National Park Service
U.S. Department of the Interior

Natural Resource Program Center

Potential Development of the Natural Gas Resources in the Marcellus Shale

New York, Pennsylvania, West Virginia, and Ohio

THIS PAGE & ON THE COVER:
Upper Delaware Scenic and Recreational River, New York & Pennsylvania.

Photos by David B. Soete

Potential Development of the Marcellus Shale

December 2008

I. Introduction

Approximately 33 units of the National Park System overlie or are in the vicinity of the geologic formation known as the "Marcellus Shale." In addition, a number of special status areas (e.g., sites on the National Register of Historic Places, National Trails, and other affiliated areas) also exist in or near the shale deposit. The Marcellus Shale formation occurs primarily beneath the states of New York, Pennsylvania, West Virginia, and eastern Ohio.

Oil and gas industry interest is increasing as this geologic formation becomes better understood. While early (2002) United States Geological Survey (USGS) reports stated that the Marcellus Shale contained an estimated 1.9 trillion cubic feet of natural gas, subsequent exploration and recent efforts of oil and gas companies to produce gas from the shale have lead experts to believe that as much as 31 trillion cubic feet of gas may be recoverable from the Marcellus formation. This translates to being enough gas to meet the needs of the entire United States for over one year. Given innovations in drilling technologies from horizontal drilling to hydraulic fracturing, the economics of extracting gas from the Marcellus Shale have improved dramatically over the last few years.

Development of the natural gas resource from the Marcellus Shale may pose numerous environmental and socioeconomic impacts for the four state area that overlies what may be the most productive areas of the shale. The potentially large amount of industrial activity resulting from shale-gas development may include impacts to air and water quality, sound and night sky resources, and depending upon future economic scenarios, a boom/bust scenario may occur. In addition, an influx of oil and gas industry workers could result in housing shortages, overcrowding in schools, and may strain available infrastructure such as shopping, lodging and eating establishments. Units of the National Park System and other affiliated areas may also experience visitor use conflicts with the potentially large amount of drilling-related industrial activity occurring in and around parks. This activity may degrade the visitor experience. The large amount of drilling support traffic may also pose visitor safety risks.

The states of New York, Pennsylvania, West Virginia, and Ohio each regulate the development of oil and gas to varying degrees. Each of these four states requires permits to explore for and develop the oil and gas resource and also conditions each permit with stipulations to protect the environment and public health and safety. Since the NPS has no direct regulatory control over oil and gas operations external to its boundaries, it is advantageous for the NPS to participate in the "public comment" process offered during the permitting process by the four states listed above. In addition, the states of Pennsylvania and New York have state environmental quality acts which may offer the NPS another opportunity to provide input to help minimize impacts to parks associated with oil and gas development permitted by these states. If exploration or development activities are proposed within park boundaries pursuant to privately held oil and gas rights, the NPS may be able to apply its regulations at 36 CFR Part 9, Subpart B to ensure protection of park resources and visitor values. However, because these regulations only apply when an entity must cross federally owned or controlled lands or waters to reach its private property rights, the 9B regulations may not be applicable in all cases.

Location of the Marcellus Shale

Due to the significant number of units of the National Park System and affiliated areas overlying and near the Marcellus formation, it is important for the NPS to become well informed and stay abreast of Marcellus shale development issues. For a detailed list of NPS units located both in and near the vicinity of the Marcellus Shale occurrence, please see Appendix 1.

II. Geology & Estimated Size of the Marcellus Shale

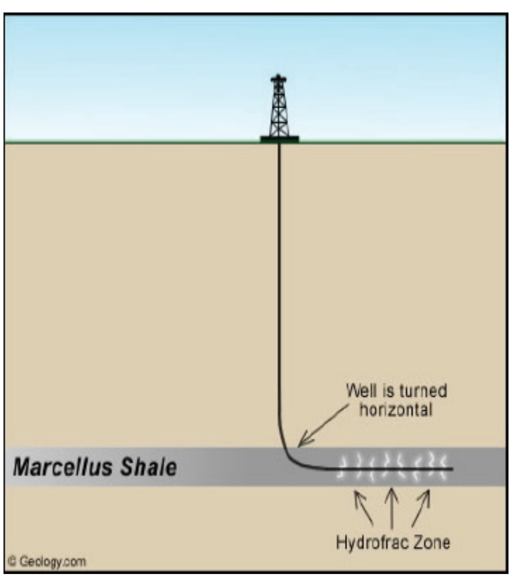
The geology of the Marcellus Shale is well defined and its capacity to store large amounts of natural gas is explained through a process that occurred approximately 390 million years ago. Geologists believe that sediments sank to the bottom of the shallow sea that covered the Appalachian Basin and formed the Marcellus Shale. Those sediments, along with the remains of tiny sea plants and animals, were deposited over large areas in Pennsylvania, West Virginia, New York, and Ohio, and small areas in Virginia, Maryland, and Tennessee.

As sea plants and animals died, they sank to the bottom of the ocean and were buried along with the layers of sediments that over time turned into rock. There was very little oxygen in the water at the bottom of the ocean to oxidize organic matter, so much was preserved in the sediment and subsequent rock. Eventually, the layers of sedimentary rock became thousands of feet thick, subjecting the plant and animal remains to enormous heat and pressure. The pressure, the heat of the earth, and the lack of oxygen, combined to change this organic mixture into petroleum and natural gas. Generally speaking, lower temperatures and pressures generate petroleum while higher temperatures and pressures generate natural gas, but this is also a function of the "type" of organic matter present. Over time, concentrations of natural gas became trapped in the rock layers now called the Marcellus Shale.

If it were not for fracturing of the rock, the natural gas would have remained trapped in the extremely small pore spaces of the rock. However, as pressure built in the rock pores as natural gas formed, very fine cracks occurred in the rock which gradually enlarged into what are known as "joints and fractures." Mountain building caused a second set of joints and fractures to form in the rock. This second set formed almost 90 degrees to the original joint set. These two joint sets in combination with artificially induced fractures from in-situ hydraulic fracturing, now allow a tremendous amount of natural gas to be extracted from the fractures in the Marcellus Shale.

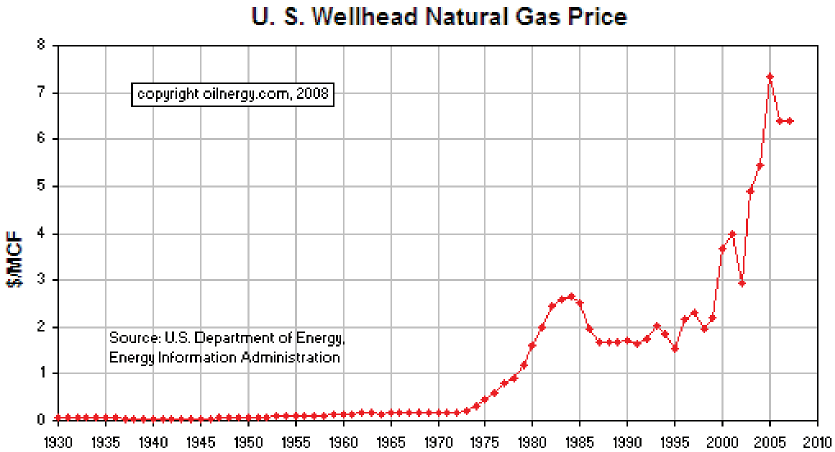
The areal extent of the Marcellus Shale underlying the states of New York, Pennsylvania, West Virginia, and eastern Ohio ranges from 48,000 to 54,000 square miles (roughly 31million acres), and the formation has an average thickness of approximately 100 feet. Although the true natural gas producing potential of the Marcellus Shale will not be known until a significant number of wells are drilled, a 2002 USGS assessment (USGS Fact Sheet FS-009-03) calculated that the Marcellus Shale contained an estimated 1.9 trillion cubic feet of recoverable natural gas. However, as the Marcellus formation is further studied, a 2006 USGS assessment places the recoverable gas resources at approximately 31 trillion cubic feet (USGS Open File Report Series 2006-1237).

III. Technology Associated with Gas Production



Horizontal Drilling Technology

While limited production has occurred in the Marcellus Shale to date, drillers in the Barnett Shale of Texas have demonstrated that new technology in the form of horizontal drilling and hydraulic fracturing of the shale (fracturing through the use of high pressure liquids) has helped overcome the flow capacity problem of gas shales. Horizontal drilling is a technique used to expose long sections of the reservoir rock to the wellbore. While a conventional vertical well penetrates and exposes only the thickness of a pay zone (e.g., 50 to 300 feet in the Marcellus shale), horizontal drilling can expose over a mile of reservoir rock for production by steering a drill bit to follow the pay zone. Hydraulic fracture stimulation creates additional flow paths to the well. In this process, fluid is pumped into the formation at high enough pressures and rates to split the rock. Sized particles such as sand are also mixed with the fracturing fluid to hold the crack open once pumping stops. In addition, wells can be oriented to intersect natural fractures that occur in many formations.



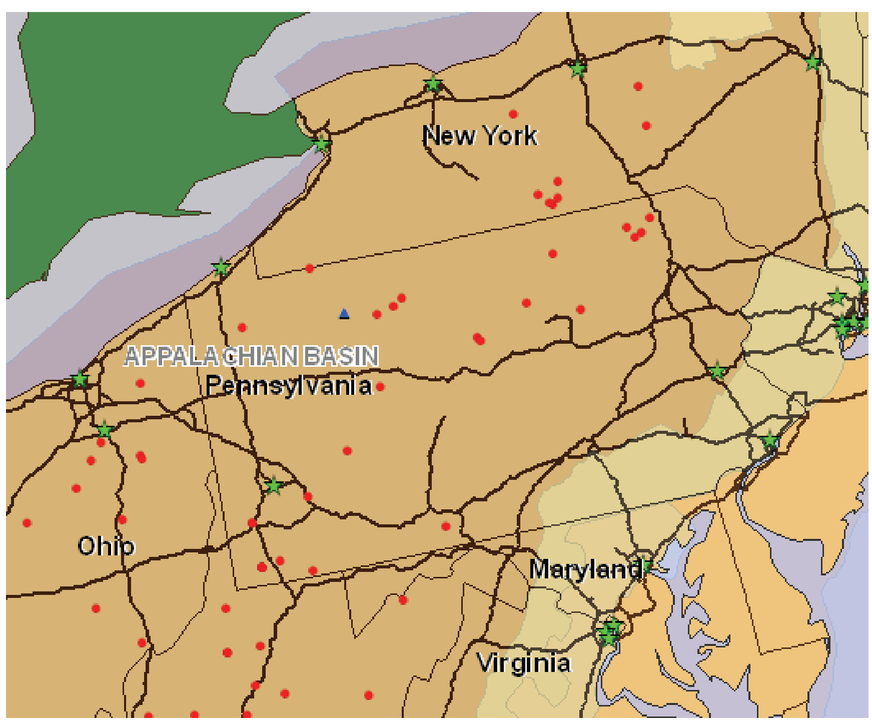
The higher demand and increased prices for natural gas will support the higher costs of using the new horizontal drilling technology as shown in the graph of historical natural gas prices.

During this early testing and development phase of the Marcellus Shale, operators will experiment with both vertical and varying length horizontal well completions as well as different hydraulic fracturing techniques and job sizes. Gradually drillers will determine the best methods for extracting the most gas per investment dollar. The best methods will likely vary across the Marcellus Shale play due to differences in thickness, composition, water content, pressure, and depth to name a few factors.

IV. Current Activity to Extract Gas

Drilling in the Marcellus Shale is entering its second year. Companies seem to be focused on Pennsylvania, though drilling is also occurring in West Virginia and Ohio. New York is seeing active leasing and initial well permit applications. Over the past decade, it was common for Pennsylvania to have about 10 active drilling rigs at any point in time drilling conventional oil and gas wells. In the past year, rig count has steadily increased to nearly 40 active rigs. Pennsylvania's Bureau of Oil and Gas Management reports that 277 wells have been drilled to the Marcellus Shale as of September 12, 2008. However, the Bureau has very limited information on the production rates (success) of the completed wells. In these early stages of Marcellus development, well operators are choosing to keep well information confidential. The Bureau also indicated it has issued an additional 518 drilling permits to date.

The figure to the right is an example of a map from the Baker Hughes website, a company that provides the oil and gas industry with geologic formation evaluation. The red dots represent active rig locations as of September 30, 2008. Data is updated weekly. These two sources provide a general sense of where the Marcellus Shale drilling activity is occurring now. Leasing activity is the leading indicator of future drilling activity. However, since most leases in the vicinity of the Marcellus Shale are occurring on private property, the state permitting agency will not learn about the leases until a lessee applies for a permit to drill.



September 2008 locations of active drill rigs in the Marcellus Shale area.

V. Likely Affected Parks and Special Status Areas

Units of the National Park System and special status areas (e.g., sites on the National Register of Historic Places, National Trails, and other affiliated areas) located in southern New York, western and central Pennsylvania, eastern Ohio, and most of West Virginia may be affected by development of the natural gas resource of the Marcellus Shale. In 2008, landowners in and near Upper Delaware Scenic and Recreational River began receiving offers from developers to lease the privately held natural gas resource. These sometimes lucrative offers may include a "bonus bid" to hold the property until development occurs, and contracted "royalties" on gas produced in the future. The lease offers have split some communities between those who see this as an opportunity to make a significant amount of money from their property, and those who wish their land to remain untouched, in a more natural condition.

Upper Delaware Scenic and Recreational River is one of numerous NPS units in the Marcellus Shale area that is vulnerable to impacts from development of nonfederal mineral rights within park boundaries on privately held mineral estate. It is important that all parks listed in Appendix 1 be aware of any nonfederal mineral ownership which may occur in the park. Special status areas may also be faced with such development due to split estate ownership of he surface and mineral estate.

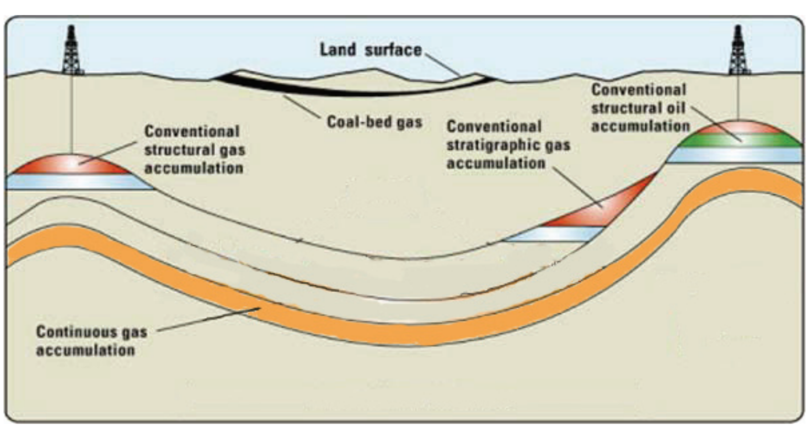
VI. Potential Environmental Effects

Natural gas drilling and production is an industrial activity with a host of environmental consequences. Effects can range from water contamination related to drilling and disposal of drilling fluids, air quality degradation from internal combustion engines on drill rigs and trucks, excess dust from equipment transportation, impacts to solitude and night skies from noise and lighting, and safety concerns associated with the large number of trucks needed to support drilling operations (*see* Section VI., Truck Transportation Needs). While the horizontal drilling and hydraulic fracturing practices expected to be used in developing the Marcellus Shale may have negative environmental effects on the surrounding area, when compared to development of conventional oil and gas resources this development method could result in fewer impacts than conventional vertical wells due to greater flexibility in well location.

Appendix 2 provides a general summary of impacts from the various phases of natural gas operations and common mitigation strategies. The list is by no means exhaustive nor does every concern and strategy apply to every operation. Below is a summary of the most likely impacts. The Geologic Resources Division is available to help park managers identify specific impacts relative to specific proposals. In doing so, GRD will coordinate with other experts in the Natural Resource Program Center.

Widespread Development and Well Spacing

Well spacing requirements vary by state (*see* the table on the next page). Conventional gas reservoirs are scattered over a trend and rely on geology to trap and hold gas that has migrated to relatively small areas of a rock formation. Conventional reservoirs are relatively limited in areal extent. On the other hand, unconventional (continuous) or "resource" plays contain natural gas throughout the formation. They are both the source of natural gas and the reservoir. The Marcellus Shale is continuously deposited over vast areas of New York, Pennsylvania, Ohio, and West Virginia. It is conceivable that over the course of many years wells could be drilled on every available spacing unit. A spacing unit is the number of acres per well required to



Conventional well spacing

Sample of Well Spacing Requirements

Gas Shale Name	State(s)	Well Spacing
Barnett Shale	TX	▪ 40- to 160-acre spacing typical ▪ 20-acre spacing being tested
Fayetteville Shale	AR	▪ 40-acre spacing by rule (Arkansas Oil and Gas Commission Rule B-43 ▪ 80- to 160-acre spacing in practice ▪ 60-acre spacing being tested
New Albany Shale	IL, IN, KY	▪ 160-acre spacing initially ▪ 80-acre spacing now common
Antrim Shale	MI	▪ 40- to 80-acre spacing
Ohio Shale	OH	▪ 40- to 160-acre spacing
Woodford Shale	OK	▪ 640-acre spacing initially ▪ 160-acre spacing now common ▪ 80-acre spacing proving effective ▪ 40-acre spacing being tested
Marcellus Shale	NY, PA, OH, WV	▪ 160- to 320-acre spacing initially ▪ 40- to 80-acre spacing can be expected

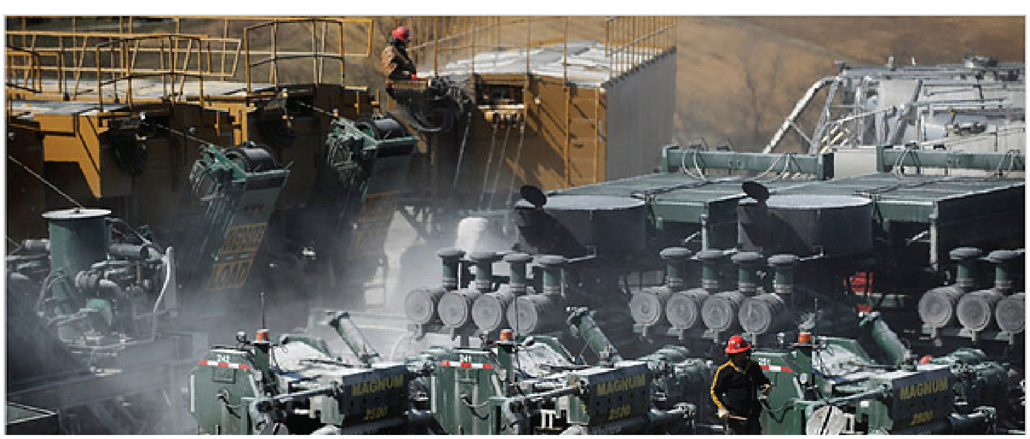
efficiently develop the natural gas resource. In most cases, state regulatory agencies initially define allowable spacing units. This often results in wells being spaced closer together over time.

The spacing histories of the Barnett, Fayetteville, Antrim, New Albany, Ohio, and Woodford shales all trend from larger to smaller spacing units. For the Marcellus Shale, it is reasonable to expect 320-acre or 160-acre spacing initially, and eventually some areas experiencing infill drilling to 80-acre or even 40-acre spacing should infill drilling be economic.

Larger Sites in Support of Bigger Rigs and Hydraulic Fracture Stimulation Equipment

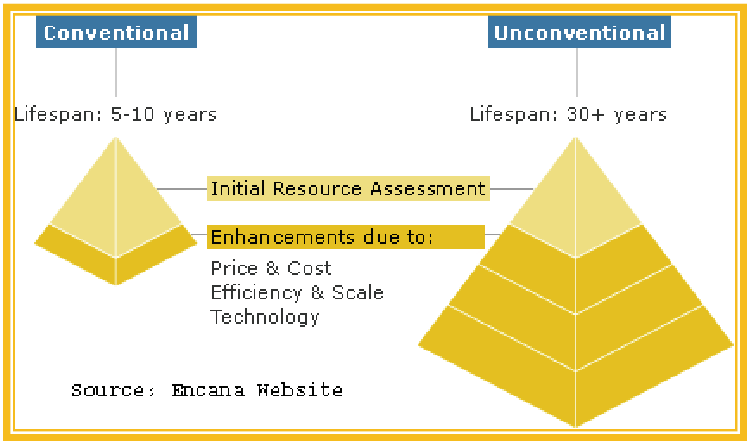
The rigs being used to drill horizontal sections are larger and require more space than conventional drilling techniques. The dimensions of a drill site also need to take into account the space needed for equipment and material storage necessary for fracture stimulation. Whereas conventional oil and gas wells result in 1-1/2 to 3 acres of disturbance at the drill site, Marcellus well sites are likely to range from 4 to 6 acres.

One of the benefits of horizontal well completions is the ability to site multiple wells on one location. So while the individual sites may be much larger, the overall disturbance on an acres/well basis could end up being less than in the past. Also, with the horizontal sections ranging from 2000 to 4000 feet in length, there may be opportunities to site the surface operations away from sensitive areas without losing the ability to recover the gas.



Typical equipment on a gas well site

Longer Well Life



Life span; conventional vs. unconventional shale gas wells

Shale gas wells will invariably produce for a much longer period than wells drilled in conventional reservoirs. Unconventional reservoirs like the Marcellus are capable of delivering profitable production for decades through the application of advanced technology and large manufacturing-like development programs that capture economies of scale. Original assessments of recoverable reserves from conventional reservoirs typically identify the majority of the resource in place, with a limited upside potential. These reservoirs are typically produced over a five-to ten-year lifespan.

In contrast, original assessments of unconventional gas reservoirs often show only a small percentage of what is ultimately recoverable. Unconventional development involves drilling numerous wells in a repeatable manner that captures economies of scale. These reservoirs are produced over 30 years or more. As a result, the company can take advantage of operational efficiencies and new technologies, developed over time, to reduce costs, extend the life of the wells, and increase recoveries. The diagram above compares the potential of a conventional gas reservoir to that of an unconventional reservoir.

High Water Use Needs

Water related issues rank high among concerns associated with the development of gas wells in the Marcellus Shale. These issues include water quantity, quality, rights, and disposal of contaminated water.

Development of the natural gas resource from shale often requires large volumes of water which are used primarily in the hydrofracturing process of well development. Hydrofracturing or "fracing," is when fluids are forced under high pressure into the well to fracture the shale surrounding the borehole in an effort to liberate more gas from the low permeability shale gas reservoirs.

State permitting agencies have projected that the horizontal drilling method that will likely be employed in the Marcellus Shale may require extensive amounts of water to develop and recover natural gas. Traditional (i.e., vertical) gas wells typically use less than one million gallons, but horizontal wells can require up to 3.5 million gallons per well. In addition, the potentially large volumes of water would be mixed with one or multiple chemical additives to optimize well bore and fracture treatment to achieve the desired gas production rate.

Drilling methods will most likely involve slick water fracturing (also called sand fracturing), a method using a mixture of sand and the carrier fluid of water or brine. Fracture fluids typically also contain materials such as demulsifiers, corrosion inhibitors, friction reducers, clay stabilizers, scale inhibitors, biocides, breaker aids, mutual solvents, alcohols, surfactants, anti-foam agents, defoamers, viscosity stabilizers, iron control agents, diverters, emulsifiers, foamers, oxygen scavengers, pH control agents, and buffers.

Hydrofracturing waste water containing any of the above listed constituents may be disposed of by various methods. One method is to capture the waste water in tanks and haul it to a licensed disposal or treatment facility. This option will increase the amount of truck traffic (*see* Section VI., Truck Transportation Needs) at the site and on surrounding roads, but minimizes the possibility of onsite impacts from leakage or spills. Operators may also opt for onsite storage and treatment in lined storage ponds. As in the management of any liquid waste and particularly those of large volume, there is both an increased potential for a release to the environment in handling the larger volumes and the potential for greater effects should a larger release occur (e.g.,in breaching of some retaining structure). A larger surface use area will also be needed for water storage. It is also possible that more than fifty percent of the water can be reused in subsequent well fracturing. Studies show that up to twenty-four percent of the water used can be recovered as fresh water for beneficial uses.

If, as projected, a large number of gas wells are drilled in the Marcellus Shale, a significant amount of water will be needed to develop well fields. Water rights issues associated with the water needs of a large number of wells may become an issue. The Susquehanna River Basin Commission manages basin water resources in Pennsylvania, New York and Maryland; and seventy-two percent of that basin is underlain by the Marcellus Shale. Two important regulations overseen by the Commission include the regulation of consumptive water use (806.4(a)(1)) and the regulation of water withdrawals (806.4(a)(2)(iii)). Numerous other federal, state, local, and private water rights could also compete for the large amount of water that will be needed for significant gas development in the Marcellus Shale.

Water storage at a typical gas well

Potential Aquifer Contamination Associated with the Hydraulic Fracturing Process

In most areas of the Marcellus Shale play, induced fractures from treatments should not create a geological pathway to usable quality aquifers. This is because there are often thousands of feet of rock between the usable quality aquifers and the shale being treated. There are reported cases of aquifer contamination associated with hydraulic fracture programs, but these are limited to areas similar to the coalbed methane basins where the zones being treated are in close proximity to the aquifers. If development with hydraulic fracture treatments occurs where the Marcellus is shallow and in close proximity to usable quality water zones, the potential effects on aquifers must be addressed.

An appropriate concern in all cases is that companies must utilize proper surface casing design and cementing to isolate and protect aquifers from downhole pathways of contamination. It is equally important that operators monitor casing pressures throughout the life of a well to identify and correct any downhole leaks that might establish a pathway.

The state regulations of New York, Pennsylvania, Ohio, and West Virginia have safeguards in place for the protection of aquifers. However, the oversight capacity of agencies strained by a substantial increase in drilling activity is a legitimate concern.

The numerous truck-mounted pumps and temporary storage tanks needed to fracture-treat the Marcellus Shale will require larger well locations. The fracturing equipment and materials on location in this photograph represent over 100 round trips to location by large tractor trailer trucks.

Air Quality

Air quality issues of concern associated with development of the Marcellus Shale includes NOx emissions from drilling operations, depending on drilling depths. The operation of pipeline compression stations is more of a concern than drill rigs. On a site-by-site basis, emissions may not be significant but on a regional basis may prove significant as states and parks deal with regional ozone transport.

Currently, many rural counties are in attainment for the ozone standard. However, with expanded Marcellus Shale development, this activity may push several new counties (and parks) into nonattainment, particularly since EPA has recently tightened the ozone standard. In the rural areas of the East, natural gas operations would add to the rural NOx, which could make rural NOx more of an issue than urban NOx. This would be a fairly significant change for the East, in forming regional ozone episodes. It is possible that impacts to visitor health and ecological impacts to plants may occur since the Mid-Atlantic region has many plant species that are classified as ozone sensitive.

Truck Transportation Needs

Exploration, drilling, and production activities associated with oil and gas wells are extremely “transportation intensive.” Large numbers of vehicles are needed to transport equipment and other supplies to the drilling site.

Many rural roads near park areas overlying and near the Marcellus Shale occurrence will not meet standards necessary for large trucks that will be used to haul equipment, water, and other supplies to and from drill pad sites. These roads will need to be upgraded through widening, and surfacing; and road curve angles may need to be reduced. If roads are not surfaced or watered regularly, air quality may be degraded by truck traffic related dust, and area residents and park visitors may be subjected to traffic hazards. Solitude in the area will be interrupted by the large amount of truck traffic.

Oil and gas specialists in the Geologic Resources Division estimate that the “average” oil and gas well requires 320 to 1,365 truckloads of equipment to bring a well into production. While the following information provides wide-ranging estimates, it is still helpful to understand the large amount of truck traffic that will be associated with any oil or gas well. Estimates are as follows:

New Well Development

Drill Pad and Road Construction Equipment – 10 to 45 truckloads

Drilling Rig – 30 truckloads

Drilling Fluid and Materials – 25 to 50 truckloads

Drilling Equipment (casing, drill pipe, etc.) 25 to 50 truckloads

Completion Rig - 15 truckloads

Completion Fluid and Materials – 10 to 20 truckloads

Completion Equipment – (pipe, wellhead) 5 truckloads

Fracture Stimulation Fluids and Materials – 100 to 1000 truckloads

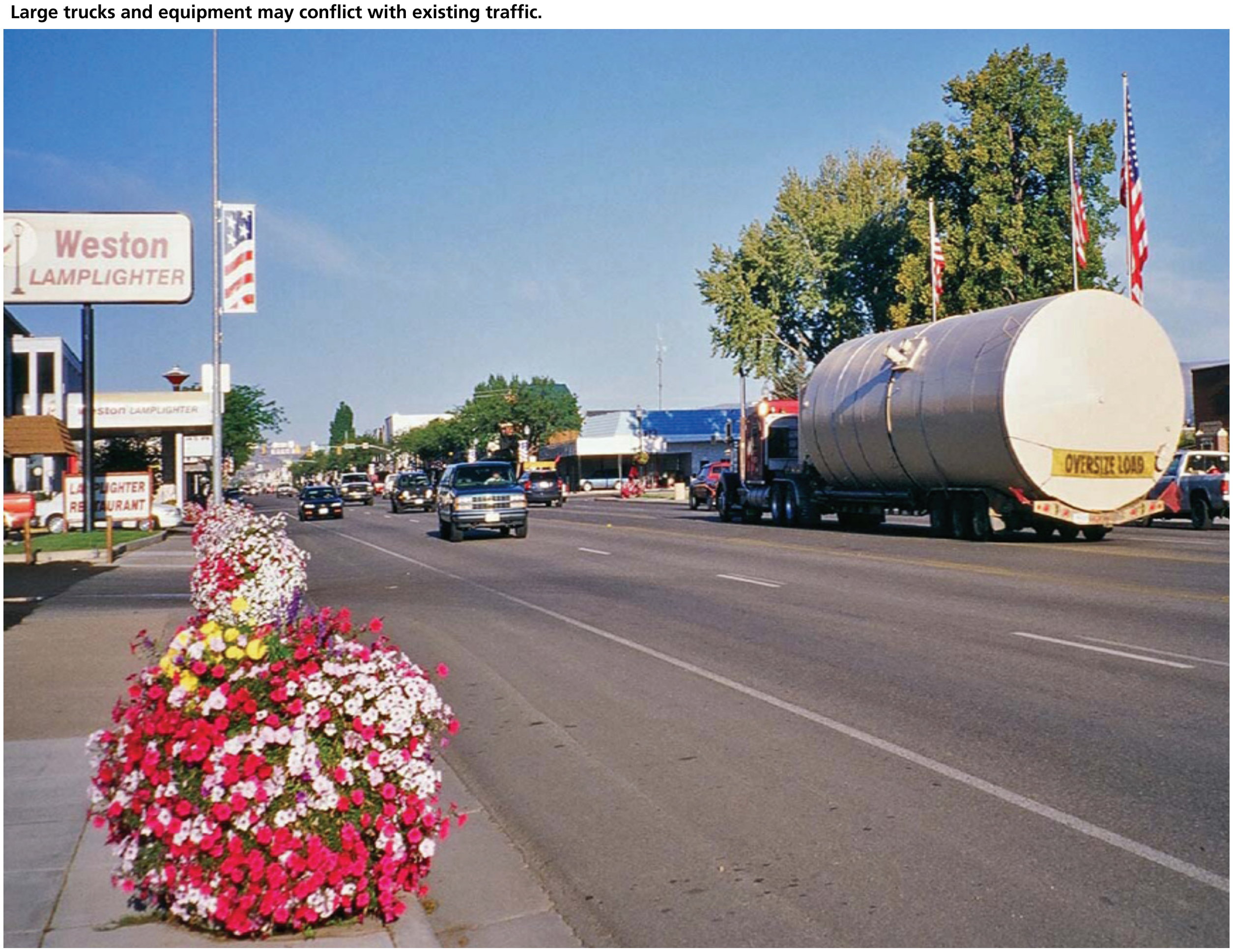
Fracture Stimulation Equipment (pump trucks, tanks) – 100 to 150 truckloads

General Well Maintenance

Every 3 to 5 years – 25 to 40 truckloads

Numerous truck-mounted pumps and temporary storage tanks are needed on location to fracture-treat wells. Larger well locations may be needed if hydraulic fracturing is part of a well completion procedure. Refracturing wells after 3 or 4 years has proven effective in the Barnett Shale of Texas. If this practice extends to the Marcellus Shale, then truck traffic will have few lulls.

Large trucks and equipment may conflict with existing traffic.



VII. Regulatory Framework

Each state has a distinct regulatory framework governing the development of gas from the Marcellus Shale and for addressing NPS (and other community) concerns. Although the information below is not an exhaustive explanation of the entire regulatory process for each state, locality, or of NPS-specific regulations, it is intended to inform the reader that there are options for addressing NPS concerns regarding gas development in most cases. See Appendix 3 for a quick reference to key provisions under each of the state regulations that provide a means for the NPS to raise park protection concerns.

NPS Regulations for In-Park Development (36 CFR Parts 9B & 6)

Regulations governing the extraction of oil or gas from the Marcellus Shale will vary depending upon ownership of the surface and mineral estate where operations will take place. It is possible that oil or gas extraction could occur in units of the National Park System if either private inholdings (fee simple ownership of both the surface and subsurface estate) or private or other nonfederal mineral estate occurs in park boundaries. If exploration or development activities are proposed within park boundaries pursuant to privately held oil and gas rights, the NPS will apply its regulations at 36 CFR Part 9, Subpart B to ensure protection of park resources and visitor values. Note: The 9B regulations only apply when an entity must cross federally owned or controlled lands or waters to reach its private property rights. This "exemption" from the regulations could prove problematic for the NPS in trying to require operators to mitigate impacts. Where the exemption does apply, the NPS will need to use the power of persuasion with operators and work closely with state regulators to have mitigation measures included in permits to protect parks and other special status lands.

Unlike the 9B regulations, the NPS will be able to apply its solid waste regulations at Part 6, without regard to whether an entity must cross federally owned lands or waters to extract private gas.

Operations External to Park Boundaries

In dealing with external oil and gas exploration and development with the potential for cross-boundary effects, the best option is to work directly with the state oil and gas permitting agency. Because the NPS has no direct regulatory control over oil and gas operations external to its boundaries, the NPS may take advantage of any "public comment" process or any other opportunity to provide input offered by the state permitting agency. The State of Pennsylvania, for example, welcomes public comment (NPS included) when processing a permit application for a proposed oil and gas operation. It is at this stage that the NPS can offer mitigation or avoidance options for the state to include in the permit to reduce impacts on adjacent NPS managed areas.

It is important to note that the states of New York, Pennsylvania, West Virginia, and Ohio, which overlie the greatest portion of the Marcellus Shale, all have slightly different procedures that provide for permitting and analyzing specific project proposals. The information below provides an overview of permitting/environmental review requirements and opportunities available to the NPS to provide input in the permitting or environmental review process of the various states in the Marcellus Shale area. For a more specific reference to applicable state regulations, please see Appendix 3.

New York

Environmental and natural resource-related permits are required for oil and gas operations. The state requires over 20 different permits and licenses, as found in New York State, Department of Environmental Conservation General Regulations, Chapter VI., Section §624.5. The State of New York also has a State Environmental Quality Review Act (SEQR). However, as communicated to the NPS in a July 2008 conference call regarding Marcellus gas drilling, the state handles compliance with New York SEQR under a "generic" environmental impact statement (EIS). Therefore, further environmental analysis is not undertaken on individual oil and gas operations that obtain permits to operate. The State of New York is currently updating its oil and gas "generic" EIS. The NPS is supplying comments on this document. Under the state rules, interested parties may submit written comments on individual permit applications.

Links to pertinent New York environmental and permitting web sites:

Environmental Quality Review – http://www.dec.ny.gov/regs/4490.html

Permits and Licenses: – http://www.dec.ny.gov/permits/363.html

Information on 2008 supplemental oil and gas EIS – http://www.dec.ny.gov/energy/46288.html

Pennsylvania

Any person proposing to drill an oil and gas well in the State of Pennsylvania must obtain the necessary permits found at the Pennsylvania Statutes and Consolidated Statutes Annotated, Title 58 – Oil and Gas, Chapter 11, Oil and Gas Act. Through the Pennsylvania Department of Environmental Protection citizens and other affected parties (e.g., the NPS) can obtain information on items including oil and gas permit updates—like changes in permit status—and environmental reviews associated with those permits. Changes in permit status are distributed by the state via e-mail alerts to users subscribed to the free service. In addition to necessary permits, the State of Pennsylvania requires an environmental impact statement on proposals for land subdivisions, rezoning, projects or other uses of land having or likely to have environmental impact (PA Code §.16-1605,Impact Statement). As with the permitting process, the State of Pennsylvania offers the opportunity for public input throughout its state EIS process.

Links to pertinent Pennsylvania environmental and permitting web sites:

Pennsylvania Oil and Gas Act –
http://www.dep.state.pa.us/dep/DEPUTATE/MINRES/OILGAS/act223.htm

Pennsylvania Environmental Impact Statement –
http://www.pacode.com/secure/data/365/chapter41/s41.16-1605.html

West Virginia

The West Virginia Office of Oil and Gas is responsible for regulating and monitoring all actions related to the exploration, drilling, storage, and production of oil and natural gas. It also ensures protection of groundwater from oil and gas activities. Title 35, Legislative Rule, West Virginia Division of Environmental Protection, Office of Oil and Gas, Section 10.5.c., (35CSR4) states that "... interested persons may intervene in the application by filing written comments with the Office of Oil and Gas within fifteen (15) days from the date that the circular is published. If objections are made by any interested person, or by the Office of Oil and Gas, or if the chief determines that other information may be necessary in order to make a determination, a public hearing will be held in accordance with 35 CSR 20." The State of West Virginia has no state environmental quality act.

Links to pertinent West Virginia permitting web sites:

West Virginia Oil and Gas Regulations – http://www.wvsos.com/csrdocs/worddocs/35-04.doc

Ohio

The Ohio Revised Code, Chapter 1509, Division of Mineral Resources Management, outlines the requirements for acquiring a state permit and operating an oil or gas well. Chapter 1509 does not provide for any type of public hearing or public input when an operator applies for a permit to drill. Hearings are initiated by the state only when an operator proposes to dispose of brine (produced waters) on the land surface, or if the well is to be located in a suburban or urban area of more than 5000 inhabitants. According to the Ohio Department of Natural Resources, Division of Mineral Resources Management, the state does not have a "state environmental quality act" which would require an environmental review of drilling permits (telecon, 10/27/08).

Links to pertinent Ohio permitting web sites:

Ohio Oil and Gas Regulations –
http://www.dnr.state.oh.us/Portals/11/publications/pdf/oil%20and%20gas%20laws%20and%20rules.pdf

VIII. Recommendations

The following recommendations will help park units be more prepared for potential development of the gas resource of the Marcellus Shale. While the NPS may not have the ability to preclude drilling, particularly adjacent to park boundaries, early involvement in the well permitting process by developing a close working relationship with the state permitting agency will pay dividends. Often, states will have no idea that the NPS may have resource or visitor-related concerns unless it is brought to the attention of the permitting agency. The Geologic Resources Division suggests the following steps:

Check your park's land/mineral ownership

It is important to know if units of the National Park System overlying the Marcellus Shale (*see* Appendix 1) have either private inholdings or state or private mineral estate underlying NPS surface. If these ownership conditions occur, shale gas or other mineral development is a possibility within park boundaries. The Service's 9B regulations will be triggered if a project proponent must cross federally owned or controlled lands or waters in a park. Note: The NPS is working on eliminating this exemption from the 9B regulations.

Be aware of land speculation, exploration, or drilling activity adjacent to park boundaries

Industry interest in securing lands for gas exploration or development could result in a quick upturn in requests for drilling permits adjacent to NPS units in the Marcellus area. If drilling activity appears, or is imminent, contact your state's Oil and Gas Division to communicate NPS concerns and issues to the decision maker.

Work with state agencies

When providing input to the various state permitting agencies the Geologic Resources Division recommends the following with regard to the exercise of private and state-owned minerals in and adjacent to park boundaries:

- Meet with state permitting agency personnel and state leasing agency personnel to discuss the park's resources and values, how oil and gas exploration and development activities may affect those resources and values, and mitigation measures that could be used to minimize or avoid impacts to park resources and values. It would be advantageous for park and state personnel to also discuss the state's specific procedure for approving permit applications and for offering leases on state lands, and for soliciting their ideas on how to best protect units of the National Park System and other nationally significant areas. It would be helpful to follow-up the meeting with a written explanation of the park's goals and objectives and any strategies park and state personnel may have discussed regarding protection of park resources and values. In these discussions, it is to the NPS' advantage to highlight whether proposed development could occur in a park unit and whether NPS regulatory authority would be triggered. It is important to note that the Service's nonfederal oil and gas regulations only apply to operations within units of the National Park System. They do not apply to operations on special status areas. Also, as noted above, the regulations contain limitations.
- Establish an agreement, formal (e.g., MOU) or informal, with the state permitting or leasing agencies, under which the state agency agrees to the timely exchange information regarding proposed activities.
- The key time for the park to engage the state regarding the exercise of privately held mineral rights is prior to the issuance of a state permit. Thus, we recommend that the park seek to have state permitting agency personnel inform park staff of pending permit applications for proposed operations within a reasonable distance from the park boundary, e.g., within the park's immediate view shed. The park can provide the state with a map indicating tracts and locations that would be of concern.
- For state owned leaseable lands, the park's most effective strategy is to try to convince the state to include park protective mitigation measures directly in the lease. It would be helpful to ask the state's leasing agency personnel to inform the park when leases will be advertised for auction on tracts within a reasonable distance from the park boundary, e.g., within the park's immediate view

shed. The park could then identify to the state specific park protection concerns, and provide the state with a map indicating tracts and locations that would be of concern.

- When informed of pending permitting actions or advertisement for lease auction, we recommend that park staff work with the state agencies to include measures that mitigate or avoid impacts to park resources. If the park is faced with operations on state leased lands and did not have the opportunity to work with the state prior to lease issuance, park staff could still be engaged in the state permitting process and see if park protective measures can be included in the permit.

Call for Help

The Geologic Resources Division is available to assist parks with policy and technical assistance with minerals and energy issues. GRD will review and comment on permitting and environmental documents with an eye toward mitigating or eliminating adverse impacts arising from the exploration and development of natural gas from the Marcellus Shale. For assistance contact the Division.

The Millennium Pipeline will allow for increased amounts of natural gas to be transported in New York State. Photo by David B. Soete.

Appendix 1

National Park System units overlying or near the Marcellus Shale occurrence

National Park System Site	Comment
Allegheny Portage Railroad NHS	Within, but near edge
Andrew Johnson NHS	Near southern edge
Appalachian NST	Mostly near, short section within
Blue Ridge PKWY	Near, but no closer than about 25 miles
Bluestone NSR	Within the Marcellus (about 20-30 miles)
Booker T Washington NM	Near, but about 30 miles east
Cumberland Gap NHP	About 30 west, but in black shale
Cuyahoga Valley NRA	Near, and within black shale
Delaware Water Gap NRA	Near eastern edge (about five miles)
Eisenhower NHS	Near, but about 40 miles east
Eleanor Roosevelt NHS	Near, but about 30 miles east
Fort Necessity NB	Within (center of the Marcellus)
Fort Stanwix NM	Within, but near edge
Friendship Hills NHS	Within (center of the Marcellus)
Gauley River NRA	Within the south central Marcellus
Gettysburg NMP	Near, but about 40 miles east
Great Smoky Mountains NP	Near southern edge
Harpers Ferry NHP	Near, but about 40 miles east
Home of Franklin D Roosevelt NHS	Near, but about 30 miles east
Hopewell Culture NHP	About 50 miles west, but in black shale
James A Garfield NHS	Within, but near edge
Johnstown Flood N Mem	Within, but near edge
Martin Van Buren NHS	Near, but about 30 miles east
Middle Delaware NSR	Within, but near edge
Morristown NHP	Near, but about 30 miles east
New River Gorge NR	Within the south central Marcellus
Saratoga NHP	Near (about 20 miles northeast)
Shenandoah NP	Near (about 20 miles east on Trail)
Steamtown NHS	Within boundary, about 40 miles from edge
Theodore Roosevelt Inaugural NHS	Near northern edge (about five miles)
Upper Delaware SSR	Within (from edge to about 60 miles in)
Vanderbilt Mansion NHS	Near, but about 30 miles east
Women's Rights NHP	Near (about ten miles north)
The Marcellus shale boundary is approximate. Therefore, sites within and near the boundary, may be affected. Parks highlighted in yellow are most at risk because the deposit exists within and immediately adjacent to their boundaries.	

Appendix 2

Resource Concerns and Mitigation Techniques

This table provides a general summary of impacts from the various phases of natural gas operations and common mitigation strategies. The list is by no means exhaustive nor does every concern and strategy apply to every operation.

	Development Phase				
Resource Concern	Exploration	Drilling	Production	Plugging / Reclamation	Mitigation Techniques
Soils (Contamination, Compaction, Erosion and Sedimentation)	X	X	X		Use Existing Roads Limit Travel Routes Vehicular Limitations Seasonal Restrictions Timely Reclamation Multi-Well Pads Minimize Vegetation Clearing Closed-Loop Mud Systems Offsite Disposal of Waste Berms and Liners Stormwater Control Erosion Control
Surface Water	X	X	X	X	Closed-Loop Mud Systems Offsite Disposal of Waste Berms and Liners Stormwater Control Erosion Control Controlled location and quantities of source water for operations
Ground Water	X	X	X		Good casing/cementing practices for drilling and plugging Well monitoring during production Liners under storage tanks Closed-Loop Mud Systems Offsite Disposal of Waste Berms and Liners
Vegetation Loss	X	X	X		Minimize Vegetative Clearing Minimize Disturbed Areas Multi-well drilling pads Implement Timely Reclamation Avoidance Seasonal Timing Restrictions Erosion Control Maintain soil & water quality
Introduction of Exotics		X	X	X	Implement Timely Reclamation Remove Exotics Manually or Chemically
Air Quality		X	X		Speed Limits Water Roads & Pads Flare Gas (Rather than Vent)

	Development Phase				
Resource Concern	Exploration	Drilling	Production	Plugging / Reclamation	Mitigation Techniques
Noise Increases	X	X	X	X	Seasonal Restrictions Use man-made or natural sound barriers Mufflers on engines
Reduction in Roadless Areas		X	X		Temporary access roads and trails Timely Reclamation Avoidance
Noise & Human presence effects on animal behavior and habitat	X	X	X	X	Timing Restrictions Mitigations for soil, water, noise, vegetation apply
Disruption of wildlife migration and mating	X	X	X	X	Timing Restrictions Avoidance of wildlife corridors
Effects on sensitive and endangered species	X	X	X	X	Timing Restrictions Mitigations for soil, water, noise, vegetation apply
Viewshed and scenic intrusions		X	X	X	Seasonal Timing Restrictions Natural Surrounding Facility Colors Vegetative or Topographical Cover Use Existing Roads or Trails Minimize Surface Disturbance
Night sky intrusion		X	X	X	Light Shields Location Selection Limit operations to daytime
Disturbance to archeological and cultural resources	X	X	X		Avoidance Directional Drilling Limit public access
Visitor Safety	X	X	X	X	Limit public access with fences or guards Timing Restrictions

Appendix 3

State Regulatory Requirements

The table below serves as a quick reference to key provisions from state drilling and production regulations governing Marcellus Shale development–November 2008.

	New York NYCRR = Compilation of Codes, Rules & Regulations; ECL = Environmental Conservation Law	Pennsylvania Pa Code = Pennsylvania Code; P.S PA ST = PA Oil & Gas Act	W. Virginia WV ST = West Virginia Statutes; CSR = Code of State Rules	Ohio ORC = Ohio Revised Code; OAC = Ohio Administrative Code	NPS 36 CFR 9B
Permitting: **Drill, Deepen, Plug Back, etc. . .**	6 NYCRR 552.1 - .4 ECL 23-1101	58 P.S PA ST 406, 601.201 Pa. Code 78.11, 12, 13, 15, 16, 17	WV ST 22-6-6, 11 CSR 35-4-5; 39-1-4.4	ORC 1509.5, 6 OAC 1501:9-1-02	36 CFR 9.36, 9.37, 9.38
O&G Well Reporting	6 NYCRR 551.1 - .3 & 554.7	58 P.S PA ST 601.212 Pa. Code 78.121-125	WV ST 22-6-22; CSR 35-4-12, 15	ORC 1509.10	36 CFR 9.42
Bonding or Financial Assurance	6 NYCRR 551.4 - .7	58 P.S PA ST 601.215 Pa. Code 78.301-314	WV ST 22-6-6 (b), 12, 13, 14, 23, 26 CSR 35-4-5.2a3; 35-4-10.1,.2	ORC 1509.7 OAC 1501:9-1-03	36 CFR 9.48
Permit Hearings	6 NYCRR 624.3, 624.5 & 552	58 P.S PA ST 410, 411		ORC 1509.6	
Well Spacing & Location	6 NYCRR 553.1 - .4 ECL 23-0503	58 P.S PA ST 407, 601.205 Pa. Code 79.21-28	CSR 39-1-4.2, 3	ORC 1509.24, 072 OAC 1501:9-1-04	36 CFR 9.41
Pooling & Unitization	ECL 23-0701, 0901	58 P.S PA ST 408, 409 Pa Code 79.31-33	CSR 39-1-4.9; 39-1-6	ORC 1509.25-29	
Operating Practices and Standards	6 NYCRR 554.1 - .6 & 556.2 - .7	Pa Code 78.81-87	CSR 35-4-11		36 CFR 9.41
Plugging & Abandonment	6 NYCRR 555.1 - .6	58 P.S PA ST 1, 4, 5, 8, 601.210 Pa. Code 78.91-98	WVST 22-6-6, 23, 24 CSR 35-4-5.2d1, 35-4-13, 14	ORC 1509.12-.19; OAC 1501:9-11	36 CFR 9.41
Secondary / Tertiary Recovery	6 NYCRR 557.1 - .4		WV ST 22-6-25; CSR 39-1-5	ORC 1509.20, 21; OAC 1501:9-5	36 CFR 9.41
Transportation	6 NYCRR 558.1 & .2				

	New York	Pennsylvania	W. Virginia	Ohio	NPS
Penalties & Enforcement	ECL 71-1301, 1305, 1307, 1309, 1311	58 P.S PA ST 2, 3, 10, 412, 601.501 - 511	WVST 22-6-34, 39	ORC 1509.32, 33, 99	36 CFR 9.52
Lease Royalties		58 P.S PA ST 33, 34, 35	CSR 35-4-5.3	ORC 1509.30, 31	
Restoration & Reclamation		58 P.S PA ST 601.206	WV ST 22-6-30; CSR 35-4-5.2c4, 35-4-16	ORC 1509.072	36 CFR 9.39
Protection of Resources: **Water, Groundwater, etc…**	ECL 23-0501, 0305	58 P.S PA ST 601.207, 601.208 Pa. Code 78.51	WV ST 22-6-6 CSR 35-4-20	ORC 1509.22, 23 OAC 1501:9-1-07	36 CFR 9.41, 9.45, 9.46, 9.47
Safety		58 P.S PA ST 601.209 Pa Code 78.71,72	WV ST 22-6-28, 19, 20, 21	OAC 1501:9-1-05, 1501:9-9	36 CFR 9.43, 9.44
Underground Storage	ECL 23-1301, 1303, 1305, 1307	58 P.S PA ST 601.301 – 307 Pa. Code 78.401-407	WVST 22-9-1 to 22-9-13	ORC Chapter 1571	
Fracturing			WV ST 22-6-12, 13		
Transfer of Ownership or Interest		Pa. Code 78.13,14	CSR 35-4-10.3,.5	ORC 1509.31, 071	36 CFR 9.34
Saltwater Operations				OAC 1501:9-3	
Pipelines				OAC 1501:9-10	
Environmental Review Required	6 NYCRR 617.3	Pa Code 41.16-1605			36 CFR 9.37
Lead Agency Establishment	6 NYCRR 617.6 (b)				
Scoping	6 NYCRR 617.8				
EIS Preparation and Content	6 617.9 & .10 (Generic EIS)				36 CFR 9.37
EIS Decision-making/Public Participation	6 NYCRR 617.11				36 CFR 9.37
EIS Notice & Publication	6 NYCRR 617.12				
Fees & Costs	6 NYCRR 617.13 & 618.1		WV ST 22-6-6	ORC 1509.06	
NEPA/Federal Agency Cooperation	6 NYCRR 617.15				


Upper Delaware Scenic and Recreational River

National Park Service
Director • Mary A. Bomar

Natural Resource Stewardship and Science
Associate Director • Bert Frost

Natural Resource Program Center
Director • George Dickison

Geologic Resources Division
Chief • Dave Steensen
Geoscience and Restoration Branch Chief • Hal Pranger
Planning, Evaluation, and Permits Branch Chief • Carol McCoy
Washington Liaison • Lindsay McClelland

Report Credits
Report Author • Kerry Moss (GRD External Minerals and Energy Coordinator)
Contributors • Carol McCoy (GRD Branch Chief), Pat O'Dell (GRD Petroleum Engineer), Gilbert Garcia (Geo Scientist-in-the-Parks Intern and former BLM geologist), Melanie Ransmeier (GRD), Stephen Simon (Intern and LLM candidate at the Sturm School of Law, University of Denver), Gary Rosenlieb (NPS-WRD), Pete Penoyer (NPS-WRD), and Holly Salazer (NER Air Resources Coordinator).

National Park Service
U.S. Department of the Interior

Geologic Resources Division
Natural Resource Program Center
P.O. Box 25287
Denver, CO 80225

http://www.nature.nps.gov/geology
(303) 969–2090

EXPERIENCE YOUR AMERICA™