Sullivan D., Wheeler N., Chinkin L., Larkin S., Solomon R., Strand T., and Pace T. (2008) Development of wildland fire emission inventories with the BlueSky Smoke Modeling Framework. Presented at the *7th Annual Community Modeling and Analysis System (CMAS) Conference Chapel Hill, NC, October 7,* by Sonoma Technology, Inc., Petaluma, CA; U.S. Forest Service AirFIRE Team, Seattle, WA; and U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC (STI-3457).

Reid S.B., Pollard E.K., Du Y., Chinkin L.R., Hammond D., and Norris G. (2010) Development of a local-scale emissions inventory for the Cleveland Multiple Air Pollutant Study. Presented to the *19th International Emissions Inventory Conference, San Antonio, TX, September 28* by Sonoma Technology, Inc., Petaluma, CA and U.S. Environmental Protection Agency, Research Triangle Park, NC (STI-3943).

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Raffuse S.M., Sullivan D.C., Gilliland E.K., Chinkin L.R., Larkin S., Solomon R., and Pace T. (2008) Development of wildland fire emission inventories for 2003-2006 and sensitivity analyses. Presentation made at the *U.S. Environmental Protection Agency's 17th International Emission Inventory Conference, Portland, OR,, June 5,* by Sonoma Technology, Inc., Petaluma, CA; U.S. Forest Service AirFire Team, Seattle, WA; and U.S. Environmental Protection Agency Office of Air Quality Planning and Standards, Research Triangle Park, NC (STI-905028-3377).

Sullivan D.C., Raffuse S.M., Pryden D.A., Craig K.J., Reid S.B., Wheeler N.J.M., Chinkin L.R., Larkin N.K., Solomon R., and Strand T. (2008) Development and applications of systems for modeling emissions and smoke from fires: the BlueSky smoke modeling framework and SMARTFIRE. Paper presented at the *17th International Emissions Inventory Conference, Portland, OR, June 5*, by Sonoma Technology, Inc., Petaluma, CA, and the U.S. Forest Service, Seattle, WA (STI-3378).

Wheeler N.J.M., Craig K.J., Reid S.B., Gilliland E.K., Sullivan D.C., and Chinkin L.R. (2008) The BlueSky Gateway air quality forecast system for fire management. Presented at the *BlueSky Smoke Modeling Framework Stakeholders' Meeting, Boise, ID, May 20-22* (STI-905028-3367).

Raffuse S.M., Sullivan D.C., Chinkin L.R., Pryden D.A., Wheeler N.J.M., Larkin N.K., Solomon R., and Soja A. (2007) Integration and reconciliation of satellite-detected and incident command-reported wildfire information in the BlueSky smoke modeling framework. Presented at the *6th Annual CMAS Conference, Chapel Hill, NC, October 1-3*, by Sonoma Technology, Inc., Petaluma, CA, the U.S. Forest Service AirFire Team, Seattle, WA, and the National Institute of Aerospace, Hampton, VA (STI-3227).

Raffuse S.M., Sullivan D.C., Chinkin L.R., Larkin N.K., Solomon R., and Soja A. (2007) Integration of satellite-detected and incident command-reported wildfire information into BlueSky. Paper No. 205 presented at the *Air & Waste Management Association's 100th Annual Conference & Exhibition, Pittsburgh, PA, June 26-29* (STI-3127).

Reid S.B., Chinkin L.R., Penfold B.M., and Gilliland E.K. (2007) Emissions inventory validation and improvement: a Central California case study. Conference paper prepared for the *U.S. Environmental Protection Agency's 16th Annual Emission Inventory Conference, Raleigh, NC, May 14-17*, by Sonoma Technology, Inc., Petaluma, CA (STI-3109).

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McCarthy M.C., Hafner H.R., and Chinkin L.R. (2006) Temporal variability and trends in MSATs: a national perspective. Presentation for the *Coordinating Research Council, Mobile Source Air Toxics workshop, Phoenix, AZ, October 25*, Sonoma Technology, Inc., Petaluma, CA (STI-3053).

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Hafner H.R., McCarthy M.C., and Chinkin L.R. (2006) National, regional, between-city, and within-city spatial variability in air toxics. Presented at the *AWMA Symposium on Air Quality Measurement Methods and Technology, Durham, NC, May 9*, by Sonoma Technology, Inc., Petaluma, CA (STI-2884).

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APPENDIX C

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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF NEW YORK

STATE OF NEW YORK, Plaintiff,	No. 11 Civ. 02599 (NGG) (CLP)
v.	ECF Case
UNITED STATES ARMY CORPS OF ENGINEERS, *et al.*, Defendants.	

DECLARATION OF DR. JOEL SCHWARTZ

Pursuant to 28 U.S.C. § 1746, I, DR. JOEL SCHWARTZ, declare as follows:

1. I am a Professor in the Departments of Environmental Health and Epidemiology at the Harvard School of Public Health and in the Department of Medicine at Harvard Medical School, am Director of the Harvard Center for Risk Analysis, am a member of the University's faculty in the Environmental Biostatistics program and the Cardiovascular Epidemiology program, and serve on the Steering Committee of the Harvard University Center for the Environment.

2. I submit this declaration on the relationship between ozone levels and human health in opposition to defendants' motions to dismiss and for summary judgment, and in support of the cross motion for summary judgment of plaintiff State of New York.

3. As discussed in more detail below, ozone (O_3) constitutes a health risk to New Yorkers. As ozone is a long lived secondary pollutant, increased emissions of ozone precursors in states that are generally upwind of New York, such as Pennsylvania, would result in increased ozone concentrations in New York's air, and would impair the health of New Yorkers.

I. Personal Background and Qualifications

4. In addition to my work at Harvard University discussed in paragraph 1 above, I am a former member of the board of Councilors of the International Society for Environmental Epidemiology and of the Editorial Board of the American Journal of Respiratory and Critical Care Medicine. I have served on two National Academy of Sciences panels concerning air pollution, and was a recipient of a John D. and Catherine T. MacArthur Fellowship.

5. I am the most frequently cited author in the scientific literature on the health effects of air pollution. I have over 470 peer-reviewed papers published or in press, which have been cited over 24,000 times in other peer-reviewed publications.

6. I have made particulate air pollution and ground-level ozone (smog) a major focus of my research, which ranges from studies focused on critical events (e.g., deaths, heart attacks) to studies addressing mechanisms and exposure modeling.

7. I have testified before Congress twice about particulate air pollution and testified as an expert in the health effects of air pollution in federal court.

8. I have a BA in mathematics and physics from Brandeis University, a Ph.D. in physics from Brandeis University, and an MD from the University of Basel. A copy of my curriculum vitae is attached as Exhibit A. A list of references that I relied on in this declaration is attached as Exhibit B.

II. Summary of Conclusions

9. Ozone pollution has serious health effects, ranging from respiratory problems to mortality. Moreover, if there is any threshold concentration for these effects, it is so low (e.g. below 20 parts per billion, or ppb) as to be meaningless, since such low levels are almost never seen in the Eastern United States.

10. Consequently, any exposure to ozone at least above 20ppb causes adverse effects on human health in the locations where that exposure occurs.

11. This is not just my opinion: it is the scientific consensus, as reflected in the U.S. EPA's external Clean Air Scientific Advisory Committee's recommendations and EPA's 2011 Integrated Science Assessment for ozone (ISA), which is available on the internet at http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=226363#Download.

12. In the ISA, EPA states:

> The last review [of the literature] concluded that there was clear, consistent evidence of a causal relationship between short-term exposure to O_3 and respiratory health effects. This causal association was substantiated in this ISA by the coherence of effects observed across controlled human exposure, epidemiologic, and toxicological studies indicating associations of short-term O_3 exposures with a range of respiratory health endpoints from respiratory tract inflammation to respiratory emergency department (ED) visits and hospital admissions (HA). Across disciplines, short-term O_3 exposures induced or were associated with statistically significant declines in lung function. An equally strong body of evidence from controlled human exposure and toxicological studies demonstrated O_3-induced inflammatory responses, increased epithelial permeability, and airway hyper-responsiveness. Toxicological studies provided additional evidence for O_3-induced impairment of host defenses. Combined, these findings from experimental studies provided support for epidemiologic evidence, in which short-term O_3 exposure was consistently associated with increases in respiratory symptoms and asthma medication use in asthmatic children, respiratory-related hospital admissions, and asthma-related ED visits. Although O_3 was consistently associated with nonaccidental and cardiopulmonary mortality, the contribution of respiratory causes to these findings was uncertain. The combined evidence across disciplines **supports a causal relationship between short- term O_3 exposure and respiratory effects.**

(ISA, p. 81 (Executive Summary § 1.61) (emphasis in original)).

13. Hence, any exposure to ozone as a result of increased emissions of ozone precursors in upwind states such as Pennsylvania would negatively impact the health of New York State citizens.

III. Background on Ozone

14. Ozone is a ubiquitous pollutant, but is not emitted directly. Rather, it is formed in the atmosphere by the chemical reaction of other substances. For example, hydrocarbons in the air known as volatile organic compounds, from man made or natural sources, can react with nitrogen oxides (NO_x), which are combustion byproducts, in the presence of light and heat, to form ozone.

15. Because it is the product of a chemical reaction, ozone concentrations are not limited to, or even highest, in the locale where the precursors were emitted. Ozone concentrations can increase downwind as ozone precursors continue to react as they are carried by the wind.

16. Ozone itself is a powerful oxidant, capable of harming living organisms.

IV. Ozone and Human Health

A. Ozone and Asthma

17. A key finding of the EPA ISA regarding the health effects of ozone is that the research literature:

> provide[s] biological plausibility for associations in epidemiologic studies of short-term ambient O_3 exposure with respiratory symptoms and respiratory-related hospitalizations and emergency department (ED) visits.

(ISA, p. 6-1).

18. The ISA then states:

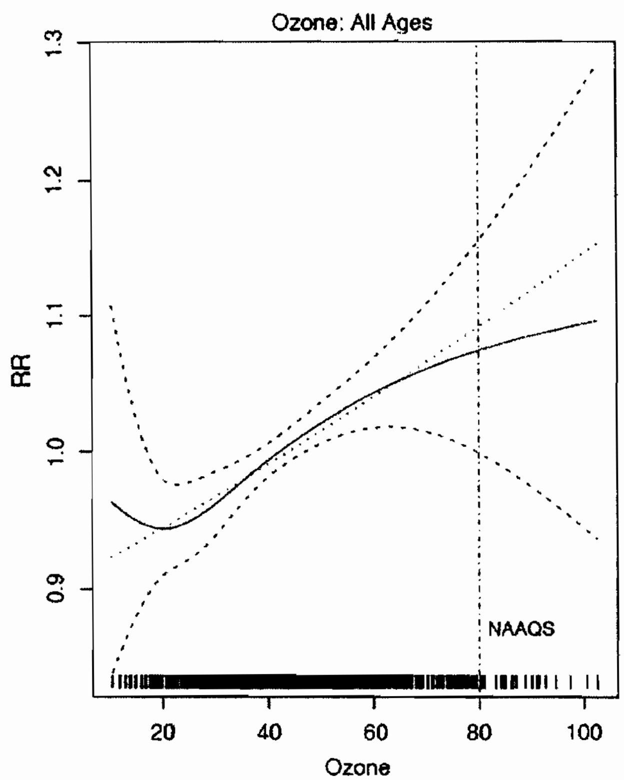
> In addition to [harm to] lung function, ambient O_3 exposure has been associated with increases in respiratory symptoms (e.g., cough, wheeze, shortness of breath), especially in large U.S. panel studies of children with asthma (Gent et al., 2003; Mortimer et al., 2000).

(ISA, p. 6-4).

19. One of the papers cited by the ISA, by Silverman and Ito, examines asthma hospital admissions in New York City (Silverman and Ito 2010). The solid line in the figure below,

reproduced from the ISA (p. 6-123), shows the positive association between the Relative Risk (RR) of hospital admission and ozone concentration (ppb) from that study. The positive relationship continues down to very low levels (20 ppb), making it clear that additional exposure to ozone results in additional hospital admissions.

Figure 1: Relative Risk of Hospital Admission for Asthma Versus O_3 in NY (Silverman and Ito, 2010)



20. There is also ample evidence that short-term ozone exposure is associated with reductions in lung functions, increased respiratory symptoms, and lung inflammation (Hazucha 1987). Some studies have showed that this effect is higher in asthmatic individuals and in individuals with already impaired respiratory function (Hoppe et al. 2003; Arjomandi et al. 2005; Lagorio et al. 2006).

21. From my work, I know that, through its Medicaid program, New York State directly pays for some of the emergency department visits and respiratory related hospitalizations of New York residents.

22. Asthma rates, emergency visits, and admissions are higher in the Medicaid population.

23. Accordingly, if New Yorkers' ozone exposure increases due to emissions from upwind states, I would expect an increased number of emergency department visits and hospitalizations for asthma and other respiratory problems in New York, which in turn would increase New York's Medicaid expenses.

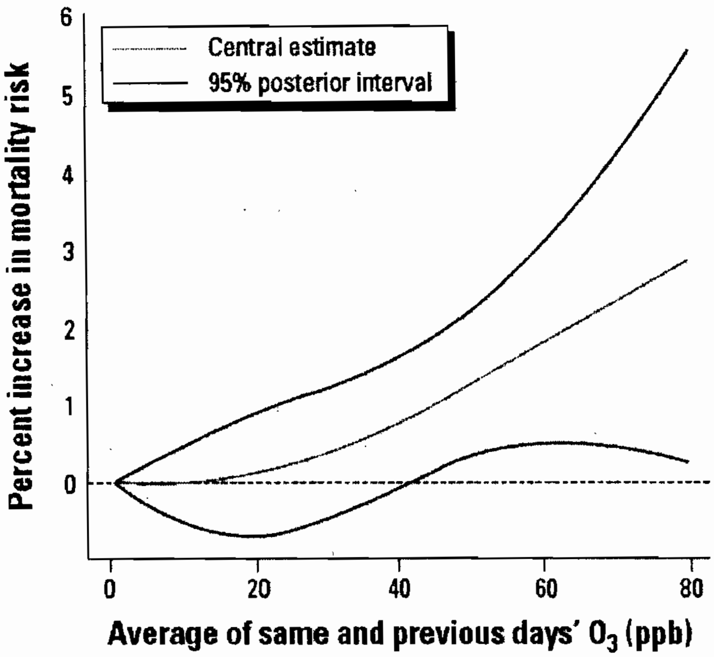
B. Ozone and Mortality

24. While studies have reported adverse health impacts from ozone for decades, reports that ozone exposure might hasten deaths have been more recent. While some individual reports were available earlier (Verhoeff et al. 1996), the first large scale report came from Europe, where seven cities were studied using identical methods and the results combined. That report concluded that ozone was associated with increased risk of death (Touloumi et al. 1997).

25. Since then a number of studies have reported similar results in both the U.S. and Europe, including three large meta-analyses commissioned by the US EPA (Bell et al. 2005; Levy et al. 2005; Ito et al. 2005).

26. Moreover, a large multicity study has found no evidence of a threshold for mortality risk due to ozone down to very low levels (Bell et al. 2006). The figure below is reproduced from that study: the central line shows a constantly increasing mortality risk as the ozone level increases.

Figure 2. Percent Increase in Mortality Risk Vs Ozone
in US Cities (Bell, 2006).



Source: Bell et al. (2006).

27. Long term exposure to ozone and mortality is a serious issue since it is clear such associations could not be detected without significant reductions in life expectancy. Until recently, only one cohort study has examined this question, and that study reported an association between long term average ozone exposure and long term average mortality rates from respiratory disease (Jerrett et al. 2009). More recently, we published a paper that examined Medicare beneficiaries in multiple cities. In an important distinction from the Jerrett study, we only looked within each city, eliminating the effect of factors that vary between cities. What we showed was that year to year variations of summer ozone concentrations around the trend line for each city were associated with year to year variations in mortality rates around the trend lines in that city (Zanobetti and Schwartz 2011).

28. Accordingly, I would expect increased mortality among New Yorkers should their ozone exposure increase due to emissions from upwind states.

C. Evaluating Possible Confounding Exposures

29. The major concern of observational epidemiology studies is whether some other exposure that is correlated with the exposure of interest – ozone, in this case – may explain the observed association. This correlation of other exposures with the exposure of interest is known as confounding, and the other exposures are known as confounders.

30. To confound the observed relationship between ozone and daily deaths, for example, such confounders must co-vary with – that is, move in the same direction as – ozone over the same timescale. There are two primary candidates for such a confounder—temperature and other secondary pollutants.

31. As noted above, ozone is a secondary pollutant in that it is not directly emitted by polluting sources. It is produced by chemical reactions in the atmosphere between nitrogen oxides and hydrocarbons, and those reactions are driven by sunlight and temperature. Hence ozone co-varies with temperature, so temperature is a possible cofounder.

32. All studies of the effect of ozone on daily deaths have therefore controlled for temperature. The association of temperature with death is highly nonlinear, with heat wave conditions associated with much larger increases in deaths than temperatures just a few degrees cooler. A question thus presents itself: how can we be sure that those studies correctly captured the relation between ozone and mortality, and that the association is not in fact capturing some of the effect of temperature?

33. I addressed this issue in an analysis of over one million deaths in 14 cities (Schwartz 2005). Rather than examine the correlation between daily ozone and daily deaths, I converted the

analysis into a case-control study and chose controls with the same temperature exposure as the cases.[1] Using this alternative approach, I found the same association with ozone that I found analyzing the data using the more traditional time series analysis. Thus, this research indicates that temperature does not explain the observed ozone-mortality association.

34. The same type of chemical process in the atmosphere (reactions driven by light and heat) that produces ozone also produces other secondary pollutants (secondary because they are not what were primarily emitted). Among these secondary pollutants is fine particulate matter, which includes (a) sulfate particles, produced from the reaction of sulfur oxides with ammonia, and (b) organic particles, which like ozone are produced from reactions of hydrocarbons. Historically, ozone studies rarely control for these other secondary pollutants.

35. To address this issue, a colleague and I analyzed data from the U.S. EPA's chemical speciation monitoring network (Franklin and Schwartz 2008). Using data from 18 cities, we showed that controlling for certain secondary pollutants, namely, nitrate particles and organic carbon particles, did not change the estimated effect of ozone on mortality.

36. In contrast, controlling for sulfate particles reduced the estimated ozone health effect by about 25%, although statistical analysis included the possibility of no reduction.

37. Hence about one-quarter of the mortality effect attributed by past studies to ozone may have been due to sulfate particles, but the rest was not, and none of the effect attributed to ozone was due to organic and nitrate particles.

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[1] More specifically, using a variant called a case-crossover analysis, I matched each decedent with themselves, on a control day in the same month of the same year that they died, which also had the same temperature (rounded to the same degree). This matching controlled for season and time trend, by choosing a control day in the same month and year as the date of death, and since the temperature was the same on the control day as the case day, it could not explain which day the death occurred on. I then compared the ozone levels on the two days to see if they predicted which day was the date of death.

38. These results regarding the lack of effect, or minimal effect, of possible cofounders further support the scientific consensus that ozone causes negative health effects.

D. Biological Mechanisms

39. A review of toxicological studies found decreases in heart rate, metabolism, blood pressure, and cardiac output when laboratory rats are exposed to typical concentrations of ozone. The authors conclude that while there is limited experimental evidence that addresses the underlying mechanisms of these health responses, there is some indication that they may be related to the stimulation of pulmonary irritant receptors (Watkinson et al. 2001).

40. Others studies have showed that the respiratory inflammation from ozone exposure may inhibit recovery from infection, or produce systemic responses such as systemic oxidative stress or pathologies of the electrical control of the heart (Romieu et al. 2008; Rich et al. 2006).

41. A recent panel study found that ozone was associated with increased levels of various markers of systemic inflammation, cardiac thrombosis, oxidative stress and impaired autonomic function, including decreased heart rate variability[2] (Chuang et al. 2007). Two previous papers had also reported decreases in heart rate variability (Gold et al. 2000) (Park et al. 2005).

42. These findings support an association between ozone exposure and cardiovascular mortality.

V. Conclusion

43. Based on research I have performed, my review of the general literature on the health effects of ozone, and my other experience, I conclude that any increase in ozone levels in New York due to increases in emissions of a principal ozone precursor, NO_x, in upwind states would

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[2] Decreased heart rate variability is associated with death from arrhythmia.

cause: increases in respiratory illness, including asthma attacks; increases in respiratory related emergency department visits and hospitalizations; and increases in premature mortality.

44. In addition, I conclude that because New York State government pays Medicaid costs for some respiratory-related emergency department visits and hospitalizations, an increase in those visits and hospitalizations in New York resulting from such increased ozone levels would increase New York State's Medicaid expenditures.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on February 9, 2012

Joel Schwartz

EXHIBIT A

EXHIBIT A

CURRICULUM VITAE
February 2, 2012

NAME:	**JOEL SCHWARTZ**
ADDRESS:	207 Lincoln Street, Newton Highlands, MA
PLACE OF BIRTH:	New York, New York

EDUCATION:

1969	B.A.	Brandeis University
1980	Ph.D.	Brandeis University (Theoretical Physics)
2010	M.D.	University of Basel

ACADEMIC APPOINTMENTS:

2005 to present	Professor of Environmental Epidemiology, Harvard School of Public Health Director, Harvard Center for Risk Analysis
1994 -2004	Associate Professor of Environmental Epidemiology, HSPH
1994 -	Associate Professor of Medicine, Harvard Medical School
1991-1993	Lecturer, Department of Environmental Health, Harvard School of Public Health

HOSPITAL APPOINTMENTS:

1994 -	Associate Epidemiologist, Brigham and Women's Hospital

OTHER PROFESSIONAL POSITIONS AND MAJOR VISITING APPOINTMENTS:

1977-1979	Legislative Assistant for Energy and Environment, Congressman Timothy Wirth
1979-1987	Staff Scientist, U.S. Environmental Protection Agency
1987-1988	Visiting Scientist, Department of Biostatistics, Harvard School of Public Health
1989, 1994	Visiting Scientist, Department of Social and Preventive Medicine, University of Basel, Switzerland
1990	Visiting Scientist, Department of Occupational Safety and Environmental Health University of Wuppertal, Germany
1989-1993	Senior Scientist, U.S. Environmental Protection Agency

HONORS AND DISTINCTIONS:

2008	John Goldsmith Career Achievement Award, International Society for Environmental Epidemiology
2001	Nichols Teaching Award, Harvard School of Public Health

2001	International Union of Environmental Protection Agencies World Congress Award
1999	Twentieth Century Distinguished Service Award, Lukacs Symposium for Statistical Ecology and Environmental Statistics
1991	John D and Catherine T MacArthur Fellowship
1984,1986	U.S. Environmental Protection Agency Silver Medal
1988-89-90-92	U.S. Environmental Protection Agency Scientific Achievement Award
1991	Alumni Achievement Award, Brandeis University

MAJOR COMMITTEE ASSIGNMENTS:

National

1985	Preventing Lead Poisoning in Young Children document, Consultant, Centers for Disease Control
1988	Advisory Committee, Boston Soil Lead Study
1989-1992	EPA Environmental Health Review Panel, Environmental Protection Agency
1989-1993	National Academy of Science, Committee on Assessing Lead Exposure in Critical Populations
1990-1993	National Academy of Science, Committee on Environmental Epidemiology
1992	Advisory Committee, Resources for the Future Center for Risk Management, Public Health/ Environmental Health Risk Studies
1992	Environmental Epidemiology Advisory Committee, Pew Memorial Trusts
1992	Ethics Committee, International Society for Environmental Epidemiology
1992	Reviewing Committee, Office of Technology Assessment for Identifying and Controlling Pulmonary Toxicants
1992-present	Technical Advisory Committee, Alliance to End Childhood Lead Poisoning
1992	Technical Advisory Committee, New York State Environmental Externalities Cost Study
1993	Subcommittee on Lead, National Advisory Committee on Environmental Policies and Technology
1993-present	Research Advisory Committee, National Center for Lead Safe Housing
1994-2002	Center for Disease Control, Advisory Committee on Childhood Lead Poisoning Prevention
1994-2005	Mickey Leland National Urban Air Toxic Research Center, Scientific Advisory Panel
1995-7	Environmental Statistics Subcommittee, National Advisory Committee on Environmental Policy and Technology
1998	Franklin Institute Science Medal Prize Committee
2003-2005	HSPH Disciplinary Committee
2004	Steering Committee, Harvard University Committee on the Environment
2005	EPA Science Advisory Board, Ad Hoc All Ages Lead Committee
2005-2008	Councilor, International Society for Environmental Epidemiology
2005-present	Editorial Board, American Journal of Respiratory and Critical Care Medicine
2005-2008	EPA Lead Clean Air Science Advisory Committee

International

1993-2004	European Economic Community Studies on Air Pollution, Daily Mortality, and Hospital Emergency Visits, Advisor

1993	Advisory Committee, European Economic Community Panel Studies on Air Pollution, Pulmonary Function, and Respiratory Function
2000-2004	Chair, Statistics Advisory Committee, APHEIS Project

PROFESSIONAL SOCIETIES:

1987	American Statistical Association
1988	American Thoracic Society
1990	Society for Epidemiologic Research
1991	International Society for Environmental Epidemiology

Editorial Board

2003-4	Epidemiology Editor, International Journal of Biometeorology
2005-2010	Editorial Board, American Journal of Respiratory and Critical Care Medicine

MAJOR RESEARCH INTERESTS:

1. Respiratory Epidemiology
2. Air, Water and Lead Epidemiology
3. Epidemiologic Methods
4. Cost-Benefit Analysis

TEACHING EXPERIENCE:

1992-2008	Environmental Epidemiology Course, University of Basel @ 30-40 Graduate Students 120 Preparation Time each year, 35 class hours
1994, 97,99, 2009, 10	Advanced Topics in Environmental Epidemiology, University of Basel, @ 20 Graduate Students, 35 class hours
1995	Short Course on Advanced Regression Analysis in Environmental Epidemiology, San Miniato, Italy @ 23 Graduate Students, 35 class hours
1996–present	Professor, ID 271 HSPH, joint course on Advanced Regression Analysis for Departments of Epidemiology, Environmental Health, and Biostatistics, 21 Graduate Students, 35 class hours 2010-present Professor, EPI 204, Methods for analyzing case control, cohort, and other studies, 100 graduate students, 35 class hours
2007-present	Professor, EH520 Seminar on preparing research proposals
2007-present	Environmental Epidemiology, Cyprus International Istitute

1998	European Course on methods for Poisson Time Series, Santorini Greece, @40 Graduate Students, 35 hours
1998	Short Course on Advanced Regression in Environmental Epidemiology, Annual meeting of International Society for Environmental Epidemiology, 45 Graduate Students, 7 hours
1999	European Course on methods of Meta-analysis. Santorini Greece, 40 students, 24 course hours
2006	Environmental Epidemiology, National Institute of Public Heath, Mexico 40 students 30 hours

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16. **Schwartz J**. Multinational trends in cancer mortality rates: Methodological issues and results. Ann New York Acad Sci 1990;609:136-145.

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Doctoral Students

Advisor:

past

Tom Bateson	HSPH Epidemiology "Case Crossover Design for Environmental Time Series"
Greg Wellenius	HSPH, Epidemiology "Air pollution and Congestive Heart Failure"
Sung Kyung Park	HSPH, Environmental Health "Genetic polymorphisms, heart rate variability, and environmental exposures to metals and air pollution"
Cathryn Tonne	HSPH, Environmental Health and Epidemiology, "Pollution and social position as predictors of Heart Attacks and survival in a population based study"
John McCracken	HSPH, Environmental Health and Epidemiology, "Cardiovascular effects following interventions with clean cooking stoves in rural Guatemala"
Elissa Wilker	HSPH, Environmental Health "Gene-Environment Interactions in the effects of air pollution and lead"
Sara Cabelli	HSPH, Epidemiology
Angeliki Lambrou	HSPH, Environmental Health
Jaime Madrigano	HSPH, Epidemiology

Current Students:

Marie-Abele Bind	HSPH, Environmental Health, Biostatistics
Yara Abu Awad	HSPH, Environmental Health
German Orrego	HSPH, Environmental Health
Lingzhen Dai	HSPH, Environmental Health
Mye-Hi Lee	HSPH, Environmental Health

Doctoral Committee

past

Chava Peretz	Univ of Utrecht, Epidemiology "Longitudinal Models for Lung Function in Children"
Antonella Zanobetti	University of Florence, Applied Statistics "A Nonparametric Distributed Lag Model to Evaluate Harvesting in the association between Air Pollution and Daily Deaths"

Yawen Cheng	HSPH Epidemiology “Lead, Hypertension, and Cardiovascular Disease”
Elizabeth Platz	HSPH Epidemiology “Thorotrast Exposure and Cancer in radiology patients”
Jeremy Sarnat	HSPH, Environmental Health “Exposure Error in Time Series Studies of Air Pollution”
Paul Stark	HSPH, Environmental Health “Asthma and aeroallergen exposure”
Sharon Tsaih	HSPH, Epidemiology “Biomarkers of Lead and Bone Turnover and Their Relationship to Kidney Function”
Hung Yi-Chuang	HSPH Environmental Health “Structural Equation Models for Lead Exposure of the Fetus, Lead and Vibration Threshold in Battery Plant Workers”
Hae Kwang Cheong	HSPH Environmental Health “Longitudinal model of the cognitive effects of lead”
Kirsi Timonnen	University of Kuopio, Finland Epidemiology “Air Pollution and Respiratory Health of Children”
Michael Wright	HSPH Environmental Health “Exposure to mutagens in drinking water, Effects of Drinking water on Pregnancy Outcome”
Shannon Magari	HSPH, Environmental Health “Cardiovascular Responses to Occupational and Environmental Particulate Exposure”
Hsing Jasmin Chao	HSPH, Environmental Health “Longitudinal Variations in Office Building Fungi and their Associations with Work–Related Symptoms”
Adrienne Ettinger	HSPH, Environmental Health. “Dietary and Environmental Determinants of Endogenous Exposure to Lead over the Course of Lactation”
Sunyeong Park	HSPH, Cancer and Cell Biology “Gene-Environment Interactions in Bladder Cancer”
R Graham Barr	HSPH, Epidemiology “Prospective Study of Hormone Replacement Therapy and Risk of Asthma or Chronic Obstructive Pulmonary Disease among Postmenopausal Women”
David Rich	HSPH, Environmental Health, “Ambient Air Pollution and the Risk of Cardiac Arrhythmias detected by implatable cardioverter defibrillators”
Stephanie Ebelt	HSPH, Environmental Health “Personal Exposure, ambient concentrations, and cardiovascular responses in a panel of elderly”
Hailay D Teklehaimanot	HSPH, Epidemiology “Modeling Malaria Epidemics”
Alexandros Gryparis	HSPH, Biostatistics “Geostatistical modeling with missing data”
Jane Burns	HSPH, Environmental Health “Diet, Air Pollution, and Respiratory Health”

Florence Wang	HSPH, Environmental Health “Determinants and Genetic Modifiers of Lead Burden and cognition”
Sara Dubowski	HSPH, Environmental Health “Acute Cardiopulmonary Responses to Traffic-Related Particles in St. Louis Senior Adults”
Mark Weisskopf	HSPH, Epidemiology. “Predictors of cognitive decline in aging and Parkinsonism”
Pradeep Rajan	HSPH, Environmental Health “Genetic polymorphisms, lead exposure, and mini mental status exams in a cohort of elderly”
Jeff Yanoski	HSPH, Environmental Health “Estimating Chronic Particulate and Gaseous Air Pollutant Exposures Using GIS-Based Spatio-Temporal Models”
Meredith Franklin	HSPH, Environmental Health “Modeling Ground and Space-Based particle Measurements with Application to Environmental Epidemiology”
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Jenn Cavallari	HSPH, Environmental Health
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Amar Mehta	HSPH, Environmental Health
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Paul Brochu	HSPH, Environmental Health
Birgit Clauss Henn	HSPH, Environmental Health
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Jaime Madrigano	HSPH, Epidemiology and Environmental Health
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Tamar Sofer	HSPH, Biostatistics
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Postdoctoral Fellows:

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Christian Schindler	(from Univ of Basel) "Air Pollution and Peak Flow Measures in Asthmatic Adults"
Arnoud Verhoef	(from Univ of Waggeningen) "Air pollution and daily mortality in Amsterdam, the Netherlands"
Gerard Hoek	(from Univ of Waggeningen) "Effects of ambient particulate matter and ozone on daily mortality in Rotterdam, the Netherlands."
Alain le Terte	(from National Institute for Public Health Surveillance, Paris) "Air Pollution and Emergency Visits for Asthma in Paris"
Claudia Spix	(from Univ of Wuppertal) "Air Pollution and Daily Deaths"
Paolo Saldiva	(from University of Sao Paolo) "Air pollution and mortality in elderly people: A time series study in Sao Paolo, Brazil"
Erica von Mutius	(Ludwig Maximillian University, Munich) "Dietary factors and Asthma"
Marie O'Neill	"Social factors in the dependence of mortality on air pollution and weather"
Tom Bateson	"Selection Bias and Confounding in Case- Crossover Analyses of Environmental Time Series Data"
Amanda Wheeler	"Air pollution and heart rate variability"
Dawn Demeo	"Air pollution and oxygen saturation in the elderly"
Francine Laden	"Association of fine particulate matter from different sources with daily mortality in six US cities."

Nicole Janssen	“Air conditioning and combustion related particles as modifiers of the effect of PM10 on hospital admissions for heart and lung diseases”
Eun-Hee Ha	“Is air pollution a risk factor for low birth weight in Seoul?”
Jon-Tae Lee	“Bidirectional case-crossover studies of air pollution: bias from skewed and incomplete waves.”
Ahmed Gomaa	“Pre and Postnatal lead exposure and children’s cognitive function”
Sahar Elmarsafawy	“Interaction of lead and calcium in predicting hypertension”
Alfesio Braga	“The time course of weather related deaths”
Yon-Chul Hong	“Effects of Air Pollutants on Acute Stroke Mortality”
Babette Brumback	“Transitional Regression Models with Application to Environmental Time Series”
Ariana Zeka	“Effects of Air pollution on Pregnancy Outcomes”
Andrea Baccarelli	“Cardiovascular Effects of Air Pollution”
Mercedes Medina-Ramon	“Effects of traffic pollution on survival of heart failure patients”
Alexandros Gryparis	“Spatio-Temporal modeling of traffic related air pollution and birth outcomes”
Nicos Midletton	“Traffic related pollution and mortality”
Stephanie von Klot	“GIS based Exposure to Heat, Mortality, and Myocardial Infarctions”
Elvira Vaclavik	“Case-Crossover Analysis of susceptibility to air pollution”
John McCracken	“Cardiovascular Effects of Wood Smoke Exposure in Guatemala”
Cizao Ren	“Gene Environment interactions and Air Pollution”
Jaana Halonen	“ Physiologic effects of Temperature”

Current Fellows

Itai Kloog	“Spatio-temporal particle models and health”
Johanna Lepeule	“Epigenetics and Pulmonary Health”
Amar Mehta	“Epigenetics, Environment, and Cardiovascular Disease”

EXHIBIT B

EXHIBIT B

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Exhibit C to

New York Attorney General's

Comments dated March 30, 2018

NEW YORK STATE OF OPPORTUNITY.

Department of Environmental Conservation

Executive Summary

Final

Supplemental Generic Environmental Impact Statement

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EXECUTIVE SUMMARY

High-volume hydraulic fracturing utilizes a well stimulation technique that has greatly increased the ability to extract natural gas from very tight rock. High-volume hydraulic fracturing, which is often used in conjunction with horizontal drilling and multi-well pad development, raises new, significant, adverse impacts not studied in 1992 in the Department of Environmental Conservation's (Department or DEC) previous Generic Environmental Impact Statement (1992 GEIS) on the Oil, Gas and Solution Mining Regulatory Program.[1]

Since issuing a draft Scope for public review in October 2008, the Department has conducted an exhaustive evaluation of high-volume hydraulic fracturing's potential significant adverse environmental and public health impacts and possible mitigation measures to eliminate, avoid or reduce those impacts. The Department received over 260,000 public comments, an unprecedented number, on the 2009 Draft SGEIS (dSGEIS) and the 2011 Revised Draft SGEIS (rdSGEIS) and the associated regulatory documents which were considered before issuing this Final SGEIS (FSGEIS) (the drafts and the final SGEIS are collectively referred to as the "SGEIS," unless otherwise distinguished). During this period of time, a broad range of experts from academia, industry, environmental organizations, municipalities, and the medical and public health professions commented and/or provided their analyses of high-volume hydraulic fracturing. The comments referenced an increasing number of ongoing scientific studies across a wide range of professional disciplines. These studies and expert comments evidence that significant uncertainty remains regarding the level of risk to public health and the environment that would result from permitting high-volume hydraulic fracturing in New York, and regarding the degree of effectiveness of proposed mitigation measures. In fact, the uncertainty regarding the potential significant adverse environmental and public health impacts has been growing over time.

1 The Generic Environmental Impact Statement (1992 GEIS) on the Oil, Gas and Solution Mining Regulatory Program is posted on the Department's website at http://www.dec.ny.gov/energy/45912.html. The 1992 GEIS includes an analysis of impacts from vertical gas drilling as well as hydraulic fracturing. Since 1992 the Department has used the 1992 GEIS as the basis of its State Environmental Quality Review Act (SEQRA) review for permit applications for gas drilling in New York State.

The Department worked closely with the New York State Department of Health (NYSDOH) during preparation of the SGEIS. Due to the increasing concern regarding high-volume hydraulic fracturing's impacts on public health, the Department on September 20, 2012, requested NYSDOH to conduct a review of the SGEIS and mitigation measures and advise the Department whether they were adequate to protect public health. On December 17, 2014, NYSDOH advised the Department that there are several potential adverse environmental impacts that can result from high-volume hydraulic fracturing which may be associated with adverse public health outcomes. These impacts include: 1) air impacts that could affect respiratory health due to increased levels of particulate matter, diesel exhaust, or volatile organic chemicals; 2) climate change impacts due to methane and other volatile organic chemical releases to the atmosphere ; 3) drinking water impacts from underground migration of methane and/or fracturing fluid chemicals associated with faulty well construction or seismic activity; 4) surface spills potentially resulting in soil, groundwater, and surface water contamination; 5) surface water contamination resulting from inadequate wastewater treatment; 6) earthquakes and creation of fissures induced during the hydraulic fracturing stage; and 7) community character impacts such as increased vehicle traffic, road damage, noise, odor complaints, and increased local demand for housing and medical care. NYSDOH concluded that "until the science provides sufficient information to determine the level of risk to public health from HVHF to all New Yorkers and whether the risks can be adequately managed … HVHF should not proceed in New York State."

The Department concurs with NYSDOH, as the uncertainty revolving around potential public health impacts stems from many of the significant adverse environmental risks identified in the SGEIS for which the Department proposed and considered extensive mitigation measures. In response to additional scientific information regarding the magnitude of high-volume hydraulic fracturing's potential significant adverse impacts, the Department considered expanding many of the mitigation measures previously proposed in the rdSGEIS to protect public health and the environment with a greater margin of safety.

As a result, more and more area within the Marcellus Shale fairway would be off limits to high-volume hydraulic fracturing. For example, the Department considered prohibiting high-volume hydraulic fracturing on private lands within the Catskill Park, increasing setbacks to residences, and natural and cultural resources, and expanding the sensitive areas that would be off limits. The additional restrictions and prohibitions and the necessity for close and coordinated regulatory oversight by the Department with involved and interested state and local agencies would substantially increase costs to industry, which would likely negatively impact the potential economic benefits associated with high-volume hydraulic fracturing..

The Court of Appeals decision in *Matter of Wallach v. Town of Dryden and Cooperstown Holstein Corp. v. Town of Middlefield*, which held that local governments could exercise their zoning and land use jurisdiction to restrict or prohibit high-volume hydraulic fracturing within their communities, would impact prior economic projections and would likely result in a decrease in potential economic benefits. This would also create potential land use conflicts with high-volume hydraulic fracturing's ancillary infrastructure in communities that reject high-volume hydraulic fracturing within their borders.

General Background

The Department has received applications for permits to drill horizontal wells to evaluate and develop the Marcellus Shale for natural gas production by high-volume hydraulic fracturing. In New York, the primary target for shale-gas development is currently the Marcellus Shale, with the deeper Utica Shale also identified as a potential resource. Additional low-permeability reservoirs may be considered by project sponsors for development by high-volume hydraulic fracturing.

Horizontal drilling with high-volume hydraulic fracturing facilitates natural gas extraction from large areas where conventional natural gas extraction is commercially unprofitable; thus, well operations would likely be widespread across certain regions within the Marcellus formation. Distinct from conventional natural gas extraction technologies governed by the Department's 1992 GEIS and related oil and gas permits, high-volume hydraulic fracturing involves substantially larger volumes of water and a multitude of potential chemical additives. The use of high-volume hydraulic fracturing with horizontal well drilling technology enables a number of wells to be drilled from a single well pad (multi-pad wells). Although horizontal drilling results in fewer well pads than traditional vertical well drilling, the pads are larger and the industrial activity taking place on the pads is more intense.

Hydraulic fracturing requires chemical additives, some of which potentially pose hazards to public health and the environment through exposure. The high volume of water associated with hydraulic fracturing may also result in significant adverse impacts relating to water supplies, other water resources, wastewater treatment and disposal, and truck traffic. Horizontal wells also generate greater volumes of drilling waste (cuttings) than vertical wells. The industry projections of the level of drilling, as reflected in the intense development activity in neighboring Pennsylvania, has raised additional concerns relating to community character, including noise, and visual impacts; adverse impacts on cultural and historic resources, agriculture, tourism, and scenic resources; and socioeconomics impacts.

The Department has prepared this Final Supplemental Generic Environmental Impact Statement (Final SGEIS) to satisfy the requirements of the State Environmental Quality Review Act (SEQRA) by examining high-volume hydraulic fracturing and identifying new potential significant adverse impacts of these operations.

The Department's environmental review associated with the Department's determination whether to authorize high-volume hydraulic fracturing in New York State required extensive evaluation of the current and developing science underlying high-volume hydraulic fracturing's impacts and the increasingly stringent mitigation measures to protect the environment and public health.

SEQRA Procedure to Date

The public process to develop the SGEIS began with public scoping sessions in the autumn of 2008. Since then, engineers, geologists and other scientists and specialists in all of the Department's natural resources and environmental quality programs have collaborated to comprehensively analyze a vast amount of information about the proposed operations and the potential significant adverse impacts of these operations on the environment, identify mitigation measures that would prevent or minimize any significant adverse impacts, and identify criteria and conditions for future permit approvals and other regulatory action.

In September 2009, the Department issued an initial dSGEIS (2009 dSGEIS) for public review and comment. The extensive public comments revealed a significant concern with potential contamination of groundwater and surface drinking water supplies that could result from this new stimulation technique. Concerns raised included comments that the 2009 dSGEIS did not fully study the potential for gas migration from this new technique, or adequately consider impacts from disposal of solid and liquid wastes. Additionally, commenters stated the 2009 dSGEIS did not contain sufficient consideration of visual, noise, traffic, community character or socioeconomic impacts. Accordingly, in 2010 Governor Paterson ordered the Department to issue a revised dSGEIS (rdSGEIS) on or about June 1, 2011. Executive Order 41 also provided that no permits authorizing high-volume hydraulic fracturing would be issued until the SGEIS was finalized.

Since the issuance of the 2009 dSGEIS, and the subsequent rdSGEIS, the Department has gained a more detailed understanding of the potential impacts associated with high-volume hydraulic fracturing with horizontal drilling from: (i) the extensive public comments from environmental organizations, municipalities, industry groups, medical and public health professionals, and other members of the public; (ii) its review of reports and studies of proposed operations prepared by industry groups; (iii) extensive consultations with scientists in several bureaus within the NYSDOH; (iv) the use of outside consulting firms to prepare analyses relating to socioeconomic impacts, as well as impacts on community character, including visual, noise and traffic impacts; and, (v) its review of information and data from the Pennsylvania Department of Environmental Protection (PADEP) and the Susquehanna River Basin Commission (SRBC) about events, regulations, enforcement and other matters associated with ongoing Marcellus Shale development in Pennsylvania. In June 2011, moreover, Commissioner Joseph Martens and Department staff visited a well pad in LeRoy, Pennsylvania, where contaminants had discharged from the well pad into an adjacent stream, and had further conversations with industry representatives and public officials about that event and high-volume hydraulic fracturing operations in Pennsylvania generally.

In addition, as discussed above, NYSDOH conducted a comprehensive health review of high-volume hydraulic fracturing and completed its Public Health Review in December 2014.

During preparation of this Final SGEIS, the Department incorporated suggestions made by the public and, where appropriate, provided additional discussion in either the Final SGEIS or the Response to Comments to clarify the content of the drafts. Specifically, the Department has revised Chapter 1 to reflect all of the procedural changes and actions that have occurred following the time of publication of the rdSGEIS for public comment. In Chapter 2, a subsection drafted in 2011 relating to the potential public need and benefit of high-volume hydraulic fracturing was deleted because the subject is now addressed more accurately in the Department's Response to Comments, which is based on analysis subsequent to the rdSGEIS and public comment. The Department also revised Chapter 7 of the Final SGEIS to remove conclusory language with respect to the mitigation proposed, to better reflect remaining uncertainty as to the effectiveness or the degree to which the mitigation would reduce impacts and risks associated with high-volume hydraulic fracturing. The Department also revised Chapter 9 to better represent both the benefits and negative consequences of the No Action Alternative. This Executive Summary was also revised to reflect these changes, as well as to reflect some of the additional mitigation measures that were considered by the Department. These minor changes to the SGEIS do not reflect that some laws or regulations may have changed from the time of publication of the 2011 rdSGEIS, notably, amendments to the Water Resources Law and corresponding regulations.

Pursuant to 6 NYCRR Section 617.9(b)(8), the Final SGEIS consists of the prior drafts of the SGEIS, including all revisions noted above and the summary of the substantive comments received and the Department's responses, which both comprise the Department's Response to Comments. Consequently, the findings for this action will consider the relevant environmental and public health impacts, mitigation measures and facts discussed in the Final SGEIS, prior drafts of the SGEIS, and the 1992 GEIS, including the Department's Response to Comments. The Department's Response to Comments represents the Department's most current assessment of the impacts associated with high-volume hydraulic fracturing and the effectiveness of proposed or considered mitigation measures to adequately mitigate significant adverse environmental and public health impacts.

Each chapter of this final SGEIS is summarized below.

Chapter 1 – Introduction

This Chapter contains background information and an introduction to the SGEIS.

Chapter 2 – Description of Proposed Action

This Chapter includes a discussion of the purpose of proposed high-volume hydraulic fracturing operations, as well as the potential locations, projected activity levels, and environmental setting for such operations. Information on the environmental setting focuses on topics determined during scoping to require attention in the SGEIS. The Department determined, based on industry projections in 2010 that it would potentially receive applications to drill approximately 1,700 - 2,500 horizontal and vertical wells for development of the Marcellus Shale by high-volume hydraulic fracturing during a "peak development" year, if high-volume hydraulic fracturing were authorized. Based on these projections, an average year could see 1,600 or more applications. Development of the Marcellus Shale in New York could occur over a 30-year period. A consultant to the Department completed a draft estimate of the potential economic and public benefits of proposed high-volume hydraulic fracturing development, including an analysis based on an average development scenario as well as a more conservative low potential development scenario. That analysis calculates for each scenario the total economic value to the proposed operations, potential state and local tax revenue, and projected total job creation. However, given the cost of compliance with New York State's draft high-volume hydraulic fracturing program conditions, the *Matter of Wallach v. Town of Dryden and Cooperstown Holstein Corp. v. Town of Middlefield* decision, the areas where high-volume hydraulic fracturing would be prohibited or restricted by the SGEIS, and the economics of oil and gas production, the Department cannot with any certainty predict how many applications would be submitted if high-volume hydraulic fracturing were authorized. However even with a reduced economic outlook, it remains likely that high-volume hydraulic fracturing would be widespread and would impact areas that previously have not been exposed to oil and gas development. In fact, if high-volume hydraulic fracturing were authorized, the proposed restrictions and prohibitions in certain areas would likely lead to intensified development in those areas where high-volume hydraulic volume would be permissible. Moreover, as discussed below, beyond directly impacting those particular areas where the activity would be allowed, the ancillary activities associated with high-volume hydraulic fracturing and their corresponding significant adverse impacts would likely spread to those areas of the State where high-volume hydraulic fracturing is prohibited.

Chapter 3 – Proposed SEQRA Review Process

This Chapter describes how the Department would use the 1992 GEIS and the Final SGEIS in reviewing applications to conduct high-volume hydraulic fracturing operations in New York State if high-volume hydraulic fracturing were authorized. It describes the proposed Environmental Assessment Form (EAF) addendum requirements that would be used in connection with high-volume hydraulic fracturing applications, and also identifies those potential activities that would require site-specific SEQRA determinations of significance after the SGEIS is completed. Specifically, Chapter 3 states that site-specific environmental assessments and SEQRA determinations of significance would be required for the following types of high-volume hydraulic fracturing applications, regardless of the target formation, the number of wells drilled on the pad and whether the wells are vertical or horizontal (the Department considered expanding some of the distances listed below):

1) Any proposed high-volume hydraulic fracturing where the top of the target fracture zone is shallower than 2,000 feet along a part of the proposed length of the wellbore;

2) Any proposed high-volume hydraulic fracturing where the top of the target fracture zone at any point along the entire proposed length of the wellbore is less than 1,000 feet below the base of a known fresh water supply;

3) Any proposed well pad within the boundaries of a principal aquifer, or outside but within 500 feet of the boundaries of a principal aquifer;

4) Any proposed well pad within 150 feet of a perennial or intermittent stream, storm drain, lake or pond;

5) A proposed surface water withdrawal that is found not to be consistent with the Department’s preferred passby flow methodology as described in Chapter 7; and

6) Any proposed well location determined by the New York City Department of Environmental Protection (NYCDEP) to be within 1,000 feet of its subsurface water supply infrastructure.

In all of the aforementioned circumstances a site-specific SEQRA assessment would be required because such application is either beyond the scope of the analyses contained in this draft SGEIS or the Department has determined that proposed activities in these areas raise additional environmental issues that necessitate a site-specific review. Many of the issues for which the Department determined that a site-specific environmental assessment and SEQRA determination of significance would be required represent areas of heightened environmental concern where environmental impacts could be expected to be significant. As indicated previously, the Department continued its evaluation of more stringent conditions to address both the uncertainty regarding the potential impacts and the impacts that remain unresolved due to the potential inadequacy of mitigation measures. The Department weighed additional conditions to address programmatic concerns as the public comment and scientific studies revealed an expanding bibliography of scientific uncertainty and unresolved and unmitigated environmental impacts.

In addition to those site-specific SEQRA assessments described in Chapter 3, the Department considered requiring site-specific environmental assessments and SEQRA determinations of significance for the following additional types of high-volume hydraulic fracturing applications:

1) Any proposed centralized flowback water surface impoundment;
2) Any proposed well location within a contiguous, 30-acre, high- or medium-scoring grassland patch in a grassland focus area unless the ecological assessment demonstrates lack of a significant adverse impact on grassland habitat and grassland birds;
3) Any proposed well location within a contiguous, 150-acre forest patch in a forest focus area unless the ecological assessment demonstrates lack of a significant adverse impact on forest interior habitat and forest interior birds;
4) Any proposed well location on private lands that are totally surrounded by New York State Office of Parks, Recreation and Historic Preservation (OPRHP) lands or Department-administered State-owned lands;
5) Any proposed well location within the Catskill Park outside the New York City watershed or the Adirondack Park; and
6) Any proposed well location wholly or partially within or substantially contiguous to an historic district.

The Department also considered expanding the buffers of some of the previously proposed locations requiring a site-specific review, including expanding the 150-foot buffer from a perennial or intermittent stream, storm drain, lake or pond to 300 feet and including freshwater wetlands, and converting some of the requirements for site-specific reviews to prohibitions.

Chapter 3 also identifies the Department's oil and gas well regulations, located at 6 NYCRR Part 550, and it discusses the existence of other regulations related to high-volume hydraulic fracturing. The Department proposed revised regulations relating to high-volume hydraulic fracturing in 2011 but abandoned the rulemaking in 2013.

Chapter 4 - Geology

Chapter 4 supplements the geology discussion in the 1992 GEIS (Chapter 5) with additional details about the Marcellus and Utica Shales, seismicity in New York State, naturally occurring radioactive materials (NORM) in the Marcellus Shale and naturally occurring methane in New York State.

Chapter 5 - Natural Gas Development Activities & High-Volume Hydraulic Fracturing

This Chapter comprehensively describes the activities associated with high-volume hydraulic fracturing and multi-well pad drilling, including the composition of hydraulic fracturing additives and flowback water characteristics. It is based on the 2011 description of proposed activities provided by industry and verified by the Department in addition to being informed by high-volume hydraulic fracturing operations ongoing in Pennsylvania and elsewhere. In this Chapter, the average disturbance associated with a multi-well pad, access road and proportionate infrastructure during the drilling and fracturing stage is estimated at 7.4 acres, compared to the average disturbance associated with a well pad for a single vertical well during the drilling and fracturing stage, which is estimated at 4.8 acres. As a result of required partial reclamation, the average well pad would generally be reduced to averages of about 5.5 acres and 4.5 acres, respectively, during the production phase.

This Chapter describes the process for constructing access roads, and observes that because most shale gas development would consist of several wells on a multi-well pad, more than one well would be serviced by a single access road instead of one well per access road as was typically the case when the 1992 GEIS was prepared. Therefore, in areas developed by horizontal drilling using multi-well pads, it is expected that fewer access roads as a function of the number of wells would be constructed. Industry estimates that 90% of the wells used to develop the Marcellus Shale would be horizontal wells located on multi-well pads. However, the evolution of the technology that facilitates extraction of natural gas from deep low-permeability shale formations where it was previously not feasible would lead to more widespread impacts in certain regions that could not occur from conventional methods of extraction. Chapter 5 describes the constituents of drilling mud and the containment of drill cuttings, either in a lined on-site reserve pit or in a closed-loop tank system. This Chapter also calculates the projected volume of cuttings and the potential for such cuttings to contain naturally occurring radioactive materials (NORM).

This Chapter also discusses the process of high-volume hydraulic fracturing, the composition of fracturing fluid, on-site storage and handling, and transport of fracturing additives. The high-volume hydraulic fracturing process involves the controlled use of high volumes of water and chemical additives, pumped under pressure into a steel-cased and cemented wellbore. To protect fresh water zones and isolate the target hydrocarbon-bearing zone, high-volume hydraulic fracturing does not occur until after the well is cased and cemented, and typically after the drilling rig and its associated equipment are removed from the well pad. Chapter 5 explains that the Department would generally require at least three strings of cemented casing in the well during fracturing operations. The outer string (i.e., surface casing) would extend below fresh ground water and would have been cemented to the surface before the well was drilled deeper. The intermediate casing string, also called protective string, is installed between the surface and production strings. The innermost casing string (i.e., production casing) typically extends from the ground surface to the toe of the horizontal well.

The fluid used for high-volume hydraulic fracturing is typically comprised of more than 98% fresh water and sand, with chemical additives comprising 2% or less of the fluid. The Department has collected compositional information on many of the additives proposed for use in fracturing shale formations in New York directly from chemical suppliers and service companies and those additives are identified and discussed in detail in Chapter 5. It is estimated that 2.4 million to 7.8 million gallons of water may be used for a multi-stage hydraulic fracturing procedure in a typical 4,000-foot lateral wellbore. Water may be delivered by truck or pipeline directly from the source to the well pad, or may be delivered by trucks or pipeline from centralized water storage or staging facilities consisting of tanks or engineered impoundments.

After the high-volume hydraulic fracturing procedure is completed and pressure is released, the direction of fluid flow reverses. The well is "cleaned up" by allowing water and excess proppant (typically sand) to flow up through the wellbore to the surface. Both the process and the returned water are commonly referred to as "flowback." The SGEIS estimates flowback water volume to range from 216,000 gallons to 2.7 million gallons per well, based on a pumped fluid estimate of 2.4 million to 7.8 million gallons. After completion of drilling operations and while natural gas production is underway, brine fluids that preexisted naturally in the formation prior to drilling are returned to the surface from the borehole, which is commonly referred to as "production brine." It is estimated that production brine per well may range from 400 gallons per day (gpd) to 3,400 gpd. Chapter 5 discusses the volume, characteristics, recycling and disposal of flowback water and production brine.

Chapter 6 – Potential Environmental Impacts

This Chapter identifies and evaluates the potential significant adverse impacts associated with high-volume hydraulic fracturing operations and, like other chapters, should be read as a supplement to the 1992 GEIS. The Department's evolving understanding of the potential significant adverse impacts associated with high-volume hydraulic fracturing is reflected in the accompanying Response to Comments, which represents the Department's current assessment of those impacts and of the effectiveness of proposed or considered mitigation measures. In this regard, the ever increasing collection of proposed mitigation measures demonstrates three essential weaknesses of the proposed program: (1) the effectiveness of the mitigation is uncertain; (2) the potential risk and impact from the proposed Action to the environment and public health cannot be quantified at this time, and (3) there are some significant adverse impacts that are simply unavoidable.

Water Resources Impacts

The Department recognizes the importance of protecting New York's water resources for drinking water supplies, economic development, agriculture, recreation and tourism. As memorialized in Environmental Conservation Law (ECL) § 15-0105, the Department must require the use of all known available and reasonable methods to protect and preserve the purity and quality of water resources over the long-term in order to serve public health, safety and welfare and to maintain ecological resources. Potential significant adverse impacts on water resources exist with regard to potential degradation of drinking water supplies; impacts to surface and underground water resources due to large water withdrawals for high-volume hydraulic fracturing; cumulative impacts; stormwater runoff; surface spills, leaks and pit or surface impoundment failures; groundwater impacts associated with well drilling and construction and seismic activity; waste disposal; and New York City's subsurface water supply infrastructure.

Water for hydraulic fracturing may be obtained by withdrawing it from surface water bodies away from the well site or through new or existing water-supply wells drilled into aquifers. Chapter 6 concludes that, without proper controls on the rate, timing and location of such water withdrawals, the cumulative impacts of such withdrawals could cause modifications to groundwater levels, surface water levels, and stream flow that could result in significant adverse impacts, including but not limited to impacts to the aquatic ecosystem, downstream river channel and riparian resources, wetlands, and aquifer supplies.

Using an industry estimate of a yearly peak activity in New York of 2,462 wells, the SGEIS estimates that high-volume hydraulic fracturing would result in a calculated peak *annual* fresh water usage of 9 billion gallons. Total *daily* fresh water withdrawal in New York has been estimated at about 10.3 billion gallons. This equates to an annual total of about 3.8 trillion gallons. Based on this calculation, at peak activity high-volume hydraulic fracturing would result in increased demand for fresh water in New York of 0.24%. Thus, water usage for high-volume hydraulic fracturing represents a very small percentage of water usage throughout the state. Nevertheless, as noted, the cumulative impact of water withdrawals, if such withdrawals were temporally proximate and from the same water resource, could potentially be significant.

Chapter 6 also describes the potential significant adverse impacts on water resources from stormwater runoff associated with the construction and operation of high-volume hydraulic fracturing well pads. All phases of natural gas well development, from initial land clearing for access roads, equipment staging areas and well pads, to drilling and fracturing operations, production and final reclamation, have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed. Proposed mitigation measures to reduce significant adverse impacts from stormwater runoff are described in Chapter 7. Nonetheless, the potential for significant cumulative as well as site-specific impacts resulting from uncontained contaminated runoff remains.

The SGEIS concludes that spills or releases in connection with high-volume hydraulic fracturing could have significant adverse impacts on water resources. The SGEIS identifies a significant number of contaminants contained in fracturing additives, or otherwise associated with high-volume hydraulic fracturing operations. Spills or releases can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents (including vehicle collisions), ground fires, or improper operations. Spilled, leaked or released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers. Proposed mitigation measures to reduce significant adverse impacts from spills and releases are described in Chapter 7.

Chapter 6 also assesses the potential significant adverse impacts on groundwater resources from well drilling and construction associated with high-volume hydraulic fracturing. Those potential impacts include impacts from turbidity, fluids pumped into or flowing from rock formations penetrated by the well, and contamination from natural gas present in the rock formations penetrated by the well. Because of the concentrated nature of the activity on multi-well pads, the larger fluid volumes and pressures associated with high-volume hydraulic fracturing and likely cumulative impacts across the area where high-volume hydraulic fracturing would be employed, an unacceptable level of uncertainty remains as to the degree of protection afforded by the enhanced procedures and mitigation measures that the Department evaluated and which are discussed in Chapter 7.

The SGEIS explains that the potential migration of natural gas to a water well, which presents a safety hazard because of its combustible and asphyxiant nature, especially if the natural gas builds up in an enclosed space such as a well shed, house or garage, was addressed in the 1992 GEIS. Gas migration most likely would be the result of poor well construction (i.e., casing and cement problems). As with all gas drilling, well construction practices mandated in New York are engineered in a manner that would reduce the risk of gas migration.

Subsequent to the publication of the rdSGEIS, the Department considered public comment and evolving scientific knowledge associated with seismicity and faults and the opportunities for contamination to migrate to groundwater and potable water supplies. Impacts to water resources may occur due to underground vertical migration of fracturing fluids through the shale formations, specifically through preexisting faults or abandoned gas wells. Pathways may exist for upward migration of fracturing fluids and/or natural gas through the shale formations.

Drilling and fracturing fluids, mud-drilled cuttings, pit liners, flowback water and production brine, although classified as non-hazardous industrial waste, must be hauled under a New York State Part 364 waste transporter permit issued by the Department. Furthermore, as discussed in Chapter 7, environmental risks posed by the improper discharge of liquid wastes would be addressed through the institution of a waste tracking procedure similar to that which is required for medical waste. However, the Department recognizes that horizontal wells associated with high-volume hydraulic fracturing produce significantly more drilling and fracturing fluids, cuttings, flowback water and production brine, and result in an increase in the duration of use of pit liners. This increase in the volume of waste consequently creates greater waste disposal impacts, including the risk of inadequate disposal options and the likelihood of spills from accidents occurring during the transportation of this waste. Information about traffic management related to high-volume hydraulic fracturing is discussed in Chapter 7.

The disposal of flowback water and production brine could cause significant adverse impacts. Residual fracturing chemicals and naturally-occurring constituents from the rock formation could be present in flowback water and production brine and could result in 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. Mitigation measures have been identified that would attempt to reduce potential significant adverse impact from flowback water and production brine or treatment of other liquid wastes associated with high-volume hydraulic fracturing.

The potential for significant adverse environmental impacts from any proposal to inject flowback water and production brine from high-volume hydraulic fracturing into a disposal well would be reviewed on a site-specific basis with consideration to local geology (including faults and seismicity), hydrogeology, nearby wellbores or other potential conduits for fluid migration and other pertinent site-specific factors.

The 1992 GEIS summarized the potential impacts of flood damage relative to mud or reserve pits, brine and oil tanks, other fluid tanks, brush debris, erosion and topsoil, bulk supplies (including additives) and accidents. Those potential impacts would also result from high-volume hydraulic fracturing operations but the potential impacts could be significantly greater. Severe flooding is described as one of the ways that bulk supplies such as additives "might accidentally enter the environment in large quantities." Mitigation measures that attempt to reduce the significant adverse impacts from floods are identified and recommended in Chapter 7.

Gamma ray logs from deep wells drilled in New York over the past several decades show the Marcellus Shale to be higher in radioactivity than other bedrock formations including other potential reservoirs that could be developed by high-volume hydraulic fracturing. However, based on the analytical results from field-screening and gamma ray spectroscopy performed on samples of Marcellus Shale, NORM levels in cuttings are similar to those naturally encountered in the surrounding environment. During production associated with high-volume hydraulic fracturing, however, radioactivity originating in wastewater may become more concentrated in pipe scale and liquid waste treatment residuals and may require additional mitigation.

As explained in Chapter 5, the total volume of drill cuttings produced from drilling a horizontal well may be about 40% greater than that for a conventional, vertical well. For multi-well pads, cuttings volume would be multiplied by the number of wells on the pad. The potential water resources impacts associated with the greater volume of drill cuttings from multiple horizontal well drilling operations would arise from the retention of cuttings during drilling, necessitating a larger reserve pit that may be present for a longer period of time that could impact integrity of a liner system, unless the cuttings are directed into tanks as part of a closed-loop tank system.

Impacts on Ecosystems and Wildlife

The SGEIS also analyzes the potential significant adverse impacts on ecosystems and wildlife from high-volume hydraulic fracturing operations. Four areas of concern related to high-volume hydraulic fracturing are: (1) fragmentation of habitat; (2) potential transfer of invasive species; (3) impacts to endangered and threatened species; and (4) use of State-owned lands.

The SGEIS concludes that high-volume hydraulic fracturing operations would have a significant adverse impact on the environment because such operations have the potential to draw substantial development into New York, which would result in unavoidable impacts to habitats (fragmentation, loss of connectivity, degradation, etc.), species distributions and populations, and overall natural resource biodiversity. Habitat loss, conversion, and fragmentation (both short-term and long-term) would result from land grading and clearing, and the construction of well pads, roads, pipelines, and other infrastructure associated with gas drilling. Possible mitigation measures are identified in Chapter 7.

The number of vehicle trips associated with high-volume hydraulic fracturing, particularly at multi-well sites, has been identified as an activity which presents the opportunity to transfer invasive terrestrial species. Surface water withdrawals also have the potential to transfer invasive aquatic species. The introduction of terrestrial and aquatic invasive species would have a significant adverse impact on the environment.

State-owned lands play a unique role in New York's landscape because they are managed under public ownership to allow for sustainable use of natural resources, provide recreational opportunities for all New Yorkers, and provide important wildlife habitat and open space. Given the level of development expected for multi-pad horizontal drilling, the SGEIS anticipates that there would be additional pressure for surface disturbance on State lands. Surface disturbance associated with gas extraction within and adjacent to state lands could have an impact on habitats, and recreational use of the state and private lands, especially large contiguous forest patches that are valuable because they sustain wide-ranging forest species, and provide more habitat for forest interior species.

The area underlain by the Marcellus Shale includes both terrestrial and aquatic habitat for 18 animal species listed as endangered or threatened in New York State that are protected under the State Endangered Species Law (ECL 11-0535) and associated regulations (6 NYCRR Part 182). Endangered and threatened wildlife may be adversely impacted through project actions such as clearing, grading and road building that occur within the habitats that they occupy. Certain species are unable to avoid direct impact due to their inherent poor mobility (e.g., Blanding's turtle, club shell mussel). Certain actions, such as clearing of vegetation or alteration of stream beds, can also result in the loss of nesting and spawning areas.

Mitigation measures for potentially significant adverse impacts from potential transfer of invasive species or from use of State lands, and mitigation measures for potential impacts to endangered and threatened species are discussed in Chapter 7.

Impacts on Air Resources

Chapter 6 of the SGEIS provides a comprehensive list of federal and New York State regulations that apply to potential air emissions and air quality impacts associated with the drilling, completion (hydraulic fracturing and flowback) and production phases (processing, transmission and storage). The Chapter includes a regulatory assessment of the various air pollution sources and the air permitting process.

As part of the Department's effort to address the potential air quality impacts of horizontal drilling and hydraulic fracturing activities in the Marcellus Shale and other low-permeability gas reservoirs, an air quality modeling analysis was undertaken by the Department's Division of Air Resources (DAR). The analysis identifies the emission sources involved in well drilling, completion and production, and the analysis of source operations for purposes of assessing compliance with applicable air quality standards.

After the September 2009 draft SGEIS was published, industry provided information that: (1) simultaneous drilling and completion operations at a single pad would not occur; (2) the maximum number of wells to be drilled at a pad in a year would be four in a 12-month period; and (3) centralized flowback impoundments, which are large-volume, lined ponds that function as fluid collection points for multiple wells, are not contemplated. Based on these operational restrictions, the Department revised the limited modeling of 24 hour $PM_{2.5}$ impacts and conducted supplemental air quality modeling to assess standards compliance and air quality impacts. In addition, the Department conducted supplemental modeling to account for the promulgation of new 1-hour SO_2 and NO_2 National Ambient Air Quality Standards (NAAQS) after September 2009. The results of this supplemental modeling indicate the need for the imposition of certain control measures to achieve the NO_2 and $PM_{2.5}$ NAAQS. These measures, along with all other restrictions reflecting industry's proposed operational restrictions and recommended mitigation measures based on the modeling results, are detailed in Section 7.5.3 of the SGEIS and in the Response to Comments as proposed operation conditions to be included in well permits. As detailed in the Response to Comments, the modeling also demonstrates that high-volume hydraulic fracturing could contribute significantly to elevated ozone levels in the New York metropolitan ozone nonattainment area.

The Department also developed an air monitoring program to address potential for adverse air quality impacts beyond those analyzed in the SGEIS, which are either not fully known at this time or not verifiable by the assessments to date. The air monitoring plan would help determine and distinguish both the background and drilling-related concentrations of pertinent pollutants in the ambient air.

Air quality impact mitigation measures are further discussed in Chapter 7 of the SGEIS, including a detailed discussion of pollution control techniques, various operational scenarios and equipment that can be used to achieve regulatory compliance, and mitigation measures for well pad operations. In addition, measures to reduce benzene emissions from glycol dehydrators and formaldehyde emissions from off-site compressor stations are provided.

Greenhouse Gas Emission Impacts

All operational phases of proposed well pad activities associated with high-volume hydraulic fracturing were considered, and resulting greenhouse gas (GHG) emissions determined in the SGEIS. Emission estimates of carbon dioxide (CO_2) and methane (CH_4) are included as both short tons and as carbon dioxide equivalents (CO_2e) expressed in short tons for expected exploration and development of the Marcellus Shale and other low-permeability gas reservoirs using high-volume hydraulic fracturing. The Department not only quantified potential GHG emissions from activities, but also identified and characterized major sources of CO_2 and CH_4 during anticipated operations so that key contributors of GHGs with the most significant Global Warming Potential (GWP) could be addressed, with particular emphasis placed on mitigating CH_4, with its greater GWP.

Whether the combustion of natural gas results in a net increase of GHG emissions depends on what energy sources are being displaced by natural gas. Replacing higher-emitting fuels such as coal and petroleum in the power, industry, building and transportation sectors may reduce GHG emissions. Recent research demonstrates that low-cost natural gas suppresses investment in and use of clean energy alternatives (such as renewable solar and wind, or energy efficiency), because it makes those alternatives less cost-competitive in comparison to fossil fuels. New York is also implementing a number of policies that promote the continued investment in renewables and efficiency, which should reduce the potential for gas development to pose an economic obstacle to development of renewable energy and investment in energy efficiency. In the long term, New York's policies are directed towards achieving substantial reductions in GHG emissions by reducing reliance on all fossil fuels, including natural gas.

Socioeconomic Impacts

To assess the potential socioeconomic impacts of high-volume hydraulic fracturing, including the potential impacts on population, employment and housing, three representative regions were selected. The three regions were selected to evaluate how high-volume hydraulic fracturing might impact areas with different production potential, different land use patterns, and different levels of experience with natural gas well development. All of the projections identified below relied on assumptions concerning the number of high-volume hydraulic fracturing wells that would be drilled in a year without reference to the buffers and prohibitions proposed in the SGEIS or to the Court of Appeals' decision in the *Matter of Wallach v. Town of Dryden and Cooperstown Holstein Corp. v. Town of Middlefield* and without reference to changes that have occurred in the energy market since this analysis was completed. The current circumstances reduce the projections of economic benefits for the regions where high-volume hydraulic fracturing would likely occur. In fact, the assumptions concerning the number of high-volume hydraulic fracturing wells that would be drilled, and thus, economic benefits initially projected in the dSGEIS do not accurately reflect the current energy market, the high cost of adherence to the conditions that would have been imposed in New York State if high-volume hydraulic fracturing were authorized and the patchwork of local laws and land use controls that prohibit development. Therefore, such benefits would be significantly less than projected in this SGEIS, as explained in the Response to Comments.

Region A consists of Broome, Chemung and Tioga County. Region B consists of Delaware, Otsego and Sullivan County, and Region C consists of Cattaraugus and Chautauqua County. Using a low and average rate of development based on industry estimates, high-volume hydraulic fracturing could potentially have a positive economic effect where the activity takes place.

There would potentially be positive impacts on income levels in the state as a result of high-volume hydraulic fracturing. Employee earnings from operational employment were expected to range from $121.2 million under the low-development scenario to $484.8 million under the average-development scenario in Year 30. Indirect employee earnings were anticipated to range from $202.3 million under the low-development scenario to $809.2 million under the average-development scenario in Year 30. However, as discussed above, given the expected cost of compliance with New York State's draft high-volume hydraulic fracturing program conditions, the economics of oil and gas production and the areas where high-volume hydraulic fracturing would be prohibited or restricted these earnings and employment figures would be significantly lower. Chapter 6 details how the potential job creation and employee earnings might be distributed across the three representative regions.

Chapter 6 also assesses the potential temporary and permanent population impacts on each of the three selected regions, finding that Region A will experience an estimated 1.4% increase in the region's total population the first decade after high-volume hydraulic fracturing is introduced. The population of Region C is projected to be more modestly impacted by high-volume hydraulic fracturing.

While potentially providing positive impacts in the areas of employment and income, high-volume hydraulic fracturing could cause adverse impacts on the availability of housing, especially temporary housing such as hotels and motels. In Region A, where the use of high-volume hydraulic fracturing is expected to be initially concentrated, there could be shortages of rental housing. High-volume hydraulic fracturing would also bring both positive and negative impacts on state and local government spending. Increased activity could result in increases in local tax revenues and increases in the receipt of production royalties but would also result in an increased demand for infrastructure repair and local services, including emergency response services.

Visual, Noise and Community Character Impacts

The construction of well pads and wells associated with high-volume hydraulic fracturing will result in adverse impacts relating to noise. In certain areas the construction and development activities would also result in visual impacts. Potential mitigation measures to address such impacts if high-volume hydraulic fracturing were authorized are summarized in Chapter 7.

The cumulative impact of well construction activity and related truck traffic would cause impacts on the character of the rural communities where much of this activity would take place. Despite the recent New York Court of Appeals in *Matter of Wallach v. Town of Dryden and Cooperstown Holstein Corp. v. Town of Middlefield* that found that ECL Section 23-0303(2) does not preempt communities with adopted zoning laws from prohibiting or restricting the use of land for high-volume hydraulic fracturing drilling, it is likely that localities still may not be able to prevent cross boundary cumulative impacts to their respective community character. Even were a community to prohibit drilling, it is reasonably foreseeable that regional impacts related to high-volume hydraulic fracturing activities, including truck traffic, visual impacts, and impacts on cultural, historic, agricultural, tourism, and scenic resources would adversely affect neighboring municipalities that enact zoning prohibitions.

Transportation Impacts

The introduction of high-volume hydraulic fracturing has the potential to generate significant truck traffic during the construction and development phases of the well. The cumulative impact of this truck traffic has the potential to result in significant adverse impacts on local roads and, to a lesser extent, state roads where truck traffic from this activity is concentrated. It is not feasible to conduct a detailed traffic assessment given that the precise location of well pads is unknown at this time. However, such traffic has the potential to damage roads and impact air quality. Chapter 7 discusses the potential mitigation measures to address such impacts, including the requirement that the applicant develop a Transportation Plan that sets forth proposed truck routes, surveys road conditions along those routes and requires local road use agreements to address any impacts on local roads.

Additional NORM Concerns

Based upon currently available information it is anticipated that flowback water would not contain levels of NORM of significance, whereas production brine could contain elevated NORM levels. Although the highest concentrations of NORM are in production brine, it does not present a risk to workers because the external radiation levels are very low. However, the build-up of NORM in pipes and equipment (pipe scale and sludge) has the potential to cause a significant adverse impact because it could expose workers handling (cleaning or maintenance) the pipe to unsafe radiation levels. Also, wastes from the treatment of production brine may contain concentrated NORM and, if so, controls would be required to limit radiation exposure to workers handling this material as well as to ensure that this material is disposed of in accordance with applicable regulatory requirements.

Seismicity

There is a reasonable base of knowledge and experience related to seismicity induced by hydraulic fracturing. The information on the potential seismic impacts from high-volume hydraulic fracturing has increased since the release of the rdSGEIS. A recent study (Skoumal, 2015) ascribed a series of earthquakes in Poland, Ohio to high-volume hydraulic fracturing operations. Between March 4 and March 12, 2014, 77 earthquakes, ranging between 1.0 and 3.0

in magnitude, were identified and found to be closely related spatially and temporally to hydraulic fracturing operations at a nearby well. The Department's review of available information indicates unanswered questions remain on the seismic impacts associated with high-volume hydraulic fracturing. The Department would need to evaluate the risk to the public, infrastructure, and natural resources from induced seismicity related to hydraulic fracturing if this activity were authorized.

Chapter 7 – Mitigation Measures

This Chapter describes the measures the Department identified as of 2011 to address the potentially significant adverse impacts from high-volume hydraulic fracturing operations if high-volume hydraulic fracturing were authorized. However, there is currently insufficient scientific information to conclude that this activity can be undertaken without posing unreasonable risk to public health, and to determine what mitigation measures provide a level of assurance that potential risks have been satisfactorily minimized.

The Department recognizes the importance of protecting New York's surface and groundwater for drinking water supplies, economic development, and agriculture. In recognition of the potential for spills or releases in connection with high-volume hydraulic fracturing, the Department considered, as a general matter, requiring that operators develop and implement a groundwater monitoring program to detect potential spills and releases around the high-volume hydraulic fracturing well pad and to detect potential contamination in groundwater.

The following describes some of the mitigation measures that were evaluated in the SGEIS, as well as additional measures that were considered:

No High-Volume Hydraulic Fracturing Operations in the New York City and Syracuse Watersheds

In April 2010, the Department concluded that due to the issues presented by high-volume hydraulic fracturing operations within the drinking watersheds for the City of New York and Syracuse, the SGEIS would not apply to activities in those watersheds. Those areas present issues that primarily stem from the fact that they are unfiltered water supplies that depend on strict land use and development controls to ensure that water quality is protected. Then in 2011, the Department concluded that the proposed high-volume hydraulic fracturing activity is not consistent with the preservation of these watersheds as unfiltered drinking water supplies. Notwithstanding the mitigation measures considered for this activity, a risk remains that significant high-volume hydraulic fracturing activities in these areas could result in a degradation of drinking water supplies from accidents, surface spills, etc. Moreover, such large-scale industrial activity in these areas, even without spills, could imperil Filtration Avoidance Determinations and result in the affected municipalities incurring substantial costs to filter their drinking water supply. Accordingly, this SGEIS supports a finding that high-volume hydraulic fracturing well pads not be permitted in the Syracuse and New York City drinking water supply watersheds or in a protective 4,000-foot buffer area around those watersheds.

In response to concerns raised about infrastructure associated with the Syracuse and New York City drinking water supply watersheds, the Department considered extending its initial 4,000-foot setback from unfiltered drinking water supply watersheds for the siting of high-volume hydraulic fracturing well pads. The setback would encompass a portion of the water supply infrastructure, including tunnels that transport water for drinking supplies. Beyond that, the Department also considered prohibiting the placement of any portion of a wellbore less than 2,000 feet from any water tunnel or underneath a tunnel, and requiring enhanced site-specific review plus consultation with the municipality for any wellbore located within two miles of any water supply infrastructure for the Syracuse and NYC drinking water supplies.

No High-Volume Hydraulic Fracturing Operations on Primary Aquifers

Eighteen other aquifers in the State of New York have been identified by NYSDOH as highly productive aquifers presently utilized as sources of water supply by major municipal water supply systems and have been designated as "primary aquifers." Because these aquifers are the primary source for many public drinking water supplies, the potential significant impacts, similar to those that would impact the New York City and Syracuse drinking water supply watersheds, must be reduced to ensure that high-volume hydraulic fracturing would not pose a threat to these critical resources and the communities that rely on them. While the Department recommended in the SGEIS that high-volume hydraulic fracturing well pads should not be permitted above a

Primary Aquifer or within a 500-foot buffer area, the impacts may be more widespread and significant than was previously considered, and consequently broader mitigation measures may be necessary.

No High-Volume Hydraulic Fracturing Operations on Certain State Lands

This SGEIS supports a finding that site disturbance relating to high-volume hydraulic fracturing operations should not be permitted on certain State lands because the potential impacts resulting from high-volume hydraulic fracturing are inconsistent with the purposes for which those lands have been acquired including public access for a wide range of recreational activities. Prohibition of high-volume hydraulic fracturing development would prevent the loss of habitat in the protected State land areas, which represent some of the largest contiguous forest patches where high-volume hydraulic fracturing activity could occur. Depending on the location of ancillary infrastructure and activities horizontal extraction of gas resources underneath State lands from well pads located outside this area may not significantly impact valuable habitat on forested State lands.

No High-Volume Hydraulic Fracturing Operations on Principal Aquifers Without Site-Specific Environmental Review

Similar to Primary Aquifers, Principal Aquifers are also highly productive. Because they are largely contained in unconsolidated material, and due to the high permeability (which allows rapid movement of groundwater) and shallow depth to the water table, both Primary and Principal Aquifers are particularly susceptible to contamination. Protection of these aquifers is critical for existing water supply needs, as well as to fulfill future needs for new or expanded water supplies. In order to reduce the risk of significant adverse impacts on these important water resources from potential surface discharges from high-volume hydraulic fracturing well pads, the SGEIS proposed that for at least two years from issuance of the final SGEIS, applications for high-volume hydraulic fracturing operations at any surface location within the boundaries of principal aquifers, or outside but within 500 feet of the boundaries of principal aquifers, would require (1) site-specific environmental assessments and SEQRA determinations of significance and (2) individual SPDES permits for storm water discharges. The Department considered removing the two year re-evaluation period for impacts to Principal Aquifers.

No High-Volume Hydraulic Fracturing Operations within 2,000 feet of Public Drinking Water Supplies

More than 360,000 people (or roughly 40.9% of the population) in the Marcellus Shale play area are served by individual private wells or public surface water supplies, or community supplies outside of Primary and Principal Aquifer areas. The SGEIS seeks to reduce the risk of significant adverse impacts on water resources from potential surface discharges from high-volume hydraulic fracturing well pads by proposing that high-volume hydraulic fracturing well pads at any surface location within 2,000 feet of public water supply wells, river or stream intakes and reservoirs should not be permitted. In an attempt to further reduce the potential risks, the Department additionally considered requiring a 2,000-foot prohibition around a public (municipal or otherwise) drinking water supply intake in flowing water with an additional prohibition of 1,000 feet on each side of the main flowing waterbody and any tributary to that waterbody, both for a distance of 1 mile upstream from the public drinking water supply intake.

No High-Volume Hydraulic Fracturing Operations in Floodplains or Within 500 Feet of Private Water Wells

In order to address potential significant adverse impacts due to flooding, the SGEIS evaluated the significant impacts associated with high-volume hydraulic fracturing development located wholly or partially within a 100-year floodplain. In further recognition of the increasing frequency and intensity of recent and potentially future flood events, the Department considered requiring that, in certain areas, well pads be elevated two feet above the 500-year floodplain elevation or the known elevation of the flood of record. However, the Department notes that flood risks change over time and consequently potential impacts could still occur from high-volume hydraulic fracturing as a result of incomplete data.

Since just 2000, 16,000 new private water wells in the Marcellus Shale play area have been reported to the Department; this averages out to over 1,000 per year. In order to reduce potential impacts on drinking water supplies from high-volume hydraulic fracturing operations, the SGEIS evaluated impacts on private water wells and domestic use springs and considered prohibiting any well pad located within 500 feet of a private water well or domestic supply spring, unless the Department issued a variance from the requirement, with the consent of the landowner, and any tenants, if applicable. The final SGEIS reflects the importance of protecting this resource so critical to residents within the Marcellus Shall play area.

Mandatory Disclosure of Hydraulic Fracturing Additives and Alternatives Analysis

The SGEIS identifies by chemical name and Chemical Abstract Services (CAS) number 322 chemicals proposed for use for high-volume hydraulic fracturing in New York. Chemical usage was reviewed by NYSDOH, which provided health hazard information that is presented in the document. In response to public concerns relating to the use of hydraulic fracturing additives and their potential impact on water resources, this SGEIS contains a requirement that operators evaluate and use alternative hydraulic fracturing additive products that pose less potential risk to water resources if high-volume hydraulic fracturing were authorized. In addition, in the EAF addendum a project sponsor must disclose all additive products it proposes to use, and provide Material Safety Data Sheets for those products, so that the appropriate remedial measures could be employed if a spill were to occur. If high-volume hydraulic fracturing were authorized, the Department would publicly disclose the identities of hydraulic fracturing fluid additive products and their Material Safety Data Sheets, provided that information which meets the confidential business information exception to the Department's records access program will not be subject to public disclosure. In addition, the Department considered expanding the fracturing fluid chemical disclosure requirements to ensure that each chemical, and not merely each product, would be disclosed both before drilling and after completion of each well.

Enhanced Well Casing

In order to mitigate the risk of significant adverse impacts to water resources from the migration of gas or pollutants in connection with high-volume hydraulic fracturing operations, the SGEIS added a requirement for a third cemented "string" of well casing around the gas production wells in most situations. This enhanced casing specification is designed to specifically reduce potential impacts from migration of gas into aquifers.

Required Secondary Containment and Stormwater Controls

The risk of a significant adverse impact to water resources from spills of chemical additives, hydraulic fracturing fluid or liquid wastes associated with high-volume hydraulic fracturing, secondary containment, spill prevention and storm water pollution prevention have been evaluated in the SGEIS. However, because of the unique aspects of multi-well pad development associated with high-volume hydraulic fracturing, the existing Department engineering controls and management practices that would be required are untested for the scale of this activity and, consequently, it remains uncertain whether they would be adequate to prevent spills and mitigate adverse impacts if a spill occurs. Compounding this risk is the current uncertainty, as identified by NYSDOH, regarding the level of risk high-volume hydraulic fracturing activities pose to public health.

Conditions Related to Disposal of Wastewater and Solid Waste

The Department had proposed to require that before any permit is issued the well operator have Department-approved plans in place for disposing of flowback water and production brine. In addition, the Department proposed to require a tracking system, similar to what is in place for medical waste, for all liquid and solid wastes generated in connection with high-volume hydraulic fracturing operations.

The SGEIS also contains a requirement for closed-loop drilling to address impacts related to the disposal of pyrite-rich Marcellus Shale cuttings on-site.

Air Quality Control Measures and Mitigation for Greenhouse Gas Emissions

The SGEIS identifies additional mitigation measures designed to ensure that emissions associated with high-volume hydraulic fracturing operations would not result in the exceedance of any NAAQS if high-volume hydraulic fracturing were authorized. In addition, the Department has committed to implement local and regional level air quality monitoring at well pads and surrounding areas.

The SGEIS also identifies mitigation measures that could be required through permit conditions and possibly new regulations to reduce GHG emissions from high-volume hydraulic fracturing activities. The SGEIS would require a GHG emission impacts mitigation plan (the Plan). The Plan would include: a list of best management practices for GHG emission sources for implementation at the permitted well site; a leak detection and repair program; use of the U.S. Environmental Protection Agency's (EPA) Natural Gas Star best management practices for any pertinent equipment; use of reduced emission completions that provide for the recovery of methane instead of flaring whenever a gas sales line and interconnecting gathering line are available; and a statement that the operator would provide the Department with a copy of the report filed with EPA to meet the requirements of the EPA GHG Reporting Program (40 CFR §98), which mandates the monitoring and reporting of GHG emissions from certain source categories in the United States.

Mitigation for Loss of Habitat and Impacts on Wildlife

The Department had proposed several mitigation measures to attempt to address the significant adverse impacts on wildlife habitat caused by fragmentation of forest and grasslands on private land. Although a site-specific environmental assessment and SEQRA determination of significance may have assisted the Department in reducing such impacts, the cumulative nature of the impacts across the area where high-volume hydraulic fracturing would likely occur is such that the impacts would remain only partially mitigated.

Chapter 8 – Permit Process and Regulatory Coordination

This Chapter explains inter- and intra-agency coordination relative to the well permit process, including the role of local governments and a revised approach to local government notification and consideration of potential impacts of high-volume hydraulic fracturing operations on local land use laws and policies. The Department also considered requiring that every ECL Article 23 well application proposing high-volume hydraulic fracturing on a new well pad be subject to a fifteen-day public notice period, limited to site-specific issues on the subject application not addressed in the 1992 GEIS or this SGEIS. As a result of the *Matter of Wallach v. Town of Dryden and Cooperstown Holstein Corp. v. Town of Middlefield* decision, some towns could exercise their zoning authority in such a way that they would be involved agencies under SEQRA. This means that the Department would be required to coordinate the environmental review with such government agencies if the permit required discretionary approvals from a local government agency (e.g., a special use permit or some other type of zoning approval).

Chapter 9 – Alternative Actions

Chapter 9 discusses the alternatives to well permit issuance that were reviewed and considered by the Department. The SGEIS considers a range of alternatives for authorizing high-volume hydraulic fracturing operations in New York. As required by SEQRA, the SGEIS considers the No Action Alternative. The No Action Alternative would not result in any of the significant adverse impacts identified herein, but would also not result in any of the potential economic and other benefits identified with natural gas drilling by this method.

The alternatives analysis also considers the use of a phased-permitting approach to developing the Marcellus Shale and other low-permeability gas reservoirs, including consideration of limiting and/or restricting resource development in designated areas.

The SGEIS also contains a review and analysis of the development and use of "green" or non-chemical fracturing alternatives. The use of environmentally friendly or "green chemicals" would depend on both their reduced toxicity and their technical effectiveness in the Marcellus Shale play and other shale plays. While more research and approval criteria would be necessary to establish benchmarks for "green chemicals," this Final SGEIS proposes that if high-volume hydraulic fracturing were authorized, this alternative approach be adopted by requiring applicants to review and consider, to the Department's satisfaction, the use of alternative additive products that may pose less risk to the environment, including water resources, where feasible, and to publicly disclose the chemicals that make up these additives. These requirements would be altered and/or expanded as the use of "green chemicals" begins to provide reasonable alternatives and the appropriate technology, criteria and processes are put in place to evaluate and produce "green chemicals."

Chapter 10 – Review of Selected Non-Routine Incidents in Pennsylvania

Chapter 10 discusses a number of incidents involving high-volume hydraulic fracturing operations in Pennsylvania that have caused concern about the safety and potential adverse impacts associated with high-volume hydraulic fracturing operations.

Chapter 11 – Summary of Potential Impacts and Mitigation Measures

Chapter 11 highlights the mitigation measures implemented through the 1992 GEIS and summarizes the impacts and mitigation that are discussed in Chapters 6 and 7.

Response to Comments

The accompanying Response to Comments includes summaries of the substantive comments received on both the 2009 dSGEIS and the 2011 rdSGEIS, along with the Department's responses to such comments.