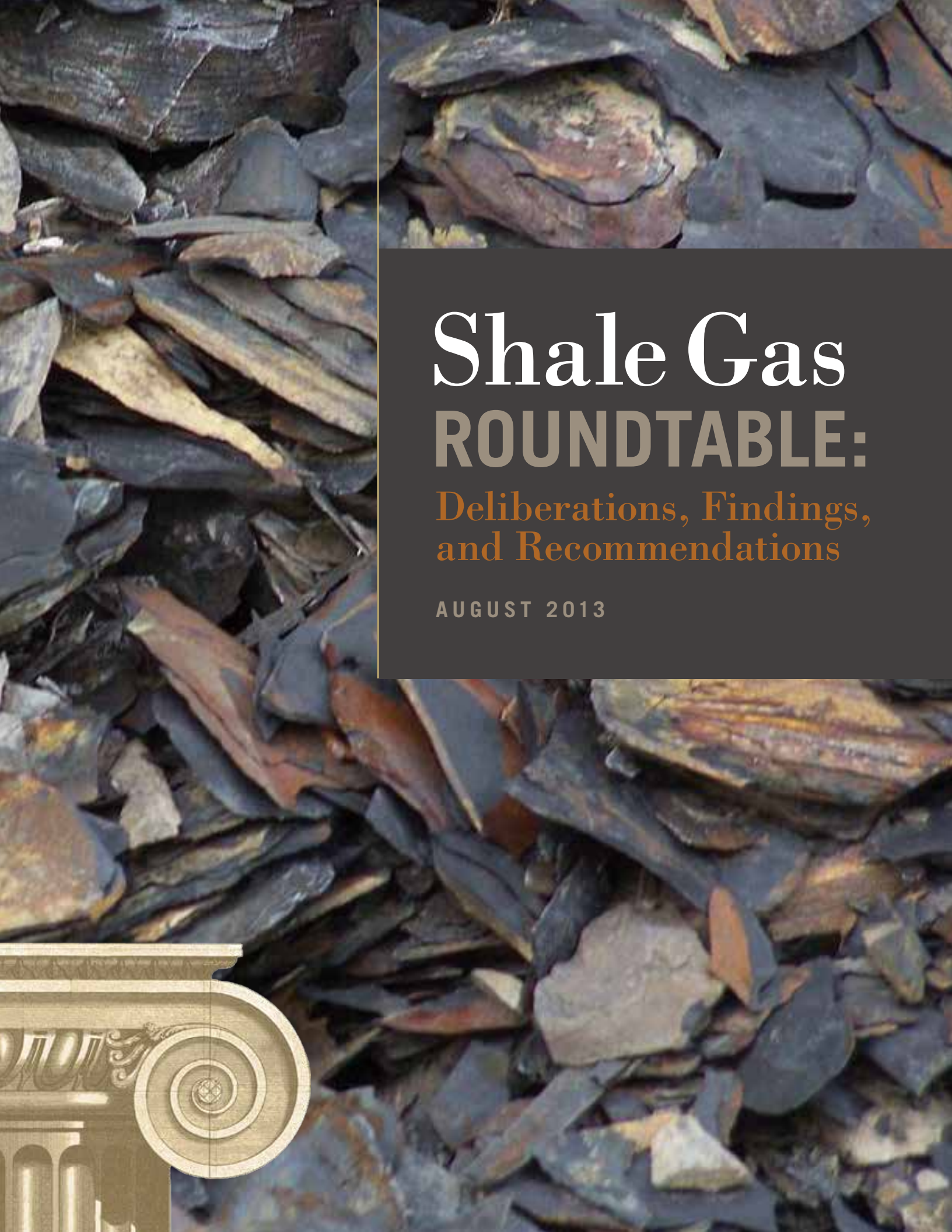


Shale Gas ROUNDTABLE:

Deliberations, Findings, and Recommendations

AUGUST 2013

The Shale Gas Roundtable cochairs and staff worked thoughtfully and diligently to assemble a high-level, diverse membership including 26 individuals from relevant, interested constituencies. Roundtable members were recruited to serve because of the unique perspectives and contributions each could bring to the effort. A full listing of Roundtable members can be found on page 4.

In adopting this document, the Roundtable members endorse that the final report was built on constructive dialogue, was informed by sound research and information, and that the included recommendations merit consideration by policymakers at all levels as they seek to effectively and safely manage unconventional oil and gas development.

While the Roundtable has achieved general agreement on the report's value in informing decision makers, individual Roundtable members may not agree on the details of every recommendation. The final report reflects the careful deliberations and findings of the Shale Gas Roundtable; it does not necessarily reflect the views of the members' affiliated organizations or of the Institute of Politics.

Shale Gas ROUNDTABLE: Deliberations, Findings, and Recommendations

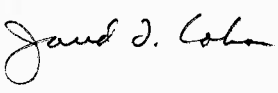
The Shale Gas Roundtable was created in the fall of 2011 to explore natural gas development in Southwestern Pennsylvania. The Roundtable operated by building and sustaining relationships among relevant regional stakeholders; identifying critical focus areas through dialogue, research, and collaboration; assessing those focus areas; and developing recommendations that promote responsible regional shale gas development. Twenty-four civic leaders from the private, nonprofit, and public sectors served with us on the Roundtable. From the beginning, our process relied on broad stakeholder consultation, in-depth research, education on important issues, and respectful consensus building among our diverse members.

Our central question was this: As a region, how can we most effectively and responsibly safeguard our communities and environment, grow our economy, and manage unconventional oil and gas development? Our members recognized the value judgments and trade-offs inherent in attempting to answer this question and the balancing act that would be necessary to make progress. Issues such as the use of natural gas, water resources management, air quality impacts, infrastructure maintenance, housing, and community quality of life quickly entered our conversations. Through a process of careful review and thoughtful prioritization, we selected four areas for the Roundtable's attention: water management, conservation and unitization, research, and midstream development.

This final report represents the culmination of our work. It contains eight core, overarching recommendations that emerged from our overall effort and specific recommendations within each of the four focus areas. The report also includes substantial background and educational information in both the main text and appendices.

In adopting this report, the Roundtable endorses its fact-based and consensus-driven process and the benefit of the resulting ideas, particularly in terms of informing the ongoing public policy discussion in this region and in the Commonwealth. We believe that the included ideas and recommendations deserve consideration from leaders at all levels as they evaluate and make decisions about Pennsylvania's ability to effectively and safely manage unconventional oil and gas development.

As cochairs, we thank the members of the Roundtable for their valuable and significant contributions of time, energy, and knowledge. We commend their willingness to passionately represent their values and perspectives while always striving for common ground and achievable progress. We also extend our appreciation to the many regional, state, and national stakeholders and leaders who shared their experience and insights with us. Finally, we thank the Roundtable staff members for their outstanding support and guidance.



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EXECUTIVE SUMMARY

Pennsylvania is several years into unconventional oil and gas development—the early years of what some are calling a multi-decade shale energy boom. The regulatory environment is shifting, laws are being updated, and media and public attention are high. The issues related to accessing this resource have become politically and emotionally charged, with a significant amount of misinformation in the marketplace. While shale gas development presents a unique economic and energy opportunity for Pennsylvania and its surrounding states, development of these resources also presents substantial challenges for our region in the areas of water resources management, air quality, infrastructure maintenance, housing, and community quality of life, along with other environmental and public health impacts.

Shale formations such as the Marcellus, Utica, and Burket are referred to as unconventional resources due to the nontraditional methods utilized in producing oil and gas from them. Unlike conventional gas formations, shale gas is released from deep deposits using techniques that include multi-well pads, directional drilling, and hydraulic fracturing. In 2010, estimates of Pennsylvania's accessible natural gas reserves doubled as a result of the application of these technologies to the Marcellus Shale formation. The increase in Pennsylvania was a significant contributor to the rise in total U.S. accessible reserves, accounting for about 20 percent of the overall increase that year. Although hydraulic fracturing has been used since the middle of the last century, it was only a decade ago when its coupling with horizontal drilling and use in accessing deep shale deposits were piloted in Texas's Barnett Shale and more recently applied to the Marcellus Shale.

From 2002 through 2012, 6,283 unconventional oil and gas wells were drilled in Pennsylvania on more than 2,700 well pads. These wells produced a total of 3.7 trillion cubic feet of natural gas in that decade, with 85 percent of that total produced in 2011 and 2012. Approximately 35 percent of these wells are located in the 10-county Southwestern Pennsylvania region.

In 2012, 57 percent of all wells drilled in Pennsylvania and 90 percent of all wells drilled in Southwestern Pennsylvania were unconventional. At the end of 2012, 57 percent of all drilled unconventional wells in Pennsylvania were producing natural gas for market. Though unconventional wells represented only 5 percent of the total producing wells in the Commonwealth, they accounted for 90 percent of Pennsylvania's total gas production in 2012.

The Commonwealth's Department of Environmental Protection (DEP), through its Office of Oil and Gas Management, is the state agency primarily responsible for oversight of this sector. DEP issues permits; regulates water, air, and solid waste impacts; responds to complaints; and enforces compliance with relevant state laws and regulations. While DEP has the largest responsibility, the Pennsylvania Public Utility Commission, Pennsylvania Department of Conservation and Natural Resources, the U.S. Environmental Protection Agency, and several other state and federal agencies have roles in the management of various aspects of the oil and gas industry.

Over the last several years, Pennsylvania has made substantial efforts to improve the management of unconventional oil and gas development, including, but not limited to, updating water standards for total dissolved solids, increasing permit fees to support regulatory staffing needs, adopting the first comprehensive update of its Oil & Gas Act through Act 13 of 2012, and promulgating updated Chapter 78 environmental regulations to implement Act 13.

SHALE GAS ROUNDTABLE OVERVIEW

In response to the desire of regional, multi-sector leaders to elevate and inform the regional energy dialogue, the Shale Gas Roundtable was created in the fall of 2011 to fulfill a three-part mission related to unconventional oil and gas production, transport, and use:

- Building and sustaining relationships among relevant cross-sector stakeholders to better support diverse regional environmental protection, community quality of life, and economic development goals
- Identifying high-priority focus areas through consensus-building dialogue, extensive research, and shared goals for the region
- Assessing the focus areas and developing ideas and recommendations that promote the improved management of and outcomes from regional unconventional oil and gas development

The principles used to guide the Roundtable's deliberations and activities were as follows:

- Operating with integrity, inclusiveness, and accountability
- Seeking the best possible balance between environmental/community protection and shale gas development/economic growth
- Conducting a thorough and objective study of issues

- Seeking the best available data to guide fact-based dialogue
- Incorporating stakeholder input with the help of members
- Working closely with diverse decision makers to seek input and counsel

The Shale Gas Roundtable cochairs and staff worked thoughtfully and diligently to assemble a high-level, diverse membership of 26 individuals from relevant, interested constituencies. Roundtable members were recruited to serve because of the unique perspectives and contributions each could bring to the effort. The Roundtable's geographic scope included the 10 counties of Southwestern Pennsylvania—Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Lawrence, Westmoreland, and Washington. These counties represent approximately one-third of the unconventional oil and gas permits issued, wells drilled, and gas produced in the Commonwealth over the last 10 years. The 10-county Roundtable focus does not imply that unconventional oil and gas development is only a regional issue. Rather, the region was selected to maintain a manageable geography for frequent in-person member interaction on these issues.

The Roundtable members collectively determined their direction, process, and recommendations. In this work, they were supported by the Institute of Politics at the University of Pittsburgh. The Institute staff team, through neutral facilitation and unbiased research, established a productive framework for members to develop, discuss, and evaluate policy ideas and options. The activities of the Shale Gas Roundtable and the services of the Institute of Politics were generously supported by the Pittsburgh Foundation, the Heinz Endowments, and the Richard King Mellon Foundation.

In adopting this document, the Roundtable members endorse that the final report was built on constructive dialogue, was informed by sound research and information, and that the included recommendations merit consideration by policymakers at all levels as they seek to effectively and safely manage unconventional oil and gas development.

While the Roundtable has achieved general agreement on the report's value in informing decision makers, individual Roundtable members may not agree on the details of every recommendation. The final report reflects the careful deliberations and findings of the Shale Gas Roundtable; it does not necessarily reflect the views of the members' affiliated organizations or of the Institute of Politics.

BUILDING A COMMON UNDERSTANDING (2011–12)

At the inaugural meeting of the Shale Gas Roundtable in September 2011, members crafted a work plan to guide their collective efforts. That work plan was then implemented over the subsequent six months. It included the following components:

- Completing an extensive literature review of laws, policies, regulations, scientific studies, and advocacy materials related to unconventional oil and gas development in the region
- Conducting and summarizing more than 120 benchmarking interviews with environmental organizations, industry associations, landowner groups, researchers, and regulators and elected officials from the local, county, state, and federal levels. These interviews were completed through site visits to Colorado, New York, Ohio, Texas, and West Virginia. Interviews also were held with multi-sector leadership in Harrisburg and Washington, D.C.
- Continuing outreach to individual Roundtable members and to key stakeholders in Southwestern Pennsylvania to collect as much information as possible about regional unconventional oil and gas development
- Implementing a "Shale Gas University" to allow Roundtable members to participate in shared learning experiences. Educational modules featured expert guest speakers on topics ranging from water management to utility regulation to the full life cycle of natural gas production, transport, and use. Also included were field tours of a compressed natural gas fueling station, a centralized water treatment facility, a drilling site, and areas of the region most impacted by oil and gas development. The Shale Gas University sessions also provided opportunities for relationship building and education on critical issues and were held as needed throughout the entire course of the Roundtable's work.

The Roundtable met regularly to share the findings and results from the above activities.

"GETTING IT RIGHT" FRAMEWORK AND RECOMMENDATIONS DEVELOPMENT (2012–13)

The economic benefits of unconventional resource development are often described as worthwhile as long as that development is done right. Roundtable members agree, but "done right" often is not well-defined. Through extensive review and in-depth discussion of the data that resulted from the activities outlined above, the Roundtable concluded that the necessary ingredients for a "getting it right" framework are:

- a strong, adaptive legal and regulatory system with adequate implementation staff and resources;
- aggressive development and industry adoption of best management practices and other operational performance standards;
- investments in technological and operational innovation; and
- carefully targeted and balanced research to inform the continual improvement of statutes, regulations, best management practices, standards, and technology.

If Pennsylvania and its surrounding states pursue excellence in these four areas, the Appalachian Basin could serve as a national model for getting unconventional upstream, midstream, and downstream development right. Specifically, the Roundtable believes that Pennsylvania could best implement this framework by aiming progress at three interrelated goals:

- Minimizing the acute and cumulative impacts of oil and gas activity on the environment, public health, and local communities
- Minimizing surface disturbance from oil and gas activity and maximizing the efficiency of resource recovery and transport
- Enhancing the regional use of natural gas and supporting opportunities for regional economic growth based on the full natural gas value chain

In early 2012, the Roundtable agreed that its attentions would best be concentrated in the legislative, regulatory, and research aspects of this framework. This decision was based largely on the degree to which other organizations and efforts were already focused on creating best management practices and driving innovation.

With the above framework and goals in mind, the Roundtable decided to select a small number of areas for comprehensive exploration and focused recommendations. After considerable deliberation over 30 potential areas, the members prioritized four areas for targeted attention:

Policy-relevant research: increasing the amount and enhancing the perception of research on the impacts of unconventional oil and gas development and ensuring that the resulting knowledge is used for the improvement of regulations and best practices

Conservation and unitization: developing a balanced proposal for modernizing the 1961 Pennsylvania Oil and Gas Conservation Law to account for modern technologies and approaches, limit surface disturbance, avoid wasted oil and gas resources, and move toward uniform conservation rules for all unconventional shale formations

Water management: protecting water resources by identifying improvements in management and regulation in the areas of water sourcing, hydraulic fracturing chemical disclosure, erosion and sedimentation, impoundments, vehicle traffic for water transport, wastewater treatment and disposal, groundwater protection, water related violations, regional water management, and water monitoring

Midstream development (pipelines and related infrastructure): developing recommendations that minimize the environmental and surface footprints of midstream construction, improve pipeline safety, enhance coordination and planning of siting decisions, and provide increased opportunity for economic and community development

The Roundtable's full report contains extensive background information and recommendations for each of these four areas along with a set of core recommendations that emerged from the Roundtable's discussions. All of the recommendations were constructed using a thorough and deliberative process to prioritize and address critical issues for Southwestern Pennsylvania.

CORE RECOMMENDATIONS

Through examination of the four focus areas, the Roundtable also identified a set of broader, overarching recommendations that fit within its framework:

The Commonwealth of Pennsylvania should increase investments in improving the accuracy, functionality, and transparency of its oil and gas data infrastructure. DEP has made significant progress in its management of oil and gas data over the last several years, but additional investments in innovation and data transparency and utility are necessary. Increased investment in user-friendly, accurate, and real-time systems will improve the efficiency of DEP-industry interactions, enhance research and data analysis capabilities, facilitate public access to information, and build public trust.

The Commonwealth should develop regulatory staffing parameters and oil and gas annual reports. DEP also should report annually—and publicly—on its oil and gas activities, including information about the prior year's progress and priorities for the upcoming year. The inclusion of transparent staffing parameters (possibly including minimum inspector-to-well ratios, frequency and number of well inspections, time frame required for permit review and action, expectations for timely responses to public and stakeholder complaints and inquiries, and other critical metrics) in this annual report would provide a clearer picture of DEP's additional staffing needs, if any, and demonstrate its continued ability to fully implement the state's oil and gas regulations.

The Commonwealth should restructure the Oil and Gas Technical Advisory Board. While most DEP advisory committees are diverse and provide opportunities for cross-sector dialogue on policy and technical issues, the existing Oil and Gas Technical Advisory Board (TAB) has five members, all with geologic and petrochemical backgrounds and most with industry ties (this structure is statutorily mandated in the current Pennsylvania Oil & Gas Act). The administration and the legislature should expand the Advisory Board's scope beyond technical issues and diversify the membership at the earliest possible time.

The Commonwealth should continue to regularly evaluate the ability of existing budget support and permit fees to support oil and gas regulation. As the administration and legislature consider future DEP budgets, they should regularly evaluate the ability of budget support and permit fees to adequately support DEP oil and gas operations. Currently, the oil and gas program is entirely funded by a combination of new permit fees, impact fee revenue, fines, and civil penalties. With current low natural gas prices and slowed drilling, it is unclear if new permit fees will be able to sustain the necessary oil and gas regulatory staffing level.

The Commonwealth should participate in regular, comprehensive STRONGER reviews. DEP should regularly participate in State Review of Oil and Natural Gas Environmental Regulations, Inc. (STRONGER) reviews in order to benefit from independent assessments of the state's oil and gas regulations and to identify opportunities for additional improvement. A STRONGER review already is underway in 2013–14, and it may take into account proposed regulations based on Act 13.

The federal government, state government, and stakeholder groups should support efforts to increase balanced research on and rigorous monitoring of the possible impacts of unconventional oil and gas development. The Roundtable's recommendation for an independent research fund, described below, represents a particularly compelling opportunity for progress in the understanding of oil and gas development impacts.

Government, industry, and regional universities should support NETL as the premier national unconventional oil and gas technology research hub and, through NETL, continue to advance technology and operational innovations. The Appalachian Basin states are well-positioned to lead on oil and gas technology and operational innovations with the excellent capabilities of local research universities and with the U.S. Department of Energy's National Energy Technology Laboratory (NETL) headquartered in Southwestern Pennsylvania. The federal and state governments, along with diverse stakeholders throughout the basin, should seek stronger relationships with NETL in order to continue developing innovations that can diminish the environmental risks of unconventional resource extraction, transport, and use.

DEP should strengthen engagement with and support of various cross-sector and industry efforts to develop Best Management Practices. DEP should continue its engagement with and support of various multi-stakeholder and industry efforts to develop best management practices (BMPs) and high-level performance standards. As appropriate, these practices/standards should be considered for incorporation into future revisions of relevant regulations and guidance documents to ensure continual improvement of industry operations.

UNCONVENTIONAL OIL AND GAS RESEARCH FUND PROPOSAL

Shale gas development is complex and multi-faceted, with economic, environmental, public health, social, and technological components. Robust and trustworthy research should be one of the critical ingredients in decision making by the state and federal governments and other important stakeholders.

The Roundtable used various tools and approaches to explore the research focus area, including a higher education survey, interviews with key government policymakers, outreach to relevant stakeholders, and media/literature reviews. The findings indicated that:

1. While substantial research has been completed or is under way, the amount of research activity on shale gas is lacking relative to the knowledge needs of policymakers and the public. Further, this mismatch between needs and actual research often is due to a dearth of funding.

2. Research that has been completed or is underway often is perceived as biased due to the funding source or review processes used.
3. Research has not been well aligned with the information or timing needs of regulatory staff, elected decision makers, or other civic leaders.

The Roundtable also investigated possible models to address the identified research deficiencies. Most potential models proved inadequate to overcoming the particular barriers of enhanced shale gas research. The one exception, however, was the Health Effects Institute (HEI), based in Boston. To a significant degree, HEI's nonpartisan approach, independent structure, history, and activities informed the Roundtable members' thinking on unconventional oil and gas research issues and aided in the development of the proposal below.

Based on the demonstrated need for additional balanced research, the investigation of models, stakeholder input, and the other information gathered, the Roundtable recommends that a fund be created to support rigorous and enhanced research to guide unconventional oil and gas development. The fund would have the following characteristics:

- diverse funding streams (state and federal governments, industry, and private philanthropy)
- regularly updated multi-year strategic research plan
- scientifically rigorous (competitive funding awards and peer review)
- transparency of funding and of research outcomes
- strong government and stakeholder relationships
- supportive of informed policy and practice based on state-of-the-art science
- able to synthesize existing research for shorter-term consumption by decision makers
- adequacy of funding support and staffing to implement a multi-year strategic research plan

In combination, these characteristics will help the research fund to maintain its ability to be nimble and responsive while being deliberative, strategic, and scientifically rigorous.

FUND GEOGRAPHY

While the fund could grow into a national effort, the best interim start-up strategy is to focus specifically on geologic formations found in the Appalachian Basin. Exact geographic dimensions of the basin vary, but the most commonly included states are New York, Pennsylvania, Ohio, and West Virginia.

These states share unconventional resources in the Marcellus, Utica, and other shale formations. They have a shared historical experience with resource extraction and, in many ways, similar regulatory regimes.

At the end of 2011, the U.S. Secretary of Energy Advisory Board's Natural Gas Subcommittee endorsed the creation of Regional Centers of Excellence that would involve public interest groups, state and local agencies, colleges and universities, and industry in basin-specific best practice development. While this research fund would have a slightly different mission, an Appalachian Basin scale would be consistent with the U.S. Department of Energy's emphasis on regional, shale-basin defined, and cross-sector approaches.

FOCUS OF RESEARCH ACTIVITIES

A multi-sector fund appears particularly well suited to support research on the acute and cumulative environmental, ecological, public health, social, and community impacts of unconventional oil and gas extraction, production, transport, and use. These are the most contentious areas that require increased attention and skilled, impartial investigation.

FUND IMPLEMENTATION STRATEGY

In order to begin the implementation of the research fund proposal, planning already is under way for a process to establish a multi-year unconventional oil and gas research agenda that will include targeted, carefully timed, and policy-relevant research questions. This initial process and resulting agenda will, to the highest degree possible, conform to the characteristics of the fund itself.

It will be essential for diverse stakeholders to be able to trust the rigor and independence of the process and the resulting agenda. The agenda cannot be viewed as being driven by one sector or one institution. Expert scientific staff with experience in collaboratively identifying research questions, setting priorities, and establishing strategic research plans will be essential ingredients in the process. A scientifically credible, impartial facilitator with a track record in this type of work and with experienced staff would heighten the chances of successfully crafting an agenda that can attract implementation funding.

In parallel with the agenda-setting process, a detailed plan for the implementation of the agenda through a multi-year, cross-sector fund will be constructed. Longer-term emphasis will be on securing stability and predictability for the research fund through multi-year funding commitments, regular stakeholder communications, hiring full-time staff, establishing research and review committees, and eventually drafting requests for proposals based on the strategic research agenda.

MODERNIZATION OF THE OIL AND GAS CONSERVATION LAW

In long-standing Pennsylvania law, the "rule of capture" provides that ownership of a natural resource is determined by who "captures" the resource first. This legal paradigm resulted in the early, inefficient extraction of Pennsylvania's oil reserves. Through over-drilling to capture the oil resource, well operators depressurized oil reservoirs, stranded numerous barrels of oil, and littered the landscape with wells. The Oil & Gas Conservation Law, which was originally adopted to satisfy Pennsylvania's membership requirements for the Interstate Oil & Gas Compact Commission, was designed to more effectively and efficiently manage oil and gas reservoirs.

However, the Conservation Law has not been updated since 1961. It is the last portion of a three-part Pennsylvania oil and gas legal structure to be updated—both the Oil & Gas Act (Act 13) and the Coal & Gas Resource Coordination Act have been revised within the last several years. The 1961 Pennsylvania Conservation Law uses outdated depth restrictions, which in turn generate distinct regulatory systems for the Utica, Marcellus, and other shale formations.

The Shale Gas Roundtable has developed a balanced proposal for modernizing the Conservation Law and ensuring a standardized regulatory structure through all unconventional formations. This framework can be used to inform a comprehensive update of the Conservation Law or, in the interim, components of the framework could be legislated separately.

The Roundtable's considerations in crafting this proposal included the following:

- The Commonwealth should not have different conservation rules for different shale layers.
- The 1961 law did not anticipate horizontal drilling, multi-well pads, or large-volume hydraulic fracturing, and any update should take these advances into account.
- It is in the best interest of the Commonwealth to limit the density of well pad development. Fewer pads equal fewer acres of surface disturbance, less infrastructure build out including gathering pipelines, and likely fewer potential environmental impacts.
- Land and mineral rights owners have complicated relationships with each other and with the natural gas resource. The Commonwealth should approach any update with careful attention paid to the ability of all stakeholders to constructively participate in the unitization process.
- Natural gas is an important economic asset of the Commonwealth. With substantial extraction already under way, the Commonwealth should make every effort to increase the efficiency of resource recovery and to prevent waste through stranded gas/acreage.

The framework below aims to provide uniform conservation rules that account for modern oil and gas development approaches and that prevent unnecessary environmental impacts and wasted resources.

APPLICABILITY AND ADMINISTRATION OF THE CONSERVATION LAW

Modernized provisions in the Conservation Law should apply to all unconventional reservoirs as defined by Act 13. Given that the original act will likely be amended instead of replaced, 1961 provisions that remain relevant to either conventional or unconventional gas development should be retained.

The Department of Environmental Protection (DEP) would carry out the functions outlined in these recommendations, including the review of proposed units and integration requests. Operators are accustomed to state unit review and approval processes in many other oil and gas-producing states. The aim is not to create new bureaucracy but to enable DEP to ably manage the additional Conservation Law responsibilities in strong alignment with existing environmental regulations. DEP would be required to design a unit filing process that enables operators to clearly demonstrate their fulfillment of the established requirements and facilitates timely decisions. Recently instituted state permit review and decision guarantees (assuming accurate/complete applications) would apply to DEP unit reviews. In order to pay for the additional staff necessary to conduct unit and integration reviews, DEP would be enabled to charge fees for integration requests and unit proposal filings.

RATIONALIZATION OF DRILLING UNITS

The Conservation Law should govern the logical organization of drilling units in order to minimize surface disturbance and maximize the efficiency of extraction and transport of oil and natural gas.

The Commonwealth should not legislatively define minimum and maximum unit sizes, number of pads per unit, or number of wells per unit. Instead, DEP would be charged with developing a maximum ratio of surface disturbance to unit size and requirements that the unit be effectively drained. For example, if the legislation required exactly 400-acre units with one pad per unit, the operator would need three pads to drain 1,200 acres. What if, instead, the operator could design a 1,200-acre unit and drain it with two pads? Or, what if the operator could drain an

800-acre unit with one pad and drain the adjacent 400-acre unit from a pad on the 800 acres? A ratio tool and requirements for effective drainage would allow flexibility to DEP and operators in effectively managing the gas reservoir, avoiding stranded gas, adapting to technological and best practice advances, rationalizing units, and limiting surface disturbance. These unit parameters should be evaluated for revisions every three years to account for advancing technology and operational practices.

Operators would be encouraged to propose multiple units to DEP in one filing. Such an approach would allow for more comprehensive conservation by allowing industry and the Commonwealth to work toward development that limits surface impact and improves efficiency over multiple units covering a larger geographic area.

Based on fracture propagation data and area geology, operators should be required to propose setback distances between the unit boundary (boundary with leases/land not included in that unit) and any well laterals. This approach prevents subsurface trespass and protects adjacent mineral rights owners. It also protects operators from cross-fracturing each other's laterals.

INTEGRATION OF UNITS

In most cases, operators would control all leases in a proposed unit. DEP would not have jurisdiction over which leases or acreage are included in the proposed unit, only over whether the operators are meeting surface disturbance and effective drainage requirements.

In many other oil and gas-producing states, when operators are not able to secure leases for all of the acreage in a proposed unit, compulsory integration of non-consenting rights owners is an important component of conservation law. In Pennsylvania, full compulsory integration is currently available below the Onondaga Limestone via the 1961 Oil & Gas Conservation Law. Given the aim of minimizing surface impacts and avoiding waste, such compulsory integration does efficiently and effectively serve these goals. At a minimum, Pennsylvania should consider enabling company integration and existing lease integration:

- Company-on-company compulsory integration: The capability to request integration should be available to "persons" defined as operators. This will provide a remediation tool in the event that operators are effectively blocking the integration of efficient units.
- Existing lease integration: If an operator has the right to develop multiple, contiguous, held-by-production leases separately, the operator should be able to request integration of those leases into a unit for the purposes of oil and gas development via horizontal drilling (unless expressly prohibited by an existing lease). A similar provision is found within Pennsylvania Senate Bill 259, which passed the Senate and the House of Representatives in June 2013.

Seventy percent of the acreage in a proposed unit should be under the control of the operator before any type of integration request can be filed. The operator should demonstrate and document its attempts at good faith negotiation before a request can be considered. A fee would be associated with filing any type of integration request, which would serve to discourage such requests and provide additional revenue to support DEP's unit review functions.

AVAILABILITY OF UNIT INFORMATION

DEP should develop requirements for formatting and data inclusions in unit proposal and final unit filings. A statewide electronic filing system for unit proposals and declarations should be designed and implemented. The resulting maps and data should be publicly accessible via an online portal. There would be a need to ensure that the new filing system integrates with other DEP, Department of Conservation and Natural Resources, Pennsylvania Natural Diversity Inventory (PNDI), and Pennsylvania Spatial Data Access (PASDA) data systems. The current county-level paper filing system for final unit declarations should be retained to remain consistent with Pennsylvania title practices.

OIL AND GAS LEASE RELEASE REQUIREMENT

Upon the expiration of an oil and gas lease, the operator should, within 30 days after a request by the rights owner, execute, acknowledge, and deliver or cause to be recorded, a quitclaim of all interest in and to the resources covered by the oil and gas lease. Such a request can only be filed and only requires a response if the lease is no longer in the primary term and the lease is not held by production. This requirement facilitates the cleaning of title upon lease expiration and improves the marketplace for acreage then available to be included in future units.

TEMPORARY REGULATIONS

DEP should be allowed to issue temporary regulations to speed implementation of the modernized Conservation Law until permanent regulations can be promulgated and approved. Temporary regulations should be in place a maximum of two years.

WATER AND UNCONVENTIONAL OIL AND GAS RECOMMENDATIONS

In the spring of 2012, the Shale Gas Roundtable began to collect and analyze data for a regional scan of water-related issues relevant to shale gas extraction, transport, and use. Based on the information gathering and stakeholder dialogue processes, the Roundtable also was able to construct a set of recommendations focused on preventing potential water-related impacts of unconventional oil and gas development. The Roundtable developed recommendations in the categories provided below, with a risk-based life-cycle approach to managing water impacts.

WATER SOURCING

- Pennsylvania should sign the pending memorandum of understanding that supports the Ohio River Valley Water Sanitation Commission's (ORSANCO) study of water quantity regulation in the Ohio River Basin and also actively engage in the Commission's forthcoming studies.
- DEP should incorporate the recommendations in the Upper Ohio Basin flow study into its water management programs and update its policy to reflect this recent research. The Susquehanna River Basin Commission's new policy, based on a similar study, creates classes of streams based on their sensitivity to water withdrawals and limits withdrawals when they are likely to have ecological impacts. DEP should consider similar factors when managing water in the Upper Ohio Basin.
- The potential benefits of using abandoned mine water for hydraulic fracturing operations are well documented. The technology necessary to use this water largely exists, and the most significant barrier remains potential liability. As such, the General Assembly should adopt Pennsylvania Senate Bill 411, or similar legislation, to encourage the use of abandoned mine water in well development. The U.S. Environmental Protection Agency (EPA) and possibly the U.S. Congress should consider also addressing operator liability concerns under federal law.
- A water quantity life-cycle analysis for shale gas development should be supported and conducted at the earliest possible time to inform the public and future water quantity regulation.
- The draft Chapter 78 Water Management Plan (WMP) provisions should be enacted, including the extension of certain existing Susquehanna River Basin Commission water withdrawal rules to the Ohio River Basin. DEP should fully leverage the expertise of department water staff in WMP reviews, compliance monitoring, and enforcement (in collaboration with oil and gas staff).

HYDRAULIC FRACTURING CHEMICALS

- The Roundtable recognizes DEP for its strong efforts at facilitating public transparency of fracturing chemicals and its pressure to update the FracFocus.org platform to more adequately communicate needed information. DEP should continue to evaluate methods for improving the accessibility and utility of collected chemical information, with commensurate pressure on FracFocus.org to improve and innovate in order to meet Pennsylvania's needs in this regard.
- Industry, federal and state governments, and academia should prioritize the development of biodegradable "green" fracturing fluids. A green fracturing fluid would minimize the potential harm to natural gas workers and the potential environmental damage that could result from surface spills or underground migration of fracturing chemicals or flow back water. In the interim, the use of DNA or isotopic tracers in the fracturing fluid mixture may improve the ability to monitor underground fluid migration.

EROSION AND SEDIMENTATION

- In the design and review of oil and gas Post-Construction Stormwater Management Plans, DEP should require "whole-site" plans that take into account not only the well pads but the access roads and pipelines that service a particular development location.

IMPOUNDMENTS AND CONTAINERS

- DEP should evaluate various natural gas wastewater storage techniques, including mobile containers and centralized impoundments, to determine best practices for management of these fluids. This evaluation should use a life-cycle approach that estimates potential environmental and safety risks associated with each of the available storage technologies. In particular, DEP should continue to monitor potential acute emissions problems with open impoundments.

VEHICLE TRAFFIC/WATER TRANSPORT

- In addition to the new uniform rules in the draft Chapter 78 revisions, DEP should continue to seek methods that facilitate and incentivize the use of fresh water pipelines for water transport (possibly including a requirement that water transportation plans be included in the Water Management Plan).
- While Excess Maintenance Agreements (EMA) typically have been sufficient tools to ensure infrastructure repairs, the Commonwealth should evaluate whether the 30-year-old bonding rates should be increased to better protect local municipalities from EMA default.

WASTEWATER TREATMENT AND DISPOSAL

- The Commonwealth should transparently define and codify the categories of waste produced by unconventional oil and gas development and the differences among drilling, flow back, and produced waters. The lack of formal definitions adds unneeded complexity and uncertainty to disposal data and should be remedied through future legislation and regulation.
- DEP should consider requesting that operators include their water manifest tracking data in their biannual waste reporting and that the resulting data be made available for public consumption. The ability to follow all wastewater from well site to disposal location could improve public faith in the handling of these materials.
- Many wastewater treatment technologies leave residual by-products after the water is reclaimed. Additional government attention and industry/academic research should be aimed at the appropriate disposal and/or beneficial reuse of these by-products.
- DEP should evaluate current and future wastewater regulations by their ability to move toward zero discharge of natural gas-related wastewater in favor of recycling, reuse, and underground injection.
- DEP should proactively engage with U.S. EPA in a dialogue about the effectiveness and management of the Underground Injection Control and Wastewater Pre-Treatment programs, which are currently administered by EPA. Also, EPA recently completed a comprehensive risk analysis for Class 1 hazardous materials injection wells. EPA and/or the Commonwealth should consider conducting a similar analysis for Class 2 oil and gas brine disposal injection wells.

GROUNDWATER PROTECTION

- Enhanced research and monitoring are needed to establish baseline groundwater conditions and gauge possible cumulative impacts of unconventional oil and gas development on groundwater. Act 13 provided impact fee monies to the Commonwealth Financing Authority in order to fund statewide initiatives that can help to collect baseline water quality data on private water supplies. This program and others should be supported and expanded.
- The Pennsylvania General Assembly should pass House Bill 343, or similar legislation, which would establish construction standards for new private water wells. Legislators also should consider adding technical and financial assistance provisions that aid homeowners in the evaluation, maintenance, and refurbishment/replacement of existing private water wells.
- DEP should undertake efforts to standardize rigorous pre-drilling water testing parameters, methodologies, land owner notification procedures, and reporting requirements. Consistent parameters for post-drilling monitoring and sampling processes also should be developed.
- Regular inspection of sites is necessary to ensure industry compliance with DEP cementing and casing standards. In anticipation of future well re-stimulation activities, the Commonwealth should develop requirements for checking the continued strength and stability of the original cementing and casing. As noted in the Core Recommendations, it will be essential that DEP sets transparent goals and possesses the resources and staff to meet its inspection obligations.
- Due to groundwater infiltration concerns, Chapter 78 should be amended to prohibit on-site disposal of drill cuttings from the horizontal phase of drilling operations or solid wastes from hydraulic fracturing of unconventional wells.

WATER-RELATED VIOLATIONS

- DEP should invest in improvements to the violation database systems. Violations should be better categorized to improve understanding of the nature of the violation, its actual or potential severity of impact, DEP's enforcement actions, and the operator's response to the violation (as required by Act 13). DEP should consider annually summarizing and reporting on violation activity—and progress in remedying violations and preventing future incidents.
- DEP also should remove redundant violation records for single incidents so that the public and policymakers can more clearly evaluate violations activity.

REGIONAL WATER MANAGEMENT

- As delineated in the water sourcing section, the Commonwealth should support and actively engage in the ongoing ORSANCO water quantity studies.
- In 2009, a regional effort led by the Regional Water Management Task Force endorsed the creation of a water planning division at the Southwestern Pennsylvania Commission (SPC). That effort, which is under way, is designed to improve the cohesion of water monitoring, planning, investment, and technical assistance within a 10-county Ohio River Basin area. While SPC plans to initially focus its primary attention on stormwater, shale gas water management issues provide further impetus for this work. The region should support the growing role of SPC in planning for the future of Southwestern Pennsylvania's water resources.

- The Chapter 78 draft rulemaking states that DEP will collaborate with the Susquehanna River Basin Commission, the Delaware River Basin Commission, and the Great Lakes Commission on water monitoring and regulation of oil and gas activities. While Southwestern Pennsylvania does not have a direct corollary agency, DEP should consider outreach to and partnership with both ORSANCO and SPC on Ohio River Basin water resources management. Such collaborations would allow DEP to have natural water partners within this region of a similar type to those that already exist in Central and Eastern Pennsylvania.
- Local communities should consider the potential benefits of developing and maintaining a Source Water Protection Plan for drinking water sources. DEP should continue to encourage local jurisdictions to complete such plans and provide technical assistance to support the planning processes.

MIDSTREAM DEVELOPMENT RECOMMENDATIONS

Midstream infrastructure includes pipelines, processing facilities, compressor stations, and related infrastructure for transporting natural gas from well sites and preparing that gas for market. As of December 2012, 57 percent of Pennsylvania's spud unconventional wells were producing gas, a number that at least partially reflects the lack of adequate pipeline infrastructure to bring these wells into production. In the last six months of 2012, 683 wells were producing that had not been in the previous six-month period, possibly indicating the scale of recent midstream investment.

This ongoing development of a gathering and transmission network for Pennsylvania's unconventional wells caught the Roundtable's attention for multiple reasons:

- Building pipelines includes both substantial surface disturbance (both temporary and permanent) and construction activities that have environmental risks such as erosion and sedimentation, invasive species introduction, forest fragmentation, and stream crossings and encroachments.
- While incidents have been rare, the safety of pipeline systems will continue to be a public concern.
- Air quality and climate change impacts from compressor stations and methane leakage are possible.
- The pipeline system is a delivery mechanism to get shale resources from production to end users. As the markets for these resources continue to develop within the Commonwealth, the locations of midstream infrastructure can, at times, be either a help or a hindrance to users' cost-effective access.
- Pipeline rights of way become fairly permanent aspects of the landscape, and midstream planning will continue to interact with other local economic and community development planning.
- Any development inefficiencies that add to the costs of the overall system could possibly be passed on to consumers/ratepayers.

The natural gas midstream system has a wide range of potential impacts on landowners, the environment, public health, the local and state economy, and the individual consumer. As midstream infrastructure in Pennsylvania continues to expand to serve new producing wells, the short-term and long-term consequences of this development will require careful monitoring and management with the best interests of the public in mind.

In order to promote midstream development, which is environmentally protective and economically beneficial, the Roundtable recommends that the Commonwealth and interested stakeholders pursue a suite of important goals, including the following:

Crafting legislative and regulatory provisions that, in the public interest, encourage the efficient development of intrastate midstream infrastructure

The Commonwealth should actively seek opportunities to improve the efficiency of intrastate midstream infrastructure development, possibly including the sharing of pipeline capacity to transport produced gas. In addition to sharing infrastructure, such coordinated systems could jointly take advantage of existing rights of way that may be available and even co-locate with other utilities or natural gas-related infrastructure.

While joint efforts could be challenging because the new transmission would have to account for the diverse needs and lease-holdings of multiple operators, approaches such as these could serve the public interest by limiting surface disturbance and preventing the construction of unnecessary or duplicative lines. Identifying opportunities for increased efficiency also could decrease the total costs of infrastructure development, in turn positively influencing consumer rates.

Creating and leveraging opportunities for enhanced communication between midstream operators and other key stakeholders

In the near future, the Public Utility Commission (PUC) and DEP should consider partnering to convene three in-depth workshops to guide thinking on midstream issues in the Commonwealth:

1. Environmental and community impacts: A targeted discussion on present and future potential issues of concern regarding pipeline infrastructure. Industry; landowners; municipal and county officials; and environmental, conservation, and sportsmen's groups would be natural participants. What are the high-priority concern areas? How are companies proactively

addressing them? Are the appropriate state regulatory tools available to manage those areas of concern?

2. Economic and regulatory efficiency: A multi-part dialogue with an initial focus on supporting increased efficiency of infrastructure development. The multiple state and federal agencies that regulate aspects of midstream development should participate to discuss their own efforts at collaborative oversight and at improving the efficiency of interactions with industry.

3. Building midstream and downstream connections: A unique effort to create a dialogue among those who produce, transport, and use natural gas and related products in Pennsylvania. An initial conversation could include participants such as exploration and production companies, midstream operators, local distribution utilities, power generation companies, transportation sector representatives, and manufacturing companies. The goal would be to identify points of agreement and disagreement that have implications for Pennsylvania's management of its energy portfolio.

These conversations would be aimed at cross-sector relationship building and the identification of critical opportunities and challenges in the improvement of midstream policy and regulation. Due to the diverse interests and aspirations of the participants, the Commonwealth agencies are particularly well suited to serve as neutral conveners. If any or all of the discussions prove useful, additional follow-up sessions focused on more specific issues are possible.

Ensuring the availability of the necessary expertise and resources for state midstream permitting, planning, and inspection agencies

Staffing and resource issues for DEP are addressed at length in the Core Recommendations. As midstream activity increases, the PUC also should regularly monitor and report on the sufficiency of its resources, staff, and technical capabilities to meet federal and Pennsylvania public safety regulation and inspection requirements for midstream development.

Maintaining the protective adequacy of pipeline safety regulations, especially as larger volume, higher pressure gathering and transmission systems are being constructed

Current Pennsylvania law incorporates federal pipeline safety regulations by reference and enables the PUC to implement them. Any changes to those federal regulations, then, will automatically transfer to Pennsylvania as well. Given this arrangement, Pennsylvania should continue to proactively engage with other states and with the federal government to aid in shaping and strengthening any potential safety updates.

Minimizing and avoiding surface disturbance, forest fragmentation, and other impacts on sensitive ecological areas

Most states, including Pennsylvania, lack regulatory power for the review of intrastate pipeline siting determinations. However, since intrastate lines cannot be sited using eminent domain power, individual property owners can impact siting decisions through easement negotiations with midstream operators. In the absence of state review, multiple avenues are available to the Commonwealth and to operators in minimizing the environmental footprint of midstream infrastructure:

- The Roundtable's proposed modernization of the Oil & Gas Conservation Law could be one of the strongest tools available to the Commonwealth in avoiding surface disturbance and forest fragmentation. The Conservation Law framework is designed to rationalize units and prevent the construction of unnecessary well pads to extract the resource. Fewer pads should translate to less pad-related infrastructure, including gathering lines and access roads.
- DEP and other relevant state and federal regulatory agencies should consider creating a voluntary pre-construction consultation process, wherein developers would have the ability to discuss the proposed placement of new midstream infrastructure, particularly large transmission pipelines, and plans to minimize the impacts of that development. The utility and mechanics of such a process could be one of the discussion points for the second workshop outlined above.
- Ecological impacts also can be reduced through the increased use of siting decision support tools, which some operators already employ to great effect. These tools include mitigation banking and the identification and use of low-impact utility corridors where infrastructure can be clustered to avoid other more sensitive areas.
- The first recommendation in this section, regarding improved efficiency to avoid unnecessary infrastructure, also could be an important method for minimizing the surface footprint of the pipeline system.

Monitoring and responding to the implications of cumulative pipeline placement decisions on the needs of communities and citizens, on the potential for Pennsylvania consumers to use gas produced within the state's borders, and on the future use and value of land

County commissioners and other local government officials, while having limited midstream regulatory power, should be consulted throughout the midstream development process as important partners in protecting public safety and ensuring that operators are aware of and can adapt to local economic, land use, and community plans.

During these consultations, operators and local officials also should review economic development considerations related to pipeline placement. Opportunities may exist for innovative supply approaches along pipeline paths to feed various downstream users of natural gas, oil, and natural gas liquids. In a related vein, midstream operators could have an important role in supporting the expansion of consumer access to affordable natural gas service, particularly in rural and underserved areas.

CONCLUSION

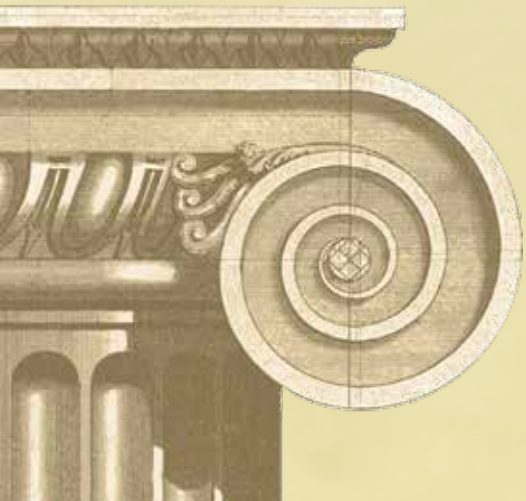
The Roundtable recognizes that enacting these core and focus area (research, conservation and unitization, water, and midstream) recommendations will require serious consideration and action by a broad group of decision makers. Some recommendations will need legislative action for full implementation; others can be addressed through policy or regulatory actions by federal, state, and local agencies; and some can even be voluntarily pursued by regional stakeholders. In most cases, specific Roundtable recommendations identify which actors can pursue implementation.

A primary goal of this report is to inform the ongoing public policy discussion in this region and in the Commonwealth. As such, the Roundtable will continue to share its recommendations with state and federal officials, local civic leaders, and other relevant regional stakeholders to spread awareness of the report's contents and key findings—findings that can assist Pennsylvania in improving environmental, public health, and economic outcomes for local communities impacted by unconventional oil and gas development. ■

Shale Gas ROUNDTABLE:

DETAILED

Deliberations, Findings, and Recommendations



STATUS OF UNCONVENTIONAL OIL AND GAS DEVELOPMENT IN PENNSYLVANIA

Pennsylvania is several years into unconventional oil and gas development – the early years of what some are calling a multi-decade shale energy boom. The regulatory environment is shifting, laws are being updated, and media and public attention are high. The issues related to accessing this resource have become politically and emotionally charged, with a significant amount of misinformation in the marketplace. While shale gas development presents a unique economic and energy opportunity for Pennsylvania and its surrounding states, development of these resources also presents substantial challenges for our region in the areas of water resources management, air quality, infrastructure maintenance, housing, and community quality of life, along with other environmental and public health impacts.

The Marcellus Shale is the most well-known and actively producing formation in the northeastern United States. It underlies a 95,000-square-mile tract from West Virginia through Pennsylvania and into southern New York and includes sections of Ohio, Virginia, and Maryland. The Marcellus Shale ranges from a depth of zero feet in central Pennsylvania to more than 9,000 feet below the surface in parts of southwestern and northeastern Pennsylvania.[1] It ranges in thickness from about 250 feet in eastern Pennsylvania to only a few feet thick in Ohio and is typically about 50 feet thick along the Ohio River.[2] As Table 1 demonstrates, the Marcellus Shale is the largest shale gas play in the United States and is conservatively estimated to contain approximately 84.2 trillion cubic feet (Tcf) of technically recoverable natural gas. The Utica Shale, another Appalachian Basin formation, is currently estimated to be the fifth largest shale gas play in the United States.[3]

Table 1: Top Five Shale Plays in United States[4]

Shale Formation	Location	Shale Gas Resources (Tcf)
Marcellus	PA, MD, NY, OH, WV, VA	84.2
Haynesville	LA, TX	65.7
Eagle Ford	TX	50.2
Shublik	AK	38.4
Utica	PA, OH	37.3

[1] Pennsylvania Department of Conservation and Natural Resources. "Marcellus Shale." http://www.dcnr.state.pa.us/topogeo/econresource/oilandgas/marcellus/marcellus_faq/marcellus_shale/index.htm
[2] Ibid.
[3] U.S. Geological Survey National Assessment of Oil and Gas Resources Team. Map of Assessed Shale Gas in the United States. 2012. http://pubs.usgs.gov/dds/dds-069/dds-069-z
[4] Ibid.

Shale Plays in the Lower 48 States[5]

METHODS FOR PRODUCING UNCONVENTIONAL OIL AND GAS

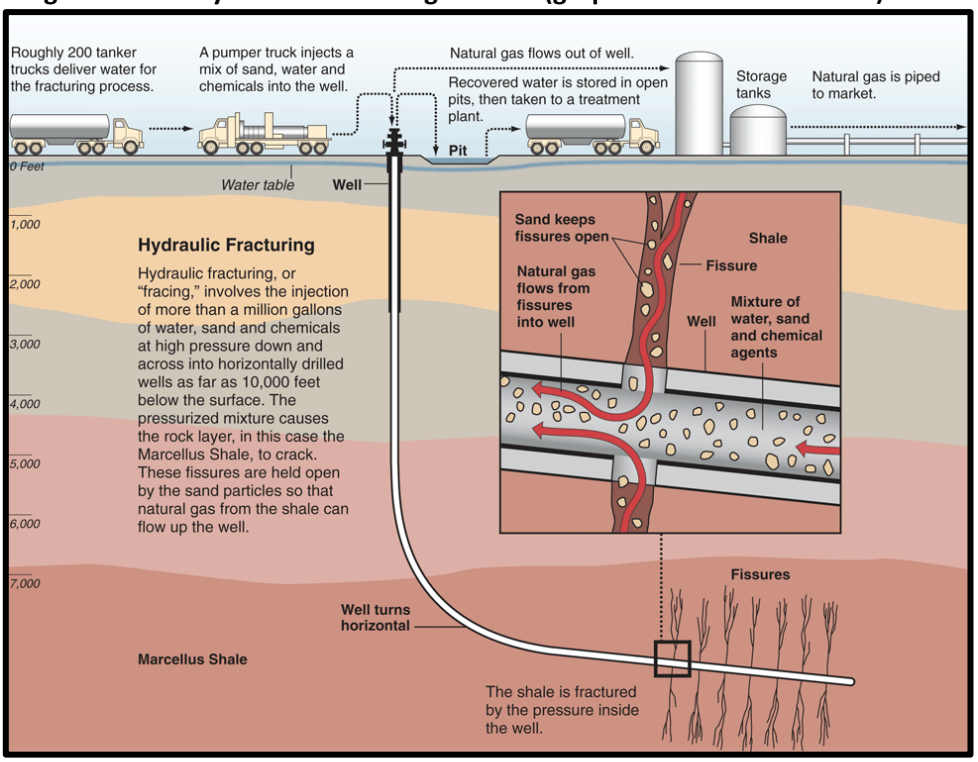
Traditional vertical wells have been drilled into shale for more than 50 years. The wells, although long-lived, have been low producing because of the low permeability and porosity of shale formations as compared to conventional gas reservoirs such as sandstone formations. These shale formations, including the Utica and Burket as well as the Marcellus, are now referred to as unconventional shale resources due to the methods used to produce oil and gas from them.

Unlike conventional gas, shale gas is released from its deep deposits by using multi-well pads, directional drilling, and hydraulic fracturing. Operators drill vertically to the desired depth and then horizontally through the shale layer. This directional drilling capability allows operators to cluster multiple wells on one well pad. Hydraulic fracturing is a well completion technology where first the horizontal portion of the well casing is perforated, typically with explosive charges. A fluid mixture, including fracturing chemicals and sand proppants, is then injected under high pressure to fracture the formation surrounding the perforations. Fracturing fluid contains specially designed chemical combinations to keep the well flowing freely and to prevent the buildup of corrosive materials inside the well bore. The proppants are generally sand, resin-coated sand, or ceramic. After hydraulically fracturing a well, some fluid will flow back to the surface but much of the fluid and proppant remains trapped in the formation,

[5] U.S. Energy Information Administration (EIA). "Lower 48 Shale Plays." May 9, 2011. http://www.eia.gov/oil_gas/rpd/shale_gas.pdf

keeping the fractures open and enhancing gas recovery.[6] Although hydraulic fracturing has been used since the middle of the last century, it was only a decade ago when its coupling with horizontal drilling and use in accessing deep shale deposits were piloted in Texas's Barnett Shale and more recently applied to the Marcellus Shale.

Diagram of the Hydraulic Fracturing Process (graphic not drawn to scale)[7]



OVERVIEW OF PENNSYLVANIA OIL AND GAS ACTIVITIES AND RESOURCES

As of 2011, more than 26 percent of the energy consumed in the United States was produced through the burning of natural gas.[8] As a percentage of total domestic production, unconventional natural gas production has risen steadily from near zero in the 1990s to 23 percent in 2010.[9] Estimates of recoverable U.S. natural gas reserves also have increased, rising by 12 percent in 2010 to 317.6 Tcf, primarily due to advances in directional drilling and hydraulic fracturing technologies that have allowed extraction from previously inaccessible shale-based resources.[10] In 2010, estimates of Pennsylvania's accessible natural gas reserves doubled as a result of the application of these technologies to the

[6] University of Colorado Natural Resource Law Center, Intermountain Oil and Gas BMP Project. http://www.oilandgasbmps.org/resources/fracing.php
[7] Graphic by Al Granberg. "What Is Hydraulic Fracturing?" *ProPublica*/Creative Commons. http://www.propublica.org/special/hydraulic-fracturing-national
[8] EIA. "Energy Perspectives 1949-2011." September 2012. http://www.eia.gov/totalenergy/data/annual/perspectives.cfm
[9] EIA. "U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Proved Reserves, 2010." August 2012. pgs.11 & 20. http://www.eia.gov/naturalgas/crudeoilreserves/pdf/uscrudeoil.pdf
[10] Ibid, pg.2.

Marcellus Shale formation.[11] The increase in Pennsylvania was a significant contributor to the rise in U.S. accessible reserves, accounting for about 20 percent of the overall U.S. increase that year.[12]

From 2002 through 2012, 6,283 unconventional oil and gas wells were drilled in Pennsylvania on more than 2,700 well pads, producing a total of 3.7 Tcf of natural gas.[13] One estimate projects that at least 60,000 wells will be needed to produce oil and gas from just the Marcellus Shale formation by 2030.[14] Approximately 35 percent of the more than 6,000 unconventional drilled wells are located in the 10-county Southwestern Pennsylvania region.[15] In December 2012, all but two of Pennsylvania's 70 operating drill rigs were reported as gas rigs, representing nearly 16 percent of the nation's gas rigs at that time.[16]

In 2012, 57 percent of all wells drilled in Pennsylvania and 90 percent of all wells drilled in Southwestern Pennsylvania were unconventional, though they still cumulatively represented only five percent of the total producing wells in the Commonwealth.[17] Fifty-seven percent of drilled unconventional wells were producing by the end of 2012, accounting for 90 percent of Pennsylvania's total gas production in that year.[18] Please see the Southwestern Pennsylvania Unconventional Oil and Gas Dashboard in Appendix A for more detailed figures on permits issued, wells drilled, rigs in operation, producing wells, and other relevant indicators of oil and gas activity.

OVERSIGHT OF PENNSYLVANIA'S UNCONVENTIONAL DEVELOPMENT

Under the authority of the Pennsylvania Oil and Gas Act, the Commonwealth's Department of Environmental Protection (DEP) is the primary state agency responsible for oversight of unconventional oil and gas development. DEP regulates these activities through its offices of Oil and Gas Management; Water Management; and Waste, Air, Radiation and Remediation. DEP issues permits; regulates water, air, and solid waste impacts; responds to complaints; and enforces compliance with state law and regulations. While DEP oversees most aspects of this industry, the U.S. Environmental Protection Agency (EPA) regulates wastewater pretreatment and underground injection control within the Commonwealth.

Under an extensive 2011 DEP reorganization, the administration created a new Office of Oil and Gas Management led by a deputy secretary. District Oil and Gas Operations (field operations) now report to this office in Harrisburg to ensure consistency in regulation, including permitting, inspections, and compliance activities. The Bureau of Oil and Gas Planning and Program Management also is located in Harrisburg and is an important component of the new office. This bureau is responsible for developing

[11] Ibid.
[12] Ibid.
[13] Kelso, Matt. "Trends in PA Data for Unconventional Wells." *FracTracker.* October 29, 2012. http://www.fractracker.org/2012/10/trends-in-pa-data-for-unconventional-wells. See also Southwestern Pennsylvania Oil and Gas Dashboard in Appendix A.
[14] Johnson, Nels, "Pennsylvania Energy Impacts Assessment."*The Nature Conservancy.* Nov. 2010. pg.13. http://www.nature.org/media/pa/pa_energy_assessment_report.pdf
[15] Summary data from Shale Gas Roundtable Dashboard based on data from Pennsylvania Department of Environmental Protection, Pennsylvania Public Utility Commission, Carnegie Museum of Natural History, Baker Hughes, EnergyDigger.com, and RigData. (see Appendix A)
[16] Ibid.
[17] Ibid.
[18] Ibid.

policy and regulations for the management of oil and gas activity in the Commonwealth. For additional information on the DEP oil and gas regulatory structure and decision making process, please see Appendix D.

Act 13 (House Bill 1950), introduced by Representative Brian Ellis, was the first comprehensive overhaul of Pennsylvania's 1984 Oil and Gas Act. It was signed into law on February 14, 2012. The legislation provides for an unconventional gas well impact fee, the administration of that fee, and the distribution of the subsequent fee revenue. Additionally, the legislation addresses regulation and permitting of the industry, matters related to local zoning, and improved environmental safeguards. DEP is currently promulgating rules that will implement Act 13 through updated Chapter 78 regulations. The DEP Oil & Gas Technical Advisory Board reviewed this rulemaking in early 2013, and the proposed regulations will be examined by the Commonwealth's Environmental Quality Board in August 2013.

Act 13 divides impact fee revenue between state agencies and local governments to offset the impacts of gas drilling on infrastructure and the environment. A fixed amount of the impact fee revenue is first distributed to county conservation districts, DEP, the Pennsylvania Public Utility Commission, the Pennsylvania Fish and Boat Commission, the Pennsylvania Emergency Management Agency, the Office of the State Fire Commissioner, and the Pennsylvania Department of Transportation.[19] Of the remaining revenue, 60 percent is funneled back to the counties and municipalities that are being impacted by drilling and production.[20] The final 40 percent of revenue is allocated for the Marcellus Legacy Fund, which, when combined with fund transfers from the Oil & Gas Lease Fund, is distributed to a variety of areas, including local bridge improvement funds, the environmental stewardship fund (Growing Greener), and PENNVEST, with some additional funding for parks, recreation, and open space.[21] The Public Utility Commission has collected and distributed impact fee revenues for 2011 and 2012. Please see Appendix A for details on these annual disbursements and county-by-county allocations within Southwestern Pennsylvania.

In addition to establishing the impact fee, Act 13 also codified and altered the original Oil and Gas Act and instituted or modified a range of environmental provisions. The legislation increases well setbacks from drinking water sources, requires operators to produce Water Management Plans, enhances hydraulic fracturing chemical disclosure, requires 24 hours of notice to DEP before any critical stage in the drilling process commences, and imposes strict site containment standards. Act 13 also requires more reporting and general information from operators and provides DEP with additional inspection and enforcement powers. The updated environmental provisions went into effect on April 14, 2012.

Pennsylvania has invested substantial effort in improving the management of its unconventional oil and gas development over the last several years, including but not limited to updating water standards for total dissolved solids, increasing permit fees to support regulatory staffing needs, adopting the first comprehensive update of the Oil & Gas Act through Act 13 of 2012, and promulgating updated Chapter 78 environmental regulations to implement Act 13.

[19] Act 13 of 2012, HB 1950 § 2314c.1
[20] Act 13 of 2012, HB 1950 § 2314d
[21] Act 13 of 2012, HB 1950 § 2315a.1

SHALE GAS ROUNDTABLE BACKGROUND

MISSION

In response to the desire of multi-sector high-level leaders to elevate and inform the regional energy dialogue, the Shale Gas Roundtable was created in the fall of 2011 to fulfill a three-part mission related to unconventional oil and gas production, transport, and use:

- Building and sustaining relationships among relevant cross-sector stakeholders and civic leaders to better support diverse regional environmental protection, community quality of life, and economic development goals
- Identifying high-priority focus areas through consensus-building dialogue, extensive research, and shared goals for the region
- Assessing the focus areas and developing ideas and recommendations that promote the improved management of and outcomes from regional unconventional oil and gas development

The principles used to guide the Roundtable's deliberations and activities were:

- Operating with integrity, inclusiveness, and accountability
- Seeking the best possible balance between environmental/community protection and shale gas development/economic growth
- Conducting thorough and objective study of issues
- Seeking the best available data to guide fact-based dialogue
- Incorporating stakeholder input with the help of members
- Working closely with diverse decision makers to seek input and counsel

GEOGRAPHIC FOCUS

The Roundtable's geographic scope included the 10 counties of Southwestern Pennsylvania – Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Lawrence, Indiana, Washington, and Westmoreland. These counties represent approximately one-third of the unconventional oil and gas permits issued, wells drilled, and gas produced in the Commonwealth over the last 10 years. The 10-county Roundtable focus does not imply that unconventional development is only a regional issue. Rather, the region was selected to maintain a manageable geography for frequent in-person member interaction on these issues. The Roundtable recognizes that the state and federal governments will play the largest roles in considering and implementing its recommendations.

ROUNDTABLE MEMBERS AND ROLES

The Roundtable cochairs and staff worked thoughtfully and diligently to assemble a high-level, diverse membership of 26 individuals from relevant, interested constituencies. Roundtable members were recruited to serve because of the unique perspectives and contributions each could bring to the effort. A full listing of Roundtable members can be found on pages 3-4.

In adopting this document, the Roundtable members endorse that the final report was built on constructive dialogue, was informed by sound research and information, and that the included recommendations merit consideration by policymakers at all levels as they seek to effectively and safely manage unconventional oil and gas development.

While the Roundtable has achieved general agreement on the report's value in informing decision makers, individual Roundtable members may not agree on the details of every recommendation. The final report reflects the careful deliberations and findings of the Shale Gas Roundtable; it does not necessarily reflect the views of the members' affiliated organizations or of the Institute of Politics.

ROUNDTABLE STAFF SUPPORT

The Shale Gas Roundtable was housed at and staffed by the Institute of Politics at the University of Pittsburgh. The Institute is not an advocacy or a public education organization; it is a nonpartisan entity responding to critical regional needs as defined by its policy committees. The Institute of Politics, through neutral facilitation and unbiased research, establishes productive frameworks for diverse high-level stakeholders to develop, discuss, and evaluate policy ideas and options.

The Institute of Politics staff team did not have a predetermined outcome in mind or established policy agenda for the Shale Gas Roundtable. Instead, the staff provided any necessary services as the Roundtable members collectively determined their own direction, process, and recommendations. The activities of the Shale Gas Roundtable and the services of the Institute of Politics were generously supported by the Pittsburgh Foundation, the Heinz Endowments, and the Richard King Mellon Foundation.

BUILDING A COMMON UNDERSTANDING (2011-12)

The inaugural meeting of the Roundtable was held in September 2011. Agenda items included the development of a work plan, an overview of shale gas development in the region, and an in-depth discussion of goals and interest areas. The resulting work plan was implemented over the subsequent six months and included the following:

- Conducting an extensive literature review of laws, policies, regulations, scientific studies, and advocacy materials related to unconventional oil and gas development in the region
- Investigating and summarizing benchmark information from other oil and gas producing states
- Interviewing relevant multi-sector leaders in Harrisburg and Washington, D.C.
- Continuing outreach to individual Roundtable members and to key stakeholders in Southwestern Pennsylvania to collect as much information as possible about regional unconventional oil and gas development
- Implementing a "Shale Gas University" to allow Roundtable members to participate in shared learning experiences. Educational modules featured expert guest speakers on topics ranging from water management to utility regulation to the full life cycle of natural gas production, transport, and use. Also included were field tours of a compressed natural gas fueling station, a centralized water treatment facility, a drilling site, and areas of the region most impacted by oil and gas development. The Shale Gas University sessions also provided opportunities for relationship building and education on critical issues and were held as needed throughout the entire course of the Roundtable's work.
- Meeting regularly to share the findings and results from the above activities

In late 2011, after completing the literature review, staff conducted benchmarking trips to Colorado, Ohio, New York, Texas, and West Virginia. Information-seeking trips to Harrisburg and Washington, D.C. also were completed during this time. Over the course of 120 meetings in these locations, staff gathered insights from environmental organizations, industry associations, landowner groups, researchers, and regulators and elected officials from the local, county, state, and federal levels. Staff also continued ongoing outreach to individual Roundtable members and to key stakeholders in Southwestern Pennsylvania to collect as much information as possible about unconventional oil and gas development. While the specific context certainly varied, staff found that a common set of issues were on the minds of interviewees in the six states (PA, NY, WV, OH, TX, and CO), including the following:

Community

- Deterioration of local roads and other infrastructure
- Housing availability for industry workers and local citizens
- Noise, light, and other nuisance issues for local communities
- Public health impacts, particularly in rural areas
- Tensions between surface and mineral rights owners

Economic

- Boom-and-bust natural resource extraction cycles and their impacts on communities
- Conversion of vehicle and other engines to run on natural gas and the related necessary construction of a fueling infrastructure
- Creating opportunities for the use of natural gas in local markets
- Job creation and opportunities for new small businesses
- Possibilities for attracting new industries in areas such as petrochemicals and manufacturing
- Workforce development needs to position local workers for jobs in the industry

Environmental

- Absence of baseline environmental and public health monitoring and data
- Acute and cumulative impacts on water and air quality
- Avoiding waste in oil and natural gas development through avoiding the stranding of resources through inefficient practices
- Disposal of drill cuttings and the possibility of problems associated with normally occurring radioactive materials (NORM)
- Induced seismicity from underground injection wells
- Land reclamation, mitigation banking, and bonding requirements
- Need for updated erosion and sedimentation rules to account for new practices
- Siting, stability, and safety of flowback water pits and impoundments
- Surface disturbance from pad, road, and pipeline construction
- Requirements for setbacks from houses, water sources and other important areas
- Underground methane migration
- Water quantity concerns based on the volume of water used in hydraulic fracturing
- Well casing and cementing requirements
- Wildlife and ecosystem protection

Regulatory

- Accountability of operators' subcontractors
- Adaptability of regulation to evolving technology and operations
- Capacity of local governments and counties to have adequate numbers of trained staff for functions such as the clerk of courts and department of emergency services
- Fracturing chemical disclosure
- Inadequacy of staffing and budget resources for state regulatory agencies
- Lack of basic science and data upon which to base sound regulation and policy
- Lack of tools for large-scale comprehensive development planning
- Local and state severance taxes, impact fees, and other revenue streams
- Need for improved communication among government, industry, and key stakeholders
- Role of local, state and federal governments in regulation and monitoring
- Unitization, spacing, conservation, and integration rules for the efficient development of oil and gas

"GETTING IT RIGHT" FRAMEWORK AND RECOMMENDATIONS DEVELOPMENT (2012-13)

The economic benefits of unconventional resource development are often described as worthwhile as long as that development is done right. Roundtable members agree, but "done right" often is not well-defined. Through extensive review and in-depth discussion of the data that resulted from the activities outlined above, the Roundtable concluded that the necessary ingredients for a "getting it right" framework are:

- a strong, adaptive legal and regulatory system with adequate implementation staff and resources;
- aggressive development and industry adoption of best management practices and other operational performance standards;
- investments in technological and operational innovation; and
- carefully targeted and balanced research to inform the continual improvement of statutes, regulations, best management practices, standards, and technology.

If Pennsylvania and its surrounding states pursue excellence in these four areas, the Appalachian Basin could serve as a national model for getting unconventional upstream, midstream, and downstream development right. Specifically, the Roundtable believes that Pennsylvania could best implement this framework by aiming progress at three interrelated goals:

- Minimizing the acute and cumulative impacts of oil and gas activity on the environment, public health, and local communities
- Minimizing surface disturbance from oil and gas activity and maximizing the efficiency of resource recovery and transport
- Enhancing the regional use of natural gas and supporting opportunities for regional economic growth based on the full natural gas value chain

In early 2012, the Roundtable agreed that its attentions would best be concentrated in the legislative, regulatory, and research aspects of this framework. This decision was based largely on the degree to which other organizations and efforts were already focused on creating best management practices and driving innovation. (For more information on the development of best practices, see the Survey of Standards in Appendix E.)

The Roundtable's framework is consistent with an August 2011 report of the U.S. Secretary of Energy Advisory Board's Shale Gas Production Subcommittee.[22] The subcommittee was convened by then Secretary of Energy Steven Chu at the direction of President Barack Obama and was tasked with identifying immediate steps that could be taken to improve the safety and environmental performance of shale gas development.

The subcommittee issued recommendations in four key areas:

- **Make information about shale gas development more accessible to the public:** Recommendations in this area included disclosing all chemicals used in fracturing fluid, creating a comprehensive national clearinghouse of all public information related to shale gas, and providing government funding to support existing multi-stakeholder mechanisms such as the Ground Water Protection Council's Risk Based Data Management System and the State Review of Oil and Natural Gas Environmental Regulation (STRONGER).
- **Develop immediate and long-term actions to reduce environmental and safety risks of shale gas development:** Recommendations in this area placed an emphasis on the protection of air and water quality and included designing measurement systems to collect comprehensive air emissions data from shale gas operation sites; taking measures to reduce emissions of air pollutants, ozone precursors, and methane as well as developing national standards to reduce emissions of all air contaminants; encouraging federal interagency collaboration to collect and analyze the overall greenhouse gas footprint of the shale gas industry over its entire life cycle in comparison to that of other fuels; the adoption of a systematic approach to water management that includes consistent measurement and public disclosure; and adopting requirements for the baseline testing of methane levels in water reservoirs and wells in close proximity of drill sites prior to drilling activity.
- **Create a shale gas industry operations organization:** The subcommittee recommended that industry take a more comprehensive and systematic approach to improving the techniques and methods used in the field in order to continually improve their best operating practices.
- **Utilize research and development to improve safety and environmental performance:** The report suggested that the federal government can and should play a role as it relates to the shale gas industry by setting up a research and development mission and appropriate funding level, with a focus on the efficient use of water and other important areas to meet environmental objectives.

[22] Natural Gas Subcommittee of the Secretary of Energy Advisory Board. "August 18, 2011 90-day Interim Report." http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf

In November 2011, members of the subcommittee released an updated report that prioritized the included recommendations and clarified which actors could implement each recommendation.[23]

With the above framework and goals in mind, the Roundtable decided to select a small number of areas for comprehensive exploration and focused recommendations. After deliberatively considering more than 30 potential areas, the members prioritized four areas for targeted attention:

Policy-relevant research: increasing the amount and enhancing the perception of research on the impacts of unconventional oil and gas development and ensuring that the resulting knowledge is used for the improvement of regulations and best practices

Conservation and unitization: developing a balanced proposal for modernizing the 1961 Pennsylvania Oil and Gas Conservation Law to account for modern technologies and approaches, limit surface disturbance, avoid wasted oil and gas resources, and move toward uniform conservation rules for all unconventional shale formations

Water management: protecting water resources through identifying improvements in management and regulation in the areas of water sourcing, hydraulic fracturing chemical disclosure, erosion and sedimentation, impoundments, vehicle traffic for water transport, wastewater treatment and disposal, groundwater protection, water related violations, regional water management, and water monitoring

Midstream development (pipelines and related infrastructure): developing recommendations that minimize the environmental and surface footprints of midstream construction, improve pipeline safety, enhance coordination and planning of siting decisions, and provide increased opportunity for economic and community development

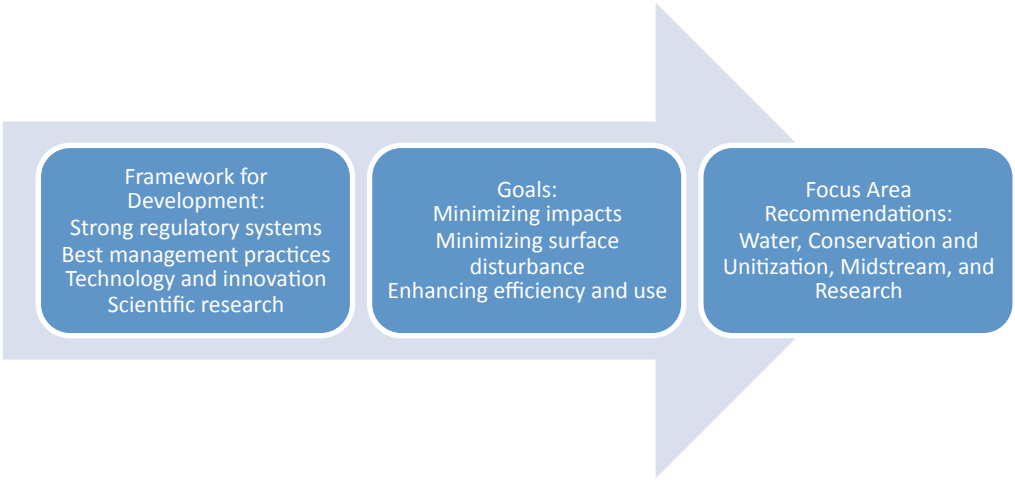
The remainder of this report contains extensive background information and recommendations for each of these four areas along with a set of core recommendations that emerged from the Roundtable's discussions. As described above, the included recommendations were crafted using a thorough and deliberative process to prioritize and address critical issues for Southwestern Pennsylvania.

The Roundtable recognizes that enacting these core and focus area (research, conservation and unitization, water, and midstream) recommendations will require serious consideration and action by a broad group of decision makers. Some recommendations will need legislative action for full implementation; others can be addressed through policy or regulatory actions by federal, state, and local agencies; and some can even be voluntarily pursued by regional stakeholders. In most cases, specific Roundtable recommendations identify which actors can pursue implementation.

[23] Natural Gas Subcommittee of the Secretary of Energy Advisory Board. "November 18, 2011 Final Report." http://www.shalegas.energy.gov/resources/111811_final_report.pdf

A primary goal of this report is to inform the ongoing public policy discussion in this region and in the Commonwealth. As such, the Roundtable will continue to share its recommendations with state and federal officials, local civic leaders, and other relevant regional stakeholders to spread awareness of the report's contents and key findings – findings that can assist Pennsylvania in improving environmental, public health, and economic outcomes for local communities impacted by unconventional oil and gas development.

Shale Gas Roundtable Recommendations Development Process



CORE ROUNDTABLE RECOMMENDATIONS

Through examination of the four focus areas and through its comprehensive research and dialogue process, the Roundtable also identified a set of broader, overarching recommendations that fit within its framework:

The Commonwealth of Pennsylvania should increase investments in improving the accuracy, functionality, and transparency of its oil and gas data infrastructure. The Pennsylvania Department of Environmental Protection (DEP) should publicly commit to substantial investments in data and information technology infrastructure, possibly using impact fee revenues. The Commonwealth has made significant progress in its management of oil and gas data over the last several years, but additional investments in innovation and data transparency and utility are necessary. In order to support these data improvements, DEP is encouraged to leverage existing university and private sector data management expertise in the Commonwealth. The Roundtable also suggests that the General Assembly consider legislation requiring more frequent industry data reporting (e.g., monthly rather than biannual production data) and instituting stronger requirements for timely and accurate filing of required data by industry. The Roundtable urges DEP to model its oil and gas regulatory data infrastructure on the Risk Based Data Management System (RBDMS).[24] RBDMS was developed in 1992 by the Groundwater Protection Council and is currently used by 22 regulatory agencies across the country. The system is regularly updated based on state feedback and facilitates streamlined collaboration among states on oil and gas issues. While Pennsylvania previously attempted to use this data platform and determined that it could not be effectively adapted to existing state systems, DEP could benefit from modeling its data infrastructure on RBDMS. Increased investment in user-friendly, accurate, and real-time systems will improve the efficiency of department-industry interactions, enhance research and data analysis capabilities, facilitate public access to information, and build public trust.

The Commonwealth should develop regulatory staffing parameters and oil and gas annual reports. Since 2008, well permit applications have increased nearly six-fold, with a corollary growth in oil and gas staff from 64 in 2004 to 202 employees today.[25] As DEP moves forward, it should now develop publicly available parameters for relevant staffing measures (possibly including minimum inspector-to-well ratios, frequency and number of well inspections, time frame required for permit review and action, expectations for timely responses to public and stakeholder complaints and inquiries, and other critical metrics). These parameters should be transparently developed and based on requirements in the Oil & Gas Act, benchmarks against other states, comparisons with regulatory best practices, and diverse stakeholder input. While some suggest that DEP is adequately staffed to manage unconventional oil and gas development, diverse stakeholders report continued concern about DEP's limited resources and the

[24] Groundwater Protection Council, Risk Based Data Management System: http://www.gwpc.org/programs/rbdms
[25] DEP. "3-Year Oil and Gas Regulatory and Program Cost Analysis Report to the EQB." pg.2. http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/OilGasReports/2012/TAB%20MEETINGS/APR232013/2013-04-23_Three_Year_Report_to_Oil_and_Gas_TAB_-_Final.pdf

resulting impact on environmental protection. DEP also should report annually – and publicly – on its oil and gas activities, including information about the prior year's progress and priorities for the upcoming year. The inclusion of transparent staffing parameters in this annual report would provide a clearer picture of DEP's additional staffing needs, if any, and demonstrate its continued ability to fully implement the state's oil and gas regulations, including Act 13/Chapter 78 provisions.

The Commonwealth should restructure the Oil and Gas Technical Advisory Board. While most DEP advisory committees are diverse and provide opportunities for cross-sector dialogue on policy and technical issues, the existing Oil and Gas Technical Advisory Board (TAB) has five members, all with geologic and petrochemical backgrounds and most with industry ties (this structure is statutorily mandated in the current PA Oil & Gas Act).[26] As DEP moves forward with Chapter 78 rulemaking to implement Act 13, the absence of a diverse regulatory committee to support oil and gas staff activities, to evaluate/generate ideas, and to inform the Environmental Quality Board's decision making is a notable deficiency. (For additional information on the TAB and the overall Pennsylvania regulatory process, please see Appendix D.) The TAB should be diverse in terms of geography, expertise, stakeholder representation, and political affiliation. Ideally, TAB members should continue to be unpaid volunteers and should be appointed to staggered four-year terms by the Governor. A sample seven-member composition could include three with substantial oil and gas experience (at least two of these with an undergraduate degree in petroleum geology or petroleum engineering); one local county/municipal official; one with substantial environmental protection experience; one with substantial conservation, ecology, or reclamation experience; and one engaged in agricultural production. At least one of the seven members also should be a royalty owner, and a maximum of four members should be from the same political party. The administration and the legislature should expand the Advisory Board's scope beyond technical issues and diversify the membership at the earliest possible time.

The Commonwealth should continue to regularly evaluate the ability of existing budget support and permit fees to support oil and gas regulation. As the administration and the legislature consider future DEP budgets, they should regularly evaluate the ability of budget support and permit fees to adequately support DEP oil and gas operations. Currently, the oil and gas program is funded by a combination of new permit fees, impact fee revenue, fines, and civil penalties. With current low natural gas prices and slowed drilling, it is unclear if new permit fees will be able to sustain the necessary oil and gas regulatory staffing level. In 2009, DEP adopted a rulemaking that, for the first time in 25 years, increased the well permit fee from a flat $100 to a sliding scale based on the length of the well bore.[27] The average fee for an unconventional well over the last four years was $3,200.[28] That same 2009 rulemaking also required DEP to review the adequacy of permit fees every three years and submit this evaluation to the Environmental Quality Board. The first of these triennial reports was prepared in early 2013, and it indicated a need for additional funding support for the oil and gas program.[29] Specifically, the report

[26] DEP Technical Advisory Board: http://www.portal.state.pa.us/portal/server.pt/community/oil_and_gas_technical_advisory_board_%28TAB%29/18260
[27] DEP. "3-Year Oil and Gas Regulatory and Program Cost Analysis Report to the EQB."pg.1.
[28] Ibid.
[29] Ibid. pg.3.

suggests that DEP should abandon the well bore length fee schedule and adopt a flat fee of $5,000 for horizontal unconventional well permits and $4,200 for vertical unconventional well permits.[30] Conventional wells would retain the sliding scale adopted in 2009.[31] The 2013 review and future versions will be particularly helpful to the legislature, the governor, and the public in gauging funding requirements for oil and gas regulatory activities. In order to help defray the costs of ongoing compliance inspections, the General Assembly could consider enabling DEP to establish an annual permit fee for active wells, such as those used in other state environmental permitting areas.

The Commonwealth should participate in regular, comprehensive STRONGER reviews. DEP should regularly participate in State Review of Oil and Natural Gas Environmental Regulations (STRONGER) reviews in order to benefit from independent assessments of the state's oil and gas regulations and to identify opportunities for additional improvement.[32] Pennsylvania has led by example through its previous STRONGER participation, including the completion of a review in 2009 that focused on its hydraulic fracturing regulations. Indeed, a more comprehensive and up-to-date STRONGER review already is underway in 2013-14, and it may take into account proposed regulations based on Act 13.

The federal government, state government, and stakeholder groups should support efforts to increase balanced research on and rigorous monitoring of the possible impacts of unconventional oil and gas development. The federal and state governments and all stakeholder groups should support efforts to increase the amount of balanced research on and robust monitoring of the possible acute and cumulative environmental, economic, ecological, and public health effects of unconventional oil and gas development. The Roundtable's recommendation for an independent research fund represents a particularly compelling opportunity for progress in the understanding of oil and gas development impacts.

Government, industry, and regional universities should support NETL as the premier national unconventional oil and gas technology research hub and, through NETL, continue to advance technology and operational innovations. The Appalachian Basin states are well-positioned to lead on oil and gas technology and operational innovations with the excellent capabilities of local research universities and with the U.S. Department of Energy's National Energy Technology Laboratory (NETL) and its Regional University Alliance, which are headquartered in Southwestern Pennsylvania.[33] The federal and state governments, along with diverse stakeholders throughout the basin, should seek stronger relationships with NETL and support NETL's critical national role in research and technology development. This enhanced government and industry partnership, through NETL, should continue to focus on innovations that diminish the environmental risks of unconventional resource extraction, transport, and use.

DEP should strengthen engagement with and support of various cross-sector and industry efforts to develop Best Management Practices. DEP should continue its engagement with and support of various

[30] Ibid.
[31] Ibid.
[32] State Review of Oil and Natural Gas Environmental Regulations: http://www.strongerinc.org
[33] U.S. Department of Energy National Energy Technology Laboratory: http://www.netl.doe.gov. Regional University Alliance: http://www.netl.doe.gov/rua

multi-stakeholder and industry efforts to develop best management practices (BMPs) and high-level performance standards. As appropriate, these practices and standards should be considered for incorporation into future revisions of relevant regulations and guidance documents to ensure continual improvement of industry operations.

If implemented, these core recommendations will strengthen Pennsylvania's ability to effectively and safely manage unconventional oil and gas development.

UNCONVENTIONAL OIL AND GAS RESEARCH FUND PROPOSAL

This recommendation was designed to strengthen research on the impacts of unconventional oil and gas development and use – and to ensure that the resulting knowledge is used for the improvement of regulations and best practices.

The Roundtable started with a set of assumptions regarding the relative lack of shale gas research given the size of the need, the perception that some research already underway or completed is biased, and the existence of gaps between research and the information needs of policymakers. During the summer and fall of 2012, the Roundtable validated these assumptions through a higher education survey, a literature and media review, and stakeholder outreach and interviews.

While exploring the assumptions, the Roundtable also investigated potential models for overcoming barriers to improved and expanded shale gas research activity. The Health Effects Institute (HEI), a nonpartisan research organization that has supported balanced air quality research for more than 30 years, was identified as the most relevant model that could address the particular challenges of shale gas research. Several discussions were held with HEI, including multiple visits by its senior leadership team to Pittsburgh.

Based on its work and deliberations, the Roundtable believes that substantial benefit can be secured through the creation of a scientifically rigorous, third-party entity with diverse funding streams that can support unconventional oil and gas research to inform sound regulatory and legislative decision making. This proposal describes the recommended characteristics of the research fund, suggests that the region continue to rely on the counsel of HEI in the replication of its model, and outlines a preliminary high-level implementation strategy.

SHALE GAS RESEARCH NEEDS: VALIDATING THE ROUNDTABLE'S ASSUMPTIONS

Shale gas development is complex and multi-faceted, with economic, environmental, public health, social, and technological components. Robust and trustworthy research should be one of the critical ingredients in decision making by the state and federal governments and other important stakeholders. Southwestern Pennsylvania is particularly well-suited to answer the call for additional research given its number of higher education institutions with active interest in shale gas and with relevant capabilities.

The Roundtable made three assumptions about the nature and adequacy of ongoing shale gas research:

1. While substantial research has been completed or is underway, the amount of research activity on shale gas is lacking relative to the knowledge needs of policymakers and the public. Further, this mismatch between needs and actual research is likely due to a dearth of funding.

2. Research that has been completed or is underway often is perceived as biased due to the funding source or review processes used.
3. Research has not been well aligned with the information or timing needs of regulatory staff, elected decision makers, or other civic leaders.

The Roundtable endeavored to validate these assumptions by using various tools and approaches, including a higher education survey, interviews with key government policymakers, outreach to relevant stakeholders, and media/literature reviews.

Existing Research Efforts – The Roundtable designed and distributed a research survey to university and college presidents in August 2012. The surveyed institutions included all colleges and universities in the 10-county Southwestern Pennsylvania region along with other institutions, such as Cornell University, West Virginia University, Ohio State University, Pennsylvania State University, the University of Pennsylvania, and Virginia Tech. The survey was designed to gauge the level of ongoing shale gas research, identify barriers to increased research, and capture potential untapped research capabilities. The survey questions and a summary of responses are included in Appendix B.

Fifty-two faculty and staff members from 18 higher education institutions (out of 37 institutions surveyed) responded to the survey. The results indicate the following:

- Substantial and relevant research is ongoing, but capabilities are under-utilized; multiple important shale areas may not be receiving adequate attention.
- Research collaboration among universities inside and outside the region has occurred, and such partnerships are likely to increase.
- Most research by Pennsylvania institutions has focused on Pennsylvania; however, multi-state research that reflects the broader extents of the Marcellus and Utica formations is increasing.
- Two large research barriers are the availability of and access to accurate data and difficulties in forming effective partnerships with industry and government.
- The largest challenge to previously completed research and to enhancing future research is the overall lack of funding support. Respondents are concerned about accepting funds directly from industry or other shale gas stakeholder groups.
- Research results are increasingly being prepared for peer-reviewed publication.
- The emphasis has not been on sharing research outcomes with the public or with decision makers, though this has begun to shift more recently.
- Diverse faculty beyond the traditional engineering and public health disciplines are interested in shale gas research.

Accusations of Bias – Reviews of media coverage indicate a significant number of bias accusations in shale gas research. The results of high-profile projects at a number of higher education institutions nationally and in Pennsylvania have been labeled as biased due to being supported or initiated by a particular sector. Research conducted by some industry trade associations and environmental organizations also has been criticized in this regard. The Roundtable is not in a position to evaluate the validity of bias claims or to rule on the scientific rigor of research studies. However, the presence of

numerous bias storylines in the national and regional media does substantiate the perceived bias concern in the second assumption.

The Intersection of Research and Policy/Regulation/Best Practices – Governor Tom Corbett's Marcellus Shale Advisory Commission recognized the potential value of state government support for various types of shale gas research in its final report recommendations 9.2.37 and 9.4.11:

> *9.2.37*
> *The Department of Health should work in partnership with the Commonwealth's graduate schools of public health and other appropriate medical institutions to better protect and enhance the public health interests of citizens, such as through the establishment of the population-based health registry and curriculum development.*

> *9.4.11*
> *Academic research efforts across the Commonwealth, including initiatives such as SAFER (Shale Alliance for Energy Research), the Ben Franklin Technology Partners' Shale Gas Innovation and Commercialization Center and others, should be marshaled to focus academic-supported efforts on needs such as research and development, business start-up incubation and seed-capital start-up assistance.*

Based on a presidential Executive Order in April 2012, the federal government established the Interagency Steering Committee consisting of the U.S. Environmental Protection Agency (EPA), Department of Energy (DOE), and Department of Interior (DOI) to determine collective unconventional oil and gas research priorities. Their resulting memorandum of understanding explains the partnership:

> *The DOE, DOI, and EPA will identify research priorities and collaborate to sponsor research that improves our understanding of the impacts of developing our Nation's unconventional oil and gas resources and ensure the safe and prudent development of these resources. Through enhanced cooperation, the Agencies will maximize the quality and relevance of this research, enhance synergies between the Agencies' areas of expertise, and eliminate redundancy.*

In January 2013, it was announced that the U.S. Department of Health and Human Services was joining the steering committee as an informal advisory member. The Interagency Steering Committee is expected to release its federal research plan for public comment in 2013. The Roundtable engaged, as appropriate, in the interagency process and anticipates interest from the federal level in additional shale gas research efforts in this region.

Through multiple conversations with elected officials and legislative/executive/regulatory staff at the state and federal government levels, the Roundtable secured additional beneficial perspectives about research needs and the use of shale gas research. Interviewees expressed general support for additional research but also shared four specific concerns:

- While public health and environmental impacts need to be investigated, many fear heavy-handed research methods in shale gas development areas. Several interviewees expressed a

strong desire for populations living in shale gas areas, particularly rural populations, to be treated with dignity and respect and not as "test subjects." Research methodologies will require careful attention.

- Researchers need to place particular emphasis on sharing research findings with policymakers and on the accurate translation and explanation of research outcomes, particularly on technical projects. A frequently cited example was a study on underground fluid migration pathways. Interviewees noted that the research conclusions appeared to vary depending on the newspaper reporting on them.
- Multiple research efforts are getting underway, and efforts should be made to avoid duplication. For this reason, the Roundtable will continue to engage with possible collaborators. The research fund is not designed to supplant or control other existing efforts but rather to complement and strengthen them. In particular, the Roundtable believes there will be synergies with the innovative technology research conducted by the National Energy Technology Laboratory and its Regional University Alliance.
- Elected officials expressed frustration about the lack of scientific guidance on the issues they have examined. However, they also recognized the difficulty of peer-reviewed rigorous research that aligns with legislative schedules. Several interviewees suggested that research will be more appropriately aimed at regulatory decision makers in the short-term while strategic longer-term research investments could impact legislative actions. Interviewees also suggested that research could help to inform the efforts of non-governmental organizations that are focused on developing and improving best practices.

Funds originally slated for research investment from the impact fee revenue were ultimately removed from Act 13 due, in part, to the concerns noted above. Recent state legislative proposals include the creation of a shale gas health advisory panel and the redirection of some impact fee revenues to public health research.

Interviewees at both the state and federal levels expressed a desire to stay informed and involved in discussions about improving and increasing shale gas research efforts.

MODEL RESEARCH ORGANIZATIONS

While the above activities were underway, the Roundtable also investigated possible "boundary organization" models to address research needs. Boundary organizations are funding and/or administrative intermediaries that operationally and functionally reside at the intersection of multiple interested constituencies (in this case, the natural gas industry, government, environmental organizations, academia, and the public).

Most potential models proved to be inadequate to overcoming the particular barriers of enhanced shale gas research. For example, the National Water Research Institute, Water Environment Federation, and Electric Power Research Institute fund high-quality respected research in the areas of water supply, water quality, and electric power, respectively. However, their research agendas are largely determined and funded by their industry members, with some augmentation from other funding sources. If these models were used for shale gas research, the bias issue would largely remain.

In other instances, the federal or state governments have supported enhanced use of ongoing research on a given topic. For example, the Decision Center for a Desert City at Arizona State University is funded by the National Science Foundation to support the translation, sharing, and use of significant climate change research that is being conducted at that university. While use of the research is an issue in the shale gas arena, the current level of research probably could not be defined as sufficiently robust and merely in need of distribution.

These models and others were useful for informational purposes, but none provided a comprehensive model framework for shale gas research. The one exception, however, was the Health Effects Institute (HEI) based in Boston. Multiple constituencies suggested HEI as an ideal model for the Roundtable's consideration. The Roundtable researched HEI's structure, history, and activities and conducted several interviews with HEI senior staff. The HEI website provides a succinct overview of the organization (www.healtheffects.org):

> *HEI is a nonprofit corporation chartered in 1980 as an independent research organization to provide high-quality, impartial, and relevant science on the health effects of air pollution. Typically, HEI receives half of its core funds from the US Environmental Protection Agency and half from the worldwide motor vehicle industry. Other public and private organizations periodically support special projects or certain research programs.*
>
> *To accomplish its mission, HEI*
>
> - *Identifies the highest priority areas for health effects research;*
> - *Funds and oversees the conduct of research projects;*
> - *Provides intensive independent review of HEI-supported and related research;*
> - *Integrates HEI's research results with those of other institutions into broader evaluations; and*
> - *Communicates the results of HEI research and analyses to public and private decision makers.*
>
> *To this end, HEI has funded over 250 studies in North America, Europe, and Asia that have produced important research to inform decisions on carbon monoxide, air toxics, nitrogen oxides, diesel exhaust, ozone, particulate matter, and other pollutants. The results of all endeavors have been published in over 200 Research Reports and Special Reports. At the urging of the World Health Organization and countries throughout the world, HEI has extended its international research to help inform air quality decisions in Europe, Asia, and elsewhere.*
>
> *An independent Board of Directors consists of leaders in science and policy who are committed to the public–private partnership that is central to HEI. The Health Research Committee works with scientific staff to develop the Five-Year Strategic Plan with input from HEI's sponsors and other interested parties, select research projects for funding, and oversee their conduct. The Health Review Committee, which has no role in selecting or overseeing studies, works with staff*

to evaluate and interpret the results of funded studies and related research. All project results and HEI Commentaries are widely communicated through HEI's home page, Annual Conferences, publications, and presentations to legislative bodies and public agencies.

A third committee, the Special Committee on Emerging Technologies, advises HEI on new technologies and fuels, and their potential health and environmental impact. Its membership was selected to provide a broad range of technical expertise from government, industry, public interest, and academic organizations.

Examination of this model proved to be useful. In particular, several visits by HEI's senior management team to Pittsburgh were critical to informing the Roundtable and advancing this proposal. During the visits, HEI representatives were able to interact with Roundtable members, foundation and civic leadership, and representatives of regional higher education institutions.

PROPOSED FRAMEWORK FOR THE SHALE GAS RESEARCH FUND

The Roundtable – based on the demonstrated need for additional balanced research, the investigation of models, stakeholder input, and other information gathered – recommends that a fund be created to support rigorous and enhanced research to guide shale gas development.

Characteristics of the Shale Gas Research Fund

- **Diverse funding streams**. State and federal governments, industry, and private philanthropy will be asked to contribute to a unified fund. These contributions will support the overall research agenda and cannot be directed to individual projects. Ideally, funders would make three-to-five-year commitments in alignment with the strategic planning cycle, with each funding sector contributing an equal amount. Other stakeholders that may be unable to contribute will still be consulted on an ongoing basis. Increased, multi-sector, multi-year funding will help to address the overall amount of research completed and the perceived bias of that research. Full disclosure of funding sources and amounts will be required.
- **Regularly updated multi-year strategic research plan**. Research priorities in the plan will be based on diverse input, from funders and non-funders, and designed to inform regulatory and legislative decision making at the state and federal levels.
- **Scientifically rigorous**. Research funding will be competitively awarded and research products intensely reviewed – both using peer-review protocols. While such processes do slow research, the gains in perceived trustworthiness and rigor are worth the slightly slower output. Given the ongoing national challenges in shale gas research, researchers have recently reported an emerging difficulty in recruiting a sufficient number of qualified peer reviewers. A funding structure, such as the one proposed here, may help to increase the attractiveness for researchers who consider serving in this capacity.
- **Transparency.** Ethical and transparent operations will be essential to gaining the trust of diverse audiences. Given the heightened media and public attention to shale gas issues, the fund will need to make substantial preparations for transparent, effective communication regarding the strategic priorities and the meaning of research outcomes. Methodologies that respect the local populations and offer opportunity for their active participation will be preferred.

- **Strong government and stakeholder relationships.** The research fund will need strong relationships with industry, environmental organizations, the federal government, and all state governments in which it operates.
- **Supports informed policy and practice based on state-of-the-art science.** Research supported by the fund will not make direct policy recommendations. Rather, emphasis will be placed on translating and communicating research results in a timely manner in order to inform legislative/regulatory decision making and best practice improvements. Pennsylvania Senate President Pro Tempore Joseph Scarnati has introduced Senate Bill 555, which would establish the Health Advisory Panel on Shale Gas Extraction and Natural Gas Use. Should that legislation be enacted, the Health Advisory Panel could be a potential partner in helping to identify research needs and a natural recipient of the resulting findings.
- **Able to synthesize available shale gas research.** In addition to funding original research, this effort can, at the request of policymakers, provide additional value by synthesizing high-quality completed research or aggregating existing data on a given topic. This approach could help with timeliness concerns. For example, if a West Virginia legislator requested information on a given topic and there was a lack of time to commission original work, the fund could consider supporting a synthesis of the available research in the short term.
- **Adequacy of funding support and staffing**. It is estimated that $4-7 million per year will be necessary to meet reasonable expectations of success (though less funding may be sufficient in the startup phase and, if the effort is successful, substantially more funding could be gainfully invested in additional, valuable research). Funding structures could include an endowment to decrease the ongoing fundraising burden. This level of funding over a full strategic plan cycle could support multiple, large research projects and assorted smaller original research and synthesis efforts. The Roundtable estimates that five to seven administrative, scientific, and external relations staff members will be needed for full implementation. Every effort will be made to minimize overhead costs and maximize funding for research. For comparison, the Health Effects Institute operates its national air quality research efforts with approximately $10 million annually and 25 staff members.

In combination, these characteristics will help the research fund to maintain its ability to be nimble and responsive to the constantly evolving natural gas arena while being deliberative, strategic, and scientifically rigorous.

Geographic Scope

The Roundtable identified three facets of geography for this effort:

1. From which geographic territory should the funding be drawn?
2. In which geographic territory should the research activities be directed?
3. From which geographic territory would the fund draw eligible researchers/applicants?

These questions could conceivably be answered differently, and the options could include the 10-county region, Pennsylvania, the Marcellus Shale area, or the nation. However, interviewee input and Roundtable deliberations made it clear that answering all the questions in the same manner would

avoid confusion and give the effort more consistency. The selection of the uniform answer is a more complicated issue. On one hand, a regional or Pennsylvania-specific effort could be unduly limiting, ensnare projects in an individual state's politics, and potentially cause competitive funds to be established in other nearby states. This is particularly problematic for industry and nonprofit partners that operate across state lines. On the other hand, a national effort could be difficult to launch with the right partners due to the diversity of shale plays and state actors. Unlike many other environmental issues, oil and gas regulation is managed mostly by the states.

The best option may be to focus specifically on geologic formations found in the Appalachian Basin. Exact geographic dimensions of the basin vary, but the most commonly included states are New York, Pennsylvania, Ohio, and West Virginia. These states share unconventional resources in the Marcellus, Utica, and other shale formations. They have a shared historical experience with resource extraction and, in many ways, similar regulatory regimes. The main potential complication from a multi-state, basin approach is related to the alignment of funding sources and expenditures. For example, if Pennsylvania invests in the fund, it may object to the expenditure of those dollars in West Virginia and vice versa.

At the end of 2011, the U.S. Secretary of Energy's Shale Gas Subcommittee endorsed the creation of Regional Centers of Excellence that would involve public interest groups, state and local regulatory agencies, local colleges and universities, and industry in basin-specific best practice development. While this research fund would have a slightly different mission, an Appalachian Basin scale would be consistent with DOE's emphasis on regional, shale-basin defined, and cross-sector approaches.

Importantly, the Appalachian Basin boundaries would not be "un-crossable" but rather would serve as initial geographic guides to answering the three questions at the top of this section. If funding sources or researchers from outside that area wanted to participate, it would not make much sense to arbitrarily and permanently exclude those participants. The research fund leadership, in consultation with funders and stakeholders, could make such decisions on a case-by-case basis. Conceivably, an Appalachian Basin focused fund could expand, over time, into a national or even international effort, which presents an opportunity for Southwestern Pennsylvania to lead the way in innovatively supporting and using shale gas research.

Focus of Research Activities

A multi-sector research fund appears particularly well suited to support research on the acute and cumulative environmental, ecological, public health, social, and community impacts of unconventional oil and gas extraction, production, transport, and use. These are the most contentious areas that require enhanced attention and skilled impartial investigation. In addition, investments in the unbiased evaluation of new technologies and innovations and their potential to decrease the environmental footprint of oil and gas development would be useful. In response to the Roundtable's original research assumptions, the fund should prioritize research in areas needing increased attention where unbiased data will be most helpful and where policymakers lack reliable information.

By suggesting this type of research focus, the Roundtable avoids being either overly prescriptive or overly broad. Dictating specific research projects at this stage would limit the flexibility and diminish the attractiveness of an unbiased, independent funding and research effort.

IMPLEMENTATION STRATEGY AND NEXT STEPS

In order to begin the implementation of the research fund proposal, planning is underway for a process to establish a multi-year unconventional oil and gas research agenda that will include targeted, carefully timed, and policy-relevant research questions. This initial process and resulting agenda will, to the highest degree possible, conform to the characteristics of the fund itself.

Research priorities in the agenda will be based on diverse input and designed to inform regulatory and legislative decision making at the state and federal levels. The process will not be a series of linear steps but rather a set of concurrent activities that include: recruiting a research committee to guide the process; completing a scan of existing research; framing future research questions with critical input from policymakers, researchers, and relevant stakeholders; drafting an agenda for stakeholder review; and adopting a final agenda for implementation.

It will be essential for diverse stakeholders to be able to trust the rigor and independence of the process and the resulting agenda. The agenda cannot be viewed as being driven by one sector or one institution. Expert scientific staff with experience in collaboratively identifying research questions, setting priorities, and establishing strategic research plans will be essential ingredients in the process. A scientifically-credible, impartial facilitator with a track record in this type of work and with experienced staff would heighten the chances of successfully crafting an agenda that can attract implementation funding.

In parallel with the agenda-setting process, a detailed plan for the implementation of the agenda through a multi-year, cross-sector fund will be constructed. Longer-term emphasis will be on securing stability and predictability for the research fund through multi-year funding commitments, regular stakeholder communications, hiring full-time staff, establishing research and review committees, and eventually drafting requests for proposals based on the strategic research agenda. The next round of dialogue among regional stakeholders will define a path forward that best positions the fund for valuable contributions to unconventional oil and gas research and policy.

MODERNIZATION OF THE PENNSYLVANIA OIL & GAS CONSERVATION LAW

In long-standing Pennsylvania law, the "rule of capture" provides that ownership of a natural resource is determined by who "captures" the resource first. This legal paradigm resulted in the early, inefficient extraction of Pennsylvania's oil reserves. Through over-drilling to capture the oil resource, well operators depressurized oil reservoirs, stranded numerous barrels of oil, and littered the landscape with wells. The Oil & Gas Conservation Law, which was originally adopted to satisfy Pennsylvania's membership requirements for the Interstate Oil and Gas Compact Commission (IOGCC), was designed to more effectively and efficiently manage oil and gas reservoirs.

However, the Conservation Law has not been updated since 1961. It is the last portion of a three-part Pennsylvania oil and gas legal structure to be updated – both the Oil & Gas Act (Act 13) and the Coal & Gas Resource Coordination Act have been revised within the last several years. The 1961 Pennsylvania law uses outdated depth restrictions, which in turn generate distinct regulatory systems for the Utica, Marcellus, and other shale formations. IOGCC's model conservation statute has not been updated since 2004, which predates the widespread use of horizontal drilling and hydraulic fracturing as well.[34]

The Shale Gas Roundtable has developed a balanced proposal for modernizing the Conservation Law and ensuring a standardized regulatory structure through all unconventional formations. In addition to extensive research, benchmarking, and dialogue, the Roundtable framework also benefitted from a systems synthesis project on unitization that was conducted by students at Carnegie Mellon University's Heinz College. This framework can be used to inform a comprehensive update of the Conservation Law, or, in the interim, components of the framework could be legislated separately (e.g., suggested improvements in the submission and accessibility of final unitization declarations).

Goals of a conservation law modernization include (regular font indicates that the text is from the Governor's Marcellus Shale Advisory Commission summer 2011 report; *italicized font indicates the text was developed by the Shale Gas Roundtable*):

- Include the Marcellus Shale and other deep unconventional geologic formations currently excluded from existing conservation statutes. (*The Commonwealth should not have different conservation rules for different shale layers.)*
- Conform with the best practices for shale gas development in the great majority of states with said production.
- Ensure the protection of property rights for both surface and mineral rights owners. *(Land and mineral rights owners have complicated relationships with each other and with the natural gas resource. The state should approach any update with careful attention to the ability of all*

[34] IOGCC Model Oil and Gas Conservation Law: http://iogcc.publishpath.com/Websites/iogcc/docs/ModelAct-Dec2004.pdf

stakeholders to constructively participate in the unitization process. Protection of correlative rights is an important part of this discussion.)

- Account for the opportunities afforded by advances in technology of natural gas extraction practices, including horizontal and directional drilling and well stimulation. *(The 1961 act did not anticipate horizontal drilling, multi-well pads, or large volume hydraulic fracturing, and any update should take these advances into account.)*
- Ensure the minimization of surface impact through the proper placement and spacing of well pads. *(It is in the best interest of the Commonwealth to limit the density of well pad development. Fewer pads mean fewer acres of surface disturbance, less infrastructure build out including gathering pipelines, and likely fewer potential environmental impacts.)*
- Prevent the waste or stranding of natural gas so as to maximize job and revenue-generating opportunities for the Commonwealth and its citizens. *(Natural gas is an important economic asset of the state. With substantial extraction underway, the Commonwealth should make every effort to increase the efficiency of resource recovery and to prevent waste through stranded gas/acreage.)*

The 1961 Oil & Gas Conservation Law (Conservation Law) should be amended to reflect the goals above and integrated into a consolidated statute. Act 13 was an amendment process for the Oil & Gas Act, though substantial in its changes. The framework below aims to provide uniform conservation rules that account for modern oil and gas development approaches and that prevent unnecessary environmental impacts and wasted resources.

DEFINITION OF KEY CONCEPTS

- **Unconventional reservoir** – as defined by Act 13, "a geological shale formation existing below the base of the Elk Sandstone or its geologic equivalent stratigraphic interval where natural gas generally cannot be produced at economic flow rates or in economic volumes except by vertical or horizontal well bores stimulated by hydraulic fracture treatments or by using multilateral well bores or other techniques to expose more of the formation to the well bore."
- **Unit** – a consolidation of interests of persons actively engaged in the business of extracting oil or gas from land owned or leased by the persons within a defined geographic area, in order to facilitate the efficient extraction of resources from one or more unconventional reservoirs. Unitization is the act of joining multiple leases into one unit for the purposes of producing oil and gas and distributing the resulting royalties.
- **Oil & Gas Technical Advisory Board (TAB)** – per the Oil & Gas Act, a five-member board, appointed by the Governor, with whom the Department of Environmental Protection consults during the formation, drafting, and presentation stages of all regulations of a technical nature promulgated under that act. The TAB is given a reasonable opportunity to review and comment on all regulations of a technical nature prior to submission to the Environmental Quality Board.
- **Environmental Hearing Board (EHB)** – a five-member independent adjudicatory panel, appointed by the Governor and confirmed by the Senate, which functions as the statutorily established statewide trial court for appeals of DEP final actions.

- **Cross fracturing** – when hydraulic fracturing occurs on adjacent units such that the fractures from multiple laterals overlap, potentially resulting in a depressurizing of one or both well bores.
- **Integration** – a process by which an oil and gas developer can, under specific defined circumstances, compel other mineral rights owners or lessors to participate in a unit.
- **Dormant Oil & Gas Act (DOGA)** – this act allows for oil and gas development to occur when not all mineral rights owners of a property can be located. The Act provides for the creation and administration of trusts for the benefit of the absent rights owners where proceeds from the oil and gas development are deposited.
- **Stranded acreage** – land that cannot be developed for oil and gas production because of previously created units or regulatory restrictions.
- **Primary term** – the initial, typically five-year, period of an oil and gas lease in which an operator holds acreage in anticipation of producing natural gas. If the operator does not begin production within the primary term, the lease will typically expire.
- **Held by production** – if oil and/or gas are produced from leased acreage during the primary term, the lease then enters the secondary term. The operator can then hold the acreage included in the lease for as long as the acreage is producing in paying quantities.

APPLICABILITY OF THE CONSERVATION LAW

- Modernized provisions in the Conservation Law should apply to all unconventional reservoirs as defined by Act 13.
- Given that the original act will be amended instead of replaced, 1961 provisions that remain relevant to either conventional or unconventional gas development could be retained.

ADMINISTRATION OF THE CONSERVATION LAW[35]

- DEP staff would carry out the functions outlined in these recommendations, including approving/disapproving proposed units and integration requests. The aim is not to create new bureaucracy but to enable the department to ably manage the additional Conservation Law responsibilities in strong alignment with existing environmental regulations.
- The expanded Technical Advisory Board would review and provide advice on regulations needed to implement this act. All regulations would go through the existing Pennsylvania regulatory approval process.
- DEP staff decisions could be appealed to the Environmental Hearing Board (EHB). EHB decisions could, in turn, be appealed to the Commonwealth Court.
- In order to pay for the additional qualified staff necessary to conduct unit and integration reviews, DEP would be enabled to charge fees for compulsory/lease integration requests and unit proposal filings. DEP would need to collaborate closely with the Pennsylvania Department of Conservation and Natural Resources and its geologists in implementation of this act.

[35] See Appendix D for a guide to DEP regulatory processes and roles.

RATIONALIZATION OF DRILLING UNITS

The Conservation Law should govern the logical organization of drilling units over a defined geologic formation in order to minimize surface disturbance and maximize the efficiency of extraction and transport of oil and natural gas.

- Definition of formations
    - DEP would proactively define unconventional formations within the state and then prepare unitization requirements for those formations. Rules should not typically vary across formations, unless there is an operational or geologic reason for different requirements.
- Unit size, drainage efficiency, and surface disturbance requirements
    - The state should not legislatively define minimum and maximum unit sizes or minimum and maximum number of pads or wells per unit. Instead, when defining rules for the formation, the state would develop a maximum ratio of surface disturbance to unit size and requirements that the unit be effectively drained. For example, if the legislation required exactly 400-acre units with one pad per unit, the operator would need three pads to drain 1,200 acres. What if, instead, the operator could design a 1,200-acre unit and drain it with two pads? Or, what if the operator could drain an 800-acre unit with one pad and drain the adjacent 400-acre unit from a pad on the 800 acres? A ratio tool and requirements for effective drainage would allow flexibility to the state and operators in effectively managing the gas reservoir, avoiding stranded gas, adapting to technological and best practice advances, rationalizing units, and limiting surface disturbance.
    - The state, through its regulatory process, would develop the ratio and drainage requirements with full stakeholder input. These parameters should be based on maximizing drainage while minimizing surface disturbance. They should be evaluated for revisions every three years to account for advancing technology and operational practices.
    - Roads, pipelines, and other items needed to service pads would not be required inclusions for the ratio calculation. However, in making its unit proposal, an operator could voluntarily include the minimization of service infrastructure to strengthen its case, including access roads and gathering pipelines.
    - The ratio calculation should include the acreage of non-consenting rights owners in the unit's geographic footprint. Requirements for effective drainage also will account for the presence of non-consenting rights owners, though avoiding the inclusion of such acreage to the maximum ability should be encouraged.

- Unit boundary setbacks
    - Based on fracture propagation data and area geology, operators should be required to propose setback distances between the unit boundary (boundary with those leases and land not included in that unit) and any well laterals. This approach prevents subsurface trespass and protects adjacent mineral rights owners. It also protects operators from "cross-fracturing" each other's laterals. DEP should be required to review the proposed boundary setback distances.

INTEGRATION OF UNITS

- Compulsory integration
    - Company-on-company compulsory integration should be enabled in unconventional shale formations as defined above. The capability to request integration should be available to "persons" defined as operators. This will provide a remediation tool in the event that operators are effectively blocking the integration of efficient units.
        - In company-on-company integration, the integrated interest should have options for participation, including:
            - electing to participate as a working interest owner/operator under a Joint Operating Agreement
            - electing to participate as a non-consenting party with a risk penalty of 200 percent
    - In many oil and gas producing states, full compulsory integration that applies to all non-consenting rights owners is an important component of conservation law. In Pennsylvania, full compulsory integration is currently available below the Onondaga Limestone via the 1961 Conservation Law. Given the aim of minimizing surface impacts and avoiding waste, full compulsory integration would most efficiently and effectively serve these goals. If it becomes apparent that there is a lack of current political support for this or any other individual component, it should not prevent the implementation of other important aspects of these recommendations.
    - Seventy percent of the acreage in a proposed unit should be under the control of the operator before any integration request can be filed. The state can take operators' environmental compliance history into account when reviewing integration requests.
    - If full compulsory integration is not included, the updated act should contain required notifications/declarations to non-consenting rights owners at the time of unit proposal – including notifications that once the unit is created and production begins, the unit cannot be altered and therefore the rights owner could not join that particular unit. This does not necessarily mean that the non-consenting owner is without options to pursue later development of his or her gas or prevent him or her from developing a contractual

relationship with the unit, but it does mean he or she forfeits full participation in and proceeds from that unit.

- Existing lease integration
    - If an operator has the right to develop multiple, contiguous, held-by-production leases separately, the operator should be able to request integration of those leases into a unit for the purposes of oil and gas development via horizontal drilling (unless expressly prohibited by an existing lease). At the time of proposed unit filing with DEP, the operator also would need to seek integration approval for the included leases.
    - In determining the royalty where separate, contiguous leases are integrated into a unit, in the absence of an agreement by all affected royalty owners, the production should be allocated to each lease in such proportion as the operator, in its unit/integration application to DEP, reasonably estimates to be attributable to each lease.
    - In the event that the current royalty owners cannot be located for an included lease, royalty payments for these rights owners would be made using the existing Dormant Oil and Gas Act (DOGA) system.
    - Several similar provisions are also found within Pennsylvania Senate Bill 259, sponsored by Senator Gene Yaw, which passed the Senate and the House of Representatives in June, 2013.
- The operator should, in any type of integration request, demonstrate and document its attempts at good faith negotiation before a request can be approved.
- A fee would be associated with filing any type of integration request. This serves to discourage such requests and to provide additional revenue to support DEP's unit review functions.

UNITIZATION REVIEW SYSTEM

- Operators are accustomed to state unit review and approval processes in many other oil and gas producing states.
- In Pennsylvania, DEP would develop unitization guidelines, including effective drainage requirements and maximum surface disturbance to acreage ratios. DEP would be charged with minimizing both waste and surface disturbance via its review process.
- Operators would submit proposed units to DEP for review and approval/disapproval. DEP would be required to design a unit filing process that enables operators to clearly demonstrate their fulfillment of the established requirements and facilitates timely decisions. Recently instituted state permit review and decision guarantees (assuming accurate and complete applications) would apply to DEP unit reviews.
- DEP would not have jurisdiction over which leases or acreage are included in a proposed unit, only over whether the operators are meeting surface disturbance and effective drainage requirements. These unit proposals also should be sent to involved and adjacent surface and mineral rights owners and municipalities for notification purposes. These parties could comment on proposed units.

- DEP would, to the highest degree possible, seek to avoid the creation of stranded acreage in units through requirements for effective drainage of included acreage.
- DEP would retain some flexibility in review to accommodate technological advances and special situations.
- DEP would review and approve/disapprove unit integration requests by operators.
- DEP would be required to review any changes to previously approved unit proposals.
- Operators would be allowed/encouraged to propose multiple units to the state in one filing. Such an approach would allow for more comprehensive conservation by allowing industry and the state to work toward development that limits surface impact and improves efficiency over multiple units covering a larger geography. Operators could be offered priority review and discounted unit filing fees for simultaneously proposing multiple units. Colorado has offered such a voluntary approach for several years that has not yet been used by industry. In addition to the priority review and lower fees, DEP could encourage multiple unit filings by working with stakeholders to develop a template for how the process would unfold and be used.

AVAILABILITY OF UNIT INFORMATION

- DEP should develop requirements for formatting and data inclusions in unit proposal and final unit filings (including Geographic Information System coordinates, surface tract boundaries, mineral interest boundaries, proposed location of well laterals, etc.). Transparency would help to level the playing field among all stakeholder groups.
- A statewide electronic filing system for unit proposals and declarations should be designed and implemented. Operators should be required to file proposed units and final unit declarations in the appropriate format, including GIS coordinates for unit boundaries. Final units should no longer differ from proposed units available in the Pennsylvania Internet Record Imaging System (PA*IRIS) as DEP would approve new units and changes to approved units. The resulting maps and data should be publicly accessible via an online portal.
- The current county-level paper filing system for final unit declarations should be retained to remain consistent with current Pennsylvania title practices.
- There would be a need to ensure that the new filing system integrates with other DEP, DCNR, Pennsylvania Natural Diversity Inventory (PNDI), and Pennsylvania Spatial Data Access (PASDA) data systems and GIS layers.
- Under Act 13, the filing system should be a permitted use of DEP's impact fee revenue.

OIL AND GAS LEASE RELEASE REQUIREMENT

- Upon expiration of an oil and gas lease, the lessee/operator should, within 30 days after request by the lessor, execute, acknowledge, and deliver or cause to be recorded, a quitclaim of all interest in and to the resources covered by the oil and gas lease. Such a request can only be filed and only requires a response if the lease is no longer in the primary term and the lease is not held by production.

- This requirement facilitates the cleaning of title upon lease expiration and improves the marketplace for acreage then available to be included in future units.

TEMPORARY REGULATIONS

- DEP should be allowed to issue temporary regulations to speed implementation until permanent regulations can be promulgated and approved. Temporary regulations should be in place a maximum of two years.

WATER AND UNCONVENTIONAL OIL AND GAS

In the spring of 2012, the Shale Gas Roundtable began to collect and analyze data for a regional scan of water-related issues relevant to shale gas extraction, transport, and use. Based on the information gathering and stakeholder dialogue processes, the Roundtable also was able to construct a set of recommendations focused on preventing potential water-related impacts of unconventional oil and gas development.

BACKGROUND ON THE INTERSECTION OF WATER AND SHALE OIL AND GAS

The average $3 million drilling and fracturing process required for each well uses an average of 4.2 million gallons of water, much of which has traditionally been freshwater.[36] The volume of water can vary significantly and is highly dependent on the length of the drilled lateral. More than 99 percent of the fracturing fluid is water and sand, while other components such as lubricants and bactericides constitute the remaining 0.5 percent.[37] This fracturing mixture enters the well bore, and some of it returns as flowback or produced water, carrying with it, in addition to the original materials, dissolved and suspended minerals and other materials that it picks up in the shale. Once in production for several years, natural gas wells can feasibly undergo additional hydraulic fracturing to stimulate further production, thereby increasing the volume of water needed for each well.

Approximately 10-25 percent of the water injected into the well is recovered within three to four weeks after drilling and fracturing a well.[38] Water that is recovered during the drilling process (drilling water), returned to the surface after hydraulic fracturing (flowback water), or stripped from the gas during the production phase of well operation (produced water) must be disposed of properly. The recovered water contains numerous pollutants such as barium, strontium, oil and grease, soluble organics, and a high concentration of chlorides. The contents of the water can vary depending on geological conditions and the types of chemicals used in the injected fracturing fluid. These wastewaters are not well suited for disposal in standard sewage treatment plants, as recovered waters can adversely affect the biological processes of the treatment plant (impacting the bacteria critical to digestion) and leave chemical residues in the sewage sludge and the discharge water.

Many producers have been transporting flowback and produced water long distances to acceptable water treatment facilities or injection sites. But deep well injection – an important option for shale gas water disposal – is now also meeting challenges. Pennsylvania's ability to provide deep well injection sites is somewhat limited by its use of underground geologic areas for seasonal subsurface storage of natural gas in anticipation of winter use. The state currently has seven operating brine disposal injection

[36] Yoxtheimer, Dave. "Potential Surface Water Impacts from Natural Gas Development." pg.5. http://www.marcellus.psu.edu/resources/PDFs/Halfmoon%208-24-11.pdf
[37] Ibid. pg.4.
[38] Hammer, Rebecca and Jeanne VanBriesen. "In Fracking's Wake: New Rules are Needed to Protect Our Health and Environment from Contaminated Wastewater,"pg. 11. May 2012. http://www.nrdc.org/energy/files/Fracking-Wastewater-FullReport.pdf

sites – one well in Beaver and two wells each in Clearfield, Somerset, and Warren counties – all of which are overseen by the U.S. Environmental Protection Agency under the Underground Injection Control (UIC) Program.[39] These wells are permitted as Class II, which means only fluids associated with oil and natural gas production can be injected into them.[40] Ohio and West Virginia have opted to run their own UIC programs and have many permitted deep well injection sites available. These wells have been a popular disposal choice for Pennsylvania developers. However, a series of small Ohio earthquakes that began in late 2011 were believed to be the result of high-volume flowback and produced water injection. New Ohio injection well development was halted until the state instituted a more rigorous set of regulations in March, 2012.[41] The moratorium has since been lifted on all but one of the deep well injection sites, and new regulations have been put in place requiring seismic testing before, during, and after injection.[42] Similar seismic activity has been observed in Arkansas, Oklahoma, and Texas.[43]

The water disposal challenge has spurred a new water treatment industry in the region, with entrepreneurs and established companies creating portable treatment plants and other innovative treatment technologies to help manage produced water. An example includes the facility operated by Reserved Environmental Services near New Stanton, PA. This facility processes hundreds of thousands of gallons of shale gas wastewater daily from many of the region's natural gas developers through the use of a zero liquid discharge wastewater treatment plant. The treated water is then recycled and reused by industry to fracture additional wells. Another example of innovative water treatment technologies is Epiphany Water Systems, which recently negotiated an agreement with CONSOL Energy to pilot its solar-powered water treatment system at well sites.

While progress has been made on the water quantity and quality impacts of shale gas development, challenges remain, including the potential cumulative long-term water impacts of the industry. Additional water research and environmental policy changes will be necessary in order to fully realize the economic opportunity of the region's natural gas wealth while safeguarding the environment.

RECENT GOVERNMENT ACTIONS ON WATER AND SHALE GAS

Given the economic benefits and environmental challenges that result from the continued development of shale gas in the region, government entities at all levels have established policies and regulations to support responsible extraction. The overview below summarizes critical aspects of this recent government activity related to water issues.

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[39] StateImpact. "Deep Injection Wells in Pennsylvania." http://stateimpact.npr.org/pennsylvania/2011/09/22/burning-question-where-are-pas-deep-injection-wells/

[40] EPA. "Class II Wells – Oil and Gas Related Injection Wells (Class II)." http://water.epa.gov/type/groundwater/uic/class2/index.cfm

[41] Hopey, Don. "Ohio Earthquakes Caused by Deep Disposal Well for Marcellus Wastewater." *Pittsburgh Post-Gazette*. March 9, 2012. http://pipeline.post-gazette.com/index.php/news/archives/24374-ohio-earthquakes-caused-deep-disposal-well-for-marcellus-wastewater

[42] Speakman, Burton. "D&L Energy Seeks Permit for New Injection Well." *Akron Beacon Journal.* Nov. 16, 2012. http://www.ohio.com/blogs/drilling/ohio-utica-shale-1.291290/d-l-energy-seeks-permit-for-new-injection-well-1.350769

[43] National Research Council of the National Academies. "Induced Seismicity Potential in Energy Technologies." pg.77-81. 2012. https://download.nap.edu/catalog.php?record_id=13355#toc

FEDERAL

U.S. Environmental Protection Agency (EPA) Hydraulic Fracturing Study

During fiscal year 2010, the U.S. House of Representatives Appropriations identified the need for a comprehensive study of the hydraulic fracturing process and its relationship with drinking water and groundwater resources.

At the direction of Congress, EPA is investigating the relationship between surface and ground water resources and hydraulic fracturing at every stage of the process, including the source of water; the creation of hydraulic fracturing fluid by combining water, sand, and chemicals; the injection of the fracturing fluid into the wells; the flowback of the produced water; and finally the treatment of the wastewater and its ultimate disposal. The research is designed to examine any potential impacts that the process has on drinking water resources at each stage, as each stage offers its own set of potential complications and consequences.

A progress report was released in December 2012. The draft final report will be released in 2014 for peer review and public comment. In March 2013, EPA announced the formation of its Hydraulic Fracturing Research Advisory Panel, which will provide feedback on the 2012 progress report, solicit public input, and peer review the 2014 draft report. David Dzombak, Walter J. Blenko Sr. University Professor of Civil and Environmental Engineering at Carnegie Mellon University, will chair the Advisory Panel.[44]

EPA Proposed Regulations

On October 20, 2011, EPA announced its intent and schedule to develop wastewater standards for the natural gas industry. These regulations would not apply to recycled or injected waters but to that wastewater disposed at the surface through permitted treatment facilities. The proposed rule for natural gas wastewater will be released in 2014.

Furthermore, EPA announced on November 23, 2011, that it would be moving toward a proposed rulemaking on enhanced fracturing chemical testing and disclosure under the Toxic Substances Control Act. This movement was in partial response to a petition by environmental groups that asked for EPA to become involved in the disclosure of gas development materials and chemicals. No timeline has been announced for this rulemaking.

PENNSYLVANIA

Total Dissolved Solids

Due to increased concern over drinking water supplies being adversely affected, the Pennsylvania Department of Environmental Protection (DEP) in 2010 revised Chapter 95, Pennsylvania Wastewater Treatment Requirements, to address the cumulative impacts of oil and gas wastewater discharges. The new rule for wastewater treatment plants limits the discharges of total dissolved solids (TDS) such as sodium and chloride from new or expanded facilities that take oil and gas wastewater. These

[44] EPA. Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources: http://www.epa.gov/hfstudy

wastewaters must now be treated to drinking water standards. For example, this means that any new discharges cannot exceed 250 mg/l for chlorides. The reduction in TDS also precludes most of the potential for radium contamination. The new Chapter 95 rule was designed to increase the use of recycled water and promote the development of alternative forms of disposal while also promoting the use of alternative types of fracturing fluids.

In April 2011, DEP called on the Marcellus gas industry to voluntarily stop sending its wastewater to the 15 grandfathered wastewater treatment plants not covered under the new Chapter 95 rule. The request came amidst growing concern that the treatment plants were unable to effectively process and treat wastewaters from drilling operations. Michael Krancer, then secretary of DEP, gave the industry a 30-day deadline to voluntarily comply with this request and received cooperation from all operators by the deadline. It is important to note that this voluntary compliance applied to flowback and produced water from unconventional wells and not to wastewaters from conventional natural gas extraction activities.

Additionally, in 2010, DEP announced a rulemaking for establishing an ambient water standard for chloride levels (in addition to the end-of-pipe discharge standard in the 2010 Chapter 95 update).[45] The proposed rulemaking recommended adopting the current EPA National Aquatic Life Criteria for chloride of a four-day average of 230 mg/L and a one-hour average of 860 mg/L.[46] DEP eventually withdrew the chloride ambient water standard over concerns that it was out of line with other states' standards. Some stakeholders believe an ambient chloride standard could substantially decrease the possibility of water degradation from all oil and gas activities in Pennsylvania. EPA is currently reviewing and updating its recommended chloride criteria. These new criteria could be used in the future by Pennsylvania should it decide to pursue the ambient standard.

Comparison of MSAC Recommendations and Act 13

In March 2011, Governor Tom Corbett created the Governor's Marcellus Shale Advisory Commission (MSAC) to examine existing Pennsylvania statutes and provide recommendations to "promote the efficient, environmentally sound, and cost effective development of Marcellus Shale and other unconventional natural gas resources."[47] The Commission comprised stakeholders from industry, environmental organizations, and state and local government. Ultimately, the Commission developed 96 recommendations, including 43 related to environmental protection.[48] The Commission's recommendations appeared to significantly inform the subsequent content of Act 13, but in some cases, the Commission's recommendations were reworked or omitted from the final bill. An informational comparison of Act 13 water provisions and the MSAC's water recommendations can be found in Appendix C. Some of the MSAC recommendations that have not yet been addressed might be implemented through administrative or regulatory changes, and others may require additional legislative attention.

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[45] "Ambient Water Quality Criterion; Chloride (Ch); Notice of Proposed Rulemaking." 40 Pa.B.2264. May 1, 2010. http://www.pabulletin.com/secure/data/vol40/40-18/771.html

[46] Ibid.

[47] Penn. Exec. Order No. 2011-01 (April 3, 2011)

[48] "Governor's Marcellus Shale Advisory Commission Report." July 22, 2011. pg.103. http://files.dep.state.pa.us/PublicParticipation/MarcellusShaleAdvisoryCommission/MarcellusShaleAdvisoryPortalFiles/MSAC_Final_Report.pdf

KEY ISSUES IN REGIONAL SHALE GAS WATER MANAGEMENT

The issues discussed below were identified through research and interviews with stakeholder groups as the priorities that are critical to understanding and improving the management of water and natural gas resources. The Roundtable developed recommendations with a risk-based life cycle approach to managing the cumulative water impacts.

WATER SOURCING

An essential component of shale gas development is obtaining the quantities of water necessary for drilling and fracturing operations. Overall, freshwater usage for gas development is estimated to be less than 1 percent of Pennsylvania's total annual freshwater withdrawals.[49] This usage figure, while telling, can be somewhat misleading, as it does not address the timeframes for the freshwater withdrawals nor does it indicate that much of the water is permanently retained deep underground and therefore not returned to the much shallower water table. Estimates for average total water use range from 3 to 5 million gallons per well, but per well volumes as high as 8.3 million gallons have been recorded in Pennsylvania.[50/51]

The potential problem is not necessarily the amount of water used but rather that the 3-5 million gallon withdrawals, which may take place over a matter of a few weeks, can create a dramatic spike in water usage (when compared to a lower continuous draw over a period of months). Rapid withdrawals from water bodies can create problems for aquatic ecosystems, water quality, and existing and designated uses of water. Issues related to withdrawal can be further exacerbated during periods of low stream flow or drought. Additionally, operators may choose to draw from multiple smaller water bodies when they lack access to municipal water or other large water sources, which impacts the smaller bodies to a proportionally greater degree. To offset the water withdrawal impact, some developers withdraw more slowly, at periods of high flow, and store the fresh water in centralized impoundments until it is needed.

While data concerning water extraction from the Ohio River Basin (which includes most of Southwestern Pennsylvania) is not available online (though DEP does get quarterly reports on water withdrawals), data are readily available from central Pennsylvania and the Susquehanna River Basin Commission (SRBC). In 2012, the SRBC region reported a consumptive water use of 10.4 million gallons per day (mgd) for shale gas activities.[52] Similar data are available in the Delaware River Basin Commission service territory, but the Ohio River Valley Water Sanitation Commission (ORSANCO) does not have a role in water quantity monitoring or management. ORSANCO is currently conducting a series of studies and outreach activities to determine how it should be involved with water quantity issues in the future. The Headwaters Resources Committee, staffed by Carnegie Mellon University's Steinbrenner Institute, is supporting

[49] Curtright, Aimee and Kate Giglio. "Conference Proceedings: Coal Mine Drainage for Marcellus Shale Natural Gas Extraction: Proceedings and Recommendations from a Roundtable on Feasibility and Challenges." RAND. pg.1. http://www.rand.org/content/dam/rand/pubs/conf_proceedings/2012/RAND_CF300.pdf

[50] Ibid.

[51] Penn State Cooperative Extension. "Water Withdrawals from Development of Marcellus Shale Gas in Pennsylvania." pg.2. http://pubs.cas.psu.edu/freepubs/pdfs/ua460.pdf

[52] Susquehanna River Basin Commission. "State of the Susquehanna: 2013 Report." pg.5. http://www.srbc.net/stateofsusq2013/docs/2013_SOTS_Report_Final_high_res.pdf

these studies and ensuring that perspectives from the Ohio River headwaters in Pennsylvania are included in the ORSANCO process.

Under Act 13, shale gas developers are required to file Water Management Plans before site development can occur.[53] Water Management Plans require developers to demonstrate that the withdrawals will not harm the water source and are protective of public health, safety, and welfare.[54] Water withdrawals must be in keeping with designated and existing uses of water sources.

In order to lessen the impact on local water sources, many shale gas developers are trying to find ways to offset their use of freshwater. Currently, the most viable method of freshwater usage reduction is through the recycling of flowback and produced water. Portable and stationary water treatment and recycling systems allow drillers to process flowback into an acceptable fluid for reuse in drilling operations. Although recycling flowback does lessen the impact on local water reserves, only a percentage of fracturing water is recovered from the drilling process and therefore able to be recycled.

Another possible approach to lessening local water impacts is the use of treated abandoned mine water (instead of freshwater) in the hydraulic fracturing process. Estimates place the total volume of abandoned mine water in Southwestern Pennsylvania at nearly 600 billion gallons, which is nearly 12 times the estimated annual water requirement for hydraulic fracturing under an *extremely high end* assumption of 5,000 wells per year.[55] Additionally, the Marcellus Shale formation is located over large portions of the region where abandoned mine water is available.

The use of abandoned mine water does pose some problems for use in well fracturing operations. The composition of the drainage can vary greatly depending on a variety of circumstances related to geology and location of the mine, and it can change over time. Researchers also have found large variations in pH and sulfates, which can cause scaling and gas flow obstruction.[56] An additional concern on the part of industry is the possibility of having to assume long-term liability for the mine water once operators start using it. DEP has preliminarily examined the liability issue and offered possible solutions under the Environmental Good Samaritan Act (EGSA) and Consent Order and Agreement approach.[57] The EGSA provides immunity from civil liability for "water pollution abatement projects," which are defined as treatment of water pollution on abandoned mine lands or treatment of abandoned mine drainage. Alternatively, through a Consent Order and Agreement, DEP would agree not to hold developers using abandoned mine water for fracturing water liable as long as certain conditions were met.

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[53] Act 13 of 2012, HB 1950 § 3211(m)(1)
[54] Ibid § 3203
[55] Iannacchione, Anthony. "Assessing the Coal Mine Water Resources: A Marcellus Shale Perspective." *Conference Proceedings: Coal Mine Drainage for Marcellus Shale Natural Gas Extraction: Proceedings and Recommendations from a Roundtable on Feasibility and Challenges*. RAND. pg.5.
http://www.rand.org/content/dam/rand/pubs/conf_proceedings/2012/RAND_CF300.pdf
[56] Cravotta, Charles III. "Use of Acidic Mine Drainage for Marcellus Shale Gas Extractions – Hydrochemical Implications." *Conference Proceedings: Coal Mine Drainage for Marcellus Shale Natural Gas Extraction: Proceedings and Recommendations from a Roundtable on Feasibility and Challenges.* RAND. pg.6-7.
http://www.rand.org/content/dam/rand/pubs/conf_proceedings/2012/RAND_CF300.pdf
[57] DEP. "White Paper: Utilization of AMD in Well Development for Natural Gas Extraction." Nov. 2011. pg.5.
http://files.dep.state.pa.us/Water/Watershed%20Management/WatershedPortalFiles/FINAL_WhitePaperReviewTeamFindingsForUseOfAMD_ForFracWater.pdf

Pennsylvania Senate Bill 411, sponsored by Senator Richard Kasunic, was introduced in the 2013-14 session and was temporarily tabled in March 2013. The Senate passed the same bill in the last session (October 2012), but the House did not act on it. The bill encourages the use of abandoned mine water for shale gas drilling and was crafted using policy recommendations from the Governor's Marcellus Shale Advisory Commission. In an effort to reduce the cost and liability associated with the constant treatment of these mine pools, the legislation encourages the use of abandoned mine water in gas well development and expressly provides the protections of the state's Environmental Good Samaritan Act to operators that acquire this alternative water supply. Importantly, state attention to abandoned mine water liability issues has not yet been matched by the necessary federal attention.

Water sourcing will continue to be an area that requires attention from the region and from industry, particularly the timing of withdrawals and incentivizing technological innovations that can help to reduce water needs. The sustainability of the region's water resources will likely be more stressed in the coming years by population growth, increases in demand related to other energy and industrial activities, and climate change.

Water Sourcing Recommendations

- The Susquehanna River Basin Commission (SRBC) and Delaware River Basin Commission (DRBC) play active water quantity monitoring and management roles in their respective basins. Currently, the Ohio River Valley Water Sanitation Commission (ORSANCO) is gauging its potential future involvement in water quantity issues in the Ohio River Basin. As a first step in this effort, ORSANCO is seeking the approval of a memorandum of understanding (MOU) from the governors of its eight member states, affirming their support of conducting the water quantity studies. The MOU does not commit ORSANCO or the member states to any course of action on water quantity but rather encourages an open dialogue and evaluation process. Pennsylvania should sign the MOU that supports ORSANCO's study of water quantity regulation in the Ohio River Basin and also actively engage in the forthcoming studies.
- DEP should incorporate the recommendations in the Upper Ohio Basin flow study into its water management programs and update its policy to reflect this recent research. The Nature Conservancy recently completed ecologically-based flow recommendations for streams and rivers in the Upper Ohio River Basin in Western Pennsylvania.[58] Recommendations are based on more than 150 publications and reports, streamflow analysis, and consultation with regional experts. The study was similar to one completed for the Susquehanna River Basin Commission in 2010. The recommendations therein were used to help produce the revised Low Flow Protection Policy, which was adopted by the Susquehanna River Basin Commission in 2012. SRBC's new policy creates classes of streams based on their sensitivity to water withdrawals and limits withdrawals when they are likely to have ecological impacts. DEP should consider similar factors when managing water in the Upper Ohio Basin.

[58] DePhillip, M. and T. Moberg. "Ecosystem Flow Recommendations for the Upper Ohio River Basin in Western Pennsylvania." *The Nature Conservancy.* Harrisburg, PA. March 2013. http://www.ohioriverbasin.org/largeuploads/Final%20Ecosystem%20Flow%20Recommendations%20Upper%20Ohio%20River%20PA%202013_Report&App.pdf

- The potential benefits of using abandoned mine water for hydraulic fracturing operations are well documented. The technology necessary to use this water largely exists, and the most significant barrier remains potential liability. As such, the General Assembly should adopt Pennsylvania Senate Bill 411, or similar legislation, to encourage the use of abandoned mine water in gas well development and expressly provide the protections of the state's Environmental Good Samaritan Act (EGSA) to operators acquiring this alternative water supply. The U.S. EPA and possibly Congress consider also addressing operator liability concerns under federal law. Both state and federal action are likely necessary to fully overcome operator concerns.
- A water quantity life cycle analysis for shale gas development should be supported and conducted at the earliest possible time to inform the public and future water quantity regulation. It is currently unclear whether shale gas development is a net water user or producer (and what magnitude of user/producer it is). The research should examine water withdrawals in relation to water recovery rates, recycled flowback and produced water, and possible recovery of water vapor through the burning of captured natural gas.
- The draft Chapter 78 Water Management Plan (WMP) provisions should be enacted, including the extension of certain existing SRBC water withdrawal rules to the Ohio River Basin. These withdrawal rules encourage DEP to fully leverage the expertise of department water staff in WMP reviews, compliance monitoring, and enforcement (in collaboration with oil and gas staff). This requires adequate resources for the water division to further integrate industry regulation within the department and prevents the need for duplicative water expertise in multiple offices.

HYDRAULIC FRACTURING CHEMICAL DISCLOSURE

Under Act 13, well operators are required to disclose the chemicals used in their fracturing water to DEP and to FracFocus.org.[59/60] In the event of an environmental or medical emergency, Act 13 requires operators to disclose the exact quantities of all chemicals in their mixture of fracturing water, including proprietary ingredients.[61] FracFocus.org is a national hydraulic fracturing chemical registry managed by the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission. The website was created to provide the public with information about hydraulic fracturing and groundwater protection. Users are able to search for wells in their area and find a list of chemicals that have been used in the development of those particular gas wells.

Complaints have been raised over the lack of functionality of the FracFocus.org website, which precludes data aggregation for research. Performing large queries for specific chemicals can be difficult and time consuming because results are sorted by individual well and only displayable in PDF form. Another issue is that chemicals may be identified using a variety of names, all of which refer to the same substance. For example, ethylene glycol (antifreeze) also is known by the names ethylene alcohol, glycol, glycol alcohol, Lutrol 9, Macrogol 400 BPC, and monoethylene glycol, which makes a comparative analysis of fracturing water ingredients difficult. Pennsylvania, and other states that use this website as

[59] Act 13 of 2012, HB 1950 § 3222.1b2
[60] PA DEP, *Act 13 FAQs:* http://files.dep.state.pa.us/OilGas/OilGasLandingPageFiles/Act13/Act_13_FAQ.pdf
[61] Act 13 of 2012, HB 1950 § 3222.1b11

their public disclosure portal, have been working with FracFocus.org to improve functionality and searchability.

In response to these criticisms, FracFocus.org has redesigned its database to provide enhanced functionality. As of June 2013, the resulting "FracFocus 2.0" website was fully operational. It will allow users to search and aggregate information by geography, dates, chemicals, and chemical abstract service (CAS) numbers. Additionally, states will be able to input data already received directly from companies and download data that companies have previously submitted to FracFocus.org.[62]

Hydraulic Fracturing Chemical Recommendations

- The Roundtable recognizes DEP for its strong efforts at public transparency of fracturing chemicals and its pressure to update the FracFocus.org platform to more adequately communicate needed information. DEP should continue to evaluate methods for improving the accessibility and utility of collected fracturing chemical information, with commensurate pressure on FracFocus.org to improve and innovate in order to meet Pennsylvania's needs in this regard.
- While there are concerns about water quality related to the underground substances from the shale brought to the surface through extraction activities, the constituent chemicals in injected fracturing fluid remain a focus of public trepidation. The industry, federal and state governments, and academia should prioritize the development of biodegradable "green" fracturing fluids. A green fracturing fluid would minimize the potential harm to natural gas workers and the potential environmental damage that can result from surface spills of fracturing chemicals or flowback water. In the interim, the use of DNA or isotopic tracers in the fracturing fluid mixture may improve the ability to monitor underground fluid migration.

EROSION AND SEDIMENTATION

At a well or pipeline construction site during a rain event, disturbed soil can be vulnerable to erosion, and stormwater has the potential to move chemical contaminants and soil away from the site and into surface water or groundwater. DEP routinely cites gas developers for violations related to erosion and improper stormwater management. Between January 2008 and August 2010, erosion and sediment-related citations accounted for nearly a third of all gas well violations.[63]

The state requires any industrial construction site developer, including well drillers, to "develop, implement and maintain best management practices to minimize the potential for accelerated erosion and sedimentation and to manage post construction" stormwater impacts on the sites where they are working. Additionally, "best management practices shall be undertaken to protect, maintain, reclaim and restore water quality and the existing and designated uses of waters of this Commonwealth."[64] DEP also requires developers to develop and implement a Post-Construction Stormwater Management Plan

[62] Smith, Carl Michael. "FracFocus: Chemical Disclosure, State Regulations and Industry Transparency." *American Bar Association Section of Environment, Energy, and Resources.* Oct. 10-13, 2012. pg.8. http://abaseer20fm.conferencespot.org/51-Smith/8

[63] Pennsylvania Land Trust Association. "Marcellus Shale Drillers in Pennsylvania Amass 1614 Violations since 2008." pg.1. http://conserveland.org/violationsrpt

[64] 25 Pa.C.S. §102.2b

as part of its erosion and sediment control permit. The plan must ensure that the volume and flow rate of stormwater be the same pre- and post-development.

DEP has recently updated its erosion and sediment control general permit regulations. Under the new Erosion and Sediment Control General Permit-2 (ESCGP-2), expedited reviews of projects will not be available for projects in critical areas such as special protection waters, floodplains, and lands contaminated by substances regulated under Pennsylvania's land remediation statute.[65] Activities with the potential to discharge sediment into already impaired water bodies are now required to use anti-degradation best available control technologies.[66] Additionally, ESCGP-2 makes changes to DEP notification requirements, pre-construction conferences with DEP, non-compliance self-reporting, and temporary stabilization requirements.[67]

Erosion and Sedimentation Recommendation

- In the design and review of oil and gas Post-Construction Stormwater Management Plans, DEP should require whole-site plans that take into account not only the well pads but also the access roads and pipelines that service a particular development location.

IMPOUNDMENTS AND CONTAINERS

Impoundments are temporary holding ponds that are used to hold freshwater or flowback during the development of a gas well. Lined with a black nitrile material to prevent leakage and/or overflow, shale gas impoundments can hold millions of gallons of fluids. Centralized fracturing fluid impoundments can service multiple well sites and have to be removed within nine months of completing well development.

Concerns around impoundments for flowback and produced water are threefold: leakage, evaporation, and liner disposal. Breaching of the ponds would allow for the discharge of fracturing fluids, likely resulting in the pollution of both surface and ground water. Another concern is the evaporation of the volatile organic compounds (VOC) in natural gas wastewaters, some of which, when inhaled, may be hazardous or even carcinogenic. Finally, once fracturing ponds are emptied, the liners must be properly disposed of to avoid contamination from fluid residues remaining on the liners.

Fears of fracturing pond leakage have resulted in a movement by industry to use storage containers, which are enclosed tanks used to store flowback waters. The high cost of these tanks has prevented broader adoption by industry. It is estimated that approximately 20 centralized fracturing impoundments are currently in use in the state.

Community and environmental groups also have expressed concerns over Act 13 language that permits impoundments in all zoning districts, including residential, if they are located more than 300 feet from existing buildings.[68]

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[65] 42 Pa.B.442 §6n. "Proposed ESCGP-2 Form." http://www.pabulletin.com/secure/data/vol42/42-3/96.html
[66] "DEP 2012 Industry Training: Erosion & Sedimentation Control General Permit for Oil & Gas Activities." August 22, 2012. http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/OilGasReports/2012/Training_Materials/ESCGP-2.pdf
[67] Ibid.
[68] Act 13 of 2012. HB 1950 § 3304(b)6

Impoundments and Containers Recommendation

- DEP should evaluate various natural gas wastewater storage techniques, including mobile containers and centralized impoundments, to determine best practices for management of these fluids. This evaluation should use a life cycle approach that estimates potential environmental and safety risks associated with each of the available storage technologies. In particular, DEP should continue to monitor potential acute emissions problems with open impoundments.

VEHICLE TRAFFIC FOR WATER TRANSPORT

Much of the shale gas development within Southwestern Pennsylvania occurs in rural areas of the region. Municipal and county bridges and roads, which were not designed to support heavy vehicles, are often damaged by large trucks that make frequent trips hauling water and other materials to and from the drilling sites.

An average gas well requires 320-1,365 truckloads of equipment, sand, gravel, freshwater, and fracturing fluids to come into production.[69] A Marcellus Shale well with an 8,000-foot lateral drill length may use 3-6 million gallons of water in the process of drilling and fracturing the shale, nearly all of which must be hauled in and some of which must be hauled out. If a well pad has more than one well located on it, the number of truckloads can be correspondingly greater. General well maintenance and future re-fracturing also will result in additional truckloads of equipment traveling to well sites.

The state legislature has mandated legal standards for overweight hauling and the process by which local roads are posted with weight limits. Once a road is posted with a weight limit, the municipality has the authority to require businesses that intend to haul materials in excess of the posted weight limits to obtain permits. The permitting process requires the hauler to provide bonding to insure the repair of any damage that may occur. Operators with overweight vehicles pay a bond for segments of roads on a per mile basis regardless of the number of overweight vehicles traveling that span. The bonding rates are $6,000/mile for unpaved roads and $12,500/mile for paved roads. These bonding rates have remained unchanged for more than 30 years and may need to be revisited to adequately protect roadways. The estimated cost of reconstructing a one-mile stretch of a two-lane asphalt road is about $850,000, which is higher than the current bonding rates.[70]

Overweight vehicle owners also are required to obtain Excess Maintenance Agreements (EMAs) when placing overweight vehicles on roads.[71] Overweight vehicle owners are required to either pay for or make the repairs to any damaged roadways as a result of their overweight vehicles traveling along the

[69] National Park Service. "Development of the Natural Gas Resources in the Marcellus Shale: New York, Pennsylvania, Virginia, West Virginia, Ohio, Tennessee, and Maryland." Nov. 2009. pg.10. http://www.marcellus.psu.edu/resources/PDFs/marcellusshalereport09.pdf.pdf

[70] Estimate provided by The Gateway Engineers, Inc., Pittsburgh, PA.

[71] Pennsylvania Department of Transportation. "Chapter 15: Weight Restrictions on Highways (Posted Highways)." *Pub 23 – Maintenance Manual.* pg.15-8. ftp://ftp.dot.state.pa.us/public/PubsForms/Publications/PUB%2023/Pub%2023-Chapter%2015.pdf

road.[72] In this context, the bonds are needed only if an operator violates the EMA and fails to adequately fix the roads.

Future vehicle impacts may be somewhat diminished through the use of water supply pipelines, recycling of wastewater, and increased infrastructure funding from Act 13 impact fees. Act 13, after the distribution to the state agencies, provides 60 percent of impact fee funding to counties and municipal governments impacted by shale gas development.[73] While not excusing developers from EMAs, these funds enable local governments to invest in infrastructure repairs and environmental remediation, presumably enhancing investment in road and bridge systems near shale gas activities.

Freshwater pipelines are being increasingly used, especially for drilling near large water impoundments, to decrease the truck trips necessary for hydraulic fracturing operations. In April 2012, Aqua America and Penn Virginia Resource Partners (PVR) announced a newly completed freshwater pipeline project in north-central Pennsylvania that eliminates more than 2,000 truckloads of water from the area roads.[74] DEP is currently promulgating regulations on the use of freshwater pipeline systems and could potentially play a stronger role in facilitating the use of such systems.

Vehicle Traffic and Water Transport Recommendations

- In addition to the new uniform rules in the draft Chapter 78.68b, DEP should continue to seek methods that facilitate and incentivize the use of freshwater pipelines for water transport (possibly including a requirement that water transportation plans are included in the Water Management Plan). The use of freshwater pipelines would allow developers to service well sites without the damage to large stretches of local roads associated with water hauling.
- While Excess Maintenance Agreements (EMA) typically have been sufficient tools to ensure infrastructure repairs, the Commonwealth should evaluate whether the 30-year-old bonding rates should be increased to better protect local municipalities from EMA default.

WASTEWATER TREATMENT AND DISPOSAL

In the second half of 2010, the Pennsylvania unconventional natural gas industry generated about 174 million gallons of total wastewater through its drilling operations. In 2012, unconventional wells produced approximately 536 million gallons of wastewater from July through December.[75] Some estimates indicate that as much as 10-25 percent of the water injected to hydraulically fracture a well is recovered and disposed of or recycled.[76] The recovered water, known as "flowback," contains pollutants such as barium, strontium, oil and grease, soluble organics, and a high concentration of chlorides. In January 2013, DEP announced its intention to conduct research on the levels of naturally occurring

[72] Ibid. 15-17 through 15-19.
[73] Act 13 of 2012. HB 1950 § 2314d
[74] Marcellus Drilling News Press Release: http://marcellusdrilling.com/2012/05/new-water-pipeline-reduces-water-truck-trips-in-pa/
[75] PA DEP Oil & Gas Statewide Waste Data: https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/DataExports/DataExports.aspx
[76] Hammer and VanBriesen. pg.11.

radioactivity in waste materials associated with unconventional gas development.[77] A sample overview of flowback contents is provided in Table 2, though the constituents can vary depending on geological conditions and the types of chemicals used in the injected fracturing water.

Table 2: Contents of Flowback Based on a Sample Analysis[78]

Parameter	Range	Median	Units
Total alkalinity	48.8-327	138	mg/L
Hardness as $CaCO_3$	5,100-55,000	17,700	mg/L
Total suspended solids	10.8-3,220	99	mg/L
Turbidity	2.3-1,540	80	NTU
Chloride	26,400-148,000	41,850	mg/L
Total dissolved solids	38,500-238,000	67,300	mg/L
Specific conductance	79,500-470,000	167,500	Umhos/cm
Total Kjeldahl nitrogen	38-204	86.1	mg/L
Ammonia nitrogen	29.4-199	71.2	mg/L
Biochemical oxygen demand	37.1-1,950	144	mg/L
Chemical oxygen demand	195-17,700	4,870	mg/L
Total organic carbon	3.7-388	62.8	mg/L
Dissolved organic carbon	30.7-501	114	mg/L
Bromide	185-1,190	445	mg/L

Early in the Marcellus play, developers in the region tended to treat flowback and produced water at public sewage treatment plants. Although disposal of shale gas wastewater at municipal treatment plants is a relatively low-cost method of treatment, most plants are unable to adequately treat the high total dissolved solids (TDS) found in the shale gas wastewater (see Table 3 below). The use of sewage

[77] StateImpact. "PA DEP to Study Radiation Related to Marcellus Shale." http://stateimpact.npr.org/pennsylvania/2013/01/24/pa-dep-to-study-radiation-related-to-marcellus-shale/

[78] Penn State Water Resources Extension, C.W. Abdalla, J.R. Drohan, K. Saacke Blunk, and J. Edson (funded by PA Water Resources Research Center). "Marcellus Shale Wastewater Issues in Pennsylvania – Current and Emerging Treatment and Disposal Technologies." pg.2 http://extension.psu.edu/natural-resources/water/marcellus-shale/waste-water/current-and-emerging-treatment-and-disposal-technologies-1/marcellus-shale-wastwater-issues-in-pennsylvania-current-and-emerging-treatment-and-disposal-technologies/view.

treatment plants resulted in high levels of TDS and metals being found in the region's water bodies. Based on this TDS problem, DEP completed the Chapter 95 rulemaking in 2010 (TDS end-of-pipe discharge limits). DEP also issued a request in April 2011 for shale gas developers to voluntarily stop taking shale gas drilling wastewater to grandfathered treatment facilities by May 2011 (all operators voluntarily complied by the deadline). The combination of these two actions has demonstrably decreased the TDS levels in the Monongahela River. The grandfathered facilities are still available to conventional natural gas developers as a wastewater treatment and disposal option.

Another disposal practice is underground injection, a process by which conventional and unconventional natural gas produced fluids are forced into porous rock formations deep within the earth for permanent storage. In the second half of 2012, injection well disposal accounted for approximately 15 percent of unconventional wastewater disposal or 81 million gallons.[79] 77.4 million gallons were disposed of in Ohio injection wells, about 2.1 million gallons in West Virginia wells, and the remaining 1.5 million gallons in Pennsylvania injection facilities.[80] Injection wells are regulated under the federal Safe Drinking Water Act, which requires such wells to be permitted by the state or EPA. Injection wells in Pennsylvania and New York are regulated under the EPA permitting process. In West Virginia and Ohio, permitting is administered by their respective state environmental agencies. With burgeoning Utica and Marcellus development in Ohio, adequate capacity to accept Pennsylvania wastewaters is diminishing. Pennsylvania currently has seven active Class II brine disposal injection wells. Two additional disposal wells have been approved, one well has been approved but is held up in permit appeals, and EPA is reviewing proposals for several more wells.

More than three quarters of shale gas wastewater in Pennsylvania is currently being reused for hydraulic fracturing of additional wells through on-site and centralized treatment and recycling systems. In the second half of 2010, 65 percent of waste fluid went to industrial treatment facilities and about 25 percent of wastewater was reused.[81] From July through December 2012, operators used on-site recycling technology or centralized treatment facilities to reuse 453 million gallons of wastewater or 84.5 percent of the total produced during that time period.[82] Some companies have reported that they are able to recycle more than 90 percent of their wastewater.[83]

[79] PA DEP Oil and Gas Statewide Waste Data.
[80] Ibid.
[81] Penn State Extension. "Water's Journey through the Shale Gas Drilling and Production Processes in the Mid-Atlantic Region." pg.7. http://pubs.cas.psu.edu/FreePubs/PDFs/ee0023.pdf
[82] PA DEP Oil and Gas Statewide Waste Data.
[83] Napsha, Joe. "Private Firms Poised to Treat Wastewater." *Pittsburgh Tribune-Review.* May 19, 2011. http://triblive.com/x/pittsburghtrib/business/s_737873.html#axzz28jot49tZ

Table 3: Advantages/Disadvantages of Treatment and Disposal Options for Flowback Water[84]

Treatment	Advantages	Disadvantages
Dilution and treatment at publically owned sewage treatment plants	Minimal cost	Limited capacity after 2010 DEP TDS regulations Potential to upset the sewage treatment process Does not ensure protection of downstream public water supplies
Treatment at a dedicated brine treatment plant	Meets 2010 DEP TDS regulations Protects downstream public water supply intakes Ensures available assimilative capacity for other industries	Limited current capacity Potentially high transportation costs Higher treatment costs
Direct reuse without treatment (blending of flowback with freshwater for reuse)	Minimal cost	Some potential for well plugging because of high TDS and sand in water
On-site treatment and reuse (recondition water through treatment)	Minimal potential for well plugging	Moderate costs
Off-site treatment and reuse	Minimal potential for well plugging	High transportation costs
Off-site disposal via deep underground injection	No discharge to a stream	High transportation costs

[84] Penn State Water Resources Extension, C.W. Abdalla, J.R. Drohan, K. Saacke Blunk, and J. Edson (funded by PA Water Resources Research Center). "Marcellus Shale Wastewater Issues in Pennsylvania – Current and Emerging Treatment and Disposal Technologies." Pg.4. http://extension.psu.edu/natural-resources/water/marcellus-shale/waste-water/current-and-emerging-treatment-and-disposal-technologies-1/marcellus-shale-wastwater-issues-in-pennsylvania-current-and-emerging-treatment-and-disposal-technologies/view

Wastewater Treatment and Disposal Recommendations

- The lack of specific and codified definitions in the oil and gas wastewater area has proven problematic. DEP should take steps to transparently define and codify the categories of waste produced by natural gas development and also the differences among drilling, flowback, and produced waters. The lack of formal definitions adds unneeded complexity and uncertainty to disposal data and should be remedied in future legislation and regulation.
- Act 13 requires operators to track the origins and destinations of all oil and gas wastewaters and to make that information available to DEP upon request. Given the significant public interest in wastewater issues and this Act 13 enabling language, DEP should consider requesting that operators include this "manifest tracking" data in their biannual waste reporting and that the resulting data be made available for public consumption. Several other oil and gas states have similar requirements, and the cost to industry is not great because they are already required to collect and track this information. The ability to follow all wastewater from well site to disposal location could greatly improve public faith in the handling of these materials.
- Many wastewater treatment technologies leave residual by-products after the water is reclaimed. Additional government attention and industry and academic research should be aimed at the appropriate disposal and/or beneficial reuse of these by-products.
- To ensure the protection of drinking water sources, DEP should evaluate current and future wastewater regulations by their ability to move toward zero discharge of natural gas-related wastewater in favor of recycling, reuse, and underground injection. On-site reuse is particularly useful because it has the added benefit of avoiding off-site spills and accidents during transport.
- Given the increased attention to Pennsylvania wastewater disposal, DEP should proactively engage U.S. EPA in a dialogue about the current effectiveness and management of the Underground Injection Control and Wastewater Pre-Treatment programs, which are currently administered by EPA. The two agencies have not discussed existing regulation in these two programs for some time and might be able to cooperatively improve management of them. Also, EPA recently completed a comprehensive risk analysis for Class 1 hazardous materials injection wells. EPA and/or the Commonwealth should consider conducting a similar analysis for Class 2 oil and gas brine disposal injection wells.

GROUNDWATER PROTECTION

More than 3 million rural and suburban Pennsylvanians rely on private water wells for everyday drinking water.[85] Within the counties in Marcellus Shale development areas, more than 30 percent of county residents rely on private water wells.[86] Under current rules, Pennsylvania, along with Michigan, remains one of two states without private well regulations concerning well location, construction, testing, and

[85] Swistock, Bryan, Stephanie Clemens, and William E. Sharpe. "Drinking Water Quality in Rural Pennsylvania and the Effect of Management Practices."*The Center for Rural Pennsylvania.* Jan. 2009. pg.5.
http://www.rural.palegislature.us/drinking_water_quality.pdf

[86] Boyer, Elizabeth, et.al. "The Impact of Marcellus Gas Drilling on Rural Drinking Water Supplies." *The Center for Rural Pennsylvania.* March 2012. pg.6.
http://www.rural.palegislature.us/documents/reports/Marcellus_and_drinking_water_2012.pdf

treatment.[87] Some counties and municipalities have filled this void with the establishment of local well permits and construction standards.[88]

Unfortunately, many wells still fail to meet "recommended construction standards, presumably reflective of the lack of statewide water well construction regulations, which likely contribute to impairments of certain water quality standards."[89] Poorly constructed water wells pose a human health and safety risk, resulting in pathways for bacteria and other contaminants, such as methane and nitrates, to migrate into the potable water supply.[90/91] A study conducted by the Center for Rural Pennsylvania estimates that roughly 41 percent of the 1 million water wells in the Commonwealth fail to meet at least one of the health-based drinking water standards.[92]

Pursuant to Act 13, operators are presumed to be liable for water supply pollution if that water supply is within 2,500 feet of the unconventional well and the pollution occurs within 12 months of well completion. To rebut this presumption, operators are encouraged to obtain a baseline sample of the water supply (with the owner's consent). The pre-drill samples must be analyzed by certified laboratories and can then be compared to results after development occurs. The act does not, however, provide required testing parameters or create uniform disclosure requirements for the state or companies. Post-drilling samples also are largely not collected and analyzed unless a complaint is received. The Marcellus Shale Coalition (MSC) has developed a "Recommended Practice for Pre-Drill Water Supply Surveys" that was released in August 2012. This guidance document is one in a series of recommended practices being developed by the coalition.[93] The MSC also is developing an online pre-drill water survey database to serve as a clearinghouse for sampling results from across the state, though this database will not be publicly accessible.

House Bill 343, introduced by Representative Ron Miller in January 2013 and currently under consideration in the House, would establish construction standards for Pennsylvania's private water wells. The Governor's Marcellus Shale Advisory Committee also expressed concern over private water well contamination and the need to create a regulatory structure to ensure safe drinking water (Recommendation 9.2.17).[94] Legislation on private well standards has been proposed multiple times in the past but has failed.

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[87] Wagner, Donald. "Testimony of the Pennsylvania Council of Professional Geologists to Pennsylvania House of Representatives Consumer Affairs Committee." Jan. 10, 2012. http://www.pahouse.com/consumeraffairs/docs/HB1855/Donald%20Wagner.pdf

[88] One local water well regulation example from Chester County can be accessed at: www.chesco.org/DocumentCenter/Home/View/429

[89] Wagner, Donald. "Testimony of the Pennsylvania Council of Professional Geologists to Pennsylvania House of Representatives Consumer Affairs Committee." Jan. 10, 2012. http://www.pahouse.com/consumeraffairs/docs/HB1855/Donald%20Wagner.pdf

[90] "Governor's Marcellus Shale Advisory Commission Report." July 22, 2011. pg.108. http://files.dep.state.pa.us/PublicParticipation/MarcellusShaleAdvisoryCommission/MarcellusShaleAdvisoryPortalFiles/MSAC_Final_Report.pdf

[91] Wagner, Donald. "Testimony of the Pennsylvania Council of Professional Geologists to Pennsylvania House of Representatives Consumer Affairs Committee." Jan. 10, 2012. http://www.pahouse.com/consumeraffairs/docs/HB1855/Donald%20Wagner.pdf

[92] Ibid.

[93] MSC Recommended Practices can be reviewed at: http://marcelluscoalition.org/category/library/recommended-practices/

[94] "Governor's Marcellus Shale Advisory Commission Report." July 22, 2011. pg.108. http://files.dep.state.pa.us/PublicParticipation/MarcellusShaleAdvisoryCommission/MarcellusShaleAdvisoryPortalFiles/MSAC_Final_Report.pdf

In a corollary attempt to protect groundwater, DEP updated the requirements governing cementing and casing for gas wells.[95] These components include casing and cementing protocols and provisions for ongoing integrity monitoring. Excellent cementing and casing work is perhaps the most important method for preventing methane migration incidents. While these regulations have broad support, some stakeholders remain concerned about the adequacy of DEP staffing levels for robust inspection of casing and cementing jobs. Ongoing attention to these issues will be necessary, particularly as it is unclear how cement will hold up under future re-fracturing operations.

Additional groundwater concerns are often cited with respect to the abandoned gas and oil wells throughout the region. Abandoned wells can be breached through the drilling and fracturing process and can allow for the unintended movement of wastewater or methane into aboveground and underground water bodies. Within the Commonwealth of Pennsylvania, more than 325,000 oil and gas wells have been drilled since 1859. Of that number, about 184,000 oil and gas wells are unaccounted for.[96] Proposed Chapter 78 language would require that companies take steps to identify abandoned wells within 1,000 feet of the entire vertical and horizontal length of the well bore on their permit applications (78.52a).

Groundwater Protection Recommendations

- Enhanced research and monitoring are needed to establish baseline groundwater conditions and gauge possible cumulative impacts of shale gas development on groundwater. Act 13 provided impact fee monies to the Commonwealth Financing Authority to fund statewide initiatives that can help to collect baseline water quality data on private water supplies. This program and others should be supported and expanded.
- The General Assembly should pass House Bill 343 or similar legislation that would establish construction standards for new private water wells to better ensure access to clean drinking water for all Pennsylvania residents (leaving Michigan as the only state without such requirements). This legislation would help to prevent contamination problems for all new water wells in the state. For already drilled water wells, legislators should consider adding technical and financial assistance provisions to aid homeowners in the evaluation, maintenance, and refurbishment and/or replacement of their existing wells. Perhaps counties and local governments could be encouraged to create grant programs for this purpose using impact fee revenues. The Penn State Extension Service could likely make substantial contributions in this area as well.
- DEP should undertake efforts to standardize pre-drilling subsurface geologic and groundwater quality testing parameters, methodologies, and reporting requirements. In the category of water testing, the state's existing guidance, the MSC Recommended Practice, and other relevant tools could form the basis for these requirements. Consistency of testing and reporting will help to improve the utility of this data for regulators and landowners and will enhance the image of

[95] 25 Pa. Code Chapter 78, Subchapter D
[96] StateImpact, "Across Pennsylvania, Abandoned Wells Litter the Land." Nov. 13, 2012. http://www.npr.org/2012/11/13/164139865/across-pa-abandoned-wells-litter-the-land

these processes for the public. Consistent parameters for post-drilling water sampling protocols also should be developed.

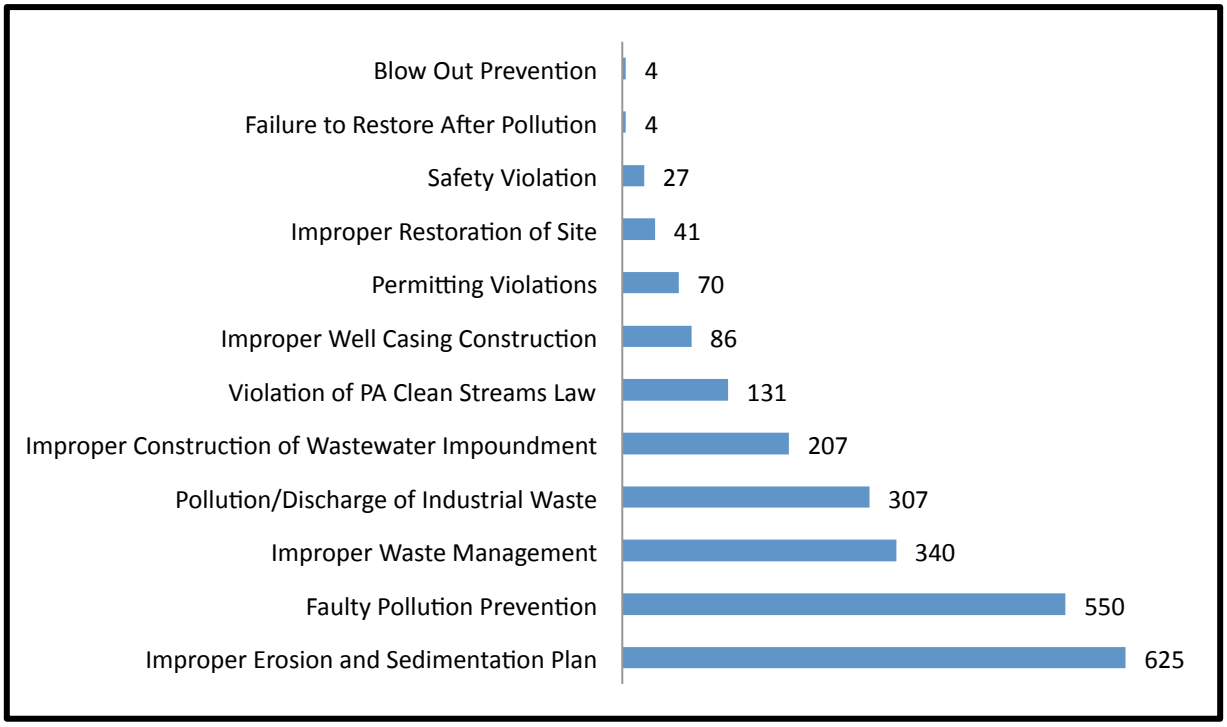
- Regular inspection of sites is necessary to ensure industry compliance with DEP cementing and casing standards. In anticipation of future well re-stimulation activities, the Commonwealth should develop requirements for checking the continued strength and stability of the original cementing and casing. As noted in the Core Recommendations, it will be essential that DEP sets transparent goals and possesses the resources and staff to meet its inspection obligations.
- Due to groundwater infiltration concerns, Chapter 78 should be amended to prohibit on-site disposal of drill cuttings from the horizontal phase of drilling operations or solid wastes from the hydraulic fracturing of unconventional wells. Given the possible constituents of these cuttings, the Commonwealth can remove the possibility of water impairment by requiring appropriate off-site disposal.

WATER-RELATED VIOLATIONS

From January 2008 to December 2011, DEP reported 3,355 environmental violations related to shale gas development by 64 different companies.[97] Of these violations, 2,392 posed a likely direct threat to Pennsylvania's environment and were not categorized as reporting or paperwork violations.[98] Improper Erosion and Sedimentation Plans, Faulty Pollution Prevention, Improper Waste Management, and Pollution/Discharge of Industrial Waste accounted for more than 75 percent of these environmental violations, as seen in Table 4 below.[99]

[97] Staaf, Erika. "Risky Business: An Analysis of Marcellus Shale Gas Drilling Violations in Pennsylvania 2008-2011." Penn Environment Research and Policy Center. Feb 2012. pg.1. http://pennenvironmentcenter.org/sites/environment/files/reports/Risky%20Business%20Violations%20Report_0.pdf
[98] Ibid.
[99] Ibid. pg.3.

Table 4: Environmental Violations by Category (2008-11)[100]



From 2008 to 2011, the top 25 shale gas well producers accounted for 94 percent of well development within Pennsylvania while causing only 82 percent of violations.[101] On average, shale gas developers received about 0.77 violations per well.[102]

The total number of shale gas violations reported is likely overstated given the antiquated violation classification system DEP currently employs. Single incidents often spawn multiple violations depending on the circumstances of the incident, the number of state laws used to cite the violation, and the number of wells on the site. For instance, a single spill can result in five spill violations if there are five wells located on the well pad and could be recorded as more than five if, for example, both the Oil & Gas Act and the Clean Streams Law are used in the citation. Additionally, DEP does not currently provide easily understandable information related to the severity of potential environmental harm from violations. Furthermore, DEP does not currently supply information on operator remediation actions in response to the violations (though it is now required to do so under Act 13).

Water-Related Violations Recommendations

- While violations are entered into the state data systems on a daily basis and are readily accessible to the public, DEP should invest in additional improvements to these databases. Violations should be better categorized to allow for understanding of the nature of the violation, its actual or potential severity of impact, DEP's enforcement actions, and the operator's response to the violation (as required by Act 13). DEP should consider annually summarizing and

[100] Ibid. pg.3.
[101] Ibid. pg.4
[102] Ibid. pg.6-7

reporting on violation activity as well as on progress in remedying violations and preventing future incidents.

- DEP also should remove redundant violation records for single incidents so that the public and policymakers can more clearly evaluate violations activity.

REGIONAL WATER MANAGEMENT

In addition to falling under the regulatory powers of the Department of Environmental Protection, activities in Pennsylvania also are overseen by a system of interstate river basin commissions: the Ohio River Valley Water Sanitation Commission (ORSANCO) in Western Pennsylvania, the Susquehanna River Basin Commission (SRBC) in central Pennsylvania, and the Delaware River Basin Commission (DRBC) in eastern Pennsylvania. All three river commissions play an important role in their respective regions' water management. A primary difference among the three is ORSANCO's lack of oversight authority with respect to water quantity issues surrounding withdrawals and diversions and its relative lack of activity upstream from the Ohio River's main stem. ORSANCO's founding compact among its eight member states and the federal government charges the commission with maintaining the Ohio River Basin's water in a condition that is:

- available for safe and satisfactory use as public and industrial water supplies after reasonable treatment,
- suitable for recreational usage and capable of maintaining fish and other aquatic life,
- free from unsightly or malodorous nuisances due to floating solids or sludge deposits, and
- adaptable to such other uses as may be legitimate.[103]

ORSANCO's lack of water quantity management and water quality attention in the headwaters is a possible gap for the consideration of policymakers. DEP has viable water management partners in the Susquehanna and Delaware commissions but currently does not in the Ohio, which has presented an increasing challenge as DEP's budget has been repeatedly decreased over the last decade.

The state legislature addressed the issue of water quantity management through several provisions in Act 13. For example, DEP has been charged with developing similar Water Management Plan (WMP) requirements to those within SRBC.[104] Oil and gas Water Management Plans under Act 13 are required not to infringe on current uses or on the current quantity or quality of water bodies. In the portions of the state currently overseen by SRBC, DRBC, and the Great Lakes Commission, operators are still required to meet these organizations' withdrawal standards.[105] Operators who meet the commissions' requirements can be considered to have met DEP's WMP provisions as well, thereby preventing duplicative measures (though DEP can add additional responsibilities if desired).

An additional tool for communities to proactively protect their drinking water has been put forward by EPA in its Source Water Protection Planning Program, authorized by the 1996 amendments to the Safe Drinking Water Act. Local communities can voluntarily develop a Source Water Protection Plan for DEP

[103] Ohio River Valley Water Sanitation Commission. "Ohio River Valley Water Sanitation Compact." June 30, 1948. http://www.orsanco.org/images/stories/files/CompactNoSeals.pdf
[104] Act 13 of 2012, HB 1950 § 3211
[105] Act 13 of 2012, HB 1950 § 3211(m)(3)(i)

review and approval, which outlines a comprehensive plan to achieve maximum public health protection through the following steps:

- Delineate the drinking water source protection area to be covered in the plan
- Inventory potential sources of water pollution within the protection area
- Determine the susceptibility of the water source to identified contaminations
- Notify and involve the public about threats to the water source and what they mean to their public water system
- Implement management measures to prevent, reduce, and eliminate identified threats
- Develop contingency planning strategies to deal with water supply contamination or service interruptions[106]

Unfortunately, because these plans are voluntary, there are relatively few DEP-approved plans in place.[107]

Regional Water Management Recommendations

- As delineated in the water sourcing section, the Commonwealth should support and actively engage in the ongoing ORSANCO water quantity studies.
- In 2009, a regional effort led by the Regional Water Management Task Force endorsed the creation of a Water Planning Division at the Southwestern Pennsylvania Commission (SPC). That effort, which is underway, is designed to improve the cohesion of water monitoring, planning, investment, and technical assistance within a 10-county Ohio River Basin area. While SPC plans to initially focus its primary attention on stormwater, shale gas water management issues provide further impetus for this work. The region should support the growing role of SPC in planning for the future of the region's water resources.
- The Chapter 78 draft rulemaking states that DEP will collaborate with the Susquehanna River Basin Commission, the Delaware River Basin Commission, and the Great Lakes Commission on water monitoring and regulation of oil and gas activities. While Southwestern Pennsylvania does not have a direct corollary agency, DEP should consider outreach to and partnership with both ORSANCO and SPC on Ohio River Basin water resources management. Such collaborations would allow DEP to have natural water partners within this region of a similar type to those that already exist in central and eastern Pennsylvania.
- Local communities should consider the potential benefits of developing and maintaining a Source Water Protection Plan for drinking water sources. DEP should continue to encourage local jurisdictions to complete such plans and provide technical assistance to support the planning processes.

[106] Pennsylvania Source Water Protection Planning Guidance: http://www.sourcewaterpa.org/
[107] *What is the Status of Your Water System's Source Water Protection Program?* Region-by-region delineation of Source Water Protection Plans: http://www.sourcewaterpa.org/?page_id=282

WATER MONITORING

Within the region, several organizations are tasked with monitoring water quality. ORSANCO sets pollution control standards for industrial and municipal wastewater discharges in the region and monitors water quality to ensure compliance. ORSANCO tracks 26 attributes to determine water quality in the region, including flow rates and levels of chloride, dissolved oxygen, and sulfates. Information is collected from 11 stations across the Ohio River Valley including from a site near West View in Pennsylvania. The U.S. Geological Survey administers the Pennsylvania Water Quality Information Network as well. Data from ORSANCO's and USGS's stations is available for public use.[108] Elsewhere in Pennsylvania, water monitoring also is conducted by SRBC and DRBC. In addition to monitoring water quality, SRBC and DRBC also are tasked with monitoring quantity in their respective regions.

Additional water monitoring is conducted by the U.S. Army Corps of Engineers through its Ohio River Water Quality Program. The program monitors and manages water quality in reservoirs, lakes, tributaries, and rivers that have corps-operated structures for flood control and navigation. The corps also monitors pollutants in sediment, macro-invertebrates, algae, bacteria, and zebra mussels. Water monitoring also is done on a smaller scale by watershed organizations. Watershed monitoring programs vary significantly in size, sophistication, and the types of monitoring they perform.

The Western Pennsylvania Conservancy (WPC) also is undertaking a monitoring effort to gauge the impacts of shale gas development on priority conservation areas and Pennsylvania's rare and threatened species. Various tools and analyses are being used to prioritize areas of greatest conservation value across the state. These priority conservation areas will then be compared to projected Marcellus and Utica development areas to determine where conservation and monitoring work will have the greatest utility and impact. The project will include a significant effort to bring together researchers and policy advocates from academic institutions, government agencies, and conservation groups to determine research priorities, share data and methods, and collaborate on monitoring efforts. WPC also will engage municipalities, conservation districts, and landowners in the development of lease language, zoning, and site management strategies for high-value conservation areas. Ultimately, WPC's efforts will result in a comprehensive science-based assessment of shale gas development impacts within areas of high conservation value to be used by policymakers, regulators, landowners, the natural gas industry, and WPC and other conservation organizations to avoid and minimize impacts to high-value conservation areas.

The National Science Foundation is working to aggregate water monitoring data through its Shale Network database. The Shale Network is attempting to harness community-based data gathered by various water monitoring organizations and standardize it for research and monitoring purposes. The network website describes the effort in this way:

> *The Shale Network is a project funded by the National Science Foundation to help scientists and citizens store data for water resources that may be affected by gas exploitation in shale. Our primary focus currently is the Marcellus shale and other shales in the northeastern U.S.A. We*

[108] USGS data can be accessed at: http://pa.water.usgs.gov. ORSANCO datasets are available at: http://www.orsanco.org/data

want to enable the generation of knowledge from water chemistry and flow data collected in areas of extraction of natural gas. The Shale Network is working with the Consortium of Universities for the Advancement of Hydrologic Sciences, Inc., (CUAHSI) to create this database. Our goal is to find, organize, and upload data for water resources for online publication. The Shale Network is seeking organizations engaged in water quality monitoring or research to join our effort.[109]

Finally, the River Alert Information Network (RAIN) is a consortium of 33 public water supply systems in the Ohio River Basin that are collaborating to detect and prevent any contamination in their systems. The RAIN system includes early warning water quality monitors at 29 sites along the Monongahela, Allegheny, Shenango, Youghiogheny, Beaver, and Ohio rivers. The monitors can identify a range of possible contaminants in real-time and automatically notify members about the presence of those contaminants. This enables the water systems to quickly implement corrective and protective actions.[110]

[109] Additional information on the Shale Network water data effort is available at: http://www.shalenetwork.org
[110] Information on RAIN available at: http://www.3rain.org/index.php

MIDSTREAM DEVELOPMENT IN PENNSYLVANIA

Midstream infrastructure consists of pipelines, processing facilities, compressor stations, and related infrastructure for transporting natural gas from well sites and preparing that gas for market. Issues related to the development of the midstream system are of growing importance within the Commonwealth, as evidenced by increased media coverage of pipeline construction, levels of midstream industry financing activity, and applications for onshore pipeline permits to the Federal Energy Regulatory Commission (FERC).[111] As of December 2012, 57 percent of Pennsylvania's spud unconventional wells were producing gas, a number that at least partially reflects the need for additional pipeline infrastructure to bring these wells into production. In the last six months of 2012, 683 wells were producing that had not been in the previous six-month period, possibly indicating the scale of recent midstream investment.[112]

This ongoing development of a gathering and transmission network for Pennsylvania's unconventional wells caught the Roundtable's attention for multiple reasons:

- Building pipelines includes both substantial surface disturbance (both temporary and permanent) and construction activities that have environmental risks in areas such as erosion and sedimentation, invasive species introduction, forest fragmentation, and stream crossings and encroachments.
- While incidents have been rare, the safety of pipeline systems will continue to be a public concern.
- Air quality and climate change impacts from compressor stations and methane leakage are possible.
- The pipeline system is a delivery mechanism to get shale resources from production to end users. As the markets for these resources continue to develop within the Commonwealth, the locations of midstream infrastructure can, at times, be either a help or a hindrance to users' cost-effective access.
- Pipeline rights-of-way become fairly permanent aspects of the landscape, and midstream planning will continue to interact with other local economic and community development planning.
- Any development inefficiencies that add to the costs of the overall system could possibly be passed on to the consumers and ratepayers.

As Pennsylvania's shale gas industry matures, the administration and legislature will need to periodically examine the Commonwealth's midstream policy and regulatory framework with these issues in mind.

[111] Federal Energy Regulatory Commission. "Major Pipeline Projects Pending (Onshore)." http://www.ferc.gov/industries/gas/indus-act/pipelines/pending-projects.asp

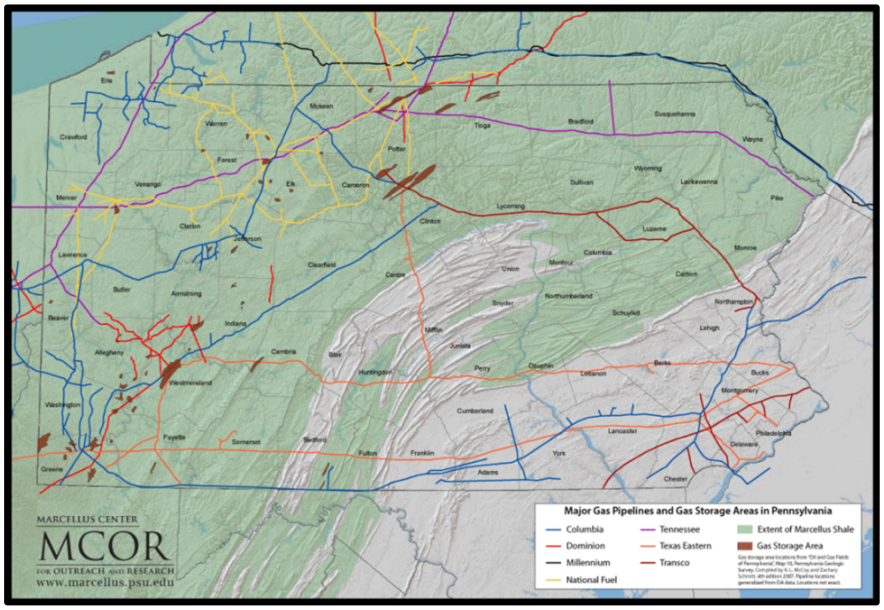
[112] See Southwestern Pennsylvania Oil and Gas Activity Dashboard in Appendix A for further information on producing wells.

The Roundtable prepared the information below to support this examination and to guide thinking on best practices for managing midstream development.

BACKGROUND ON THE NATURAL GAS MIDSTREAM SYSTEM[113]

The U.S. natural gas pipeline network is an integrated gathering, transmission, and distribution system that transports natural gas from producing wells to end users. The country has more than 300,000 miles of interstate and intrastate transmission pipelines, which are just one component of the system. As demonstrated in the map below, gas pipelines and storage areas within Pennsylvania are concentrated around large population centers and gas-producing regions.

Major Gas Pipelines and Gas Storage Areas in Pennsylvania*[114]*



The transport of natural gas from production to the final customer is a complex process that typically involves several transfers of gas ownership and multiple processing steps. The system begins at the site of production, generally a wellhead or natural gas field. The extracted natural gas, oil, and natural gas liquids are then transported through gathering lines from the production area to either a processing facility or directly to a transmission grid, depending on the initial quality of the product gathered from the wellhead. Gathering lines are generally smaller diameter pipelines buried at least several feet below the surface and are located within cleared and marked rights-of-way. During the gathering phase, the collected natural gas stream may be subjected to an extraction process in order to remove water and other impurities. Natural gas is commonly referred to as "wet" if, at the time of production, it contains significant amounts of lower molecular weight hydrocarbons such as ethane, propane, and butane. Although these hydrocarbons exist in a liquid state deep underground at high pressure, they become

[113] Overview of the midstream system and components partially summarized from the U.S. Energy Information Administration's pipeline primer: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/index.html
[114] Marcellus Center for Outreach and Research. Pennsylvania State University. http://www.marcellus.psu.edu

gases at surface atmospheric pressure. Natural gas that does not contain such hydrocarbons is often termed “dry gas.”

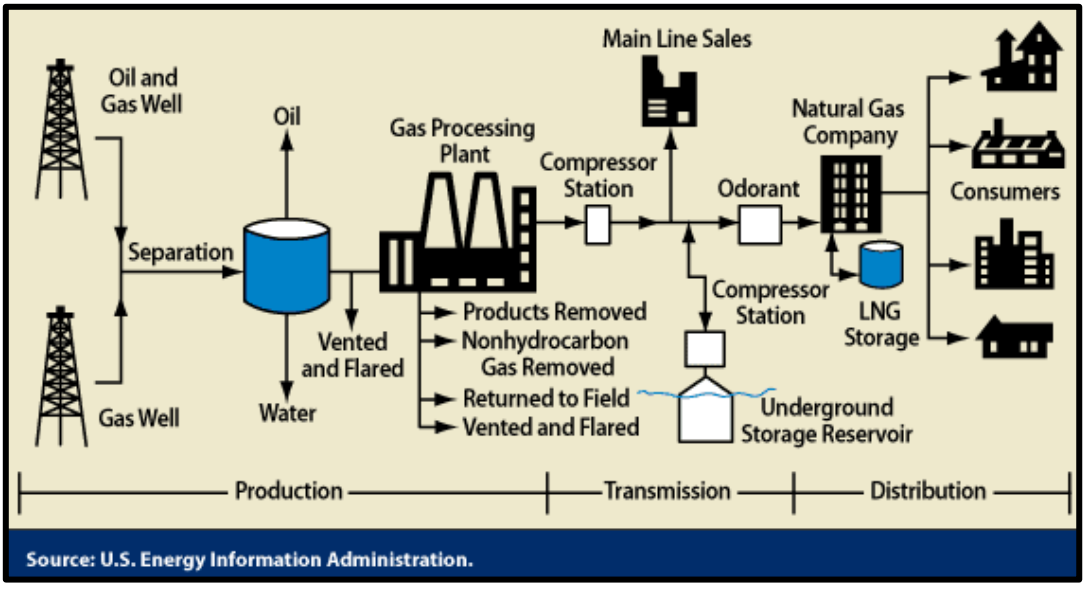
The natural gas in Western Pennsylvania is often wet gas, rich in non-methane hydrocarbons that can be more valuable than the natural gas itself. Wet gas goes through processing that extracts the other, heavier hydrocarbons from the methane, leaving the now “dried” gas pipeline ready. The extracted hydrocarbons are directed to a specialized plant to undergo a process known as fractionation. These facilities separate the hydrocarbon stream into its constituent parts, such as propane, butane, and ethane, which can then be marketed separately as commodities.

Natural gas transmission lines are wider in diameter and traverse the often long distances between the gathering systems, processing plants, and the final distribution network. Generally, transmission pipelines are designed as a trunk line system, with a large number of laterals branching off the main line to form a network of numerous interconnections that receive processed gas and deliver that gas to major markets. There are typically compressor stations of various sizes located along a transmission system whose purpose is to maintain the pressure as well as the rate of flow of natural gas through the lines.

At the terminus of the transmission system, and sometimes along the transmission pipeline route, there are underground natural gas and liquefied natural gas (LNG) storage facilities. These facilities provide inventory management, supply backup, and allow for ready access to natural gas to ensure that customer demand can be met. There are three types of underground storage facilities used in the United States today, which include depleted reservoirs in oil and gas fields, aquifers, and salt cavern formations. Two of the most important qualities of these storage facilities are their capacity to hold natural gas for future use and the speed at which natural gas inventory can be injected and withdrawn.

Transmission pipelines ultimately deliver gas to local distribution utilities, which in turn supply natural gas to industrial, commercial, and residential customers. The U.S. Energy Information Administration graphic below depicts the midstream system, from production to distribution.

Diagram of the Natural Gas Production, Transmission, and Distribution System



MIDSTREAM INFRASTRUCTURE OVERSIGHT AND REGULATION

While shale gas exploration and production occupies most of the spotlight, midstream issues also have begun to garner attention at all governmental levels. Locally, several Pennsylvania jurisdictions such as Bradford County have been working with midstream operators to enhance transparency, coordinate planning efforts, collect data on midstream infrastructure locations, and limit any negative impacts from pipeline placement decisions.[115] Nationally, the Federal Energy Regulatory Commission (FERC) in 2012 hosted a series of regional workshops to ease potential tensions between natural gas pipeline operators and electric power generation companies.[116]

FEDERAL MIDSTREAM MANAGEMENT FRAMEWORK

Regulatory oversight for pipeline infrastructure is established based on the characteristics of the specific lines under consideration. Pipelines are most often classified based on whether they cross state boundaries and on their proximity to populated areas and occupied buildings. Pipelines located in densely populated areas are designated Class 4, while very rural parts of the country have largely Class 1 lines.[117]

FERC has jurisdiction over the permitting and economic (rate) regulation of interstate pipelines, which cross state boundaries, and is responsible for overseeing the implementation and operation of the natural gas transmission system. These interstate lines can be sited using eminent domain powers under federal law. Intrastate gathering and transmission pipelines, which are completely within a single state, usually do not require economic regulation from either the federal or state government and do not have eminent domain capabilities. Local distribution systems are typically regulated by the states as public utilities.

The Pipeline and Hazardous Materials Safety Administration (PHMSA), which is located within the U.S. Department of Transportation, is charged with ensuring the safe, reliable, and environmentally sound operation of the nation's pipeline transportation system. PHMSA's safety jurisdiction over pipeline infrastructure currently extends to Class 1 transmission lines and all Class 2, 3, and 4 lines; its jurisdiction does not extend to Class 1 rural gathering pipelines.[118] Additionally, the U.S. Department of Homeland Security has a role in the regulation of pipeline system security and emergency preparedness, and the U.S. Army Corps of Engineers has a role in permitting stream crossings. The implementation of PHMSA's pipeline safety regulations and inspections are often delegated to the relevant agencies of the states.

In 2012, President Obama signed into law the *Pipeline Safety, Regulatory Certainty, and Job Creation Act*, a bill introduced by Pennsylvania Congressman Bill Shuster with bipartisan support.[119] The legislation doubles the maximum fine for safety violations, authorizes additional federal pipeline

[115] Maps resulting from Bradford County communications and data collection efforts can be found at: http://bradfordcountypa.org/Natural-Gas.asp?specifTab=2

[116] Additional details on the FERC workshops and the results are available at: http://www.ferc.gov/industries/electric/indus-act/electric-coord.asp

[117] Detailed pipeline class designations under PHMSA regulations are available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title49-vol3/pdf/CFR-2010-title49-vol3-sec192-5.pdf

[118] PHMSA mission, powers, and goals: http://www.phmsa.dot.gov/about/mission

[119] Text of Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2012: http://thomas.loc.gov/home/gpoxmlc112/hc93_enr.xml

inspectors, and requires automatic shut-off valves on new or replaced pipelines. However, existing pipelines are exempt from the automatic shut-off valve requirement, primarily due to the cost/benefit analysis of retrofits. The Act also requires the Secretary of Transportation to conduct a study of existing federal and state regulation of natural gas Class 1 gathering lines to determine the need for any additional regulation at the federal level. The study is due to the U.S. Congress by January 2014.

PENNSYLVANIA MIDSTREAM ACTIVITIES

In the Commonwealth, the Department of Environmental Protection regulates defined aspects of pipeline development, including erosion and sedimentation controls and waterway crossings. The Public Utility Commission (PUC) is the primary pipeline safety agency. It also regulates local distribution utilities and manages relevant systems such as PA One Call.

Governor Corbett's Marcellus Shale Advisory Commission 2011 report included the following recommendations relevant to midstream development:

9.1.1
Currently, there is only one gas safety inspector training center (Oklahoma) in the nation. Pennsylvania, in partnership with industry, the federal Pipeline and Hazardous Materials Safety Administration and educational institutions, should pursue existing opportunities which seek to locate a gas safety inspector training facility within the Commonwealth.

9.1.2
To address the lack of coordinated permitting processes for pipeline deployment, the Commonwealth should designate a state agency to create a "One-Stop" permitting process while expanding the use of General Permits to authorize routine development activities, as well as maintain jurisdiction over multi-county linear pipeline projects and ensure appropriate notifications have been made to local jurisdictions. It is not the purpose of this proposal to encourage the expansion of statutory jurisdiction of the Public Utility Commission beyond gas safety oversight in so far as non-jurisdictional gathering lines are concerned.

9.1.7
The Public Utility Commission should be given statutory gas safety oversight of non-jurisdictional intrastate gathering systems, including mechanisms to establish safety standards regarding the design, construction and installation of such lines within Class 1 areas.

9.1.13
A lead state agency should be designated to alleviate delays in linear pipeline project development and approval; to identify redundant (state and federal) natural and cultural resource reviews which should be eliminated; to properly tailor the scope of agency reviews; and the PA Natural Resource Inventory on-line tool should be expanded to accommodate linear projects longer than 15,000 feet.

9.1.15
State law should be amended to authorize PENNDOT to negotiate leases which permit the location of energy and utility infrastructure within PENNDOT's right-of-way.

9.2.35
Identify legislative/regulatory changes needed to:

- *Effect the sharing of pipeline capacity and reduce surface disturbance and associated environmental impacts;*
- *Encourage the use of existing pipeline infrastructure and co-location with other rights-of-way;*
- *Achieve coordination and consistency of infrastructure planning and siting decisions by state, county, and local governments;*
- *Provide sufficient authority and resources for appropriate government agencies to ensure that ecological and natural resource data are used in the review and siting of proposed pipelines, in order to avoid or minimize impacts to these resources.*

9.4.13
The Commonwealth should incentivize the development of intrastate natural gas pipelines to ensure the in-state use of Marcellus Shale gas and to lower costs to consumers through the avoidance of interstate pipeline transmission costs.

In December 2011, the Pennsylvania General Assembly passed Act 127, the *Gas and Hazardous Liquids Pipelines Act*, a partial response to the Marcellus Shale Advisory Commission's midstream recommendations.[120] The legislation, introduced by Representative Matt Baker, created a pipeline registry for natural gas midstream infrastructure and granted the PUC jurisdiction over the inspection of several classes of pipelines. Pipeline siting and inspection requirements not related to safety were not included in this legislation. Pipeline operators are now required to annually register and file certain data with the PUC. These registered operators are then charged a fee to cover the administrative costs of implementing this act. The Act became effective in February 2012, and the PUC issued its Final Order and began implementation in June of 2012.[121]

The legislation authorizes PUC inspectors to apply federal PHMSA pipeline safety regulations to Pennsylvania natural gas and hydrocarbon liquids lines that are not operated by public utilities. Under Act 127, Class 2 through Class 4 gathering, transmission, and storage facilities and Class 1 transmission will be regulated by the PUC using applicable federal safety requirements. The original House bill also included Class 1 onshore conventional and unconventional well gathering facilities (the lines that typically carry gas from the wellhead to the transmission system). While in the Senate, the final legislation was amended to include these Class 1 gathering lines in the pipeline registry and to exempt them from safety inspection requirements until such time as the federal government includes them in national regulation. As of October 2012, 43 unconventional pipeline operators had provided information to the pipeline registry. The resulting data indicated that a total of 2,535.5 miles of unconventional

[120] Text of Act 127 of 2011 available at:
http://www.legis.state.pa.us/CFDOCS/Legis/PN/Public/btCheck.cfm?txtType=HTM&sessYr=2011&sessInd=0&billBody=H&billTyp=B&billNbr=0344&pn=2816
[121] PUC Clearinghouse for Act 127 information:
http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_127_pipeline_act.aspx

gathering and transmission pipelines had been built in Pennsylvania through that date.[122] Assuming approximately 2,726 existing unconventional well pads with 2,535.5 miles of pipeline reported to the PUC, it can be estimated that an average of 1.08 miles of new pipeline has been constructed to service each Pennsylvania well pad.[123]

The recent update to Pennsylvania's oil and gas law, Act 13 of 2012, did not substantially address pipeline issues. Section 8 of that law did, however, adopt the following charge:

> *The Energy Executive of the Governor shall consult with the Department of Environmental Protection, the Pennsylvania Public Utility Commission, State legislators, local government organizations, natural gas industry representatives, conservationists and other affected entities on the issue of pipeline placement for natural gas gathering lines in this Commonwealth. The Energy Executive of the Governor shall submit a report summarizing pipeline placement for natural gas gathering lines and make his recommendations to the General Assembly within one year of the effective date of this section.*

This report to the General Assembly was completed and released by the Governor's Office in December 2012.[124] The report aimed to advance efficient and smart deployment of natural gas gathering lines so as to minimize environmental and community impacts. The report includes thorough background information on pipeline development within the Commonwealth and 16 recommendations to the General Assembly for improved pipeline development in the future (see Appendix F for a full listing of the recommendations).

The report includes recommendations for increased communication between municipal/county officials and industry operators in areas where pipeline construction is likely to occur regarding local plans for current and future community development. Based on this type of dialogue, operators can seek out opportunities to work within the community's comprehensive plan in ways that would maximize shared rights-of-way and offer the least detrimental effect to that community.

RECOMMENDATIONS FOR PENNSYLVANIA'S MANAGEMENT OF MIDSTREAM INFRASTRUCTURE

The Roundtable's deliberations in this area were based on review of existing federal and state policies and on dialogue with key stakeholders, including DEP, the PUC, staff and members of the Pennsylvania General Assembly, and conservation and industry representatives.

In order to promote midstream development that is environmentally protective and economically beneficial, the Roundtable recommends that the Commonwealth and interested stakeholders pursue a suite of important goals, including the following:

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[122] Henderson, Patrick. "Report to the General Assembly on Pipeline Placement of Natural Gas Gathering Lines: As Required by Act 13 of 2012." December 11, 2012. http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/Act13/PipelinePlacementReport/FINAL_REPORT.pdf

[123] See Southwestern Pennsylvania Oil and Gas Activity Dashboard in Appendix A for further information on well pad estimates.

[124] Henderson, Pipeline Placement Report.

Crafting legislative and regulatory provisions that, in the public interest, encourage the efficient development of intrastate midstream infrastructure

The Commonwealth should actively seek opportunities for improving the efficiency of intrastate midstream infrastructure development, possibly including the sharing of pipeline capacity to transport produced gas. A focus on intrastate midstream development would provide Pennsylvania landowners and ratepayers with protection through the limiting of eminent domain power associated with interstate pipelines and through the avoidance of increased costs associated with FERC economic regulation.

In addition to sharing infrastructure, such coordinated systems could jointly take advantage of existing rights-of-way that may be available and even co-locate with other utilities or natural gas-related infrastructure. For example, in late 2011, Aqua America and PVR Ventures announced a partnership in which the former would supply natural gas production companies with water for hydraulic fracturing via supply lines in the latter's midstream rights-of-way.

Gathering lines will mostly continue to service the well locations of individual companies, but there may be particular opportunities for sharing capacity on transmission lines. Importantly, as the Pennsylvania transmission system matures, operators will likely begin to cluster unconventional wells nearby those transmission facilities in order to minimize the costs of building gathering lines. While joint efforts could be challenging because the new transmission would have to account for the diverse needs and lease-holdings of multiple operators, approaches such as these could serve the public interest through limiting surface disturbance and preventing the construction of unnecessary or duplicative lines. Identifying opportunities for increased efficiency also could decrease the total costs of infrastructure development, in turn positively influencing consumer rates.

To the degree that operators are proposing common/shared gas infrastructure, sited using environmental best practices, the Commonwealth may wish to consider granting priority review of required permits for these applicants.

Creating and leveraging opportunities for enhanced communication between midstream operators and other key stakeholders

In the near future, the PUC and DEP should consider partnering to convene three in-depth workshops to guide thinking on midstream issues in the Commonwealth:

1. Environmental and community impacts: A targeted discussion on present and future potential issues of concern regarding pipeline infrastructure. Industry; landowners; municipal and county officials; and environmental, conservation, and sportsmen's groups would be natural participants. What are the high-priority concern areas? How are companies proactively addressing them? Are the appropriate state regulatory tools available to manage those areas of concern?
2. Economic and regulatory efficiency: A multi-part dialogue with an initial focus on supporting increased efficiency of infrastructure development. The multiple state and federal agencies that

regulate aspects of midstream development should participate to discuss their own efforts at collaborative oversight and at improving the efficiency of interactions with industry.

3. Building midstream and downstream connections: A unique effort to create a dialogue among those who produce, transport, and use natural gas and related products in Pennsylvania. The workshops that FERC convened in 2012 between midstream operators and electric power generation companies focused on only one tension point in the natural gas supply chain. The challenges that result from these tensions are often national issues, but with important Pennsylvania implications. An initial conversation could include participants such as exploration and production companies, midstream operators, local distribution utilities, power generation companies, transportation sector representatives, and manufacturing companies. The goal would be to identify points of agreement and disagreement that have implications for Pennsylvania's management of its energy portfolio.

These conversations would be aimed at cross-sector relationship building and the identification of critical opportunities and challenges in the improvement of midstream policy and regulation. Due to the diverse interests and aspirations of the participants, the Commonwealth agencies are particularly well suited to serve as neutral conveners. Similar to FERC's approach in its workshops, the PUC and DEP should position themselves as facilitators, providing a framework for discussion and necessary background materials. If any or all of the discussions prove useful, additional follow-up sessions focused on more specific issues are possible.

Ensuring the availability of the necessary expertise and resources for state midstream permitting, planning, and inspection agencies

Acts 127 and 13 contributed to improving the resources available to the PUC and DEP for shale gas-related work. Staffing and resource issues for DEP are addressed at length elsewhere in this report. As midstream activity increases, the PUC also should regularly monitor and report on the sufficiency of its resources, staff, and technical capabilities to meet federal and Pennsylvania public safety regulation and inspection requirements.

Maintaining the protective adequacy of pipeline safety regulations, especially as larger volume, higher pressure gathering and transmission systems are being constructed

Act 127 largely incorporates federal pipeline safety regulations wholesale and enables the PUC to implement them. Any changes to those federal regulations, then, will automatically transfer to Pennsylvania as well. The U.S. Department of Transportation's study of Class 1 pipelines, due in January 2014, and the evolving pipeline activity landscape due to unconventional oil and gas development are two possible triggers for future regulatory updates. Given this arrangement, Pennsylvania should continue to engage with other states and with the federal government to aid in shaping and strengthening any potential safety updates.

Minimizing and avoiding surface disturbance, forest fragmentation, and other impacts on sensitive ecological areas

Most states, including Pennsylvania, lack regulatory power for the review of intrastate pipeline siting determinations. However, in the absence of eminent domain power, individual property owners can impact siting decisions through easement negotiations with midstream operators. In the absence of state review, multiple avenues are available to the Commonwealth and to operators in minimizing the environmental footprint of midstream infrastructure:

- The Roundtable's proposed framework for updating the Oil & Gas Conservation Law, explained earlier in this report, could be one of the strongest tools available to the state in avoiding surface disturbance and forest fragmentation. The Conservation Law framework is designed to rationalize units and prevent the construction of unnecessary well pads to extract the resource. Fewer pads should translate to less pad-related infrastructure, including gathering lines and access roads.
- DEP and other relevant state and federal regulatory agencies should consider creating a voluntary pre-construction consultation process, wherein developers would have the ability to discuss the proposed placement of new midstream infrastructure, particularly large transmission pipelines, and plans to minimize the impacts of that development. The utility and mechanics of such a process could be one of the discussion points for the second workshop outlined above.
- Ecological impacts also can be reduced through the increased use of siting decision support tools, which some operators already employ to great effect. These tools include mitigation banking and the identification and use of low-impact utility corridors where infrastructure can be clustered to avoid other, more sensitive areas. Conservation groups can be important partners in creating and effectively using such tools. For example, the Nature Conservancy has designed and built the Energy by Design protocol, which uses ecological data and computer models to help natural gas infrastructure avoid and/or mitigate impacts on high-value conservation areas.[125]
- The first recommendation in this section, regarding improved efficiency to avoid unnecessary infrastructure, also could be an important method for minimizing the surface footprint of the pipeline system.

Monitoring and responding to the implications of cumulative pipeline placement decisions on the needs of communities and citizens, on the potential for Pennsylvania customers to use gas produced within the state's borders, and on the future use and value of land

County commissioners and other local government officials, while having limited midstream regulatory power, should be consulted throughout the midstream development process as important partners in protecting the public safety and ensuring that operators are aware of and can adapt to local economic,

[125] The Nature Conservancy. Energy by Design. http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/colorado/howwework/energy-by-design-in-colorado.xml

land use, and community plans. While the PUC's Act 127 Pipeline Registry is useful, the legislature should consider amending that act to require not just the submission of pipeline mileage constructed but also the reporting of specific pipeline locations. This type of data would be extremely helpful to community planners and emergency responders.

During these consultations, operators and local officials also should review economic development considerations related to pipeline placement. While the historic analogy of railroads spurring economic development along their path is not quite applicable, there may be opportunities for innovative supply approaches along pipelines to feed various downstream users of natural gas, oil, and natural gas liquids.

In a related vein, midstream operators could have an important role in supporting the expansion of customer access to affordable natural gas service, particularly in rural and underserved areas. The Pennsylvania Senate recently adopted a resolution (SR 29), introduced by Senator Gene Yaw, directing the Center for Rural Pennsylvania to study the potential for increased residential, commercial, and industrial natural gas distribution infrastructure by Pennsylvania's public utilities to un-served and underserved areas of the Commonwealth.[126] Specifically, the Center was directed to study the deployment of natural gas distribution infrastructure by collecting and analyzing information on:

- estimated demand for natural gas service in un-served and underserved areas of the Commonwealth,
- estimated price consumers are willing to pay for access or conversion to natural gas service,
- regional differences in consumer demand and willingness to pay for natural gas service, and
- relevant economic information on the costs and benefits to expand natural gas distribution infrastructure.

SR 29 was adopted March 11, 2013, and the Center is required to report its findings, plans, and recommendations to the General Assembly no later than August 1, 2013.

In June 2012, the Senate passed two related pieces of legislation, both introduced by Senator Yaw and Majority Leader Dominic Pileggi. Senate Bill 739 would amend the Alternative Energy Investment Act to provide $20 million in grants to schools, hospitals, and smalls businesses to obtain access to natural gas service.[127] Senate Bill 738 – the Natural Gas Consumer Access Act – is designed to expand the local distribution and use of Pennsylvania-produced natural gas. The legislation would encourage government office buildings, school districts, institutions of higher education, correctional institutions, and hospitals to convert to natural gas.[128] Additionally, the legislation would:

- establish funding alternatives for gathering and distribution extensions to un-served and under-served areas,
- require the Public Utility Commission to develop rules to produce an orderly system for reviewing current levels of natural gas service and to allow for the orderly expansion of natural gas service to areas not currently served,

[126] Text of SR 29: http://www.legis.state.pa.us/cfdocs/billinfo/billinfo.cfm?syear=2013&sind=0&body=S&type=R&BN=0029
[127] Text of SB 739: http://www.legis.state.pa.us/cfdocs/billinfo/BillInfo.cfm?syear=2013&sind=0&body=S&type=B&bn=739
[128] Text of SB 738: http://www.legis.state.pa.us/cfdocs/billinfo/billinfo.cfm?syear=2013&sind=0&body=S&type=B&BN=0738

- allow municipalities to establish their own pipeline infrastructure,
- require all Pennsylvania natural gas distribution companies to file three-year plans with the Public Utility Commission outlining their plans for expansion and extension of service,
- ease the regulatory hurdles required for becoming a public utility,
- include a system of pipeline tap infrastructure for rural access, and
- provide rate incentives to state utilities that are aggressively acquiring and building new utility franchises in rural areas.

Senate Bills 738 and 739 now go to the House of Representatives for consideration.

Conclusion

From the production to the distribution stages, the natural gas midstream system has a wide range of potential impacts on individual landowners, the environment, public health, the local and state economy, and the individual consumer. As midstream infrastructure in Pennsylvania continues to expand to serve new producing wells, the short- and long-term consequences of this development will require careful monitoring and management with the best interests of the public in mind.

The recommendations contained in this report would improve the Commonwealth's ability to minimize environmental damage; enhance the efficiency of development; monitor and protect the public's safety; and manage the impacts of cumulative pipeline placement decisions on Pennsylvania's communities, landowners, and citizens.

APPENDICES

APPENDIX A: SOUTHWESTERN PENNSYLVANIA OIL AND GAS ACTIVITY DASHBOARD[129]

Unconventional Oil and Gas Permits Issued, 2001-2012

County	2001-2012	2010	2011	2012
Allegheny	63	2	9	43
Armstrong	338	66	127	61
Beaver	98	5	29	55
Butler	480	92	192	118
Fayette	416	83	103	74
Greene	1,239	228	423	281
Indiana	110	34	26	15
Lawrence	69	1	14	54
Washington	1,507	276	374	430
Westmoreland	527	92	158	115
10-County Total	4,847	879	1,455	1,246
Pennsylvania Total	14,710	3,691	4,618	3,397
SWPA % of State Total	32.95%	23.81%	31.51%	36.68%

[129] Dashboard based on data from the Pennsylvania Department of Environmental Protection, the Pennsylvania Public Utility Commission, the Carnegie Museum of Natural History, Baker Hughes, EnergyDigger.com, and RigData.

U.S. and Pennsylvania Oil and Gas Rig Counts

County	Rig Count 3/31/12	Rig Count 12/31/12
Allegheny	0	2
Armstrong	3	1
Beaver	2	0
Butler	3	6
Fayette	4	3
Greene	8	7
Indiana	0	0
Lawrence	2	0
Washington	14	10
Westmoreland	6	1
10-County Total	42	30
PA Total	98	70
SWPA % of State Total	42.86%	42.86%

In December 2012, all but two of PA's rigs were reported as gas rigs. This represented 15.7 percent of all gas rigs in the nation at that time.

Oil and Gas Rig Counts[130]

Date	PA Total	U.S. Total	PA % of U.S. Total	U.S. Oil Rigs	U.S. Gas Rigs
Dec. 2012	70	1,763	4.0	1,327	431
April 2012	101	1,950	5.2	1,322	624
April 2011	105	1,790	5.9	926	882
April 2010	77	1,479	5.2	513	958
April 2007	16	1,750	0.9	283	1,460

[130] Numbers of U.S. oil rigs and gas rigs (the right two columns) may not equal the U.S. total rig count (third column from left) as some rigs are reported without an oil or gas designation, or as both an oil and gas rig. These categories are not represented in the table.

Unconventional Oil and Gas Wells Drilled, 2002-2012

County	2002-12	2010	2011	2012
Allegheny	22	0	5	13
Armstrong	146	37	34	44
Beaver	25	1	6	17
Butler	176	35	35	70
Fayette	244	44	54	47
Greene	520	103	121	108
Indiana	45	7	21	2
Lawrence	19	0	2	17
Washington	758	167	156	195
Westmoreland	234	49	41	42
10-County Total	2,189	443	475	555
PA Total	6,283	1,608	1,968	1,359
SWPA % of State Total	34.84%	27.55%	24.14%	40.84%

Unconventional % of Total Gas Wells Drilled

PA (2002-12)	16%
SWPA (2002-12)	15%
SWPA 2010	50%
SWPA 2011	70%
SWPA 2012	90%

Top PA Operators by Active Wells

1. Chesapeake (1,636)	6. Chevron (393)
2. Range (846)	7. Cabot (377)
3. Talisman (780)	8. Atlas (376)*
4. Shell (732)	9. Anadarko (367)
5. EQT (405)	10. Consol/CNX (306)

*Some acquired by Chevron in early 2011

Unconventional Wells Drilled by Year

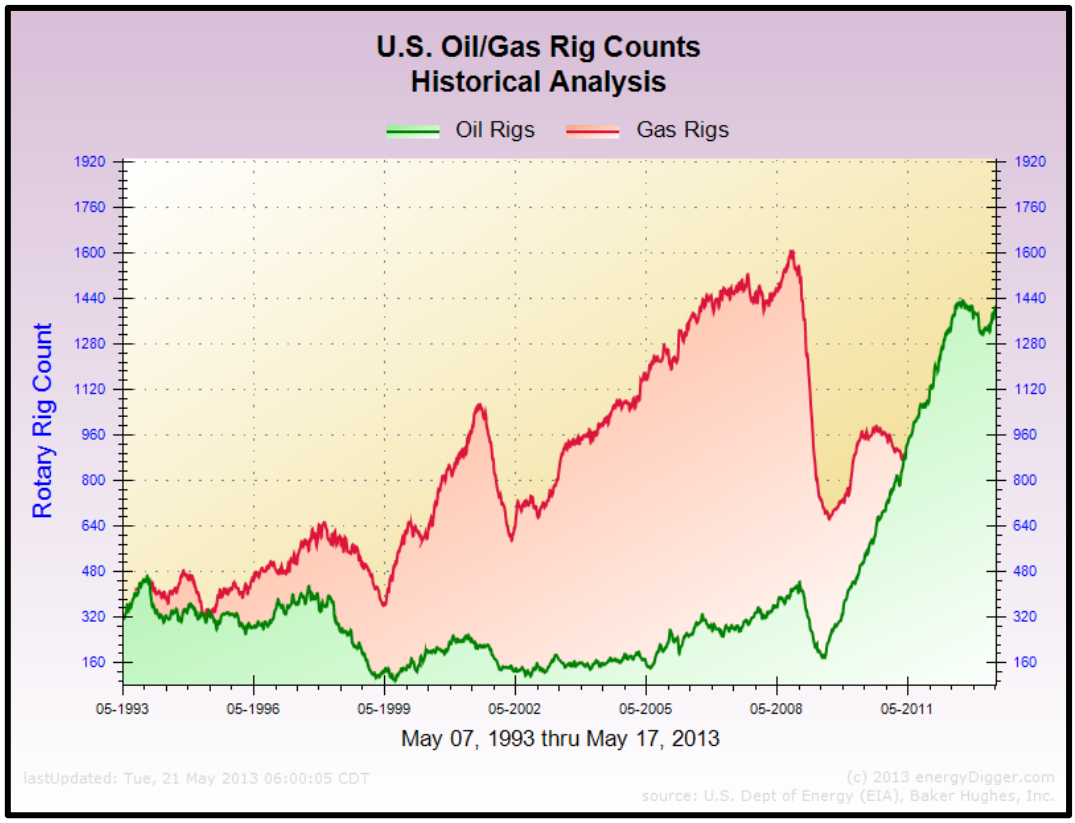
2002	1
2003	5
2004	2
2005	9
2006	37
2007	118
2008	353
2009	823
2010	1,608
2011	1,968
2012	1,359

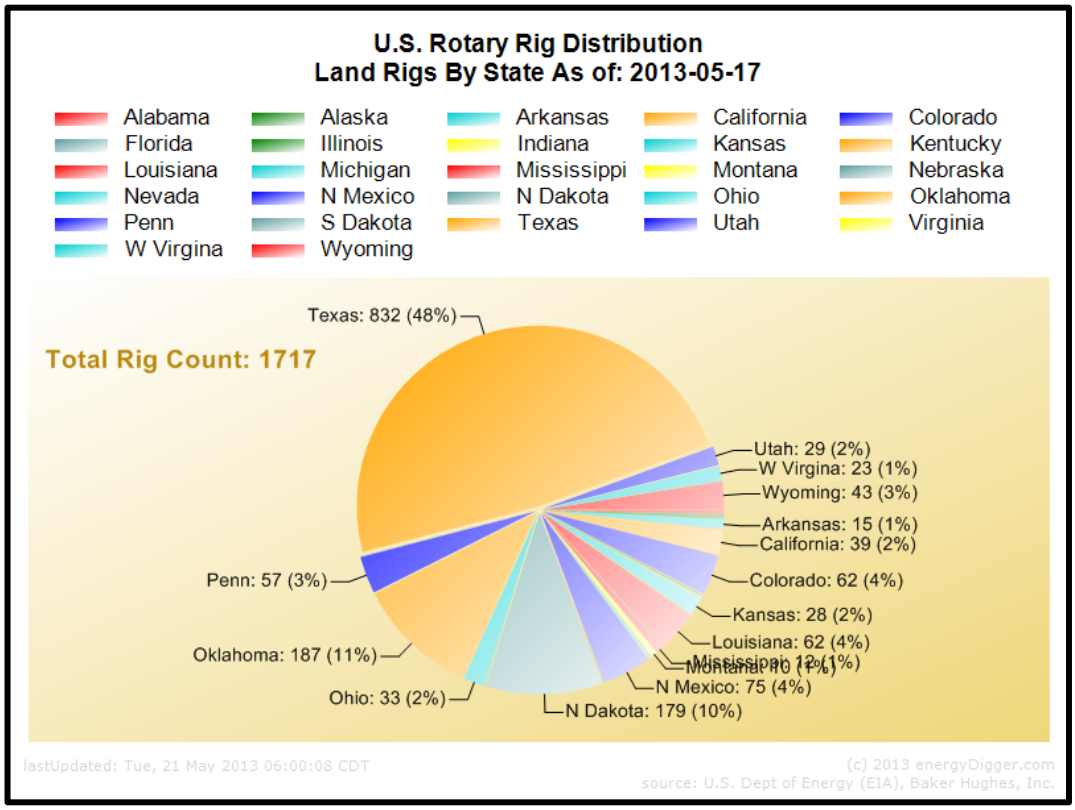
Unconventional Oil and Gas Pad Estimates as of December 2012

Pad Estimates Summary
• 2,726 well pads with at least one well drilled on the pad
• 900 additional pads are projected to be needed based on permits issued (where no wells have yet been drilled on that site)
• 2.3 average wells per pad (1.89 standard deviation)
• Maximum of 12 wells on one pad

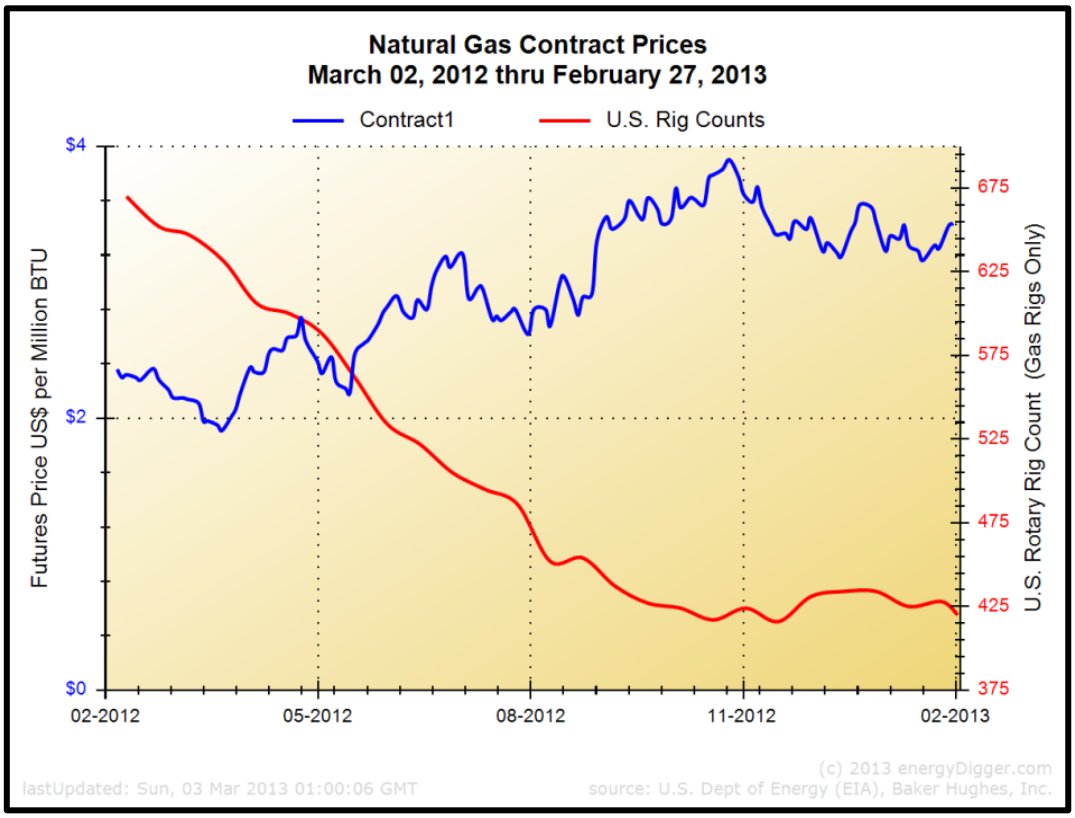
Wells per Pad	Number of Pads
1	1,422
2	485
3	250
4	208
5	94
6	152
7	53
8	40
9	8
10	9
11	4
12	1

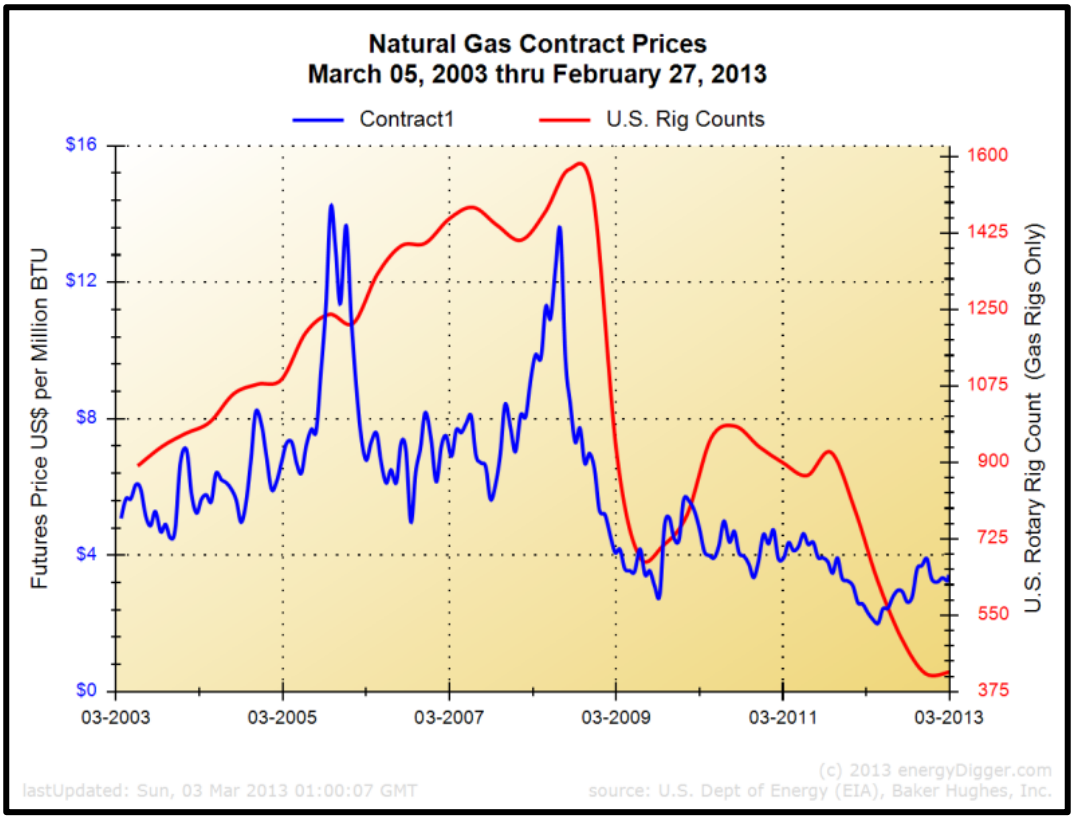
U.S. Rig Counts





Comparison of Natural Gas Prices and Natural Gas Rig Counts





Unconventional Wells in Production as of December 2012

County	Producing Wells (as of 12/31/12)	Wells Drilled (2002-2012)	% of Drilled Wells Producing
Allegheny	13	22	59%
Armstrong	121	146	83%
Beaver	5	25	20%
Butler	90	176	51%
Fayette	143	244	59%
Greene	378	520	73%
Indiana	24	45	53%
Lawrence	5	19	26%
Washington	495	758	65%
Westmoreland	161	234	69%
10-County Total	1,435	2,189	66%
PA Total	3,561	6,283	57%
SWPA % of State Total	40.30%	34.84%	

2012 PA Wells	% of Producing Wells	% of Total Production
Conventional	94.99%	9.9%
Unconventional	5.01%	90.1%

2,878 wells in the state were producing as of 7/1/12, an increase of 683 producing wells in six months (to 3,561 as of 12/31/12).

Unconventional Gas, Condensate, and Oil Production - 2011 and 2012

County	Gas Production (2011, Mcf)	Condensate (2011, Bbl)	Oil (2011, Bbl)	Gas Production (2012, Mcf)	Condensate (2012, Bbl)	Oil (2012, Bbl)
Allegheny	2,480,604	10	0	8,340,837	0	0
Armstrong	6,231,128	0	0	17,707,185	0	0
Beaver	535,809	0	8	1,694,178	5,119	0
Butler	11,645,411	154,407	648	20,937,599	70,329	7,488
Fayette	25,985,313	0	0	34,434,673	0	0
Greene	120,992,169	0	0	180,500,506	0	229
Indiana	2,677,176	0	0	4,112,246	0	0
Lawrence	0	0	0	428,812	147	45
Washington	115,521,695	529,685	393,081.63	179,674,832	1,710,904	52,239
Westmoreland	21,781,663	0	170	59,230,652	0	0
10-County Total	307,850,968	684,102	393,907.63	507,061,520	1,786,499	60,001
PA Total	1,071,594,167	684,334	394,079	2,042,052,369	1,786,820	64,108
SWPA % of State Total	28.73%	99.97%	99.96%	24.83%	99.98%	93.59%

3.7 Tcf of unconventional gas has been produced since 2002 in PA, 85 percent of that total in 2011 and 2012.

Act 13 Impact Fee Disbursements by Category

Impact Fee Recipients	2011	2012
County Conservation Districts/State Conservation Commission	$2,500,000	$5,000,000
Fish and Boat Commission	1,000,000	1,000,000
Pennsylvania Public Utility Commission	1,000,000	1,000,000
Department of Environmental Protection	6,000,000	6,000,000
Pennsylvania Emergency Management Agency	750,000	750,000
Office of State Fire Commissioner	750,000	750,000
Department of Transportation	1,000,000	1,000,000
Natural Gas Energy Development Program*	10,000,000	7,500,000
Counties and Municipalities (and Housing Fund)‡	108,726,000	107,683,200
Marcellus Legacy Fund§	72,484,000	71,788,800
Total Disbursement	204,210,000	202,472,000

***** Act 13 created a new three-year Natural Gas Energy Development Program, to be administered by the Department of Environmental Protection. Over three years, this program will make $20 million in grant funds available on a competitive basis to purchase or convert eligible vehicles to natural gas fuel.

‡ Act 13 created 13 categories that are eligible for impact fee spending by counties and municipalities. Annual municipal disbursements are not permitted to exceed the greater of $500,000 or 50 percent of the total municipal budget. Any excess funds are reallocated to the Housing Affordability and Rehabilitation Enhancement Fund.

§ Fifteen percent of the Marcellus Legacy Fund is distributed to all counties, regardless of whether the county has wells located within its borders, to be used for certain environmental initiatives. Other funds making up the Marcellus Legacy Fund include the Highway Bridge Improvement Fund and the Environmental Stewardship Fund (Growing Greener).

Act 13 Impact Fee Disbursements by Southwestern Pennsylvania County

County	2011	2012
Allegheny	$1,117,320	$1,172,557
Armstrong	570,375	591,342
Beaver	197,639	294,312
Butler	897,340	1,156,721
Fayette	1,448,563	1,346,605
Greene	3,130,610	2,906,301
Indiana	357,825	292,302
Lawrence	94,947	207,647
Washington	4,430,258	4,696,284
Westmoreland	1,721,907	1,577,394
10-County Total	13,966,784	14,241,464
Total to PA Counties	108,726,000	107,683,200
SWPA % of State Total	12.8%	13.2%

APPENDIX B: REGIONAL RESEARCH SURVEY RESULTS SUMMARY, AUGUST 2012

Overall Response Rate: 52 individual faculty and staff members responded to the survey

Question 1: Respondent Contact Information

Responding faculty and staff members represented the following institutions:

- Allegheny College
- Carnegie Mellon University
- Cornell University
- Drexel University
- Indiana University of Pennsylvania
- Ohio State University
- Ohio University
- Pennsylvania State University
- Robert Morris University
- Saint Vincent College
- Slippery Rock University
- Temple University
- University of Pittsburgh at Bradford
- University of Pittsburgh (Oakland)
- Waynesburg University
- Washington & Jefferson College
- Westminster College
- West Virginia University

Question 2: Are any faculty/staff at your institution currently engaged in research surrounding any aspect of shale gas development?

85% answered yes and 15% answered no.

Question 3: If not, why? Has your institution made a conscious decision not to work on shale gas issues (not a good fit with faculty interests, institution strengths, etc.)? Or are there barriers to your faculty becoming more involved in the shale arena? What are these barriers?

Respondents who reported no current shale gas research at their institution cited three barriers - lack of funding resources to perform research, lack of institutional interest in this type of research, and lack of ability to collaborate with industry and/or government.

Question 4 and 5 Combined: Question 4: If yes to Question 2, what research is currently being conducted or what research has been completed in the recent past related to shale gas development (project focus areas/title are sufficient detail)? If you are not the principal investigator for these projects, please consider providing a contact name/e-mail address for each research project. Additionally, we are particularly interested in learning of any water-related shale gas research that is currently being conducted at your institution. What specific projects are you undertaking in this regard?
Question 5: Additional space to discuss research activities if needed.

Respondents reported on (13) primary research areas and (90) subset research areas across their various institutions. The 13 areas included:

- Economics/finance and shale related activities – 15 subsets
- Effect of shale gas on regional water resources – 13 subsets
- Analyzing the physical and chemical properties of Marcellus Shale gas and water – 12 subsets
- Economic and social impacts of shale gas development – 12 subsets
- Wastewater management and Marcellus Shale development – 7 subsets
- The impact of shale gas activity on air emissions and air quality – 6 subsets
- Examining public policy and legal issues surrounding the emerging regional shale gas industry – 5 subsets
- Methods for finding leak detection at CO2 geological sequestration sites – 5 subsets
- Educational activities and workshops regarding shale gas - 4 subsets
- Exploring shale gas utilization with regard to transportation – 3 subsets
- Geology/geosciences -3 Subsets
- Wildlife and forest impacts and the Marcellus Shale – 3 subsets
- Developing demonstration projects – 2 subsets

Question 6: Are you collaborating (or have you collaborated) with other colleges or universities on any shale research projects?

45% of respondents stated they are collaborating with (or have collaborated with) at least one other college or university on shale gas research. These partnerships are most often with other regional institutions, but national and even international collaboratives were reported.

Question 7: In what geographic territory(ies) has your shale gas research been focused?

- Pennsylvania – 81% of respondents performed shale gas research focused on Pennsylvania
- Marcellus region – 26%
- Marcellus/Utica region – 16%
- Ohio – 13%
- West Virginia – 10%

Question 8: What were the main challenges you encountered in implementing these research projects?

7% responded that they did not encounter any research challenges. 3% suggested that it is too early in their research to respond. Other respondents cited five main challenges encountered in implementing research projects:

- 38% cited funding challenges, specifically difficulty obtaining funding from unbiased sources, insufficient government support for research, and a lack of multi-year research support
- 35% cited data challenges including the general inability to obtain/access data and the specific lack of access to company/industry data
- 21% cited the challenge of identifying appropriate research priorities that would add value, locating other interested researchers and designing collaborations among institutions and industry/government
- 10% cited infrastructure/technical challenges, including limited analytical equipment, technical staff and administration support
- 10% cited political sensitivity challenges, including difficulty reaching agreements with industry about research protocols and about how to handle confidentiality issues

Question 9: Has it been difficult to prioritize your institution's involvement in various shale gas issues?

58% of individuals said that it had not been difficult to prioritize the institution's involvement in various shale gas issues. This appears largely due to faculty interests and capabilities driving each institution's involvement. Some respondents said it was difficult to define the institution's role without being labeled "pro" or "con" shale gas development. There are strong voices on both sides of the community, and the vision is to attempt to focus on education/information/science related to the topic without "picking a side."

Question 10: Has any of this research either been published in peer-reviewed journals or other formats? If so, please provide links to the published materials if you are able.

38% of individuals reported being published in peer-reviewed journals or other formats. 17% have research that is in progress/pending being published in peer-reviewed journals or other formats. Many faculty provided links to these papers.

Question 11: Have you used any of this research to inform the public, media, or policymakers about critical shale gas? Did you find community sharing to be useful and/or impactful? Have you encountered any difficulties in translating shale gas research for consumption by these groups?

59% responded that they have not used research to inform the public, media, or policymakers about critical shale gas issues.

20% of individuals responded 'yes', using research to inform the public has been impactful but also challenging. Respondents said that the challenges are due to strongly held opinions on both sides accompanied by a resistance to accept 'gray areas,' polarization of issues by media, the quality of commentary and research being published, and the lack of good data to share.

17% responded 'yes' they have used research to inform the public, which was impactful and not challenging. Respondents noted that forms of engagement, such as working with landowner groups, business leaders, and elected officials, can create fruitful dialogue and are leading to new branches of research.

Question 12: Do you believe that your institution has the capacity and/or untapped capabilities that would allow it to further engage in research around shale gas development if the right opportunity arose? If so, what type of research and activity priorities would be of most interest to you?

97% of respondents said 'yes' - their institution has capacity and/or untapped capabilities that would allow them to further engage in shale gas research. Specific untapped capabilities or areas of interest included the following:

- Advanced materials research
- Baseline monitoring of shale areas
- Community development issues
- Cumulative impact assessment frameworks
- Development of workforce educational courses
- Downstream process engineering
- Drilling and fracturing technologies
- Economic impact on communities
- Economic impact on energy sources
- Economic/environmental impact cost/benefit analyses
- Emissions monitoring
- Environmental impact study that is comprehensive
- Gas and liquids processing research
- GIS mapping
- Leadership of multi-institution shale gas consortia
- Local planning
- Logistical/engineering and financial interface
- Making Pennsylvania a pilot jurisdiction as it relates to public policy
- Opportunities for alternative water sources
- Public health impacts
- Public policy-related issues
- Research on alternative regulatory regimes
- Safety issues
- Upstream to downstream development aspects

- Wastewater management
- Water chemistry analysis
- Water treatment technology
- Well engineering

Question 13: What barriers have prevented this additional capacity/capability from being utilized?

- 75% said that there is a lack of financial support for research (federal, state and private sources)
- 22% said that there was limited time to pursue additional research projects
- 6% said that there was a lack of support at their college to help them
- Other responses included the following:
    - Finding appropriate collaborators to make a contribution to research support
    - Some research support is viewed as biased
    - Lack of industry partners/relationships
    - Lack of understanding on the engineering side of the research issues as to how useful economists, operations, and finance faculty can be in evaluating the policy issues
    - Lack of availability of PhD Students
    - Lack of knowledge of opportunities

Question 14: Are there other areas of research that you think would require attention, even if they are outside of your institution's interest areas?

Responses included:

- Atmospheric contamination from escaped methane, diesel ground operations, etc.
- Examine international exports of huge, cheap quantities of natural gas versus the import of huge, expensive quantities of oil
- Geologic research
- Long-term well integrity evaluations
- Pipeline effects on biodiversity
- Possible negative socioeconomic impacts of boom and bust economy
- Public health, specifically whether possible illnesses that could be associated with shale gas production are impacting health
- Revisiting existing oil and gas industry legal exemptions from state and federal environmental and safety regulations
- Technological issues that could lead to better ways to conduct the resource extraction
- The need for a data warehouse for energy information that houses, reviews, and makes available pertinent statistics and information to the public
- The potential for migration of fluids and gas from horizontal hydraulic fracturing to enter surface and groundwater
- Trading tariffs and supply/demand limitations
- Workforce development issues

APPENDIX C: COMPARISON OF MSAC WATER RECOMMENDATIONS AND ACT 13

The following is adapted from the Pennsylvania Environmental Council's "Comparative Analysis and Commentary on Act 13 of 2012" completed in March 2012. Additional details from other sources on the implementation of the Marcellus Shale Advisory Commission (MSAC) recommendations are included. The full PEC report can be found on its website: http://marcellus.pecpa.org/wp-content/uploads/2012/03/PEC-Act-13-Comparative-Analysis-March-2012.pdf

Under each of the headings below are excerpts from the MSAC recommendations and corresponding sections of Act 13 that address the same issue. Not all of the MSAC recommendations require a legislative action, like Act 13, to be implemented. Of the 96 recommendations put forth by MSAC, it is likely that only 35 would require legislation. An additional five could be implemented through regulatory changes and 56 could be implemented through changes in agency policy.

Construction Restoration Requirement

Commission Recommendation 9.1.18

DEP should ensure that natural gas construction activities are required to meet the same standards as general construction activities. Modifications to current construction standards as they are applied to unconventional natural gas drilling activities may be necessary.

Note: Recommendation 9.1.18 goes beyond restoration requirements at a well site and provides guidance to both the General Assembly and DEP on the enactment and promulgation of statutes and regulations, including the upcoming Chapter 78 regulations.

Commission Recommendation 9.2.20

The Oil and Gas Act's well site remediation provisions should be amended to authorize the Department to extend the nine-month well-site restoration requirement when the Department determines that an extension would ultimately result in less surface disturbance, increased water reuse, or more efficient development of the resource. Such an extension would be for a defined period of time and could include interim restoration/stabilization measures, as specified by DEP.

Act 13 of 2012

The Act allows extension of the 9 month restoration requirement (for a period not to exceed two years) based upon demonstration of net environmental benefit, provided the operator submits and implements a restoration plan that includes removal of any pits as well as establishing postconstruction stormwater management BMPs. [§3216]

Wastewater Disposal and Transportation Record Keeping

Commission Recommendation 9.2.7

Well operators should be required to track and report on the transporting, processing and treatment or disposal of wastewater from high-volume wells (i.e., 80,000 gallons or more of water used).

Act 13 of 2012

The Act requires tracking and record keeping on the transportation and disposal of wastewater from any unconventional well, although this information only needs to be submitted to DEP upon request of the Department. [§3218.3]

Setback Distance from Drinking Water Supplies

Commission Recommendation 9.2.11

Increase the minimum setback distance from a private water well from 200 feet to 500 feet and establish a minimum setback distance from a public water supply (water well, surface water intake or reservoir) to 1,000 feet unless waived in writing by the owner or public water supply operator.

Act 13 of 2012

Act 13 follows the Commission recommendation in expanding the setback from structures and private water supplies to 500 feet and public water supplies to 1,000 feet. Both setbacks are measured from the physical well bore (not the edge of the well pad). However, the Oil and Gas Act contains its own setback distance (100 feet) from the edge of the well pad to a waterway.

The Act shifts the variance standard toward requiring a waiver when necessary for the operator to access and recover the gas resource, although submission of a BMP plan is still required. Act 13 still vests discretion in DEP in granting waivers. The waiver will only be granted if doing so ensures that the waters of the Commonwealth will be protected. [§3215(b)(4) and (f)(2)]

Restrictions for Siting within Floodplains

Commission Recommendation 9.2.12

Provide DEP with additional authority to establish further protective measures for the storage of hazardous chemicals or materials on a well site located within a floodplain.

Commission Recommendation 9.2.13

Impose additional conditions for locating well sites in floodplains, including prohibiting where appropriate.

Act 13 of 2012

The Act contains new restrictions on the siting of well sites within floodplains, prohibiting the placement of pits or other storage of hazardous or waste materials without a variance subject to implementation of BMPs. The Act also contains a new provision establishing protection standards generally for hazardous chemicals or materials, as well as new containment system standards for prevention of off-site spills. [§3215, §3218.2]

Adaptive Management of the Shale Gas Industry

Commission Recommendation 9.2.18

Over the next six months, DEP should evaluate all of its regulatory programs to determine if obstacles exist or changes could be made to facilitate the increase in proper recycling of flowback and produced water from gas wells and to facilitate and encourage the increased use of non-freshwater for hydraulic fracturing.

Note: Recommendation 9.2.18 is currently the subject of a DEP policy review.

Commission Recommendation 9.2.22

The Commonwealth should encourage the use of non-freshwater sources where technically feasible and environmentally beneficial. For example, legislation that would provide operators with immunity from environmental liability for the use of acid mine drainage water from abandoned mine pools would encourage operators to reduce their use of freshwater sources for water utilization as well as reduce the amount of acid mine water draining into local streams.

Note: Recommendation 9.2.22 is being implemented in three ways:

1. *Water Management Plans will now require a Water Reuse Plan*
2. *Legislation has been introduced by Senator Richard Kasunic to amend the Environmental Good Samaritan Statute to address state legal liabilities related to the use of acid mine drainage (AMD) in the well development process.*
3. *DEP is working on releasing a white paper regarding the use of AMD for hydraulic fracturing.*

Act 13 of 2012

The Act contains a new section requiring development and implementation of a Water Management Plan (discussed in more detail, immediately below) that describes operators' plans for reuse/recycling of wastewater. [§3211]

Water Management Plans

Commission Recommendation 9.2.21

The Oil & Gas Act should be amended to clarify that DEP has authority pursuant to the Clean Streams Law to require a Water Management Plan (Plan) as part of the Section 201 permitting process to protect the ecological health of water resources. Approval of a Plan shall authorize the removal and use of such water away from the riparian lands, provided the use is conducted in accordance with the Plan. An operator must still obtain legal permission from the riparian rights owner for access. Such program should not duplicate the authority of any interstate river basin Commissions.

Act 13 of 2012

The Act contains a new section requiring the completion and implementation of a Water Management Plan, with criteria to protect water quality and quantity. [§3211]

Stream Setback Distances

Commission Recommendation 9.2.24

The setback standard for an unconventional well should be increased to 300 feet from the wellbore to a stream or water body as provided in section 205(b) of the Oil and Gas Act. A 100-foot setback from the stream or water body to the edge of disturbance should also be implemented. DEP's current waiver authority would be retained for both setbacks. For High Quality and Exceptional Value streams, however, additional setbacks or BMPs may be required by DEP. Additional discussion of the appropriate definition of water body for the purpose of these setbacks is necessary.

Act 13 of 2012

The Act increases the setback to 300 feet from the physical well bore or 100 feet from the edge of disturbance, whichever is greater. However, while retaining reliance on USGS maps for stream identification, the new provision changes the standard to a "solid blue line stream" – a more limited standard than the original law. [§3215]

The Act increases the setback for wetlands to 300 feet, or 100 feet from the edge of disturbance from the boundary of the wetland. [§3215]

The Act also includes language on when DEP may grant a variance to these setbacks. [§3215]

Invasive Plant Species

Commission Recommendation 9.2.30

Invasive Plant Species introductions should be avoided by utilizing techniques such as:

- thorough cleaning of construction equipment;
- minimization of soil disturbances;
- timely re-vegetation of sites using native, non-invasive species;
- annual surveillance to detect and control early infestations.

Act 13 of 2012

The Act does not address this issue.

Note: Recommendation 9.2.30 does not require legislative action and is instead being implemented by Department of Conservation and Natural Resources via policy. Specifically:

- *DCNR is working with industry on and off state forest lands to develop seeding mixes made up of predominantly native grasses, which greatly reduces the introduction of invasive plant species to disturbed sites.*
- *DCNR is upgrading the current online invasive species tutorial to include items specific to gas management where applicable. When completed, the update will be available on the DCNR website.*
- *DCNR will meet with DEP about including invasive species in its permit information and the potential to incorporate best management practices (BMPs) into permit requirements.*
- *DCNR will continue to meet with stakeholders, including operators, in formal and informal settings to share information in order to update and improve invasive plant BMPs.*

Rebuttable Presumption

Commission Recommendation 9.2.6

Expand an operator's presumed liability for impaired water quality from within 1,000 feet of a well to within 2,500 feet of a well, and from 6 months to 12 months of completion or alteration of the well. In addition, the presumed liability should be applied to well stimulation.

Act 13 of 2012

Act 13 extended the "rebuttable presumption" that an unconventional gas operator caused pollution or diminution if the well was drilled within 2,500 feet (previously 1,000 feet) or the impact occurred within 12 months (previously 6 months). 58 Pa.C.S. §3218.

Pre-drilling notification

Commission Recommendation 9.2.5

Pre-drilling notification (including copy of plat) should be extended from 1,000 feet to 2,500 feet of the proposed well site, and include all landowners and water purveyors. In addition, the notification shall be made to the host municipality or adjacent municipalities within 2,500 feet of the well site.

Act 13 of 2012

Act 13 extended notice of permit applications to affected parties within 2,500 feet (previously 1,000 feet). Additionally, the Act requires notice to host municipality and adjacent municipality. 58 Pa.C.S. §3211

Quality of Water Replacement

While not included in the MSAC report, Act 13 increases the water quality replacement standard to the greater of:

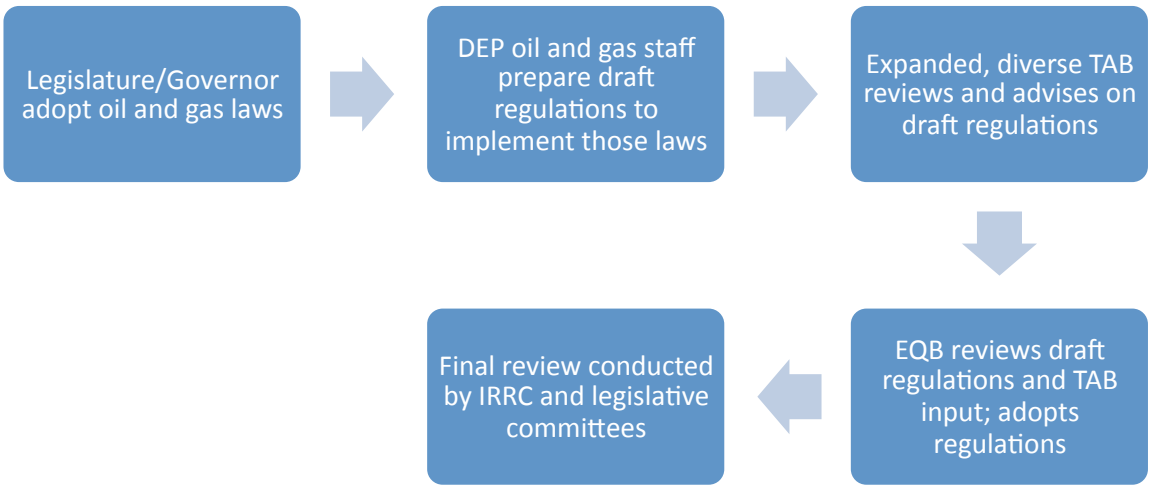
1. Safe drinking water standards or
2. Pre-existing water quality standards.

Prior to Act 13, the standard was simply restore or replace to pre-existing water quality.

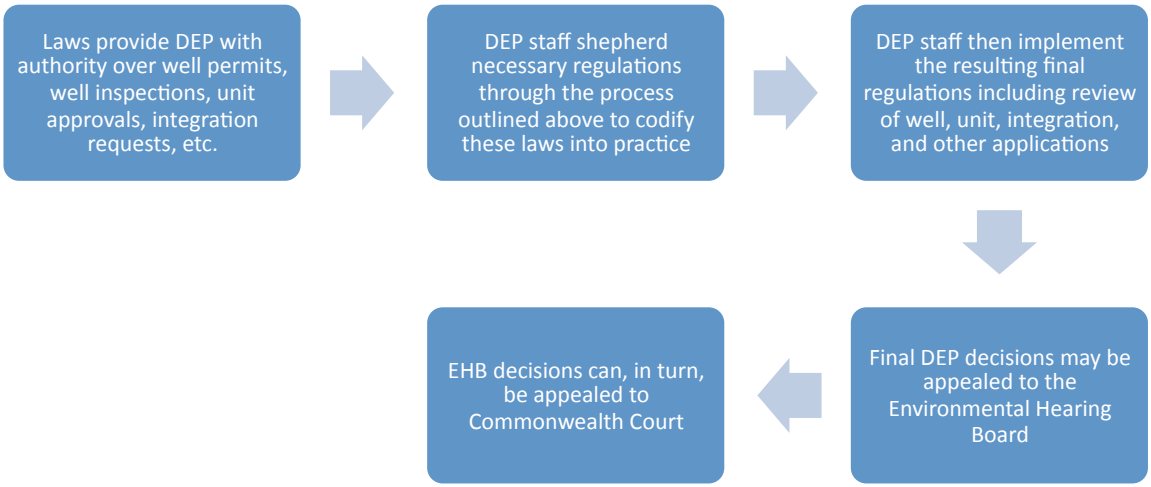
APPENDIX D: PENNSYLVANIA OIL AND GAS REGULATORY AND DECISIONS STRUCTURE

The following is a brief summary of entities engaged in overseeing oil and gas development in Pennsylvania, with one example from Colorado. The regulatory approval and decision processes graphically outlined below largely reflect the current protocols for DEP. Additional roles that reflect Roundtable recommendations also have been added.

PENNSYLVANIA DEP OIL AND GAS REGULATORY APPROVAL PROCESS



PENNSYLVANIA DEP OIL AND GAS DECISION AND APPEALS PROCESS



Pennsylvania Oil and Gas Technical Advisory Board (TAB)

The TAB was authorized under Act 223 of 1984 (Oil and Gas Act) and retained in Act 13 of 2012. DEP consults with the TAB in the formulation, drafting, and presentation stages of all regulations of a technical nature and guidance documents promulgated under the Oil and Gas Act and other relevant laws. The TAB shall be given a reasonable opportunity to review and comment on all regulations of a technical nature prior to submission to the Environmental Quality Board.

The TAB consists of five members, all of whom are chosen by the Governor and are residents of Pennsylvania. TAB members are unpaid but reimbursed for expenses.

- Three members shall be petroleum engineers, petroleum geologists, or experienced driller representatives of the oil and gas industry with three years of experience in Pennsylvania.
- One member shall be a mining engineer from the coal industry with three years of experience in Pennsylvania.
- One member shall be a geologist or petroleum engineer with three years of experience in Pennsylvania and shall be chosen from a list of three names submitted by the DEP Citizens Advisory Council to the Governor, who will sit as a representative of the public interest.

TAB subcommittees may be formed to address specific technical issues. One member of the TAB will act as chair of the subcommittee and other members will be individuals as deemed by the TAB to possess the technical competence in the specific subject area the subcommittee has been formed around.

Members of the TAB select a chair by majority vote and that chair will have a two year term. Each member of the TAB is able to exercise one vote in each matter placed before the TAB for which a vote is called for. Majority rules and four members of the TAB shall constitute a quorum. The TAB meets when called on by the Secretary of DEP, but not less than semiannually. TAB meetings are open to the public and may receive input from those in attendance. The DEP Office of Oil and Gas Management provides program and administrative support to the TAB.

Pennsylvania Environmental Hearing Board

This overview is adapted from the EHB website:
The Environmental Hearing Board (EHB) was created as part of the Department of Environmental Resources in 1970. Although its enabling statute went into effect in January 1971, the EHB was not staffed and ready to function until February 15, 1972.

When the Department of Environmental Resources was established, the legislature abolished several other departments, boards, and commissions and transferred their powers and duties to the new department. The set-up was unique in that the department was given its own legislative arm and its own judicial arm. The legislative arm, the Environmental Quality Board, was given the sole power to adopt environmental regulations. The judicial arm, the Environmental Hearing Board, was given the sole power to hear and decide appeals from department actions. Both arms were given semi-independent status.

This was achieved for the Environmental Hearing Board by having the Governor appoint the board members, subject to Senate confirmation, to six-year terms.

The EHB was made independent of the department by the Environmental Hearing Board Act of 1988. This act, effective January 1, 1989, also increased the number of board members from three to five and required them to be full-time administrative law judges with a minimum of five years of relevant legal experience.

The EHB provides a forum where persons or corporations displeased with department actions can seek judicial-like relief. Although the EHB is not part of the judicial branch of government, it operates like a court. Litigants file pleadings, motions, and petitions; engage in discovery; take part in hearings; and submit briefs. Legal representation is required for all but individuals, and the EHB urges all litigants to have a lawyer because of the technical, scientific nature of environmental law and the intricacies of entering evidence into the record.

While the EHB functions like a court, its jurisdiction is limited - it can review only final actions of the Department of Environmental Protection. But, because the Department has such extensive authority - administering 50 or so statutes - the EHB is kept quite busy. Moreover, the EHB also hears certain actions brought by the department such as Complaints for Civil Penalties. More than 13,000 cases have been filed during its existence. Many of these were settled for one reason or another. The others proceeded to a final EHB decision, either in the form of an adjudication (where a hearing has been held) or an opinion and order (where a dispositive motion had been granted). All adjudications of the EHB are circulated immediately to a list of subscribers and are published on the board's website.

Litigants dissatisfied with final decisions of the EHB have the right to appeal to the Commonwealth Court and from there, if allowed, to the Pennsylvania Supreme Court. These courts have rendered opinions in more than 400 board cases, agreeing with the Environmental Hearing Board in the vast majority of cases. Since 1998, the EHB's decisions have only been vacated, reversed or remanded 13 times. Because of its position as the first link in the judicial review chain, the EHB has made the first decisions interpreting many environmental laws and regulations with no judicial precedents to rely on. The Pennsylvania appellate courts have recognized the EHB's unique expertise in environmental regulation and have generally deferred to its interpretations.

The subject matter of the cases filed with the EHB mirrors the statutes and regulations in existence and being enforced at any one time. During the early years, the cases dealt primarily with water and air pollution. These were years when the department was striving to get municipalities to construct sewage systems and treatment plants and to get industries to install water and air purification devices. Then the cases dealt more with solid waste (landfills and incinerators) and the surface mining of coal and non-coal minerals. In recent years, many of the cases have involved issues concerning the development of energy resources in an environmentally sound way. Other subject areas include, for example, dams and encroachments, oil and gas, air, safe drinking water, storage tanks, stormwater management,

underground coal mining, water allocations, and sewage facilities planning. Because of its role in environmental regulation, the EHB becomes involved in many controversial issues.

The EHB acts *de novo*. This means that it decides cases on the basis of the evidence before it, which may differ from that considered by the department. If the EHB concludes that the department abused its discretion, it has the authority to substitute its own discretion. More often, however, the EHB remands the case to the department for corrected action. The EHB also has the authority to assess civil penalties under some statutes and to award legal fees and expenses to qualifying litigants.

The Environmental Hearing Board has had a procedural rules committee since its inception. These attorneys meet regularly to consider the EHB's procedural rules and recommend changes when deemed advisable. Under the Environmental Hearing Board Act, the Rules Committee is to consist of nine persons designated by the Governor, legislative leaders, the department secretary and the department's Citizens Advisory Council for terms of two years.

Offices of the Environmental Hearing Board have been in Harrisburg since the beginning and in Pittsburgh for nearly that long. A Norristown office was opened in 2004. The Environmental Hearing Board's Harrisburg office and hearing rooms are currently located on the second floor of the Rachel Carson State Office Building on Market Street. In Pittsburgh, they are on the second floor of Piatt Place on Fifth Avenue, and in Norristown, they are on the fourth floor at 2 East Main Street.

The Environmental Hearing Board has effectively served as a buffer between the regulators and the regulated, providing all citizens with a forum where they can challenge the actions of the department and receive judicial-like relief. This is an important role in a controversial arena.

Pennsylvania Environmental Quality Board

The Environmental Quality Board (EQB) is a 20-member independent board that reviews and adopts all of the Department of Environmental Protection's regulations. It is chaired by the Secretary of the Department of Environmental Protection.

The 20 members of the Board include representatives from 11 state agencies, five members of the Citizens Advisory Council, and four members of the General Assembly.

The EQB also considers petitions to change regulations and has other responsibilities, including reviewing State (Clean Air) Implementation Plan changes, siting a low-level radioactive waste disposal facility, and considering applications for a certificate of public necessity for hazardous waste disposal facilities.

The EQB was established by Act 275 of 1970 to do the following:

1. Develop a Master Environmental Plan for the commonwealth.
2. Formulate, adopt, and promulgate rules and regulations as necessary to accomplish the Department of Environmental Protection's work.

3. Have power to subpoena witnesses and records.
4. Review reports and advise the department on matters of policy.

Board Composition (20 members)

- Secretary of Agriculture
- Secretary of Community and Economic Development
- Secretary of Environmental Protection
- Secretary of Health
- Secretary of Labor and Industry
- Secretary of Transportation
- Executive Director of the Fish and Boat Commission
- Executive Director of the Game Commission
- Chairperson of the Public Utility Commission
- Executive Director of the Historical and Museum Commission
- Executive Director of the State Planning Board
- Five members annually elected by the Citizens Advisory Council
- Four members of the General Assembly, one appointed by each of the following:
    - President Pro Tempore of Senate
    - Senate Minority Leader
    - Speaker of the House of Representatives
    - House Minority Leader

Term

State Agency Members - consistent with term of agency appointment
General Assembly Members - at the pleasure of the legislative leaders
Citizens Advisory Council Members - elected annually by members of the Citizens Advisory Council

Voting

All board members may designate alternates with voting privileges in accordance with Sections 213 and 471 of the Administrative Code. Eight members of the board constitute a quorum.

Meetings

Meetings are held the third Tuesday of every month in the Rachel Carson State Office Building in Harrisburg. Special meetings and hearings are held at the discretion of the EQB. Meetings are open to the public; however, public statements are not permitted at the EQB meetings. EQB public hearings may be scheduled to solicit public comments on proposed regulations.

Pennsylvania Oil and Gas Conservation Commission (OGCC)

The OGCC was envisioned in the 1961 Conservation Law but was never fully activated and is believed to have met only once. As originally envisioned, the OGCC's powers and duties included the following:

- To execute and carry out the provisions of the Conservation Law
- To make such investigations and inspections of records and facilities as it deemed necessary and proper to discharge its duties and perform its functions
- To require identification on the premises of ownership of oil or gas wells
- To require the filing of drillers' logs and filing of such other appropriate well logs
- To require the drilling, casing, operation, and plugging of wells in such manner as to prevent the escape of oil or gas; the detrimental intrusion of water into any oil or gas pool that is avoidable by efficient operations; and blowouts, cavings, seepages, and fires
- To review upon proper application spacing and pooling orders and provide for the integration or communitization of interests within a drilling unit
- To classify pools as oil or gas pools, or wells as oil or gas wells, for the purposes material to the interpretation or administration of the Conservation Law
- To promulgate and enforce rules, regulations, and orders to effectuate the purposes and the intent of the Conservation Law and to fix appropriate fees for services rendered
- To protect correlative rights

Most of the powers and duties that were originally granted to the OGCC by the Oil and Gas Conservation Law were transferred to the Department of Environmental Resources (DER) in the 1970s and later to DEP in the 1990s. The rulemaking duties were granted, along with all other DEP regulatory promulgation powers, to the Environmental Quality Board in the 1990s. DEP's Office of Oil and Gas Management is now responsible for statewide oil and gas conservation and environmental programs to facilitate the safe exploration, development, and recovery of Pennsylvania's oil and gas reservoirs in a manner that will protect the commonwealth's natural resources and the environment. The office develops policy and programs for the regulation of oil and gas development and production pursuant to the Oil and Gas Act, Coal and Gas Resource Coordination Act, and Oil and Gas Conservation Law; oversees the oil and gas permitting and inspection programs; develops statewide regulation and standards; conducts training programs for industry; and works with the Interstate Oil and Gas Compact Commission and the Technical Advisory Board.

Colorado Oil and Gas Conservation Commission (COGCC)

The COGCC was created in 1951 when the Oil and Gas Conservation Law was enacted. The Commission was created to assist in accomplishing the goals set forth by the Act, which were to promote the development, production, and utilization of oil and gas resources in Colorado as well as to protect correlative rights and to prevent waste.

Timeline of the development of the COGCC:

- 1952 – Commission consisted of five governor appointees, who had expertise in the oil and gas industry to promote the development, production, and utilization of oil and gas.
- 1985 – Legislature mandates that COGCC promulgate oil and gas rules to protect public health, safety, and welfare.
- 1994 – Legislature broadened COGCC powers to include the prevention and mitigation of significant adverse environmental impacts from oil and gas development.

- 2007 – Amendments required comprehensive revisions to the Conservation Law, including the following:
    - Membership was expanded by two additional seats: the directors of Colorado Department of Public Health and Environment (CDPHE) and Department of Natural Resources (DNR)
    - Now responsible for promulgating and enforcing all laws/rules/regulations governing oil and gas activities in Colorado
    - Regulates all activities associated with the construction, completion, and production of a well
    - Requires operators to provide advance notice to affected parties
    - Requires good faith consultation with surface owners, local government, and other agencies to address oil and gas activity impacts
    - Provides protection for public health and the environment
    - Minimizes adverse impacts on wildlife resources
    - Oversees implementation of unitization and integration statutes

Current COGCC Structure:

- 9 total members, all appointed by the governor
    - 2 Executive Directors of CDPHE and DNR (ex-officio, voting members)
    - 2 who reside west of the continental divide
    - 3 with substantial oil and gas experience
    - 2 out of 3 with a college degree in petroleum geology or petroleum engineering
    - 1 local government official
    - 1 with substantial environment or wildlife protection experience
    - 1 with substantial soil conservation or reclamation experience
    - 1 engaged in agriculture production/royalty owner
    - Maximum of 4 from the same political party, excluding directors

APPENDIX E: STANDARDS AND BEST MANAGEMENT PRACTICES FOR SHALE OIL AND GAS DEVELOPMENT

This appendix provides a high-level overview of organizations that have developed or are developing standards or Best Management Practices (BMPs) for shale oil and gas development and its regulation. The included standards apply either to industry operations or to state regulations. They were developed by the following diverse organizations: the American Petroleum Institute, Appalachian Shale Recommended Practices Group, Center for Sustainable Shale Development, Environmental Defense Fund, Intermountain Oil and Gas Best Management Practices Project, Investor Environmental Health Network, Marcellus Shale Coalition, Pennsylvania Department of Environmental Protection, and State Review of Oil and Natural Gas Environmental Regulations. This list of organizations and their associated standards and BMPs is intended as a broad introduction; details can be accessed via the hyperlinks that accompany each program description. The standards cited within this survey have not been independently evaluated by the Shale Gas Roundtable – descriptions are for informational purposes only.

Specific information for each organization, if available, includes the organization's mission, the titles/categories of the organization's BMPs, how long the organization has been developing standards, the process used to develop standards, the intended audience, the geography covered, relevant hyperlinks, and an organizational point(s) of contact.

American Petroleum Institute

Established in 1919, the American Petroleum Institute (API) is a trade association that represents the oil and natural gas industry in America. Its members include producers, refiners, suppliers, pipeline operators, marine transporters, and the service and supply companies that support the industry.[131] The mission of API is "to influence public policy in support of a strong, viable U.S. oil and natural gas industry essential to meet the energy needs of consumers in an efficient and environmentally responsible manner."[132] API publicly advocates for its members with state governments, the media, Congress, and the executive branch; negotiates with regulatory agencies; represents the industry in legal proceedings; and participates in coalitions and partnerships with other associations.[133] API also organizes seminars, workshops, and conferences about policy issues.[134]

In addition to the above activities, API provides certification programs for various segments of the oil and gas industry. These certification programs, based on API operating standards, serve as BMPs for the

[131] API. http://www.api.org/globalitems/globalheaderpages/about-api/api-overview.aspx.
[132] API. http://www.api.org/globalitems/globalheaderpages/about-api/~/link.aspx?_id=5A9331A13D0F4F31BC16E003555F123B&_z=z
[133] API. http://www.api.org/globalitems/globalheaderpages/about-api/api-overview.aspx.
[134] Ibid.

standardization of industry training. They are widely recognized and used throughout industry.[135] Certification programs include the following:

- *API Monogram Program*: This program, designed for manufacturers of production, drilling and refinery equipment, verifies that manufacturers are in compliance with industry standards. http://www.api.org/certification-programs/api-monogram-program-and-apiqr.aspx
- *APIQR Program*: This program provides organizations with certifications for quality, environmental, and occupational health and safety management systems. http://www.api.org/certification-programs/api-monogram-program-and-apiqr.aspx
- *Individual Certificate Programs*: Based on industry-developed standards, many of which have served as a model for various state and federal regulations, these programs help to evaluate the knowledge and experience of inspectors and to promote self-regulation, health and safety, improved inspection capabilities, and improved management control and environmental performance. http://www.api.org/certification-programs/individual-certification-program-icp.aspx
- *Witness Programs*: These programs provide individuals with the opportunity to become knowledgeable and experienced witnesses who can observe material and equipment testing and provide verifications with objectivity and reliability. http://www.api.org/certification-programs/witnessing-programs.aspx
- *Training Provider Certificate*: This third-party certification program is used to evaluate and certify industry training courses. http://www.api.org/certification-programs/training-provider-tpcp.aspx

  Point of Contact: Edwin Bailer, 202.682.8034, bailere@api.org

In addition to certification programs, API also produces numerous publications that contain various standards for the oil and gas industry. These standards, which API has been developing for more than 85 years, are designed through extensive research and represent the industry's collective viewpoints about industry best practices.[136] API currently maintains more than 600 standards and recommended practices that are used throughout the country.[137] The following are the general BMP categories that are regularly amended by API as well as the associated contact and hyperlink that provides details about specific standards within each BMP category.

- *Drilling and Production Operations*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/drilling%20and%20production%20operations.aspx

  Point of Contact: Roland Goodman, Standards Department; goodmanr@api.org

[135] Ibid.
[136] Ibid.
[137] Ibid.

- *Exploration and Production/Oilfield Equipment and Materials*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/exploration%20and%20production.aspx

  Point of Contact: Roland Goodman, Standards Department; goodmanr@api.org

- *Marketing*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/marketing.aspx

  Point of Contact: Steve Crimaudo, Standards Department; crimaudos@api.org

- *Measurement*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/measurement.aspx;

  Point of Contact: Paula Watkins, Standards Department; watkinsp@api.org

- *Pipelines*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/pipeline.aspx

  Point of Contact: Ed Baniak, Standards Department; baniake@api.org

- *Process Safety*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/process%20safety.aspx

  Point of Contact: Steve Crimaudo, Standards Department; crimaudos@api.org

- *Refining*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/refining.aspx

  Point of Contact: Steve Crimaudo, Standards Department; crimaudos@api.org

- *Safety and Fire Inspection*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/safety%20and%20fire%20protection.aspx

  Point of Contact: Steve Crimaudo, Standards Department; crimaudos@api.org

- *Security*: http://www.api.org/publications-standards-and-statistics/annual-standards-plan/standards%20plan%20segments/security.aspx

  Point of Contact: Steve Crimaudo, Standards Department; crimaudos@api.org

- *API Publications Store (Comprehensive Search for Standards Listed in API Publications)*: http://www.techstreet.com/api/apigate.html

Appalachian Shale Recommended Practices Group

The Appalachian Shale Recommended Practices Group (ASRPG) is a consortium of the 11 largest Appalachian Basin natural gas and oil producers.[138] Members are Anadarko Petroleum Corporation, Cabot Oil and Gas Corporation, Chesapeake Energy Corporation, Chevron, EQT Corporation, Seneca Resources Corporation, Shell Oil Company, Southwestern Energy Company, Talisman Energy Inc., WPX Energy, Inc., and XTO Energy, Inc.[139] ASRPG's mission is "to identify and disseminate responsible standards and practices for effective environmental, health, and safety practices utilized in shale natural gas and oil development operations in the Appalachian Region."[140]

In April 2012, ASRPG released a BMP document that was developed to promote effective safety, environmental, and health practices that are consistent with key recommendations from the U.S. Secretary of Energy's Advisory Board and the National Petroleum Council.

Recommended Standards and Practices for Exploration and Production of Natural Gas and Oil from Appalachian Shales, April 2012: These practices are derived from a consensus based approach that examined standards utilized by other industry and stakeholder organizations – though the best practices offered by ASRPG often differed from existing industry standards in order to account for the regional uniqueness of the Appalachian Basin. ASRPG provided the practices to state regulators and legislators within the Appalachian region, to the Interstate Oil and Gas Compact Commission, the State Review of Oil and Natural Gas Environmental Regulations, and important producer organizations. Recommendations in this report included standards related to the following categories:

- General Principles
- Pre-operational Planning
- Site Selection and Assessment
- Site Design and Construction
- Drilling Operations
- Completion/Stimulation Operations
- Flowback Water
- Production Operations
- Measurement and Metrics
- Landowner Relations

http://www.asrpg.org/pdf/ASRPG_standards_and_practices-April2012.pdf
Point of Contact: John Christiansen, 832.636.8736, john.christiansen@anadarko.com

[138] ASRPG. http://www.asrpg.org/pdf/ASRPG%20Press%20release.pdf
[139] Ibid.
[140] Ibid.

Center for Sustainable Shale Development

Publicly launched in March 2013, the Center for Sustainable Shale Development (CSSD) is an independent, collaborative organization that seeks "to support continuous improvement and innovative practices through performance standards and third-party certification."[141] CSSD's focus is the Appalachian region. Its creation aligns with a recommendation by the National Petroleum Council and the U.S. Department of Energy's Shale Gas Production Subcommittee for basin-scale centers of excellence.[142] Funding for CSSD is provided by philanthropic foundations and participating energy companies. Current participants include Chevron, Citizens for Pennsylvania's Future, Clean Air Task Force, CONSOL Energy, Environmental Defense Fund, EQT Corporation, Group Against Smog and Pollution, The Heinz Endowments, Pennsylvania Environmental Council, Shell, and the William Penn Foundation.[143]

Similar to a LEED certification for environmentally friendly buildings, CSSD will encourage energy companies to apply for a third-party certification that represents a company's compliance with CSSD's standards. The current standards are associated with the protection of air quality, water resources, and climate, though CSSD anticipates the promulgation of additional standards over time.[144] The certification process will require companies to be evaluated by third-party auditors – consultant companies ICF International and DCV. The outcome of the audit will deem a company Certified, Certified with Conditions, or Not Certified. A Certified with Conditions ruling means that "only minor deviations from the standard are present and corrections must be made within 90 days."[145]

The 15 standards that CSSD released in March 2013 "apply to unconventional exploration, development, and gathering activities, including site construction, drilling, hydraulic fracturing and production in the Appalachian Basin."[146] The standards consider "geology, topography, population density, infrastructure, surface water, ground water and other issues of particular concern in the Appalachian Basin."[147] The standards include the following:

Air and Climate Standards

- Limitations on Flaring
- Use of Green Completions
- Reduced Engine Emissions
- Emissions Control on Storage Tanks

[141] CSSD: http://037186e.netsolhost.com/site/about
[142] Hopey, Don and Erich Schwartzel. "New Initiative Between Industry and Environmentalists Set Standards for Marcellus Shale Drilling." *Pittsburgh Post-Gazette*. http://pipeline.post-gazette.com/news/archives/25103-new-initiative-between-industry-and-environmentalists-sets-standards-for-marcellus-shale-drilling
[143] Ibid.
[144] CSSD. http://037186e.netsolhost.com/site/performance-standards
[145] CSSD. http://037186e.netsolhost.com/site/certification
[146] CSSD. Performance Standards. http://037186e.netsolhost.com/site/wp-content/uploads/2013/03/CSSD-Performance-Standards-3-13R.pdf
[147] Ibid.

Surface and Ground Water Performance Standards

- Maximizing Water Recycling
- Development of Groundwater Protection Plan
- Closed Loop Drilling
- Well Casing Design
- Groundwater Monitoring
- Wastewater Disposal
- Impoundment Integrity
- Reduced Toxicity Fracturing Fluid[148]

http://sustainableshale.org

Point of Contact: Andrew Place, Interim Director, 412.616.2248, andrew.place@sustainableshale.org

Environmental Defense Fund

Founded in 1967, the Environmental Defense Fund (EDF) is an environmental advocacy group with a mission "to preserve the natural systems on which all life depends" and to "find practical and lasting solutions to the most serious environmental problems."[149] EDF has four primary focus areas: climate and energy, oceans, ecosystems and health.[150] Within the focus area of climate and energy, the natural gas sub-component seeks to work with companies, organizations, and communities to ensure the safe development of natural gas through an examination of exposure to toxic chemicals and waste products, well construction and design, climate impacts, local and regional air quality, land use, and community impacts.[151] EDF also is committed to ensuring the comprehensive disclosure of hydraulic fracturing chemicals, the modernization of rules for well construction and operation, systems-based management of wastes and water, state and national standards for improving air quality and reducing climate impacts, and the minimization of land use and community impacts from natural gas development.[152]

EDF is committed to supporting best practices for shale related activities. In 2011, EDF President Fred Krupp was selected to serve on the Natural Gas Subcommittee of the U.S. Secretary of Energy's Advisory Board. EDF supports the recommendations from this subcommittee, which can be found in the following report:

> *The Secretary of Energy's Advisory Board Shale Gas Production Subcommittee 90 Day Report*, August 11, 2011. This report provides 20 recommendations that are classified into three categories: recommendations ready for implementation, primarily by the federal agencies; recommendations ready for implementation, primarily by the states; and recommendations that require new partnerships and mechanisms for success. The purpose of the recommendations is

[148] Ibid.
[149] EDF. http://www.edf.org/about/our-mission-and-history.
[150] Ibid.
[151] Ibid.
[152] Ibid.

to help ensure that shale gas resources are developed in a manner that protects human health and the environment. Recommendations were derived with input from the subcommittee; an interagency working group; consultations with the DOE, EPA and DOI; and advice from industry, state and federal regulators, environmental groups, and other stakeholders. http://www.shalegas.energy.gov/resources/111011_90_day_report.pdf

In addition to the above report, EDF is currently in the process of developing a model state regulatory framework for shale gas and oil development.

Model Regulatory Framework for Hydraulically Fractured Hydrocarbon Production Wells, Working Draft: While still a work in progress, EDF has worked with state regulators, environmental groups, scientists, and industry (although only Southwestern Energy has officially endorsed the draft[153]) to assist state governments in implementing a regulatory standardization that governs subsurface aspects of the drilling, casing, cementing, hydraulic fracturing stimulation, completion, and production of onshore hydrocarbon exploration and production wells. Draft components of this framework include the following categories:

- *Well Planning (Permitting)*
- *Pre-Drilling Water Sampling*
- *Well Operations – Drilling, Casing, and Cementing*
- *Well Operations – Completing, Hydraulic Fracturing and Subsequent Well Operations*
- *Well Operations – Production and Well Monitoring*
- *Plugging and Well Abandonment*

Draft Framework:
http://portal.ncdenr.org/c/document_library/get_file?uuid=8356eb89-9c9f-4f8e-bb4d-4bb51b605575&groupId=8198095

Point of Contact: Scott Anderson, Senior Policy Advisor, 512.691.3437, http://www.edf.org/email/154/field_email

Intermountain Oil and Gas Best Management Practices Project

Established at the Getches-Wilkinson Center for Natural Resources, Energy, and the Environment at the University of Colorado Law School, the Intermountain Oil and Gas Best Management Practices Project identifies and categorizes mandatory and voluntary BMPs within a searchable database. The BMPs, as outlined by the Intermountain Oil and Gas BMP Project, are "state-of-the-art mitigation measures applied to areas being developed for oil and gas to promote energy development in an environmentally responsible manner."[154] The BMP database is not intended to represent a consensus on BMPs, nor is it intended to provide advice about current legal requirements. Instead, the database describes specific BMPs used by or recommended for Colorado, Montana, New Mexico, and Wyoming; provides a source for and link to the BMP; and offers, when possible, supplemental information that includes construction

[153] Behr, Peter. "Authors of Model Fracking Regulation Find it's Lonely in the Middle." *Midwest Energy News*. http://www.midwestenergynews.com/2012/10/04/authors-of-model-f-regulation-find-its-lonely-in-the-middle/
[154] Intermountain Oil and Gas Best Management Practices Project. http://www.oilandgasbmps.org/

specifications, illustrations, pictures, maps, monitoring reports, and evaluations of the potential of the practice for mitigating impacts of development.[155] The database seeks to help stakeholders specifically "identify appropriate practices for minimizing impacts to surface resources during planning, design, construction, drilling, operations, reclamation, and monitoring."[156]

The following categories are addressed in the BMP database[157]:

- Air Quality and Emissions
- Aquatic and Riparian Values
- Community
- Cultural/Historic
- Grazing and Agriculture
- Human Health and Safety
- Land Surface Disturbance
- Noise
- Other
- Soils (Conservation, Pollution, Reclamation)
- Vegetation
- Visual Aesthetics
- Water Quality and Pollution
- Water Quantity and Rights
- Wildlife

http://www.oilandgasbmps.org/mainsearch.php

Point of Contact: Kathyrn Mutz, Project Manager, 303-492-1293, kathryn.mutz@colorado.edu

Investor Environmental Health Network

Founded in 2004, the Investor Environmental Health Network (IEHN) is a collaborative partnership of investment managers that is "concerned about the financial and public health risks associated with corporate toxic chemicals policies."[158] Advised by nongovernmental groups, IEHN uses dialogue and shareholder resolutions to encourage companies "to adopt policies to continually and systematically reduce and eliminate toxic chemicals in their products and activities."[159] The members of IEHN, who include foundations, investment management organizations, and health systems[160], manage approximately $35 billion in assets.[161] Specific areas of focus for IEHN include toxic hazards in the marketplace, opportunities in safer materials, and natural gas hydraulic fracturing.[162] Within the natural

[155] Ibid.
[156] University of Colorado. http://outreach.colorado.edu/programs/details/id/359
[157] Intermountain Oil and Gas Best Management Practices Project.
[158] IEHN. http://www.iehn.org/about.whatwedo.php
[159] Ibid.
[160] IEHN. http://www.iehn.org/about.members.php
[161] IEHN. http://www.iehn.org/about.whatwedo.php
[162] IEHN. http://www.iehn.org/overview.toxic.php

gas area, IEHN seeks "to promote improved disclosure by natural gas companies about the business and environmental risks of hydraulic fracturing."[163]

In order to help investors determine which companies best manage the risks associated with hydraulic fracturing, IEHN produced an investor guide that recommends 12 key management goals that companies should adopt.

> *Extracting the Facts: An Investor Guide to Disclosing Risks from Hydraulic Fracturing Operations*, December 2011. After an eighteen month dialogue with investors about risks, management practices, and disclosure; a review by industry experts of the draft practices and indicators; and input from staff at IEHN and the Interfaith Center on Corporate Responsibility, an investor guide to management goals for natural gas operations was created. This guide is based on the principle that Corporate Core Management Goals, Best Management Practices, and Key Performance Indicators can drive operational efficiencies; provide insurance in case of accident or natural disaster; reduce air emissions and water impacts that trigger violations of environmental standards; and protect and enhance companies' social license to operate by increasing the odds of positive community response to the best-managed, most transparent companies addressing community needs and concerns.[164] A detailed list of BMPs and how they can be used to secure the above outcomes is linked to and outlined within each of the guide's key management goals. These goals include the following:
>
> - *Ensure Best in Class Contractor Performance*
> - *Ensure Well Integrity*
> - *Disclose Fines, Penalties, and Litigations*
> - *Manage Risks Transparently and at Board Level*
> - *Minimize and Disclose Air Emissions*
> - *Prevent Contamination from Solid Waste and Sludge Residuals*
> - *Prevent Contamination from Wastewater*
> - *Protect Water Quality by Rigorous Monitoring*
> - *Reduce and Disclose All Toxic Chemicals*
> - *Reduce Surface Footprint*
> - *Secure Community Consent*
>
> http://www.iehn.org/documents/frackguidance.pdf

In addition to this guide, IEHN provides a comprehensive list of BMPs and Guiding Principles Reports that have been developed by various agencies and organizations - state governments, federal governmental agencies, environmental organizations, exploratory and production companies, etc.

> http://www.iehn.org/overview.naturalgashydraulicfracturing.php
> Point of Contact: Richard Liroff, Executive Director, 703.532.2929, info@iehn.org

[163] IEHN. http://www.iehn.org/overview.naturalgashydraulicfracturing.php
[164] IEHN. "Extracting the Facts: An Investor Guide to Disclosing Risks from Hydraulic Fracturing Operations." December, 2011.

Marcellus Shale Coalition

Established in 2008, the Marcellus Shale Coalition (MSC) is a membership-driven organization that "works with exploration and production, midstream and supply chain partners in the Appalachian Basin and across the country to address issues regarding the production of clean, job-creating, natural gas from the Marcellus and Utica Shale plays."[165] The coalition's guiding principles, established in October 2010, provide the foundation for its development of BMPs: to provide the safest possible workplace for employees and in the communities in which companies operate; to implement state-of-the-art environmental protection across operations; to continuously improve practices and seek transparency in operations; to attract and retain a talented and engaged workforce; to commit to being responsible members of the community; to encourage spirited public-dialogue and fact-based education about responsible shale gas development; and to conduct business in a manner that will provide sustainable and broad-based economic and energy security benefits.[166]

Since April 2012, the Marcellus Shale Coalition has produced a series of recommended practices, which are briefly described below. These documents are designed to serve as a reference for industry to improve their effectiveness; they are not intended to establish or impose binding requirements.

> *Site Planning, Development and Restoration,* April 26, 2012: Through research, stakeholder outreach, and collaboration among MSC members, this document was developed to provide guidance for site planning, development, and restoration. A table about the major steps involved in site planning, development, and restoration as well as a discussion about the pertinent health and safety practices are provided.
> http://marcelluscoalition.org/wp-content/uploads/2012/04/Site-Planning-Development-and-Restoration.pdf
>
> *Pre-Drill Water Supply Surveys,* August 28, 2012: These practices structure a common approach for operators to conduct a pre-drill water survey on identified water supply sources within a given area of a well-pad surface location in order to establish a baseline of water conditions that existed before drilling. The document provides details about the practices of initial surveying, water sampling, and reporting.
> http://marcelluscoalition.org/wp-content/uploads/2012/08/Pre_Drill_Water_Supply_Surveys_8.28.12.pdf
>
> *Responding to Stray Gas Incidents,* October 16, 2012: Provides considerations and guidelines about how to respond to stray gas incidents in oil and natural exploration and development areas. A definition of stray incidents is provided as well as how to perform initial responses, action plans, corrective actions, documentation, and reporting.
> http://marcelluscoalition.org/wp-content/uploads/2012/10/RP-Stray-Gas-Oct-2012.pdf

[165] MSC. http://marcelluscoalition.org/about
[166] MSC. http://marcelluscoalition.org/about/guiding-principles

Motor Vehicle Safety, December 4, 2012: Designed to assist industry professionals -- companies and contractors -- improve their motor vehicle safety related to transportation activities on both public and private roads and company premises. Transportation activities include personnel and freight movements and mobile plant activities.
http://marcelluscoalition.org/wp-content/uploads/2012/12/RP_MVS_Final.pdf

Supply Chain, January 24, 2013: Provides considerations and guidelines about how to engage small, diverse, and local businesses in the supply chain. Specific strategies also are offered about how to comply with Pennsylvania's Act 13, Section 216.
http://marcelluscoalition.org/wp-content/uploads/2013/01/Supply_Chain_RP_UPDATE1.pdf

Water Pipelines, January 31, 2013: General guidelines about water pipe placement, route selection, pipe materials, operational considerations, and pipe deactivation are provided.
http://marcelluscoalition.org/wp-content/uploads/2013/01/Water_Pipeline_RP.pdf

Point of Contact: Andrew Paterson, Vice President, Technical and Regulatory Affairs, 412.706.5160, apaterson@marcelluscoalition.org

Pennsylvania Department of Environmental Protection

The Pennsylvania Department of Environmental Protection (DEP) has a mission "to protect Pennsylvania's air, land and water from pollution and to provide for the health and safety of its citizens through a cleaner environment."[167] Within DEP, the Office of Oil and Natural Gas "develops policy and programs for the regulation of oil and gas development and production pursuant to the Oil and Gas Act, the Coal and Gas Resource Coordination Act, and the Oil and Gas Conservation Law; oversees the oil and gas permitting and inspection programs; develops statewide regulation and standards; conducts training programs for industry; and works with the Interstate Oil and Gas Compact Commission and the Technical Advisory Board."[168]

Various DEP offices, including the Office of Oil and Natural Gas, develop BMP guides that help regulated parties to minimize or eliminate potential environmental impacts.[169] These BMPs are extensively reviewed by multiple stakeholders and encapsulated in guidance manuals. In the development of BMPs, the department considers cost effectiveness, environmental protection, and safety. Two example manuals are the following:

Oil and Gas Operators Manual, Commonwealth of Pennsylvania, DEP, Guidance No. 550-0300-001, October 2001 as amended and updated: This manual provides a detailed list of the BMPs that are available to industry. Intertwined with these BMPs are enforceable DEP regulations. This manual is expected to be updated after the adoption of Chapter 78 revisions (in turn based on Act 13). The BMPs (and intertwined regulations) provided in this manual are listed in the following categories:

[167] DEP. http://www.depweb.state.pa.us/portal/server.pt/community/about_dep/13464
[168] DEP. http://www.depweb.state.pa.us/portal/server.pt/community/oil_and_gas/6003
[169] DEP. "Oil and Gas Operators Manual, Commonwealth of Pennsylvania, DEP, Guidance No. 550-0300-001." October 2001 as amended and updated.

- *Drilling, Altering and Completing a Well*
- *Guidelines for a Preparedness, Prevention and Contingency Plan for Oil and Gas Development Pollution Prevention Practices*
- *Inactive Status and Well Plugging*
- *Reports Required of Oil and Gas Operators*
- *Site Planning and Erosion and Sediment Control*
- *Underground Gas Storage*
- *Waste Management During Drilling, Operating, and Plugging a Well*
- *Well Operation*
- *Well Site Restoration*

http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-48243/chap4.pdf

Erosion and Sediment Pollution Control Program Manual, PA, DEP, Guidance No. 363-2134-008, March 2012, as amended and updated: This manual outlines a variety of BMPs that are intertwined with enforceable DEP regulations. BMPs "are expected to achieve the regulatory standard of minimizing the potential for accelerated erosion and sedimentation, and at the same time to protect, maintain, reclaim and restore water quality and existing and designated uses of surface waters."[170] Examples of BMP categories include the following:

- *Minimizing Earth Disturbances*
- *Silt Fence*
- *Diversion Ditches*
- *Sediment Traps*
- *Sediment Basins*
- *The Establishment of Grasses for Permanent Stabilization*

http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-88925/363-2134-008.pdf

Point of Contact: Scott Perry, Deputy Secretary of Oil and Gas,
Department of Environmental Protection

State Review of Oil and Natural Gas Environmental Regulations

The State Review of Oil and Natural Gas Environmental Regulations (STRONGER) is a non-profit organization that was founded in 1999 with the goal of invigorating and advancing the state review process that was begun in 1988 by the U.S. Environmental Protection Agency (EPA) and the Interstate Oil and Gas Compact Commission (IOGCC).[171] The current mission of STRONGER is "to educate and provide services for the continuous improvement of regulatory programs and industry practices in order to enhance human health and the environment."[172] A multi-stakeholder organization that includes states, industry and environmental organizations, STRONGER provides benchmarks for state regulatory

[170] DEP. "Erosion and Sediment Pollution Control Program Manual, PA, DEP, Guidance No. 363-2134-008." March 2012, as amended and updated.
[171] STRONGER. http://www.strongerinc.org/who-we-are
[172] STRONGER. http://www.strongerinc.org/our-mission

programs, develops recommended state program guidelines, and implements a review process to evaluate state regulatory programs against its guidelines.[173]

Approximately 22 state regulatory programs have been reviewed by STRONGER, a total of states which represent more than 94% of domestic onshore and gas production.[174] A state review process is conducted by stakeholder teams and includes a completed questionnaire by state volunteers; in-state interviews; an initial draft report that includes findings and recommendations; a second draft report that includes comments; and lastly, a final report that has obtained approval from the board to be published.[175] The guidelines used in the state review process "do not establish specific criteria or prescriptive regulatory standards for the state."[176] Instead, the guidelines "outline key elements of state oil and gas environmental regulatory programs and establish environmental goals or objectives for these programs."[177] Guideline categories include: general criteria, administrative criteria, technical criteria, abandoned sites, naturally occurring radioactive materials, stormwater management, and hydraulic fracturing.[178]

The *Hydraulic Fracturing Review Guidelines* were drafted in 2010 by the Hydraulic Fracturing Work Group.

> *Hydraulic Fracturing Review Guidelines*, 2010. Hydraulic fracturing reviews have been conducted in six states, including Ohio and Pennsylvania. The following are the list of guideline categories within the *Hydraulic Fracturing Review Guidelines*[179]:
>
> - *General (Standards, Reporting, Staffing and Training, Public Information)*
> - *Water and Waste Management*
>
> A work group has been convened to consider revisions to these guidelines. The STRONGER website notes that the *Hydraulic Fracturing Review Guidelines* "should be updated to include groundwater protection and pressure monitoring measures."[180] STRONGER also notes that applicable guidelines should be developed to monitor conflicts that are created when drilling occurs in urban areas, such as the creation of local ordinances that conflict with state requirements.[181]
> http://67.20.79.30/sites/all/themes/stronger02/downloads/HF%20Guideline%20Web%20posting.pdf
>
> Point of Contact: Thomas E. Stewart, Board Chair, 740.587.0444, stewart@ooga.org

[173] STRONGER. "The State Review Process." http://67.20.79.30/sites/all/themes/stronger02/downloads/STRONGER%20Presentation%20-%2006022012.pdf
[174] Ibid.
[175] Ibid.
[176] STRONGER. "Hydraulic Fracturing Review Guidelines." 2010. http://67.20.79.30/sites/all/themes/stronger02/downloads/HF%20Guideline%20Web%20posting.pdf
[177] Ibid.
[178] STRONGER. "The State Review Process."
[179] STRONGER. "Hydraulic Fracturing Review Guidelines." 2010.
[180] STRONGER. http://www.strongerinc.org/process.
[181] Ibid.

APPENDIX F: RECOMMENDATIONS OF THE REPORT TO THE GENERAL ASSEMBLY ON PIPELINE PLACEMENT OF NATURAL GAS GATHERING LINES

The following is a listing of recommendations, excerpted from the Report to the General Assembly on Pipeline Placement of Natural Gas Gathering Lines released by the Office of Governor Tom Corbett in December 2012 to inform the Pennsylvania General Assembly about the midstream development in Pennsylvania. The report lays out the following 16 recommendations:

The full report can be found at
http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/Act13/PipelinePlacementReport/FINAL_REPORT.pdf

1. Legal impediments to the sharing of State and local roadway rights-of-way should be repealed or modified to allow for and encourage the use of existing rights-of-way and minimize new surface disturbances. For example, Section 3 of the Limited Access Highway Law (Act 402 of 1945), was repealed in part by Act 88 of 2012 to encourage the creation of Public-Private Partnerships and should be further repealed so as to permit the sharing of rights-of-way where appropriate.
2. The Public Utility Code should be amended to clarify that the sharing of pipeline capacity, for purposes of increased efficiency and smarter deployment of gathering lines, shall not constitute public utility status.
3. In conjunction with the U.S. Army Corps of Engineers, State and federal stream-crossing permits, including those required in 25 Pa.Code Chapter 105 and the Pennsylvania State Programmatic General Permit-4, should be aligned to remove existing duplications related to the protection and preservation of historic, cultural, and natural resources while increasing predictability in planning and permit processing time.
4. The Department of Environmental Protection should regularly review its Permit Decision Guarantee policy to ensure that administratively complete permits are reviewed in a timely manner, and where able, consider providing expedited review for projects that share rights-of-way or otherwise demonstrate steps that minimize conflicts with historic, cultural, or natural resources.
5. The Pennsylvania Natural Diversity Inventory environmental review tool should continue to be enhanced so as to assist in the up-front avoidance of conflicts with threatened and endangered species, flora, fauna, habitat, and other sensitive natural resources and increase certainty in decision making and long-term planning of pipeline operators.
6. The Underground Utility Line Protection Law, commonly referred to as “PA One Call,” should be amended to include mandatory participation beyond the requirements of 58 Pa.C.S.§3218.5, including specific location registration of all gathering lines.
7. The Public Utility Commission should work with PA One Call for purposes of creating a state map of unconventional natural gas pipelines.
8. County planning offices should be encouraged to work with drilling operators and gathering line companies so that operators and companies understand current and future development plans and can seek to maximize opportunities to share rights-of-way and pipeline capacity.

9. In accordance with standards adopted by the Department of Environmental Protection that ensure the protection of water quality, permits seeking to utilize horizontal directional drilling to cross under waterways and other topographic land features, such as steep inclines and declines, should be prioritized during review to recognize their potential to avoid surface disturbances, impacts on sensitive lands, forest fragmentation, viewsheds, and direct intersection with waterways.
10. Pipeline operators should collaborate to standardize right-of-way markers, including the spacing of markers, contact information for the pipeline operator, location of the pipeline, notation to contact PA One Call prior to any excavation, and other critical information. Multiple pipelines in a common right-of-way should be noted on the marker.
11. Landowner outreach efforts, such as those of the county extension offices, should be enhanced to expand landowner awareness of the opportunities, implications, standard terms and conditions, and other important information related to engaging in the leasing of pipeline rights-of-way.
12. County and municipal governments should be encouraged to consult with gathering line operators to better understand the implications of a proposed project on a county or municipal comprehensive plan.
13. The Public Utility Commission and the Department of Environmental Protection should continue their efforts at coordination and public outreach to further citizens' understanding of the respective roles each agency plays in the review of permitting, siting, and placement of natural gas gathering lines.
14. The Governor's Center for Local Government Services, in cooperation with the Public Utility Commission and the Department of Environmental Protection, should work with local government associations and county planning offices to assist in disseminating information on applicable laws, regulations, and other standards related to the construction and installation of natural gas gathering lines.
15. Pipeline operators should be encouraged to consult with the appropriate experts to replant rights-of-way with vegetation that fosters habitat development for wildlife.
16. Consideration should be given to utilization of existing or new pipeline pathways near existing or potential industrial development to maximize job creation, lower energy costs, and secure the nation's energy independence.

APPENDIX G: USEFUL RESOURCES[182]

Academic

Resource	Description
Bucknell University Marcellus Shale Initiative Database Click Here	The Bucknell University Marcellus Shale Initiative Database focuses on scientific, technical, sociological, and economic aspects of shale gas production and hydraulic fracturing in the Marcellus Shale and other shale plays. It lists primarily print-based publications and how to obtain them.
CMU Research Guide to the Marcellus and Utica Shales Click Here	Carnegie Mellon University's catalog of literature on natural gas extraction by hydraulic fracturing in order to help policymakers and researchers comprehend the existing research on this topic and identify issues for further study. The catalog was commissioned by the PA State Association of Boroughs.
Colorado State University Advanced Energy Tracker Click Here	The Colorado State University Advanced Energy Tracker is a database that contains information about advanced energy legislation across all 50 states. Legislation is organized into the following categories: electricity generation, energy efficiency, financing, regulatory, natural gas, emissions, transportation, infrastructure, economic development, and other energy. The database provides current legislative language, recent actions, bill sponsor information, and policy trend analyses.
Institute for Energy & Environmental Research Marcellus Shale Information Clearinghouse Click Here	The Institute for Energy & Environmental Research at Wilkes University works to achieve consensus in the creation of sustainable, environmentally sound public policy on energy issues, including shale gas development, facing northeastern Pennsylvania. The Institute accomplishes its work through basic and applied research subject to internal and external review, innovative education and public outreach, and providing the best information made available by outside sources.
Temple University – PA Policy Database Project Click Here	The Pennsylvania Policy Database Project is an online resource that provides access to more than 170,000 state and news media records and enables users to trace and analyze the history of public policy in the Commonwealth since 1979.
The Shale Network Click Here	The Shale Network is a project funded by the National Science Foundation (NSF) to help scientists and citizens store data for water resources that may be affected by gas exploitation in shale. Its primary focus is the Marcellus Shale and other shale plays in the northeastern United States.
Shale Training & Education Center (ShaleTEC) Click Here	ShaleTEC is a collaboration between Pennsylvania College of Technology and Penn State Extension established to serve as the central resource for workforce development and education needs of the community and the oil and natural gas industry. This website provides resources and course information on educational opportunities related to shale gas.

[182] These links are not an exhaustive compendium of information sources for unconventional oil and gas development in Pennsylvania. Rather, they represent resources that the Roundtable found particularly useful in informing and guiding its work.

Resource	Description
Washington & Jefferson College Center for Energy Policy and Management Click Here	The Center for Energy Policy and Management provides opportunities for scientists, industry leaders, elected officials, advocates and citizens to shape policy related to the country's full array of energy sources while working to minimize environmental impact and promote economic growth. The Center's Energy Index generates analyses of the nation's progress towards energy independence and security and translates these analyses into a relatable format that is easily understood so that all parties may use its findings in their work. The Center is dedicated to enriching the civil discussion of the country's energy future by bringing experts together in a spirit of mutual respect and concern for the common good.

Government

Resource	Description
PA DEP – Office of Oil & Gas Management Click Here	DEP's Office of Oil and Gas Management is responsible for statewide oil and gas conservation and environmental programs to facilitate the safe exploration, development, and recovery of Pennsylvania's oil and gas reservoirs in a manner that will protect the Commonwealth's natural resources and the environment. The office develops policy and programs for the regulation of oil and gas development and production pursuant to the Oil and Gas Act, Coal and Gas Resource Coordination Act, and Oil and Gas Conservation Law; oversees the oil and gas permitting and inspection programs; develops statewide regulation and standards; conducts training programs for industry; and works with the Interstate Oil and Gas Compact Commission and the Technical Advisory Board.
PA DEP Oil and Gas Technical Advisory Board (TAB) Click Here	The Oil and Gas Technical Advisory Board is a five-member committee that was authorized under Act 223 of 1984 (Oil and Gas Act) and retained in Act 13 of 2012. DEP consults with the TAB in the formulation, drafting, and presentation stages of all regulations of a technical nature and guidance documents promulgated under the Oil and Gas Act and other relevant laws. The TAB is given a reasonable opportunity to review and comment on all regulations of a technical nature prior to submission to the Environmental Quality Board.
PA Public Utility Commission (PUC) Click Here	The PUC was created in March 1937. Its mission is to balance the needs of consumers and utilities, ensure safe and reliable utility service at reasonable rates, protect the public interest, educate consumers to make independent and informed utility choices, further economic development, and foster new technologies and competitive markets in an environmentally sound manner. More recently, Act 13 gave the PUC administrative oversight of the unconventional well impact fee and review of local oil and gas ordinances.
PA Marcellus Shale Advisory Commission Report Click Here	Adopted on July 15, 2011, the Marcellus Shale Advisory Commission Report offered 96 recommendations that outlined a comprehensive strategic plan for the responsible development of natural gas in the Commonwealth. The report informed the eventual content of Act 13.

Resource	Description
Act 13 of 2012 – DEP information related to the current PA Oil and Gas Act Click Here	Act 13 of 2012 was the first comprehensive update of the Oil and Gas Act since the 1980s. It enacted updated environmental standards and authorized local governments to adopt an impact fee. Among the Act's other provisions are increased setback requirements for unconventional gas development, enhanced protection of water supplies, and uniform state regulation of well development.
PA Coal and Gas Resource Coordination Act with 2011 Amendments Click Here	The amended Coal and Gas Resource Coordination Act establishes spacing requirements between natural gas well clusters and workable coal seams. The 2011 amendments included changes to definitions; updates to relevant permitting requirements set forth in the Oil and Gas Act; a requirement that well clusters covered by the Act be at least 2,000 feet apart, unless otherwise agreed upon by the coal and gas operators; and a requirement that oil and gas operators, whose well clusters will penetrate an operating coal mine obtain the written consent of the coal operator before drilling as a prerequisite to obtaining a drilling permit.
PA Oil and Gas Conservation Law of 1961 Click Here	The Oil and Gas Conservation Law of 1961 defines and prohibits waste in the production of oil and gas; defines the powers and duties of the Oil and Gas Conservation Commission (which DEP subsumed upon its creation) with respect to the prevention of waste in the production of oil and gas from certain geological horizons; protects correlative rights; provides for the spacing of well drilling operations; and provides for the unitization of lands and horizons for the purpose of regulating well spacing.
PA Act 127/Gas and Hazardous Liquids Pipeline Act Click Here	Act 127 expands the PUC's authority to enforce federal pipeline safety laws as they relate to gas and hazardous liquids pipeline equipment and facilities within the Commonwealth of Pennsylvania. The Pipeline Act requires the Commission to develop and maintain a registry of pipeline operators within Pennsylvania. The Commission will recover the costs of this program by assessments on pipeline operators based on the total intrastate regulated transmission, regulated distribution, and regulated onshore gathering pipeline miles in operation for the transportation of gas and hazardous liquids in Pennsylvania during the prior calendar year.
PA Dormant Oil and Gas Act Click Here	The Dormant Oil and Gas Act provides for the creation of a trust for the benefit of absentee owners of interests in oil and gas; authorizes the trustee to enter into leases of interests in oil and gas under terms and conditions authorized by the Court of Common Pleas; and provides for the administration of the trust and for payment of moneys to the trustee.
Chapter 78 of the Pennsylvania Code Click Here	Chapter 78 includes most Pennsylvania regulations that govern the oversight of the oil and natural gas industry. It is currently under revision based on provisions in Act 13.

Resource	Description
Interstate Oil and Gas Compact Commission Click Here	The Interstate Oil and Gas Compact Commission is a multi-state government agency that promotes the conservation and efficient recovery of domestic oil and natural gas resources while protecting health, safety, and the environment.
Blueprint for a Secure Energy Future Click Here	In March 2011, the White House released the "Blueprint for a Secure Energy Future" – a comprehensive plan to reduce America's dependence on foreign oil, save consumers money, and make the United States the leader in clean energy industries. The blueprint supports the responsible development of the nation's oil and natural gas resources, with the specific goals of promoting safe practices and reducing energy imports.
EPA Hydraulic Fracturing Research Advisory Panel Click Here	At the request of Congress, EPA is conducting a study to better understand any potential impacts of hydraulic fracturing on drinking water and groundwater. The scope of the research includes the full life span of water in hydraulic fracturing. A final report is expected in for public comment and peer review in 2014.
U.S. Secretary of Energy Advisory Board's Shale Gas Production Subcommittee Click Here	The U.S. Secretary of Energy Advisory Board's Shale Gas Production Subcommittee created 20 recommendations regarding shale gas production that are classified into three categories: recommendations ready for implementation, primarily by the federal agencies; recommendations ready for implementation, primarily by the states; and recommendations that require new partnerships and mechanisms for success.
National Energy Technology Laboratory (NETL) Click Here	NETL is headquartered in South Park, Allegheny County and represents a substantial national and regional resource on shale gas development with many relevant research projects currently underway. NETL is leading a consortium of eight state and federal agencies tasked with evaluating the environmental impacts on a Marcellus Shale test site located in Washington County, PA. This NETL prospective test site will monitor impacts to drinking water and examine the impacts to air quality, terrestrial and aquatic wildlife, seismic activity, soil properties, vegetation, and future land use.
U.S. FERC – Gas Pipeline Projects Click Here	This Federal Energy Regulatory Commission (FERC) database provides a listing of and information related to major onshore pending pipeline projects throughout the United States.

Industry

Resource	Description
American Petroleum Institute Click Here	The American Petroleum Institute (API) is the national trade association of America's oil and natural gas industry. API works with industry subject-matter experts to maintain more than 600 standards and recommended practices related to the oil and gas industry. Additionally, API works to improve the compatibility of oil and gas operations with the environment while economically developing energy resources.
Energy in Depth Click Here	Launched by the Independent Petroleum Association of America, Energy in Depth is a research, education, and public outreach campaign that is focused on the promise and potential of responsibly developing America's onshore energy resource base.
Marcellus Minutes – PA Marcellus News Feed Click Here	Marcellus Minutes provides industry news and Pennsylvania capitol insights, including news and updates on legislative movement, industry developments, and industry-related studies on shale gas.
Marcellus Shale Coalition Click Here	The Marcellus Shale Coalition (MSC) works with exploration and production, midstream, and supply chain partners in the Appalachian Basin and across the country to address issues regarding the production of natural gas from the Marcellus and Utica shale plays. It provides in-depth information to policymakers, regulators, media, and other public stakeholders on the positive impacts responsible natural gas production is having on families, businesses, and communities across the region.

Media

Resource	Description
The Allegheny Front Click Here	The Allegheny Front is a radio program covering environmental issues in Western Pennsylvania produced at WYEP-FM, a Pittsburgh NPR affiliate. It provides information on local and regional environmental news through stories, interviews, news, and commentaries.
NPR – StateImpact Pennsylvania Click Here	StateImpact Pennsylvania is a collaboration among WITF, WHYY, and National Public Radio. This website covers the economic and environmental impact of Pennsylvania's booming energy economy, with a focus on Marcellus Shale drilling.
PA Environment Digest Daily Blog Click Here	The PA Environment Digest Daily Blog provides daily links to environmental news stories from across Pennsylvania.

Resource	Description
PA Environment Digest Newsletter Click Here	The PA Environment Digest Newsletter is a weekly newsletter that provides news and links on environmental issues throughout Pennsylvania.
Pittsburgh Business Times – Energy, Inc. Click Here	"Energy, Inc." coverage is accessed from this page, where all Pittsburgh Business Times energy-related stories are accessible.
Pittsburgh Post-Gazette – Pipeline Click Here	Pipeline is a specialty news website launched by the Pittsburgh Post-Gazette that employs multimedia, social media, and interactive maps. Additionally, Pipeline provides daily coverage from the Post-Gazette and other news organizations to provide a resource for Marcellus Shale news and information.
ProPublica Click Here	ProPublica is an independent, non-profit, newsroom that produces investigative journalism in the public interest. One of the many issues that ProPublica is focusing on is hydraulic fracturing. Its stories focus on regulation, environmental issues, and energy policy.

Non-Profit

Resource	Description
CCAP Shale Gas/Act 13 Analysis and Resources Click Here	The County Commissioners Association of Pennsylvania (CCAP) advocates for and provides leadership on important issues for Pennsylvania's 67 counties. Its Shale Gas/Act 13 Analysis and Resources page informs county commissioners and administrators about pertinent shale gas and Act 13 information.
Health Effects Institute (HEI) Click Here	HEI is a nonprofit corporation chartered in 1980 as an independent research organization to provide high-quality, impartial, and relevant science on the health effects of air pollution.
Environmental Defense Fund (EDF) Click Here	EDF is taking a leading role to ensure that natural gas provides real and sustained carbon benefits without harming the environment or health of the communities where gas development occurs. This page summarizes EDF's activities and publications in the natural gas arena.
Ground Water Protection Council Click Here	The Ground Water Protection Council (GWPC) is a nonprofit 501(c)6 organization whose members consist of state groundwater regulatory agencies that come together within the GWPC organization to mutually work toward the protection of the nation's groundwater supplies. The purpose of GWPC is to promote and ensure the use of best management practices and fair but effective laws regarding comprehensive groundwater protection.

Resource	Description
FracFocus Click Here	FracFocus.org is a national hydraulic fracturing chemical registry managed by the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission. The website was created to provide the public with information about hydraulic fracturing and groundwater protection. Users are able to search for wells in their area and find a list of chemicals that have been used in the development of those particular gas wells.
IEHN – An Investor Guide to Disclosing Risks from Hydraulic Fracturing Operations Click Here	The Investor Environmental Health Network (IEHN) created this guide to offer best practice recommendations to energy companies for reporting and reducing risks and impacts from natural gas operations in shale relying on hydraulic fracturing. The guide suggests organizational shale gas goals, practices, indicators, and examples from existing companies.
PEC – Marcellus Facts Click Here	Marcellus Facts is a news and information aggregation project of the Pennsylvania Environmental Council (PEC). Its goal is to provide an open and broad-based resource for news and information about Marcellus Shale development in Pennsylvania. Articles for this site are culled from a variety of independent sources.
PEC – Marcellus Shale Lease Guide Click Here	The Marcellus Shale Lease Guide is intended as a resource for Pennsylvania residents who are considering leasing their property for Marcellus Shale gas production or who have decided to lease and are beginning the negotiating process. It identifies some of the key environmental issues that can be addressed in a lease; summarizes the types of approaches that have been used to address these issues in Marcellus Shale gas leases in Pennsylvania; and offers options for handling these issues in a more protective Marcellus Shale gas lease, using best management practices employed in oil and gas leasing in Pennsylvania and nationwide.
Research Partnership to Secure Energy for America (RPSEA) Click Here	RPSEA is a non-profit corporation comprising nearly 200 U.S. energy companies, research universities, and independent research organizations. RPSEA works to provide stewardship in focused research and development and the deployment of safe, environmentally sensitive technology in order to use domestic hydrocarbon resources in the United States.
Risk Based Data Management System (RBDMS) Click Here	RBDMS is a data management tool used by state regulatory agencies to manage and analyze oil and gas program data and water resources management information. RBDMS can help to assess and reduce the risk to underground sources of drinking water and provides data about oil and gas well locations, permitting, and production to the public and industry owners.

Resource	Description
River Alert Information Network (RAIN) Click Here	RAIN is a consortium of 33 public water supply systems in the Ohio River Basin that are collaborating to detect and prevent any contamination in their systems. The RAIN system includes early warning water quality monitors at 29 sites along the Monongahela, Allegheny, Shenango, Youghiogheny, Beaver, and Ohio rivers.
State Review of Oil and Natural Gas Environmental Regulations (STRONGER) Click Here	STRONGER is a multi-stakeholder organization whose purpose is to assist states in the documentation of the environmental regulations associated with the exploration, development, and production of crude oil and natural gas. STRONGER shares innovative techniques and environmental protection strategies and highlights opportunities for program improvement. The state review process is voluntary and is a non-regulatory program.

The University of Pittsburgh Institute of Politics convened and provided neutral facilitation and research support to the Shale Gas Roundtable.

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