

Oil & Natural Gas Technology

Reducing Onshore Natural Gas and Oil Exploration and Production Impacts Using a Broad-Based Stakeholder Approach

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ABSTRACT

Never before has the reduction of oil and gas exploration and production impacts been as important as it is today for operators, regulators, non-governmental organizations and individual landowners. Collectively, these stakeholders are keenly interested in the potential benefits from implementing effective environmental impact reducing technologies and practices. This research project strived to gain input and insight from such a broad array of stakeholders in order to identify approaches with the potential to satisfy their diverse objectives.

The research team examined three of the most vital issue categories facing onshore domestic production today: 1 - surface damages including development in urbanized areas, 2 – impacts to wildlife (specifically greater sage grouse), and 3 - air pollution, including its potential contribution to global climate change. The result of the research project is a LINGO (Low Impact Natural Gas and Oil) handbook outlining approaches aimed at avoiding, minimizing, or mitigating environmental impacts. The handbook identifies technical solutions and approaches which can be implemented in a practical and feasible manner to simultaneously achieve a legitimate balance between environmental protection and fluid mineral development. It is anticipated that the results of this research will facilitate informed planning and decision making by management agencies as well as producers of oil and natural gas.

In 2008, a supplemental task was added for the researchers to undertake a “Basin Initiative Study” that examines undeveloped and/or underdeveloped oil and natural gas resources on a regional or geologic basin scope to stimulate more widespread awareness and development of domestic resources. Researchers assessed multi-state basins (or plays), exploring state initiatives, state-industry partnerships and developing strategies to increase U.S. oil and gas supplies while accomplishing regional economic and environmental goals.

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EXECUTIVE SUMMARY

The objectives of this research project have been to evaluate the oil and gas exploration and production (E&P) process, identify the issues delaying or curtailing oil and gas exploration and production activities, and identify and publicize practices that ultimately overcome these impedances or delays in development of new energy resources. A secondary goal has been to help to advance the development of underdeveloped resources in specific basins.

Often efforts to reduce impacts resulting from E&P activities do not include input from organizations such as landowners, ranchers, farmers, and other concerned citizens. Lacking this avenue of input can result in practices that ultimately do not achieve the desired result. With that in mind, this research project gained input from a broad variety of stakeholders including: non-governmental organizations, local governmental bodies (e.g., conservation districts), farmers/ranchers, industry, state and federal agencies, and others. Through the project, the research team evaluated practices that are common and key to moving oil and gas development forward and also those that cause the most notable issues relative to delaying or curtailing E&P activities. This included exploration/exploitation activities from pre-drilling seismic surveys, to development activities, and through to final reclamation. The result of the project was an “Adverse Impact Reduction Handbook” summarizing case studies illustrating solutions to those issues that pose the most significant impedances or delays to onshore E&P activities. The handbook recommends approaches to avoid, minimize, and/or mitigate impacts; practices and variations are outlined and detailed. Further, the research provides beneficial analysis of various practices to serve as a starting point for choosing practice options. In addition to its usefulness to regulatory personnel and the regulated E&P community, the handbook is of value to non-industry persons wishing to gain an understanding of the advantages and disadvantages of various approaches to environmental mitigation.

Low Impact Natural Gas and Oil Project (LINGO)

The objective of Phase I of this project was to gather relevant data (Task 1) regarding common practices, mitigation strategies, legislation, guidance and rules pertaining to onshore E&P activities. Additional research was conducted through field reconnaissance, interviews and case studies (Task 2). The objective for Phase II was impact analysis (Task 3) of current E&P practices and other practices identified from Tasks 1 and 2 that impact efficiency, economics, environmental and other factors. The Phase III objective was to organize the information generated in Phases I and II into applicable publications and presentations (Task 4) by compiling the findings of the research in a useable format. Phase III provides opportunities for technology transfer (Task 5) to regulators, operators and the public through technical presentations and workshops.

A supplementary task was approved for the Interstate Oil and Gas Compact Commission (IOGCC) to undertake a “Basin Initiative Study” that examined undeveloped or underdeveloped oil and natural gas resources on a regional or geologic basin scope to stimulate more widespread awareness and development of domestic resources. Researchers assessed multi-state basins, exploring state initiatives, state-industry partnerships and developing strategies to increase U.S. oil and gas supplies while accomplishing regional economic and environmental goals.

The two pronged approach for *The Basin Initiative* included a call for a regional – or basin-oriented examination of undeveloped or underdeveloped oil and natural gas resources as well as the formation of individual subgroups to develop content, materials and recommendations to support the Basin Initiative and meet deliverable requirements for the project. The content arms the IOGCC member states with quotable, reliable information so that they can deliver identifiable messages to the appropriate audience. New opportunities for states to support and encourage the efficient recovery of domestic oil and natural gas resources were identified while protecting health, safety, and the environment. The effort explored state initiatives and state-industry partnerships that address policy goals. Each work group assessed underdeveloped oil and gas resources and potential regional or basin-oriented strategies to increase U.S. oil and gas supplies while accomplishing regional economic and environmental goals.

The regional/basin approach was completed in part with the IOGCC/Penn State partnership holding the Marcellus Shale Summit. The IOGCC was successful in outreach to other basins to hold a Woodford Summit that met their regional specific needs. The formation of the IOGCC Shale Gas Directors Task Force continued to focus on the regulatory issues from the states perspective.

REPORT DETAILS

EXPERIMENTAL METHODS LINGO: Research was conducted to gather and evaluate data pertinent to common practices and mitigation strategies. A wide range of documents discussing environmental mitigation practices for various aspects of onshore oil and gas development as well as those presenting issues of concern voiced by non-governmental organizations (NGO) were reviewed. This allowed identification of many potential environmental issues for further research. Several professional meetings were attended by project personnel allowing discussions and interviews with numerous representatives of regulatory agencies, the oil and gas exploration and production industry, and interested NGOs. This method significantly contributed to the identification of issues appropriate for further research. Meetings/site visits attended include:

1. IOGCC Annual Meeting in Austin, TX – there we met with members of the Project Advisory Council as well as other interested regulatory and business representatives.
2. Bureau of Land Management (BLM) Pilot Office Listening Session in Denver, CO – there we met with interested regulatory and NGO representatives
3. Powder River Basin Sage Grouse Working Group Meeting in Miles City, MT – there we met with interested regulatory and NGO representatives.
4. Montana Board of Oil & Gas Conservation Business Meeting in Billings, MT – there we met with interested regulatory and business representatives.
5. Coal Bed Natural Gas (CBNG) Development Educational Symposium (Citizens for Resource Development and Billings Chamber of Commerce) meeting in Billings, MT – presentations regarding various aspects of coal bed natural gas development in the Powder River Basin of MT and WY; participated by providing a CBNG overview presentation; met with various ranchers and producers in the area.
6. Montana Board of Oil and Gas Conservation – attended hearings on oil and gas development projects.
7. Wyoming Oil and Gas Conservation Commission – attended hearings on oil and gas development projects.
8. Wyoming Dept. of Environmental Quality Environmental Quality Council – attended quarterly meeting.
9. North Dakota Industrial Commission - reviewed hearings on oil and gas development projects.
10. Participation in public hearings for the BLM's Miles City, MT field office supplemental environmental impact statement (EIS) for the regional RMP.
11. Attended industry meetings sponsored by the Montana Petroleum Association and the Petroleum Association of Wyoming.
12. Field visits to four oil fields in the Bighorn Basin of including one large field (277 active wells) that has been in existence since 1915.
13. Field visits to approximately 45 smaller oil producing fields in the Williston Basin area of Montana and North and South Dakota.
14. Sage Grouse Best Management Practices Workshop (sponsored by BLM) meeting in Casper, WY – A meeting to participate in the open discussion and identification of environmental impact issues facing the greater sage grouse as a result of oil and gas development throughout its range in the Rocky Mountain west.
15. Sage Grouse Summit (June 27 and 28, 2007) hosted by the Governor of Wyoming in Casper – A meeting to share current information among academia, industry, and NGOs

16. Participated in BLM public hearings to identify and discuss public concerns associated with the Supplement to the Montana Statewide Oil and Gas Environmental Impact Statement and also the Miles City Field Office Resource Management Plan.
17. Meetings with three BLM Field Offices to discuss reclamation requirements, categorical exclusions, and adaptive management issues related to oil and gas development projects.
18. Meetings with various oil and gas producers to discuss air emissions, produced water, and wildlife issues
19. Initiated research on greater sage grouse population trends within the Powder River Basin of Montana and Wyoming to examine trends in populations in areas impacted by oil and gas development versus those in areas unaffected by such development.
20. Meeting regarding mitigation measures applicable to an old historic oilfield with BLM (Cody, WY). Discussions included the management of new development in an old field while also attempting to manage future reclamation.
21. Meeting with BLM (Miles City, MT) concerning numerous evolving issues relative to ongoing oil & gas development in an old field that has split estate with a shallow gas field developed on top of the older oil development – and desired by BLM for multiple operators to work together.
22. Meeting with Wyoming Oil and Gas Conservation Commission regarding development issues in Wyoming, including problems the state is having with various BLM offices in the state.
23. Meeting with the Oklahoma Corporation Commission (OCC), including a meeting by invitation only, regarding how the OCC will deal with development proposed around a large reservoir in southeastern Oklahoma that is a water supply for the City of Oklahoma City. This action could have effects elsewhere in the state and region.
24. Meeting with Ohio Department of Natural Resources (DNR) regarding rule making in Ohio for oil & gas development in urban areas – will consider a visit to their offices to gather more information.
25. Montana Petroleum Association Annual Meeting
26. Meeting with an industry group in Denver about National Energy Policy Act issues and options to streamline oil and gas development.
27. Meeting with Kevin Harvey, an environmental sustainability contractor, to discuss his new company and how they are apparently taking a different approach to development with an immediate eye toward reclamation.
28. Worked with industry to evaluate methods of working in an area of eastern Texas where there are wetlands in a manner that minimizes wetlands disturbances and allows development to push forward more quickly.
29. Interviews with individual ranchers/landowners and non-governmental organizations in the Powder River Basin area to discuss their experiences, opinions and concerns regarding environmental impacts resulting from oil and gas development
30. Continued research on greater sage grouse population trends within the Powder River Basin of Montana and Wyoming to examine trends in populations in areas impacted by oil and gas development versus those in areas unaffected by such development.
31. Visited a natural gas field in Southeastern Wyoming developed in a wilderness area (sand dunes) where oil & gas development must co-exist with recreation, wildlife studies/management, and management of a unique natural resource. Evaluated reclamation processes that would need to be done both in the dunes and out of the dunes.

EXPERIMENTAL METHODS BASIN INITIATIVE: “Basin Initiative Study” examined undeveloped or underdeveloped oil and natural gas resources on a regional --- or basin oriented -- level to stimulate more widespread awareness and development of domestic resources. Researchers assessed multi-state basins, exploring state initiatives, state-industry partnerships and developing strategies to increase U.S. oil and gas supplies while accomplishing regional economic and environmental goals.

The data for this study were gathered through informal surveys, letters, personal interviews, site visits, and published reports. Sources include government officials, regulatory agency employees, private oil and gas company owners and employees, oil and gas service-industry owners and employees, academics, trade publications, and government documents. Necessarily, much of the information is anecdotal and somewhat subjective. Statistics cited are identified by source. Estimates are based on published statistical evidence with the methodology and source identified.

In many instances, the actions of a particular state, or several states, are cited as examples of approaches to challenges faced by oil and gas development. It should be noted that in most of these cases, other oil- and gas-producing states are using similar approaches; the cited examples are deemed to be the most representative or inclusive.

The IOGCC Shale Gas Directors Task Force – comprised of the regulating officials in seventeen shale gas producing states – was formed and held its first meeting in February 2009. Directors identified challenges and opportunities facing shale gas states and discussed possible projects for development. This working group leads and directs research efforts of the Basin Initiative. The task force includes regulating officials from existing, emergent and frontier shale basins across the U.S.

Problems Addressed in this Research Project

In February 2009, the IOGCC Shale Gas Directors Task Force identified challenges of market fluctuations, public perception, urbanization, infrastructure needs, regulatory challenges, inter- and intra-state agency cooperation and water --- confirming the Appalachian/Illinois Basin Directors’ assessment that further collaboration, communication and cooperation among stakeholders will be necessary to bring gas to market.

.Market fluctuations: Fluctuations in market prices continue to challenge regulators and operators alike. Currently, natural gas prices are depressed, making development of shale gas a losing proposition in some areas. Market fluctuations have a direct impact on workforce.

Public Perception: A majority of states expressed that public perception is a major barrier for future development. Identified areas include, but are not limited to, “mystery” frac water, development in previously unexplored areas, water use, storage and recycling issues, environmental footprints, and protection.

Urban and Frontier Development: E&P in urban areas or in areas that have not been drilled previously and eminent domain issues have come into play for some. Identified issues include public perception, concerns related to the rate of development and the cumulative effect that this will have on the environment.

Regulatory Challenges: Some states are trying to apply regulations designed for vertical drilling to new technological practices for horizontal drilling. Issues include well spacing, integration issues, correlative rights, and field rules.

Inter- and Intra-state Cooperation: An increased interest in working with local regulatory authorities was expressed as well as an ongoing need for inter-agency cooperation. In western states, most shale gas is on public lands and requires cooperation with applicable federal agencies, such as the BLM and the Environmental Protection Agency (EPA).

Infrastructure Expansion: Pipeline infrastructure to transport shale gas is necessary.

Water: Challenges associated with the water necessary for hydraulic fracturing (“fracing”) must be met--- from availability to quantity to treatment to transport and disposal.

Of the identified challenges, three emerged as the most cross-cutting and influential – public perception, infrastructure, and water issues. While market fluctuations were identified as a challenge for many shale producing states, for the purposes of the report they are viewed as an external factor to take into consideration but not necessarily address in outreach activities

RESULTS and DISCUSSIONS LINGO:

The project is divided into three basic phases: Phase I Exploration and Production Practices Research – Data Gathering; Phase II Impact Analysis; Phase III Reporting and Technology Transfer. Initial work progressed very well subsequent to the October 13, 2006 Kick-Off meeting with the DOE LINGO Project Officer and the PAC. The research team identified numerous documents directly related to the project goals and objectives, and has also attended several meetings where the team had discussions with state regulators and industry representatives and ALL Consulting met with and interviewed individual ranchers/landowners and NGO’s to gather their opinions and concerns regarding oil and gas development in the Powder River Basin area. The efforts undertaken for Tasks 1 and 2 lead ALL Consulting to conclude that the full universe of potential issues and corresponding mitigation strategies exceeded the resources available therefore, we produced several focused documents rather than a single, comprehensive Adverse Impact Reduction Handbook. From our findings, we deduced the most appropriate focus topics to address issues surrounding: 1 - wildlife, 2 - air pollution, and 3 - a range of issues related to surface damages, development in urbanized areas, pits, etc.

The scope of work for the initial research project consisted of five tasks conducted in three phases over a 24-month period. The tasks were overseen by a PAC made up of oil and gas agency directors, state and federal agency representatives, and industry representatives. The approach to conducting the research in Phase I was to gather and compile information via the Internet and other published sources, leverage existing DOE and other agency studies, and through personal contacts with state and federal agency personnel, industry representatives, and other stakeholders via e-mail, telephone interviews, and field visits. The resulting comparisons and summary documents were evaluated and analyzed by senior staff at the various oil and gas agencies and by BLM and EPA personnel participating on the PAC. The final phase is documentation of the findings in a handbook and the development of a Web site to host the report, associated interim documents including a magazine-style publication directed towards non-industry stakeholders, and related project resources. Conclusions also will be shared

publicly through a series of reports, technical presentations, and workshops beginning with the November International Petroleum and Biofuels Environmental Convention in Albuquerque, NM, and the IOGCC Annual Meeting in Santa Fe, NM.

Impact Analysis Summary Report:

Many of advances in have had major impacts on lowering the invasive nature of E&P on well sites. There have been some clear indicators that technological innovation has enabled the industry to continually increase the production of natural gas, while reducing production costs for recovering oil. Some notable highlights of the effect of technological innovation include:

- * There are 22,000 fewer wells on an annual basis to develop the same amount of oil and gas reserves as were developed in 1985;
- * Drilling wastes have decreased by as much as 148 million barrels due to increased well productivity and fewer wells.
- * The drilling footprint of well pads has decreased by as much as 70 percent due to advanced drilling technology, which is extremely useful for drilling in sensitive areas
- * The size and weight of drilling rigs can be reduced by as much as 75 percent over traditional drilling rigs, reducing their surface impact including roads. The newer rigs are modular or utilize slim hole technologies.

LINGO studied three of the most vital issue categories facing onshore domestic production: 1) surface damages, impacts to wildlife, and air pollution. Some of the major technological innovations that have impacted efficiency, cost and effectiveness and have reduced impacts on sensitive or more heavily populated lands include:

Three- and four-dimensional seismic imaging

*The development of seismic in multiple dimensions has had a major impact on the nature of oil and gas E&P. Utilizing powerful computers and traditional seismic imaging techniques, this technology can provide a much clearer picture of underground structures and layers. The results include higher productivity due to improved well location, a reduced number of dry holes, faster and more accurate seismic interpretation, lower finding and producing costs, and less intrusion on sensitive lands.

Coiled tubing drilling

Coiled tubing drilling provides many benefits, including very little pipe handling and no drill pipe connections; better control of fluids in the borehole; reduced noise levels; smaller sites and less surface disturbance; lighter equipment, lower fuel consumption and air emissions and fewer workers needed at the well site.

Multilateral drilling

Multilateral drilling using one location to drill multiple boreholes, reduces surface impact and minimizes the creation of multiple well pads.

Through-tubing rotary drilling

This technology permits a new well to be drilled through the production tubing of an older well. This technology permits access to areas where conventional rigs are not allowed.

Improved fracturing techniques

Carbon dioxide/sand fracturing techniques have created liquid-free stimulation technology that holds promise for stimulating liquid sensitive reservoirs. The technology differs from conventional techniques because it uses liquid carbon dioxide instead of water as the base fluid. The CO₂ is pumped as a liquid and then vaporizes at reservoir conditions, and because no other liquids or chemicals are used, a liquid free fracture is created and eliminates the requirements for water and other fluids in the fracturing mix.

Slim-hole drilling

This technique involves the use of smaller diameter drilling tools to create a borehole from 3-4 inches in diameter compared with conventional holes of 8-10 inches. This drilling style utilizes smaller rigs, which can be transported by helicopter to more remote, possibly sensitive lands. Slim hole drilling utilizes 97 percent less drilling fluid and produces one-third the volume of cuttings. Air emissions are also reduced.

Wildlife impact mitigation

This is an emerging area of concern among stakeholders in oil and gas E&P. States, companies and industry trade organizations are increasing their focus on wildlife protection and have adopted policies and position statement that seek to protect sensitive wildlife. A case study specific to the sage grouse has been developed.

Incorporated documents such as:

- *Reasonable and Prudent Practices for Stabilization of Oil and Gas Construction Sites* – Independent Petroleum Association of America (IPAA)
- MT HB790 committee findings and associated testimony
- *A Guide to Practical Management of Produced Water from Onshore Oil and Gas Operations in the United States* – DOE
- *Best Management Practices for Oil and Gas Well Site Construction* – Ohio DNR
- *Oil and Gas at Your Door? A Landowners Guide to Oil and Gas Development* – Oil and Gas Accountability Project (OGAP)
- *Doing it Right, a Blueprint for Responsible Coal Bed Methane Development in Montana* –Northern Plains Resource Council (NPRC)
- *The Western Heritage Alternative* – Biodiversity Conservation Alliance (BCA)

Some of the documents reviewed included those prepared by the IPAA, testimony from Montana House Bill 790 concerning split estates, the DOE, and the Ohio DNR, as well as NGOs including: the OGAP, NPRC, and the BCA.

Interviews included representatives of:

- Devon Energy Corp. and other E&P firms
- PAC and other State oil and gas Agencies
- Federal land and resource management agencies
 - BLM
 - USFS
- Individual ranchers/farmers/landowners
- Non-governmental organizations:
 - Citizens for Resource Development (WY)
 - Montana Cattleman's Association

– Oil and Gas Accountability Project

Field Reconnaissance:

- Bighorn Basin – Established fields
- Fort Worth Basin – Barnett Shale Play – E&P in a highly urbanized area
- Powder River Basin – CBNG – area has been subject of public scrutiny as well as the site of innovative, low-impact solutions
- Williston Basin – Bakken Play, MT and ND

Sage Grouse Specific Information:

We assembled greater sage grouse population data from Montana and Wyoming with a focus on the Powder River Basin. What we have found is that there has been an unprecedented increase in data collection efforts over the last 10 years.

- Assembled greater sage grouse data for the states of MT and WY (1949-2006)
- Recent efforts to collect population data are unprecedented
 - Increased interest is partly because of the increase in oil and gas development activities

When you look at the large raw datasets available from the various agencies in Montana and Wyoming, only a limited fraction of the data has qualified utility in the analysis of greater sage-grouse population trends (not surprisingly, an even smaller fraction is applicable to the Powder River Basin study area). Furthermore, in assembling the data we learned that some private land owners have asked that sage grouse data from their land not be made available to the public.

- The MT and WY combined greater sage grouse database is severely limited:
 - Of 75,388 lek observations only 13,023 (17%) observations statewide are of sufficient quality for detailed analysis
 - Of that, there are only 1,733 peak male counts from 470 lek complexes located within the Powder River Basin
 - Private land data not available in some cases
- Most of the scientifically sound population data has been collected since 1997:
 - 72% of all known leks in MT and WY have been “discovered” since 1997
 - 79% of the qualified observation data has been gathered since 1997
 - Standardized survey guidelines were first recommended in 2001

Air Emissions

Prevention: Not surprisingly, the best way to reduce air pollution is to prevent or minimize emissions in the first place this can take many forms such as improving management practices, improving operational practices, and waste reduction.

- Prevention and minimization are the most effective means of air emissions reduction
- Achievable through:
 - Improved management practices
 - Improved operational practices
 - Reduction of waste and synergies

Operational Practices: Replacing high-bleed pneumatic devices with low-bleed ones has been shown to have a payout period as short as six months. The Natural Gas STAR Program estimates that partners of the program have saved 11.2 BCF to date through improvements to pneumatic devices, saving approximately \$22.4 million.

- Equipment Upgrades
 - Low-bleed pneumatic devices:
 - Six month payout not uncommon

- Natural Gas STAR partners have saved 11.2 BCF natural gas and \$22.4 MM to date by upgrading pneumatic devices
- Equipment Upgrades
 - Using minimum circulation rate on Vapor Recovery Units results in significant savings:
 - Less methane is lost to the atmosphere so more goes to market
 - Savings can be significant at larger facilities with payouts as short as three months

Waste Reduction & Synergies: Utilizing micro turbines can provide a low cost and low emissions source of power even when handling poor quality gas. They may also allow less construction impact for utility corridors.

- Micro turbines:
 - Provide a low emissions source of power
 - Can burn low quality gas (>350 BTU)
 - Minimize utility construction and corridors
- Capture and reuse of CO₂
 - According to DOE, full use of CO₂ Enhanced Oil Recovery (EOR) could generate an additional 240 billion barrels of recoverable oil in the United States

Challenges: Methane emissions from oil and gas activities are our Country's second largest anthropogenic source of methane emissions in the United States (#1 is mining, #3 is landfills, #4 is agriculture). The oil and gas industry will be challenged to develop new energy sources to meet a growing demand while doing its share to reduce greenhouse gas emissions that may play a role in global climate change.

- Oil and gas activities are the second largest anthropogenic source of methane emissions in the United States
- Methane is a greenhouse gas
- One of the oil and gas industry's challenges is to develop new energy sources while reducing greenhouse gas emissions

Surface Disturbance:

- Wide range of issues
 - Common
 - Site-specific
- Stakeholders have differing views on mitigation
- Case studies illustrate application of new and emerging technologies and practices
- Many have applicability to other oil and gas projects across the United States
- Common elements:
 - Wells, well pads, centralized facilities
 - Roads, utility corridors, construction
 - Produced water management
- Land use/demographic categories
 - Rural Farming and Ranching
 - Urban (suburban)
 - Established (vintage) vs. Emerging fields
 - Scenic and Wildlife
 - Sensitive (categorized) Areas
 - Public or Indian Ownership

Case Studies:

Rural & Emerging Field

Our first example is of a new field in a rural setting at Cabin Creek Coal Bed Natural Gas (CBNG), in the Powder River Basin, of northern WY. Hundreds of wells are planned over an area several square miles encompassing farmland, rangeland, scenic viewsheds, wildlife habitat, and a mix of state, federal and private (fee) surface and minerals ownership. The complex land use and wide mix of stakeholders created a challenging planning and design process.

- Rural Farm/Ranch/Scenic/Wildlife/Public Lands Case Study
 - Cabin Creek CBNG, PRB, WY
 - ~130 wells over ~10 square miles of farmland, rangeland, scenic viewsheds, wildlife habitat
 - Patchwork of state, federal and private (fee) surface and minerals
 - Complex land use and wide mix of stakeholders created a challenging planning and design process

Urban

Our next example is from the Barnett Shale Play; Flower Mound, TX is an affluent suburb of Dallas-Fort Worth. Annexation of rural land in and around the city core has led to long term land use planning and policy issues. Development of subsurface resources is challenging due to the City's requirements. However, variances to the set-back requirements are possible through demonstration of low impact approaches including: Horizontal drilling and working from a smaller well pad, Vegetation and tree replacement plans, Location of wells in visually hidden areas, and Aesthetic upgrades to fences and facilities were all done to demonstrate low impact.

- Emerging Urban (Suburban) Case Study
 - City of Flower Mound, TX (Barnett Shale)
 - Oil and gas development subject to multiple set-back requirements
 - Variances through low impact approaches:
 - Horizontal drilling from smaller well pads
 - Vegetation and tree avoidance or replacement
 - Location of wells in visually hidden areas
 - Aesthetic upgrades to fences and facilities
 - Upland and riparian mitigation plans

Wetlands

An example from a categorized area, in this case a wetland, is from Joaquin, TX.

In this part of East Texas old and new oil and natural gas fields are located in and around riparian and wetlands areas. New drilling in categorized wetlands requires a lengthy permit review process through the Army Corps of Engineers, with no assurance of eventual approval.

Field reconnaissance and a wetlands survey identified nearby upland areas where horizontal drilling could take place immediately vs. going through the lengthy wetlands permit review process. Because many of the upland areas were rather small, well pads had to be laid out carefully. Overall, the avoidance of wetland disturbances was preferable to going through an extended wetlands permitting process that may or may not have been approved.

- Categorized Areas Case Study:
 - Joaquin, TX - East Texas oil and gas field
 - Categorized wetlands require lengthy permit review process through Army Corps of Engineers, no guarantee of approval
 - Conducted wetlands survey and identified suitable upland well site locations
 - Horizontal drilling from proximal upland habitat avoided drilling in wetlands
 - Small upland areas required careful well pad configuration

Result of all the research was compiled to develop a handbook, titled [“Reducing Onshore Natural Gas and Oil Exploration Impacts Using a Broad-Based Stakeholder Approach”](#), identifies and explores three important environmental issues that are being addressed using new technology and creative thinking. These critical issues are: protecting landscapes and water bodies, preserving air quality, and safeguarding wildlife.

RESULTS and DISCUSSION BASIN INITIATIVE:

Natural gas accounts for 29 percent of the United States’ total energy supply (2009) and plays a key role in meeting our energy demands.¹ Although the U.S. currently produces approximately 21 trillion cubic feet (Tcf) per year, additional sources of supply must be developed for three main reasons. First, traditional sources of supply have been depleted and new sources must be developed to account for this loss. Second, consumption of natural gas is expected to rise because natural gas is seen by many as an essential part of any strategy to implement alternative forms of energy to combat global warming. Third, to meet the national goal of increased energy independence, additional production is needed because U.S. production is not sufficient to meet demand.

Due to diminishing sources of traditional natural gas supplies, new production sources must be developed to meet the U.S. energy demand. The Energy Information Administration (EIA) estimates that between 2008 and 2035, production from traditional onshore supply sources will decrease by 35 percent.² Further, from 2003 to 2008, the amount of natural gas produced from offshore wells has decreased by 42 percent.³ In fact, half of the natural gas consumed is produced from wells drilled in the past 3.5 years.⁴ As a result, shale gas is expected to provide the majority of the growth in gas supply over the next twenty years.

In addition to the decrease in traditional sources of supply, increased production from new sources is necessary because natural gas is an essential element of strategies designed to combat

¹ EIA, Annual Energy Outlook 2010, table 1 – Total Energy Supply, Disposition and Price Summary.

² EIA, Annual Energy Outlook 2010 with Projections to 2035, Table 14, Oil and Gas Supply.

³ EIA, Offshore Gross Withdrawals of Natural Gas.

⁴ DOE, Modern Shale Gas Developments in the United States: A Primer.

the challenges associated with global warming. The use of natural gas in electricity generation is growing at a rapid pace. Since 2004, the amount of natural gas used to generate electricity rose by 26percent.⁵ Compared to coal, natural gas emits 44 percent less carbon dioxide, 80 percent less nitrogen oxides, and 99 percent less sulfur dioxide.⁶ Of all fossil fuels, natural gas is by far the cleanest burning. Further, renewable sources, such as wind and solar, require a supplemental energy source when weather conditions or energy storage capacity is not available. Because of its wide availability on near instantaneous demand and its environmental benefits compared to other sources, natural gas is uniquely suited to serve as a supplemental supply for renewable energy sources.

New supplies of natural gas are also important to striving for a goal of greater energy independence. In 2009, consumption of natural gas outpaces domestic supply by approximately 2 Tcf per year. EIA estimates that this shortfall will be approximately 2.6 Tcf by 2020.⁷ Therefore, the United States must import natural gas from foreign sources. Reliance on foreign sources of energy decreases our energy security and creates an outflow of money to foreign states and corporations. As a result, a broad consensus has developed that recognizes the need to develop domestic energy resources and no longer rely on unreliable and politically unstable foreign sources.

One of the major reasons why shale gas development has grown rapidly in recent years is because of new technologies implemented by the industry to access the gas in an environmentally safe and cost effective manner. Specifically, horizontal drilling and hydraulic fracturing have allowed access to shale gas that was previously too costly to produce. As discussed in more detail below, production of shale gas using these new techniques does not have an adverse effect on the environment.

Horizontal drilling is a procedure where the wellbore is drilled vertically to a kick-off depth above the target formation and then angled through a wide 90 degree arc such that the producing portion of the well extends horizontally through the target formation. Horizontal drilling is an established technology that has been used not only in shale gas production but in other natural gas and oil fields as well

Horizontal wells are environmentally advantageous because less surface disruption occurs. For example, approximately half the number of wells are required to develop a reservoir using horizontal wells rather than traditional vertical wells.⁸ As a result, fewer surface roads, well pads, and other related equipment will be required. Further, because horizontal drilling is an established technology, the industry has developed a series of “Best Management Practices” that ensures that drilling is done safely and in an environmentally sound manner.

⁵ EIA, Spreadsheet Data 1: U.S. Natural Gas Consumption by End Use.

⁶ DOE, supra note 4.

⁷ EIA’s estimates that by 2035 the shortfall will be approximately 1.45 tcf. This assumes increased domestic supply from shale sources and an Alaska natural gas pipeline. EIA, Forecasts and Analysis of Energy Data.

⁸ DOE, supra note 4.

Hydraulic fracturing is a formation stimulation practice that creates additional permeability by pumping fracturing fluid into the formation to generate fractures. The fracturing fluid consists primarily of water and a sand proppant, which is used to prop open the fractures after the fluid pumping has stopped. The main environmental concern regarding hydraulic fracturing is the contamination of underground sources of drinking water above or below petroleum-producing formations. However, because operators have a strong economic incentive to ensure that fractures do not propagate beyond the target formation, hydraulic fracturing is extensively modeled based on formation characteristics and carefully monitored throughout the process. Allowing fracturing to extend beyond the target area could result in the loss of gas and/or excess water production. Lastly, in 2004, the EPA concluded that hydraulic fracturing (used to produce coal bed methane) did not pose a threat to drinking water.⁹

Economic Development

Production of shale gas has significant economic benefits to both the local community and the state. First, increased production of natural gas creates jobs both directly and indirectly. Second, landowners benefit from natural gas production through royalty payments. Third, the state and local community gains much needed revenue. Fourth, all natural gas customers benefit from diversification of supplies.

Production of natural gas will create jobs both directly and indirectly. In 2008 alone, development of the Marcellus Shale created over 29,000 jobs and added \$2.3 billion to the Pennsylvania economy.¹⁰ Further, by 2020, Marcellus production could be responsible for up to 175,000 jobs and \$13.5 billion.¹¹ The local economy also benefits because individual mineral rights owners receive royalty payments for gas that is produced and surface land owners receive lease payments. The combination of more people with jobs and increased income due to royalty and lease payments further helps the local and state economy as more money trickles down through the economic, generating second, positive impacts on businesses ranging from local cafes to major equipment suppliers. This furthers overall job growth in the state.

The state and local governments also benefit from increased natural gas production from both severance taxes and higher revenues from income and sales taxes. In Pennsylvania, 2008 state and local tax revenue increased by \$240 million because of Marcellus production.¹² Further, it is estimated that between 2009 and 2020, Pennsylvania will receive approximately \$13 billion dollars in state and local taxes.¹³ Additionally, states can raise revenue through the use of

⁹ In 2010, the EPA initiated a study to determine the environmental impacts of hydraulic fracturing.

¹⁰ Timothy Considine, *An Emerging Giant: Prospects and Economic Impact of Developing the Marcellus Shale Natural Gas Play* (Penn State University 2009).

¹¹ *Id.*

¹² *Id.*

¹³ *Id.*

severance taxes. For example, in Oklahoma, depending on the price of gas, there is a severance tax of 1 to 7% on each Mcf produced.¹⁴ Because of the economic downturn, many states are experiencing budget shortfalls and have been forced to cut jobs or government programs. Increasing the production of shale gas will mitigate these budget impacts through increased tax revenue.

Additionally, all natural gas customers will benefit from shale production because of supply diversity. Supply diversity increases the reliability of natural gas for end users. If supplies are concentrated in a particular region, customers may experience shortages and/or higher prices as a result of natural disaster. Developing more resources throughout the country will mitigate this risk and benefit all customers.

The IOGCC identified several potential means for addressing barriers and using its leverage as a multi-state government agency to overcome them. The IOGCC has long-standing relationships with state agencies, governors, industry associations, oil and gas legal experts, industry, federal government agencies, and the environmental community.

¹⁴ Oklahoma Tax Commission, Gross Production Monthly Rates.

Regulatory Challenges by state -- Shale Gas

	AL	AR	KY	LA	MI	NY	OK	PA	TX	UT	WV	WY
MARKET FLUCTUATIONS	X	X		X		X	X	X			X	X
PUBLIC PERCEPTION	X	X		X	X	X	X	X	X		X	
PREVIOUSLY UNEXPLORED AREAS	X	X										
REGULATORY CHALLENGES			X	X								
INFRASTRUCTURE ISSUES		X	X	X		X	X	X	X		X	X
WATER ISSUES				X	X	X	X	X	X	X	X	X
URBANIZATION				X		X			X			
WORKFORCE				X								
CUMULATIVE IMPACT	X							X				
INTER-STATE BOUNDRIES									X			
PUBLIC LANDS										X		X
INTER-AGENCY COOPERATION									X	X		X

Petroleum geologic regional framework: Work with local geological surveys and academic institutions to identify geographic areas of potential, address water requirements, and quantify the potential of individual regions.

Regulatory clearinghouse: Develop a user-friendly Web site with links to state and regulatory rules, views, and responses that can be used to increase public awareness and share best practices among the states. The clearinghouse could include regulatory items --- such as horizontal shale rules, spacing, cross-unit wells, and water analysis --- as well as scientific studies and other resources.

Inter- and Intra-Agency Forums: Continue communications both at the inter- and intra-state level to include federal, state, and local parties as well as geological survey information.

Public Education: Provide the facts, in a user-friendly fashion in a variety of mediums such as town hall meetings, local seminars, and Web sites with open lines of communication.

In response to identified regulatory challenges and opportunities, the IOGCC and the Shale Gas Directors' Task Force have initiatives at regional, state, and national levels. These initiatives address the key challenges of public perception, water challenges, and infrastructure development and the key opportunities of providing a regulatory clearinghouse, inter- and intra-agency forums and public education.

Groundwork

Perhaps the most compelling opportunity identified by the Task Force was the development of a regulatory clearinghouse that would provide regulatory information about shale gas in an easy-to-access medium.

Leveraging the already established IOGCC regulatory Web site, which launched in October 2009, the Shale Gas Directors' Task Force developed fact sheets and other regulatory information for a micro-site dedicated to Shale Gas. <http://groundwork.iogcc.org/topics-index/shale-gas>

Fact Sheets

The Shale Gas Directors' Task Force authored several fact sheets to address the identified challenges and opportunities. *Fact sheets are available as appendices to the report*

Shale Gas in the U.S.

Shale Gas: Creating American Jobs

The Regulation of Hydraulic Fracturing and Overview

Community and the Environment

Hydraulic Fracturing

Shale Gas Infrastructure

Basin-Specific Fact Sheets: Barnett, Haynesville, Marcellus, Woodford, Eagle Ford and Monterey

CONCLUSIONS

The IOGCC recognizes that the only way to address energy challenges appropriately is through an all-inclusive, collaborative approach that includes input and expertise from all of the parties involved, including industry, regulators, government representatives, and communities. Utilizing this synergistic approach, the hope is to find system-wide solutions that are the most beneficial.

The IOGCC urges legislators, regulators, producers and operators, individuals, and communities to be good stewards of the environment, good citizens, and good neighbors. By working together to preserve the environment while meeting the nation's energy needs, these groups can mold various answers into one solution that is superior to the individual parts. This means establishing and developing relationships with other groups, going above and beyond what is required, and seeking to understand the perspectives of all of the parties involved in energy production.

Recommendations LINGO:

- Work collaboratively to create land use plans that take into account all of the probable effects of exploration and production on a given area so that efficient recovery of oil and gas resources occurs with the smallest environmental footprint possible.
- Understand that local, state, and federal regulatory processes are designed to protect the environment. We urge regulators to streamline processes so that they are easier to understand and to navigate. We urge producers to cooperate and collaborate with regulators and local communities when preparing for exploration and production.
- Be informed. Citizens can make the most of their efforts by learning the energy production process and potential mitigation factors and becoming better partners in creating solutions that meet the needs of their area.

Recommendations Basin Initiative

Of the key challenges and opportunities identified by shale gas states, the most compelling is public perception of regulatory processes associated with shale gas development and the hydraulic fracturing process.

Public Perception Holds the Key

The most influential and critical challenge facing regulators of shale gas development is public perception, particularly when it comes to the process of hydraulic fracturing. A majority of states expressed that public perception is a major barrier for future development. Identified areas include, but are not limited to, chemical composition of fracking fluid, development in previously unexplored areas, water use, storage and recycling issues, environmental footprints, and protection.

In October 2009, IOGCC member states passed Resolution 09.106 that resolves that shale gas should be encouraged under conditions that protect the environment and public health and safety. Excerpts from the resolution states the concept succinctly:

It is crucial for U.S. citizens, policy-makers, and lawmakers to understand the importance of shale gas to our economy and energy security as well as the safeguards in place to minimize impacts from shale gas exploration and production.

Domestic sources of natural gas are expected to increase as a share of U.S. supply from 84 percent in 2007 to 97 percent in 2030.

Member states of the IOGCC have proven to have effective regulatory systems that protect water, air, soils, and other resources as well as public health and safety.

Regulatory processes are designed to protect health, safety and the environment. Communicating the effectiveness of these processes – to U.S. citizens, policy makers and lawmakers – is the greatest challenge and opportunity for the regulating community.

The answer is simple but not easy – the establishment of a proactive public outreach mechanism that objectively educates citizens about the effectiveness of state regulators. Once established, it will be important to maintain an ongoing informational resource for inquiries (from media, general interest, industry, etc.) about up-to-date regulatory practices, rulings and monitoring activity.

The IOGCC, through its collaborative structure among oil and natural gas producing state regulators, is the catalyst for implementing such a communications system. Although state regulatory agencies operate independently, our collaborative compact is a foundational structure from which dissemination of shared disciplines, information and techniques - being effectively applied in various regulatory processes and procedures - can be expanded. Proactively employing this outreach -- while providing passive access to a centralized communications hub containing updated facts and findings -- leverages and enhances the credibility and authority of the state regulatory community.

Support the Safe, Responsible Development of Domestic Unconventional Resources

Unconventional resources production should be encouraged under conditions that protect the environment, public health, and safety. It is important that all parties involved understand the importance of unconventional gas to our economy and energy security as well as the safeguards in place to minimize impacts from natural gas exploration and production.

FEDERAL STAKEHOLDERS

- Recognize the exemplary job by state agencies in regulating the decades-old practice of hydraulic fracturing. States and the U.S. Environmental Protection Agency agree that there has never been a single instance of drinking water contamination as a direct result of hydraulic fracturing. The federal government should support state regulation of hydraulic fracturing and avoid the application of unnecessary provisions of the Safe Drinking Water Act. Further, the Congress of the United States should oppose legislation that removes the exemption for hydraulic fracturing as unnecessary, duplicitous, and an infringement on state authority and regulatory procedures that have been in place for decades.

- Allow the states to participate as a partner should any new studies be undertaken on the impacts of oil and natural gas resource development, including any studies targeting shale oil and gas plays
- Encourage efforts by agencies such as the U.S. DOE and Environment to strengthen existing relationships with the IOGCC and member states for the purposes of providing financial and technical support, improving efficiency in the use of limited resources, minimizing or eliminating duplication of effort, supporting the national goals of energy production, environmental protection and economic development and improving public understanding of energy-related issues. Seek out additional opportunities for agencies to partner with states on issues of joint concern or interest.

STATE STAKEHOLDERS

- Foster the development of a regulatory environment that permits the development and utilization of technological advances to improve the effectiveness and efficiency of recovering oil and natural gas while at all times maintaining the highest levels of environmental protection.
- Seek opportunities to partner with stakeholders to create a greater public understanding about the role of unconventional fuels in the country's energy mix.
- Spearhead research and information transfer on under-explored and emerging resource plays.
- Recognize the need for long-term transportation and storage contracts that attract long-term, preferred financing of additional gas transportation and storage infrastructure to accommodate future gas demand, while moderating natural gas prices.
- Seek solutions to existing field-to-market bottlenecks, such as the Bakken, and proactively work to head off such barriers in emerging, unconventional plays such as the Marcellus.
- Continually seek to improve regulatory programs for the dual goals of environmental protection and full resource development. Especially in emerging play, seek to inform and involve stakeholders as issues are anticipated or arise. Possible approaches include structured public information systems and a presence in affected communities.
- Participate with the IOGCC on a regional basis to promote the potential for shale gas in the United States' energy future.

INDUSTRY

- Continue to invest in environmentally sound methodologies for responsible unconventional production.
- Go "above-and-beyond" regulatory compliance to ensure that environmental safeguards are in place.
- Recognize the need for long-term transportation and storage contracts that attract long-term, preferred financing of additional gas transportation and storage infrastructure to accommodate future gas demand, while moderating natural gas prices.

- Reach out to the general public to understand and head off confrontations regarding development in previously undeveloped areas.
- Join with states and the IOGCC in seeking streamlined yet effective regulatory structures that achieve compliance while permitting resource development.

CIVIC AND COMMUNITY

- Take advantage of educational opportunities to become knowledgeable about regulatory processes and procedures in place in individual communities.
- Participate in town hall meetings, public commentaries, and other means of community participation for rule development.

Shale Gas is an abundant source of domestic, unconventional natural gas that contributes to our nation's energy security today and tomorrow. The IOGCC has been working diligently to come up with new and innovative solutions to provide fact-based information on efficient recovery of domestic shale gas. The Shale Gas Directors work group has begun to conduct research, formulate technology transfer recommendations, and develop fact sheets for use on the web site and conferences. A secondary message for every issue addressed will be (1) improving public perception (affected and interested); and (2) environmental stewardship.

By taking the two pronged approach of the all encompassing work group as well as the basin specific examination the IOGCC will had access to an expansive audience. The IOGCC worked too convey the importance of new opportunities for the efficient recovery of domestic oil and natural gas resources while protecting health, safety, and the environment.

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ACRONYMS and ABBREVIATIONS

BLM	Bureau of Land Management
BCF	Billion Cubic Feet
CBNG	Coal Bed Natural Gas
DNR	Department of Natural Resources
DOE	Department of Energy
E&P	Exploration and Production
EIA	Energy Information Administration
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
IOGCC	Interstate Oil and Gas Compact Commission
LINGO	Low Impact Natural Gas and Oil
NGO	Non Government Associations
O&G	Oil and Gas
OCC	Oklahoma Corporation Commission
PAC	Project Advisory Council
TCF	Trillion Cubic Feet
USFS	United States Forrest Service
USGS	United States Geological Survey

APPENDIX

Link to “Stepping Lightly: Reducing the Environmental Footprint of Oil and Gas Production”:

<http://iogcc.myshopify.com/collections/frontpage/products/steeping-lightly-reducing-the-environmental-footprint-of-oil-and-gas-production>

Link to “Adverse Impact Reduction Handbook: Reducing Onshore Natural Gas and Oil Exploration and Production Impacts Using a Broad-Based Stakeholder Approach:

<http://iogcc.myshopify.com/collections/frontpage/products/adverse-impact-reduction-handbook>

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