Policy Analysis Group – College of Natural Resources

Report No. 33 **December 2013**

Oil and Gas Resource Exploration and Development Policies in Idaho

by

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and

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The College of Natural Resources Policy Analysis Group (PAG) was established by the Idaho Legislature in 1989 to provide objective analysis of public policy issues related to natural resource and land-use questions, as suggested by an Advisory Committee (see Idaho Code § 38-714). The PAG is administered by Kurt Pregitzer, Dean, College of Natural Resources.

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* We deeply regret the death of Jack Lavin on November 13, 2013. We will miss his leadership as much as his smile and good humor.

† These are "series" publications required by Idaho Code § 38-714; to meet its mandate to "publish all results and findings" the PAG also produces Issue Briefs, Fact Sheets, and other information formats that can be downloaded from the PAG website: www.uidaho.edu/cnr/pag

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About the Policy Analysis Group (PAG)

Role and Mission. The Idaho Legislature created the Policy Analysis Group (or "PAG") in 1989 as a way for the University of Idaho to provide timely, scientific and objective data and analysis, and analytical and information services, on resource and land use questions of general interest to the people of Idaho. The PAG is a unit of the College of Natural Resources Experiment Station, administered by Kurt Pregitzer, Director, and Dean, College of Natural Resources.

PAG Reports. This is the thirty-third report of the Policy Analysis Group (see inside cover). The PAG is required by law to report the findings of all its work, whether tentative or conclusive, and make them freely available. PAG reports are primarily policy education documents, as one would expect from a state university program funded by legislative appropriation. The PAG identifies and analyzes scientific and institutional problems associated with natural resource policy issues. In keeping with the PAG's mandate, several alternative policy options are developed and their potential benefits and detrimental effects are analyzed. As an operational policy the PAG does not recommend an alternative.

Advisory Committee. A standing Advisory Committee (see inside cover) has specific functions assigned by the PAG's enabling legislation. The committee's main charge is to review current issues and suggest topics for analysis. Based on those suggestions, the dean of the College of Natural Resources works closely with the PAG director to design analysis projects. The Advisory Committee has a responsibility to suggest the appropriate focus of the analysis. This is done iteratively, until an outline for the project is mutually agreed upon by the committee and the PAG. The outline is usually organized as a series of focus questions, and the PAG's analytical tasks are to develop replies to the questions. The PAG uses the resources of the university and other public and private organizations as needed. When the PAG becomes active on a project, the Advisory Committee receives periodic oral progress reports. This process defines the scope of PAG report content and provides freedom for the PAG to conduct unbiased analysis.

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ACKNOWLEDGMENTS — TECHNICAL REVIEW

The following people provided comments on earlier drafts of this report. Some of their comments are cited as sources within the report, as (Name, review comments).

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Executive Summary

Thriving markets and recent new discoveries of oil and gas reserves in southwestern Idaho have renewed interest in oil and gas resource development in the state. Because Idaho lacks a history of oil and gas development, questions exist about whether the state currently has adequate policies in place to provide for increased resource development while at the same time protecting property rights and the environment. It appears that existing state and federal policies address these concerns. Adequate resources will be needed to implement state regulations and requirements for oil and gas development.

The reports' objectives are to review current policies related to oil and gas exploration and development in Idaho and to consider policy alternatives that may create improvements. This report accomplishes the objectives by laying out a series of focus questions that serve as the report outline. We also describe historic and current exploration events, provide a brief technical background on the four phases of oil and gas development, and identify existing policies in Idaho. The focus questions are identified below, and summarized replies are provided. More detailed analyses of each of these questions, and references to supporting documents, are provided in separate chapters of this report.

1. Introduction. New discoveries of natural gas reserves in southwestern Idaho have generated renewed interest in oil and gas development in the state. Several state laws regulate such development, and when viewed together with federal statutes form a policy web intended to promote oil and gas resource development while assuring that environmental quality is maintained.

2. What is the history of oil and gas resource exploration and development in Idaho? Oil and gas exploration has been occurring in Idaho for the last 100 years, with little success until recently. Improved technologies have led to discoveries of gas reserves in a small area of southwestern Idaho. At this writing, the potential for commercial production is being tested. The test wells could be linked to an interstate gas line that passes through southwestern Idaho by constructing seven miles of pipeline. The only other area of Idaho that appears to hold development promise is southeastern Idaho.

3. How are oil and gas resources developed? The process of extracting of oil and gas resources can be delineated in four major phases: exploration, well development, production, and site abandonment. ***Exploration*** involves the search for rock formations associated with oil or natural gas deposits, and involves geophysical prospecting and/or exploratory drilling. ***Well development*** occurs after exploration has located a field that potentially could have economically recoverable resources. Then construction of one or more wells proceeds to well completion if hydrocarbons are found in sufficient quantities, or abandonment if no hydrocarbons are found. ***Production*** is the process of extracting materials from underground and separating constituents of the mixture of liquid hydrocarbons, gas, water, and solids. Waste products and constituents that have no market value are removed, and liquid hydrocarbons and gas are sold. ***Site abandonment*** involves plugging wells and restoring the site. A well is abandoned when it lacks the potential to produce economic quantities of oil or gas, or when a producing well is no longer economically viable.

4. What state policies affect exploration for and development of oil and gas resources in Idaho? Idaho law states that it is in the public interest to develop Idaho's oil and gas resources, and waste is prohibited (Idaho Code, Title 47, Chapter 3). Policies are designed primarily to protect water quality. Administrative regulations address many aspects of oil and gas exploration and development, including well drilling, hydraulic fracturing ("fracking") and other well treatments, and disposal of waste products.

5. What roles do federal and local governments have in regulating oil and gas exploration and development? We provide a brief description of federal government resource management and regulatory agencies and their roles and functions, and state policies that circumscribe the role of local governments.

Federal — Two federal agencies are responsible for 61 percent of the land in Idaho: the U.S. Forest Service (USFS, with 39 percent of the state) and the Bureau of Land Management (BLM, with 22 percent). The BLM is an agency of the U.S. Dept. of the Interior, and has authority for oil and gas leasing on all federal lands, including those managed by other federal agencies. The BLM administers competitive lease sales for development of federal oil and gas rights. Oil and gas development on BLM and USFS lands must comply with statutorily-mandated land and resource management plans and follow National Environmental Policy Act (NEPA) procedures.

Local — Cities and counties in Idaho may not prohibit oil and gas extraction within their jurisdictions, but they may enact reasonable ordinances to protect public health, safety, and order, and prevent harm to public infrastructure and degradation of private property. Local governments cannot require conditional use permits for oil and gas development activities.

6. What are the potential positive impacts of oil and gas development in Idaho? Development of the oil and gas industry in Idaho would contribute to the state's economy by providing jobs and associated economic impacts as well as royalties to landowners from oil and gas leasing and production, plus a variety of taxes to state and local governments. If the discoveries to date in southwestern Idaho develop as the Idaho Petroleum Council expects they would, annual revenues from production would be $206 million. This would generate for the state $5.1 million in severance taxes and $5.7 million from royalties because approximately one-fourth of the discovered potential is on state endowment lands. Production of natural gas may benefit Idaho consumers, as prices currently are lower than other fossil fuels. Natural gas is also cleaner than other fossil fuels, which may make its use more environmentally attractive for electricity production than the coal-fired power plants in neighboring states, plus it is a versatile resource that can also be used to heat buildings and fuel transportation vehicles.

7. What are the potential negative impacts of oil and gas development in Idaho? All resource development activities, including oil and gas extraction, pose some level of risk to the environment. Water quality is the primary concern associated with developing known oil and gas resources in Idaho. Risks can be reduced via careful planning and implementation, given adequate regulations and enforcement resources, and requiring mitigation of adverse impacts that do occur. Human safety and community well-being are also issues, as is wildlife habitat. Although current activity in Idaho is not occurring on greater sage-grouse habitat, if it did this would become a concern.

8. What policy alternatives exist to further oil and gas development in Idaho while protecting surface rights and other resources? Current state and federal policies appear to address many of the concerns related to environmental effects of oil and gas development. The key to realizing the potential of these policies is adequate implementation, monitoring, and enforcement. State policy improvements could include the following ideas:

- using an adaptive management approach to policy development, i.e., incorporating into existing policies new information as it becomes available;
- requiring more broad-ranging and comprehensive environmental review that includes cumulative effects analysis;
- providing professional oversight by the state, which requires employing the services of experienced engineering expertise or contracting for such services;
- adjusting severance tax policies to adequately compensate local governments;
- ensuring that bonding and other policies adequately protect surface owners; and
- instituting more cooperative policy development relationships between the state and local governments.

Chapter 1. Introduction

Exploration for oil and gas resources and subsequent development for resource utilization are booming throughout the United States. New discoveries of natural gas reserves in southwestern Idaho[1] and eastern Oregon have created renewed interest in oil and gas resource development in Idaho (**Chapter 2**). Several Idaho laws are related to oil and gas development, including laws regarding clean water and air, hazardous and solid waste management, injection wells, and local land-use planning. Numerous technical terms, such as injection wells, will be encountered in this report; many of them are explained in **Chapter 3** as the process of oil and gas extraction is explained using four phases: exploration, well development, production, and site abandonment.[2]

Most policies related to the development of oil and gas resources are state policies (**Chapter 4**). In Idaho, as in neighboring states with substantial oil and gas resources, policies are meant to encourage and promote oil and gas resource development by providing uniformity and consistency. Idaho Code specifically addresses oil and gas development (see Title 47, Chapter 3, Mines and Mining). In 2012 and again in 2013, the Idaho Legislature amended laws related to oil and gas exploration and production in the state. As a result of the 2012 legislation, the Idaho Department of Lands (IDL) revised its regulations regarding oil and gas development. In addition to state policies, federal and local policies are briefly described in **Chapter 5**, with additional details in **Appendix A**. The potential positive impacts of oil and gas development in Idaho are primarily economic (**Chapter 6**). The potential negative impacts are mainly to water quality (**Chapter 7**). In **Chapter 8** we identify policy alternatives that could further oil and gas development in Idaho while protecting surface rights and other resources. We were also asked to compare Idaho's regulatory oversight structure with neighboring states (**Appendix B**) in addition to general regulatory approaches (**Appendix C**). We draw conclusions in the **Executive Summary** by extracting key points from each chapter. For those interested in obtaining more in-depth knowledge of policies affecting oil and gas exploration and development, we provide an **Annotated Bibliography** (**Appendix D**) and list of **References Cited** (**Appendix E**).

Policy education and analysis are needed to provide Idaho decision makers and citizens with up-to-date information about recent changes to laws and regulations affecting development of oil and gas resources and the protection of other property rights and resources, including water supplies. Landowners, mineral rights owners, oil and gas developers, and communities throughout southwestern Idaho and in other areas where oil and gas deposits may exist are likely to have an interest in this report, as would natural gas utility companies, gas-consuming electric utility companies, and Idaho's energy consumers. Agencies and organizations with an interest in oil and gas development issues include the Idaho Department of Environmental Quality, Idaho Department of Water Resources, Association of Idaho Cities, Idaho Association of Counties, Idaho Farm Bureau Federation, Idaho Council on Industry and the Environment, Idaho Association of Commerce and Industry, Idaho Ground Water Association, Idaho Rural Water Association, Idaho Petroleum Council, Food Producers of Idaho, Idaho Conservation League, and county and municipal governments, particularly in southwestern Idaho.

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[1] Cities forming a circle around the southwestern Idaho region include, clockwise from one o'clock, Yellow Pine, Lowman, Atlanta, Glenns Ferry, Bruneau, Jordan Valley, Caldwell, Payette, Weiser, and Cambridge. Boise, the state capital, is at the region's center (http://www.visitidaho.org/assets/docs/tg-southwestern.pdf). Historically (see **Chapter 2**), exploration occurred in the west central portion of southwestern Idaho, in a polygon bounded by a few wells south of Lake Lowell (south of Nampa and Caldwell) northwest to a heavy concentration of wells near Payette and Weiser, then in a southeasterly direction to Emmett and then Eagle (see **Figure B-1** and detailed map at http://www.idahogeology.org/).

[2] We recommend the Energy Glossary & Acronym List published by the U.S. Geological Survey available online at http://energy.usgs.gov/GeneralInfo/HelpfulResources/EnergyGlossary.aspx.

Chapter 2. What is the history of oil and gas resource exploration and development in Idaho?

Oil and gas exploration began in Idaho shortly after the turn of the 20th century. Between 1903 and 1988 approximately 145 wells were drilled throughout the state to find hydrocarbons. Some wells drilled for geothermic or other mineral exploration also may have had oil and gas exploration as secondary objectives. According to a publication of the Idaho Geological Survey, exploration was an "ongoing saga of near successes and shattered expectations" (McLeod 1993).

When describing Idaho's oil and gas resource potential, the U.S. Geological Survey (USGS) includes almost all of Idaho, except the southeastern part in the Idaho-Snake River Downwarp Province (Peterson 1995; **Figure 1**). A province is a spatial area with common geologic or geomorphic attributes (USGS 2013). The southern part of the province comprises the late Tertiary Snake River Downwarp, which is considered to have potential for oil and/or gas deposits. The remainder of the province is mainly intrusive, metamorphic, and volcanic rocks that have "little or no potential for oil or gas deposits" (Peterson 1995). Although the potential is low based on geologic formations, that does not mean there is no potential (Gillerman, review comments).

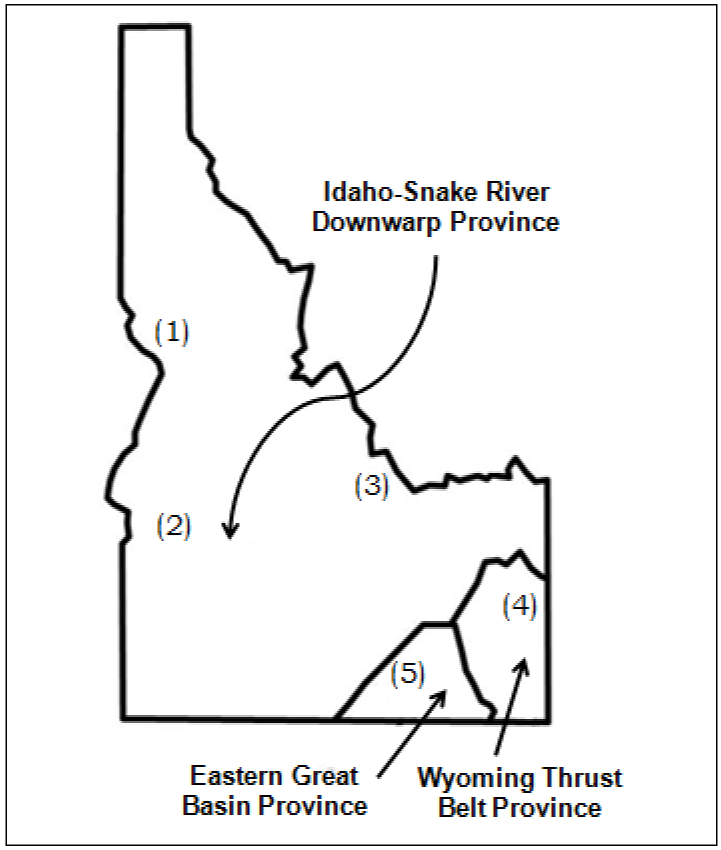


Figure 1. Oil and gas provinces of Idaho, and principal historic areas of oil and gas exploration. ***Note—*** The locations near the numbered areas have sedimentary rocks which potentially could contain zones bearing oil and gas resources: (1) eastern margin of Columbia River plateau, (2) western Snake River plain, (3) Lemhi Range/ Beaverhead Mountains area, (4) southeast Idaho thrust belt, and (5) Cassia Mountains area (source: redrawn from McLeod 1993).

Southeastern Idaho is part of two provinces. The Eastern Great Basin Province extends into southeastern Idaho from northern Utah west of Salt Lake City and Pocatello, and the Wyoming Thrust Belt Province includes the area east of Pocatello and Idaho Falls. The Eastern Great Basin Province has oil and gas potential, but most of the province lies in Utah and Nevada (USGS Eastern Great Basin Assessment Team 2007). The Wyoming Thrust Belt Province also has oil and gas potential, although most of the areas with potential lie in southwestern Wyoming (Kirschbaum et al. 2004).

Historically, exploration for oil and gas in Idaho focused on two areas: the southeast Idaho thrust belt, which is part of the Wyoming Thrust Belt Province, and the western Snake River plain, which is part of the Idaho-Snake River Downwarp Province (McLeod 1993; **Figure 1**). A few scattered test wells also were drilled in the Cassia and Beaverhead-Centennial Mountains, the eastern margin of the Columbia Plateau on the Camas Prairie, and the Idaho Panhandle north of Coeur d'Alene. Most other areas of the state are untested. Most of the recent exploration for oil and gas in Idaho has taken place in southwestern Idaho, in part of the Idaho-Snake River Downwarp Province termed the Western Idaho Basin.

Western Snake River Plain

The following capsule history of gas exploration in the Western Idaho or Payette Basin was provided by Emeritus Professor Spencer H. Wood. The recent activities in western Snake River plain are also summarized herein. Although retired from the Department of Geosciences at Boise State University, Dr. Wood remains an active researcher and consults for Snake River Oil + Gas. He has published studies of the geology of the western Snake River plain (Wood 1994) and how that geology pertains to groundwater (Wood and Clemons 2002). **Figure 2** is a cross section diagram of the gas sands of the western Idaho Basin. The key point is that a thick layer of impermeable shale separates the aquifers in the Upper Deltaic Sandy Sequence from the gas sands.

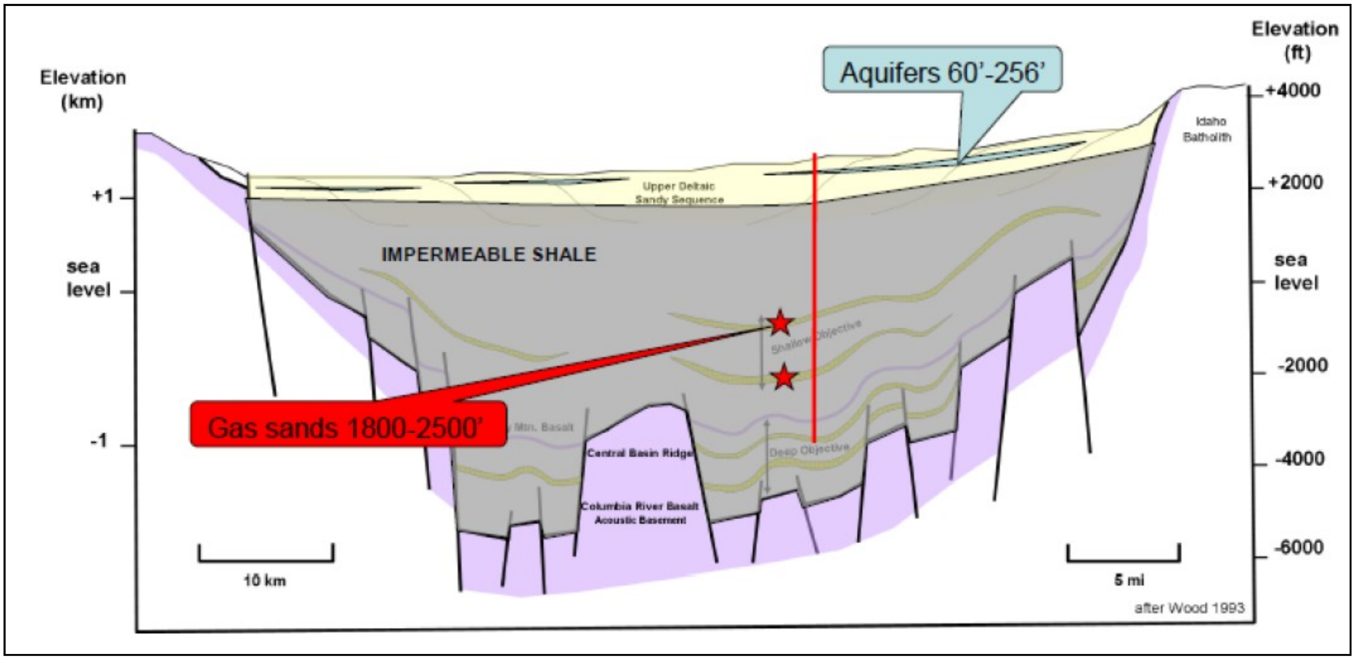


Figure 2. Gas sands of the Western Idaho Basin (source: Idaho Petroleum Council 2011, after Wood 1994).

A number of wells drilled in the early 1900's had significant shows of natural gas and some liquid hydrocarbons (Wood, review comments). (A "show" is defined as any indication of hydrocarbons observed while drilling or completing a well.) Using these wells to establish economic production was difficult because there was no infrastructure for the delivery of natural to gas markets via interstate pipelines and there was no local market. Drilling again occurred in the mid-1950's as plans began for El Paso Natural Gas to lay an interstate pipeline from British Columbia to the Four Corners Area passing through the Payette Basin. While the drilling encountered significant shows of pipeline quality gas there was not enough to justify developing the infrastructure when compared to the low-priced gas from Canada and the Southwest, which price was regulated by the Federal Power Commission. Through the 1970's and 1980's, drilling from Meridian to Marsing and in other various locales occurred to test new geological theories regarding the accumulation of hydrocarbons in western Idaho and eastern Oregon. That drilling resulted in some gas shows, the finding of thermally immature hydrocarbons and some reservoir rocks of note. Exploration in the Western Idaho Basin has proven the presence of source rocks, reservoir rocks and geological traps. These rocks were deposited in lacustrine and freshwater environments. With the current state of knowledge, the prospects in the Western Idaho Basin would be categorized as "conventional" versus unconventional, where hydrocarbons are trapped in thick, tight sand and shale formations (Wood, review comments; see **Figure 3**).

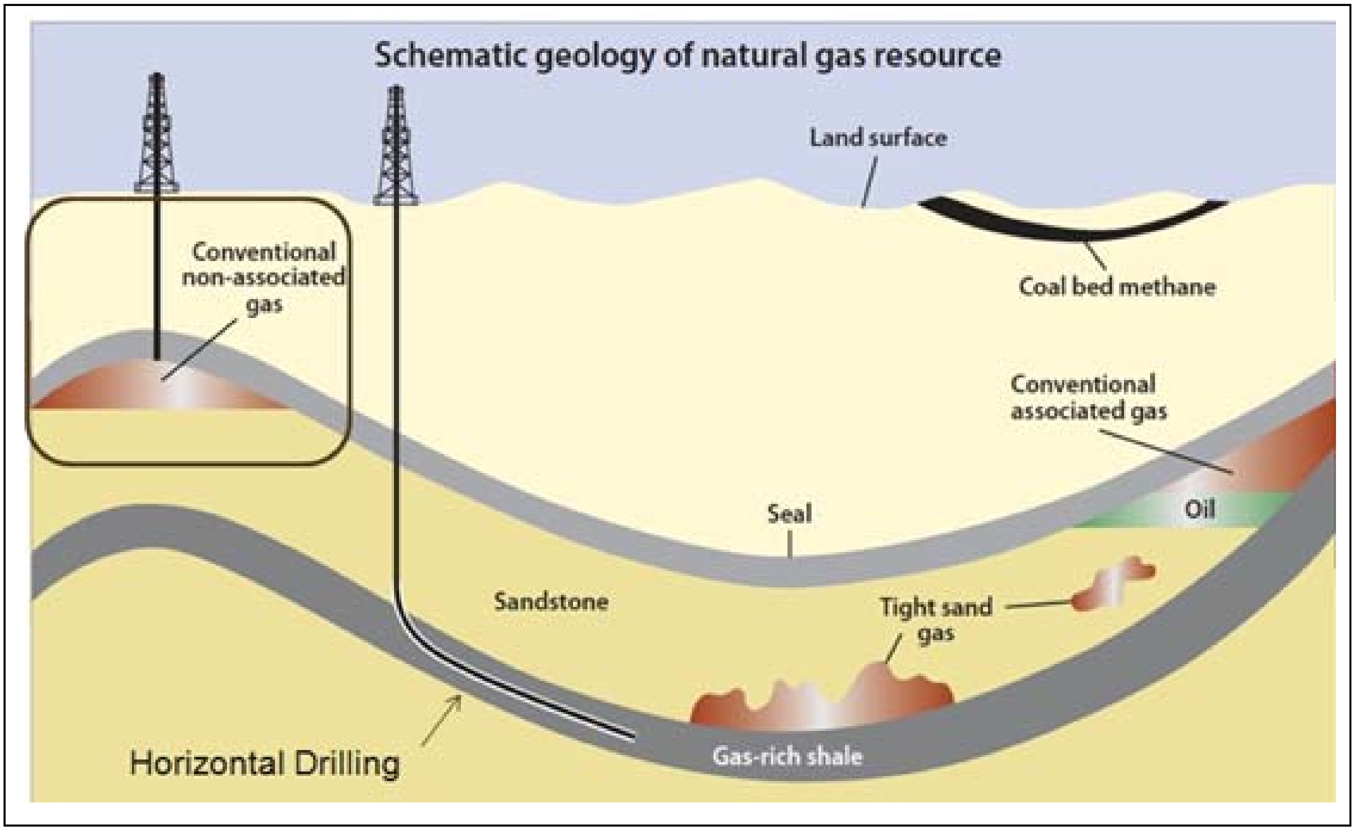


Figure 3. Cross-section of natural gas resources in sandstone formations (source: U.S. Energy Information Administration 2012). **Note:** Gas reservoir discoveries in the western Snake River plain are primarily conventional non-associated gas (left of diagram); there could also be tight sand gas (center) or conventional associated gas (right).

In 2005, a private oil and gas exploration company began leasing land for exploration primarily in Payette, Gem, and Canyon counties (INR 2012a). Two Canadian companies with an office in Denver acquired the leases, geology, geophysics, and drilling prospects—Bridge Resources Corporation (hereafter Bridge), and their joint venture partner, Paramax Resources Ltd. In 2010, Bridge drilled eleven wells northwest of Boise near the town of New Plymouth, in Payette County, to explore for natural gas at various depths down to 6200 feet. The geological target was potential reservoir sands and organic-rich shale source beds within the Tertiary basin fill along the northern margin of the western Snake River plain graben. Seven of the eleven wells had significant shows of natural gas. These wells are in the Hamilton and Willow fields (**Figure 4**), with 5 and 2 wells, respectively. Three of these seven wells have a potential for economically viable production if a) "gathering line" is constructed to connect with an existing interstate pipeline only a few miles away from the two fields (**Figure 4**), and b) additional drilling for flow testing of a longer duration proves satisfactory. The two potentially best wells are in the Willow field, which showed significant quantities of sulfur free natural gas with condensate, a naturally occurring hydrocarbon liquids component sometimes found in association with a natural gas stream. Bridge announced estimated resources in the range of at least 68 to 100 recoverable BCFE (billion cubic feet of gas equivalent). The company conducted seismic testing and reported over $20 million invested in the project, principally in drilling and lease costs. The remaining four wells of the seven showing positive results would require more attention to develop their initial promise, and the other four wells of the eleven were considered uneconomical (Gillerman and Bennett 2011; Hawk, review comments; see also INR 2012b, c, and **Figure 4**).

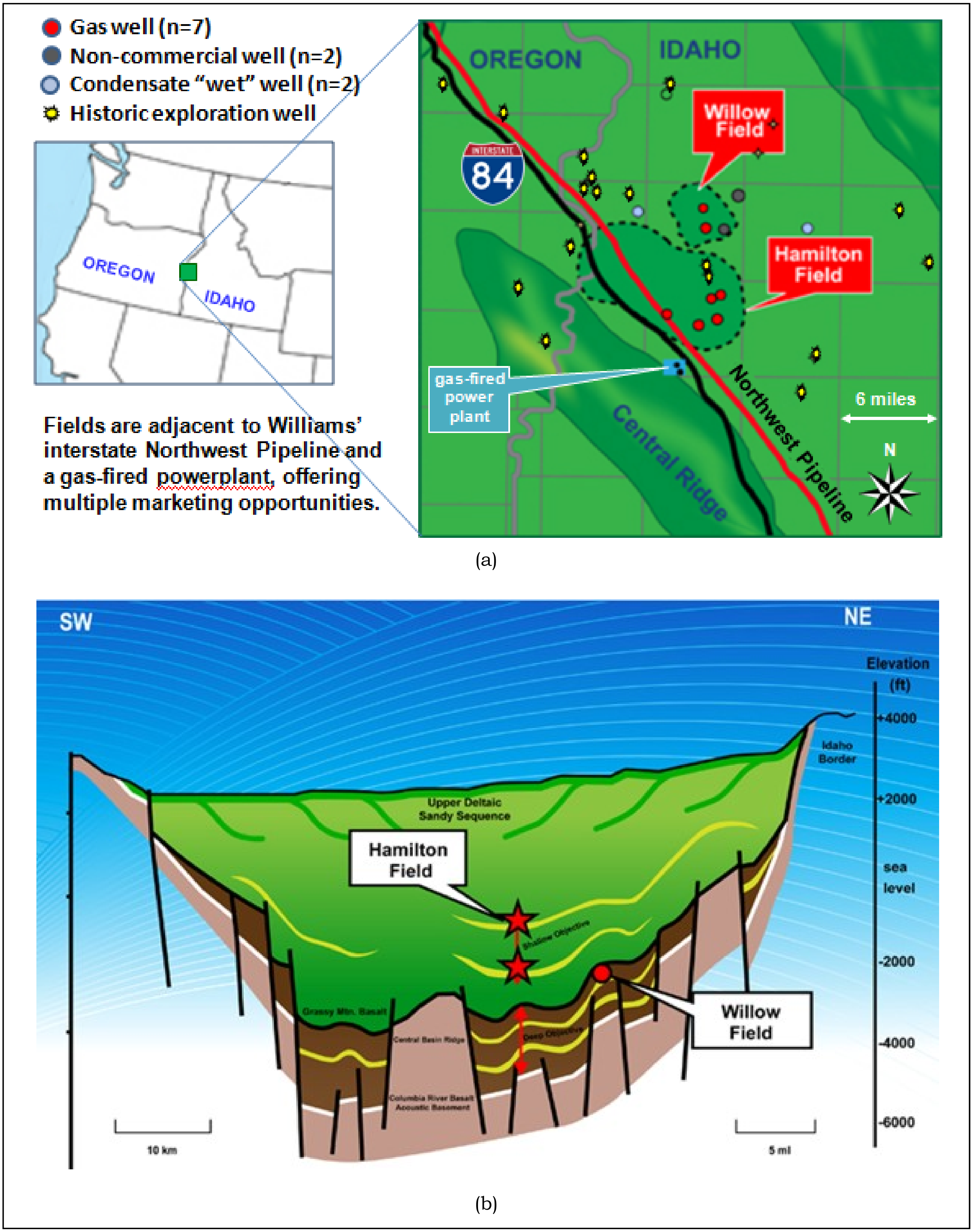


Figure 4. Oil and gas exploration wells in southwestern Idaho: (a) location of Willow and Hamilton fields, and (b) geologic cross-section of fields. Source: part (a) redrawn and part (b) reproduced from INR 2012c (from original diagrams created by Bridge Resources Corp., ca. 2010).

What Bridge had proposed for Idaho is closer to "conventional" gas production; i.e., vertical holes with smaller-scale fracking or "well-bore stimulation," a practice used successfully for many decades. The geology of the area does not require the same type of treatment as the well-publicized shale gas fields in the eastern and midwestern states (Gillerman, review comments). **Figure 5** overlays the geologic schematic diagram of natural gas deposits within the sandstone formations of the western Snake River plain with the drilling conducted by Bridge Resources in 2010.

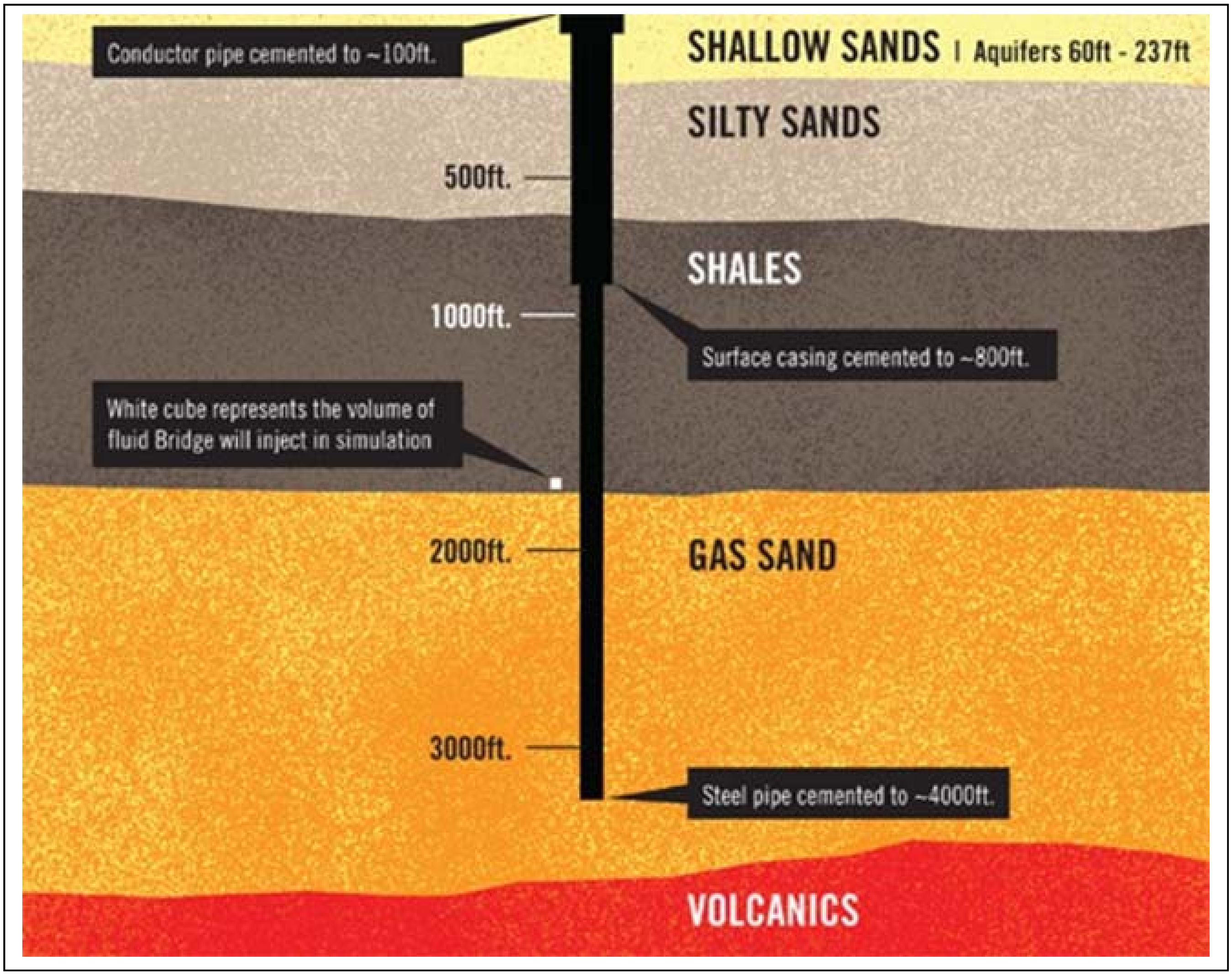


Figure 5. Underground cross-section of a typical well drilled in 2010 by Bridge Resources Corp. in Payette County, Idaho (source: Prentice 2011).

Because Idaho's regulations for hydrocarbon production were decades old, there was a need to revise them in order to better incorporate modern technology, current administrative entities, improved environmental oversight, and other changes. Under the direction of the Idaho Department of Lands, new regulations and rules were written and approved as temporary in April, 2011. In November, 2011 the new negotiated regulations were officially approved by the Idaho State Board of Land Commissioners, which until July 2013 also functioned as the Idaho Oil and Gas Conservation Commission, The regulations were then adopted by the Idaho Legislature during the 2012 session. They clarify that the State is the dominant regulator for oil and gas exploration and also include rules and requirements for drilling and hydrocarbon extraction, including the utilization and oversight of "fracking" technology.

The discovered natural gas resources in the western Snake River plain are not the same as the shale gas plays within gas-rich shale that typically may involve horizontal drilling and hydraulic fracturing or "fracking" (see **Box 1**). Fracking has become a controversial practice. One concern is potential risk of ground water contamination with fracking fluids.

Box 1. What is "fracking"?

Hydraulic fracturing as applied in the oil and gas industry (commonly referred to as "fracking") is the process of pumping a mixture of water, sand or similar material, and chemical additives, under high pressure, to create small interconnecting fractures to increase permeability in targeted subsurface rock formations. Oil and gas companies perform hydraulic fracturing after a well is drilled, cased and cemented, to increase the well's productivity. Sand is used to prop open the fractures, and chemical additives ["fracking fluids"] reduce friction, control bacteria, decrease corrosion, and serve other purposes. More than 50 percent of the natural gas, and a growing percentage of the oil, produced in the U.S. comes from hydraulically fractured reservoirs.

Hydraulic fracturing was first used in the U.S. oil and gas industry in 1947. Since then more than one million oil and gas wells have been hydraulically fractured in the U.S., and hydraulic fracturing has become a common well stimulation technique. The application of hydraulic fracturing to horizontally drilled wells uses higher volumes of fluids than more traditional applications. Today's accumulated geological and engineering knowledge and improved technology are used to protect public health and the environment while producing larger volumes of oil and gas. Modern wellbore casing and cementing are designed to isolate freshwater aquifers from hydraulically fractured oil and gas reservoirs, which are generally thousands of feet below the aquifers.

Casing and cementing are required and regulated by state regulatory agencies and have performed as intended in the oil and natural gas wells already drilled and currently operating in the U.S. There is little evidence, if any, that hydraulic fracturing itself has contaminated fresh groundwater. No occurrences are known where hydraulic fracturing fluids have moved upward from the zone of fracturing of a horizontal well into the fresh drinking water. In a single case currently under investigation, contamination may have occurred when a vertical well was hydraulically fractured in a zone just a few hundred feet below the base of the freshwater. In most cases, however, freshwater aquifers are near the surface, and are thousands of feet above deeply buried oil- or gas-bearing formations. Under these geologic conditions, it is highly unlikely that a connection would develop between a hydraulically fractured oil or gas reservoir and a freshwater aquifer.

Source: Association of American State Geologists fact sheet (see AASG 2012).

Bridge reported in 2010 that "mini-fracking" would be required on four of the seven productive holes (Gillerman and Bennett 2011). Gas deposits found to date in Payette County are conventional reserves trapped in sandstone overlain by shale (IDL 2013; see **Figure 4** above). Some well bore stimulation or "mini-fracking" will likely be used on the recent Payette County discoveries (Prentice 2011; see **Box 2**).

Box 2. What is "mini-fracking"?

Bridge Resources Corp., the Colorado-based company that in 2010 drilled 11 natural gas wells in Payette County, doesn't like to use the term "fracking." Addressing an Idaho Oil and Gas Conservation Commission hearing in New Plymouth, Bridge's exploration project manager Kim Parsons said, "We call our process 'mini-fracking.' It's dramatically less than what you've been hearing about in the media."

The evening before the commission hearing, Parsons hosted a separate meeting on the same issue: a town hall session at the New Plymouth Senior Center, not far from Bridge's exploration wells. "We've been totally transparent in what we're doing," Parsons told the standing-room-only gathering. "We have fully disclosed the ingredients that we want to use for our mini-fracking."

On its website, the company [whose assets are now owned by Snake River Oil + Gas] stated that its main (99.5 percent) mini-frack ingredient is water, followed by silica sand, guar (a food thickening substance), soap, detergent enzymes, boron (another thickener) and acetic acid (a form of vinegar). Bridge Resources officials said they would use three layers of steel pipe and cement to protect aquifers from fracking (see **Figure 5** above).

"I really don't have many concerns about what they want to use today," said Justin Hayes of the Idaho Conservation League. "But when you challenge them to commit to not using cancer-causing compounds in the future, they get all mealy-mouthed. It's a slippery slope. Unfortunately, we've seen it go horribly bad in Pennsylvania."

Hayes pleaded with the commission to introduce a bond to safeguard Idahoans from a potential fracking emergency, but the request was denied. Hayes said, "We believe that if this is done right, the state can guarantee good revenue streams, but also ensure that local communities are protected and our drinking water is not harmed. We want that balance."

Source: Prentice (2011).

Along with other interested parties, including land and mineral interest owners, Bridge formed the Idaho Petroleum Council, a non-profit designed to support the fledgling industry, counter fallacious statements by those opposed to hydrocarbon development, and to educate through verifiable and easily substantiated information (Hawk, review comments). During 2011, Bridge Resources encountered financial problems related to some of their business ventures in the North Sea and decided to sell their assets in Idaho, including the leases which they had permitted for exploration work (Gillerman and Bennett 2012). In April 2012, Bridge changed its name to Idaho Natural Resources Corp. (INR 2012a).

In May 2012, Snake River Oil + Gas, an Idaho-based subsidiary of Arkansas-based Weiser-Brown LLC, purchased the Hamilton/Willow field assets from Idaho Natural Resources Corp. and is now the principal owner of the seven productive natural gas wells in Payette County that were drilled in 2010 (SROG 2013). Snake River Oil + Gas maintains the largest presence of any natural gas developer in Idaho, with most activity taking place in Payette and Washington counties and some activity in Gem, Canyon, and Owyhee counties (IDL 2013).

A company called AM Idaho LLC has partnered with Snake River Oil + Gas to develop the Hamilton/Willow fields. Snake River Oil + Gas has proceeded in the standard way by assembling local geological and operating consultants, as well as local persons for leasing and title search (Hawk, review comments). AM Idaho LLC is a subsidiary of a Texas-based exploration and development company called Alta Mesa Holdings LP, and the company is now the operator in these two fields. In early 2013, the company acquired the lease and wells from their previous owner. With Snake River

Oil + Gas as a partner, AM Idaho LLC has been preparing to build a buried gathering gas line that will be able to deliver the natural gas to a point of intertie with Northwest Pipeline, and/or possibly the pipeline to Idaho Power's Langley Gulch gas-fired electric generating facility (see **Figure 4** above). To prepare for additional drilling the two companies have been conducting geophysical seismic surveys in the New Plymouth area to better understand the geology (Hawk, review comments).

In June 2013, AM Idaho LLC drilled a series of exploration wells, with a goal of production and sales by the end of the year. Also in June 2013, the IDL issued two new drilling permits, and drilling began in mid-July (Barker 2013). According to John Foster, who works for Snake River Oil + Gas, the potential for eventual gas production will depend on what is found in these wells (Zepelin 2013). There was no hydraulic fracturing associated with these wells. Foster did not say whether the company has future plans for hydraulic fracturing in Payette County (Zepelin 2013). According to Suzanne Budge, executive director of the Idaho Petroleum Council, hydraulic fracturing will not be used. However, she said that other well treatments may be used, including the long-established process of sending liquids and sand down a well under high pressure to enhance gas flows (Barker 2013). We presume that this is the same thing as well-bore stimulation or "mini-fracking" described above (see **Box 2**).

According to the EPA (2008), gas production from conventional reserves trapped in sandstone deposits (see **Figure 3** above) involves lower risks of environmental consequences than unconventional reserves such as shale gas that may require horizontal drilling and/or hydraulic fracturing. Unconventional reservoirs tend to require more surface occupancy area, more truck traffic, and more water and chemical usage than conventional reservoirs do when completing the wells and bringing them into production. However, to reach that conclusion it would be necessary to analyze the risks associated with a conventional deposit compared with "unconventional" shale gas (Hawk, review comments). Risk is a measure of the probability and severity of adverse effects, with two components. One is real: the potential damage or unwanted adverse effects and consequences. The other is imaginary: a mathematical, human construct called probability (Haimes 2009).

Southeastern and South-central Idaho

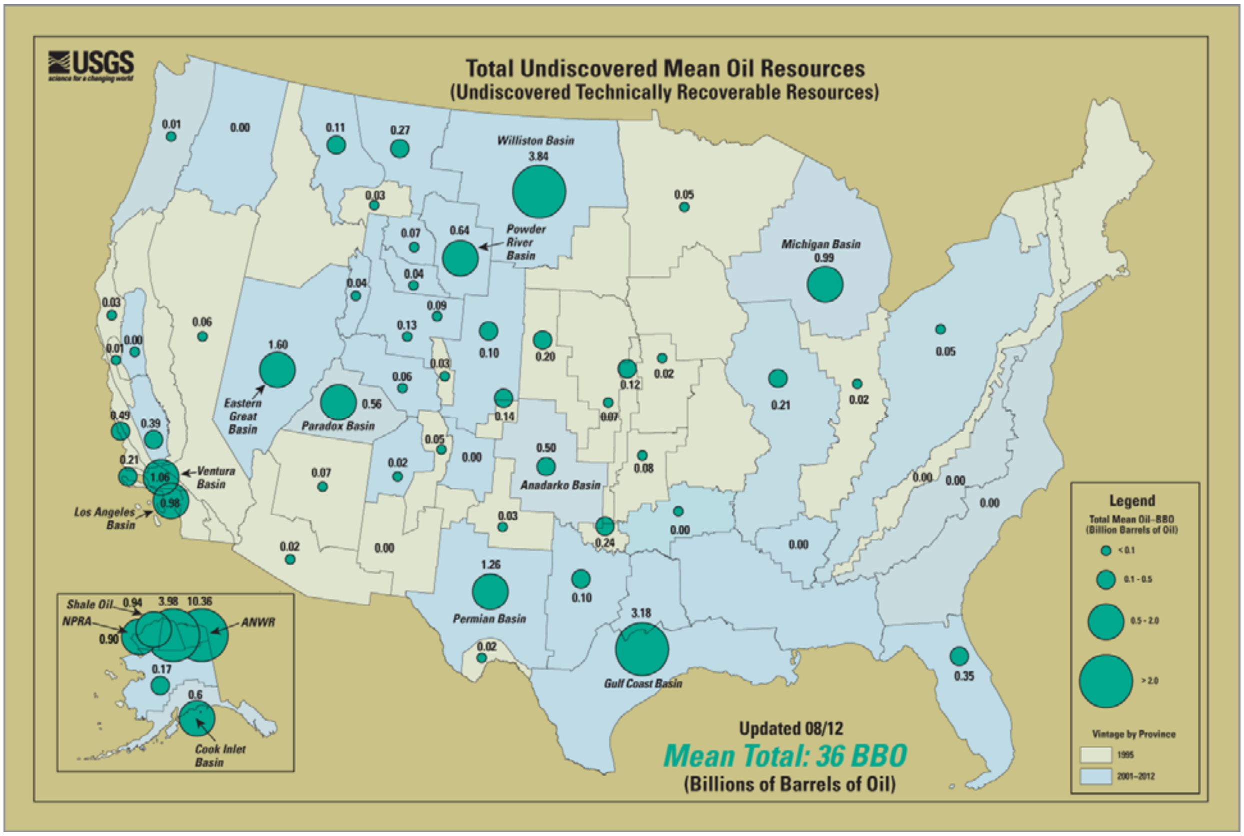
The mountainous area of southeastern Idaho has prominent thrust faults; similar thrust belt geologies in Wyoming and Utah have yielded prolific oil and gas finds (McLeod 1993). Numerous wells have been drilled looking for Paleozoic and Mesozoic rocks deposited in marine and coastline marine water environments (Wood, review comments). Source rocks, reservoir rocks, and traps have been found along with hydrocarbon shows. No economical production has been established. There is a small opportunity for Tertiary rocks to produce in a few limited basins in the southeast. Currently several oil and gas exploration companies have a significant leasehold interest in the area with emphasis on the Permian Phosphoria Formation as a source and reservoir rock (Wood, review comments).

In south-central Idaho there is the possibility that the source and reservoir rocks found in northern Nevada may extend into areas north of Wells and Elko. These are rocks deposited from the Paleozoic through the Tertiary and have a high percentage of total organic carbon. The possibility exists that prospects in this area could be both conventional and unconventional (Wood, review comments). It remains to be seen whether horizontal drilling in the Overthrust Belt will occur (Gillerman, review comments).

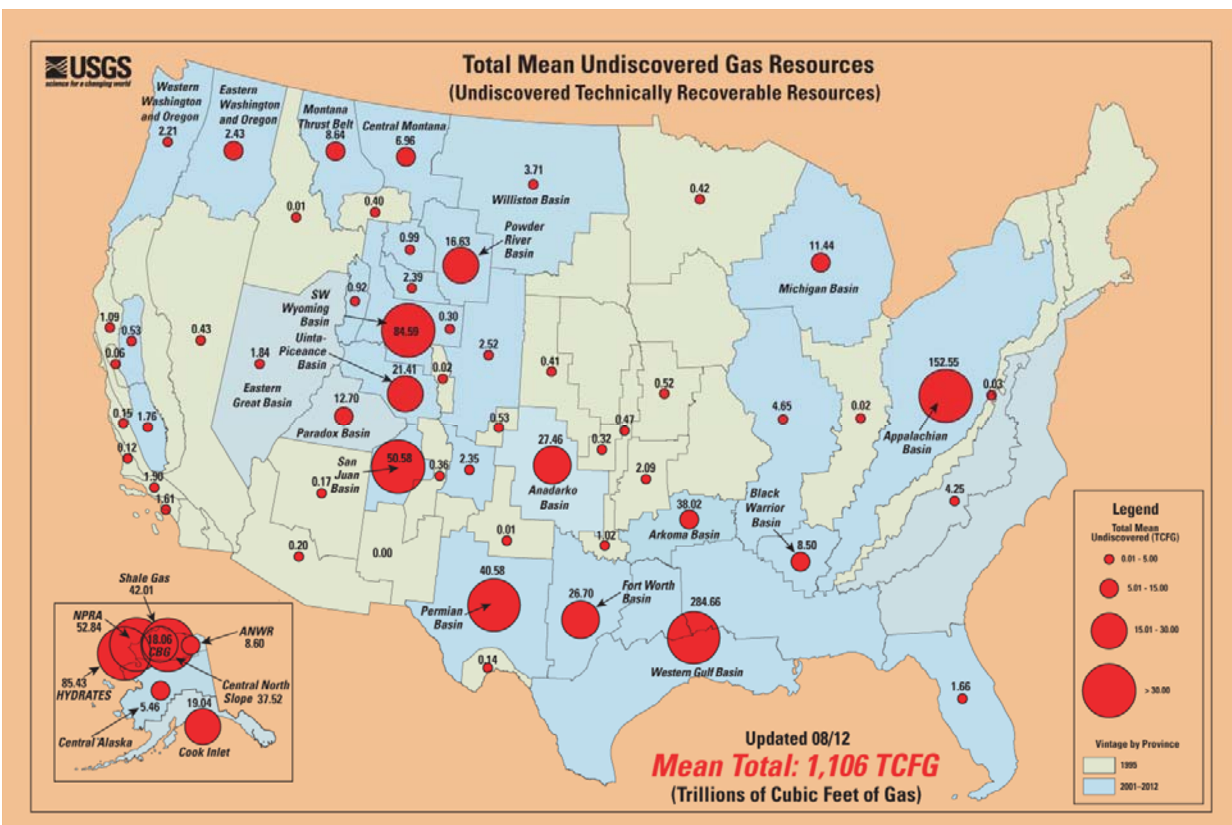
Outlook

Although the U.S. Geological Survey (USGS 2012) has stated that Idaho's potential for major oil and gas resources is low, with negligible potential discoveries of oil and only about 10 billion cubic feet of natural gas (see **Figure 6** on page 11), this is likely an understatement. The USGS has not had access to the confidential well logs of the seven wells in the Hamilton/Willow fields, nor has the agency had access to the seismic data collected before and after drilling. The Potential Gas Committee carries a "speculative" number far in excess of the USGS estimate. The USGS assessments of a few years ago gave little credence to the potential of shale gas elsewhere in the U.S. (Hawk, review comments).

After discovered oil or natural gas is in production, it must be transported to markets. Natural gas liquids and condensate must be removed from the gas stream to meet interstate pipeline gas quality requirements. That product is stored in tanks and moved via truck and/or rail to a refinery. Natural gas is distributed through pipelines. Local distribution gas lines include those of Intermountain Gas Company, which is the gas utility for all of southern Idaho, and the Northwest Pipeline of Williams has two major gas lines running together across the southern part of the state from Payette to Pocatello, including through the Western Idaho Basin (see **Figure 7** on page 12). However, distribution lines in prospective areas of gas development are farther apart, requiring greater prospect reserves for a deposit to be considered economic (Hawk, review comments). The wells drilled in summer 2013 will need about seven miles of pipeline to connect up with the existing interstate pipeline running through Payette County (Barker 2013).



(a)



(b)

Figure 6. Potential for undiscovered (a) oil, and (b) gas resources in the U.S. (source: USGS 2012).

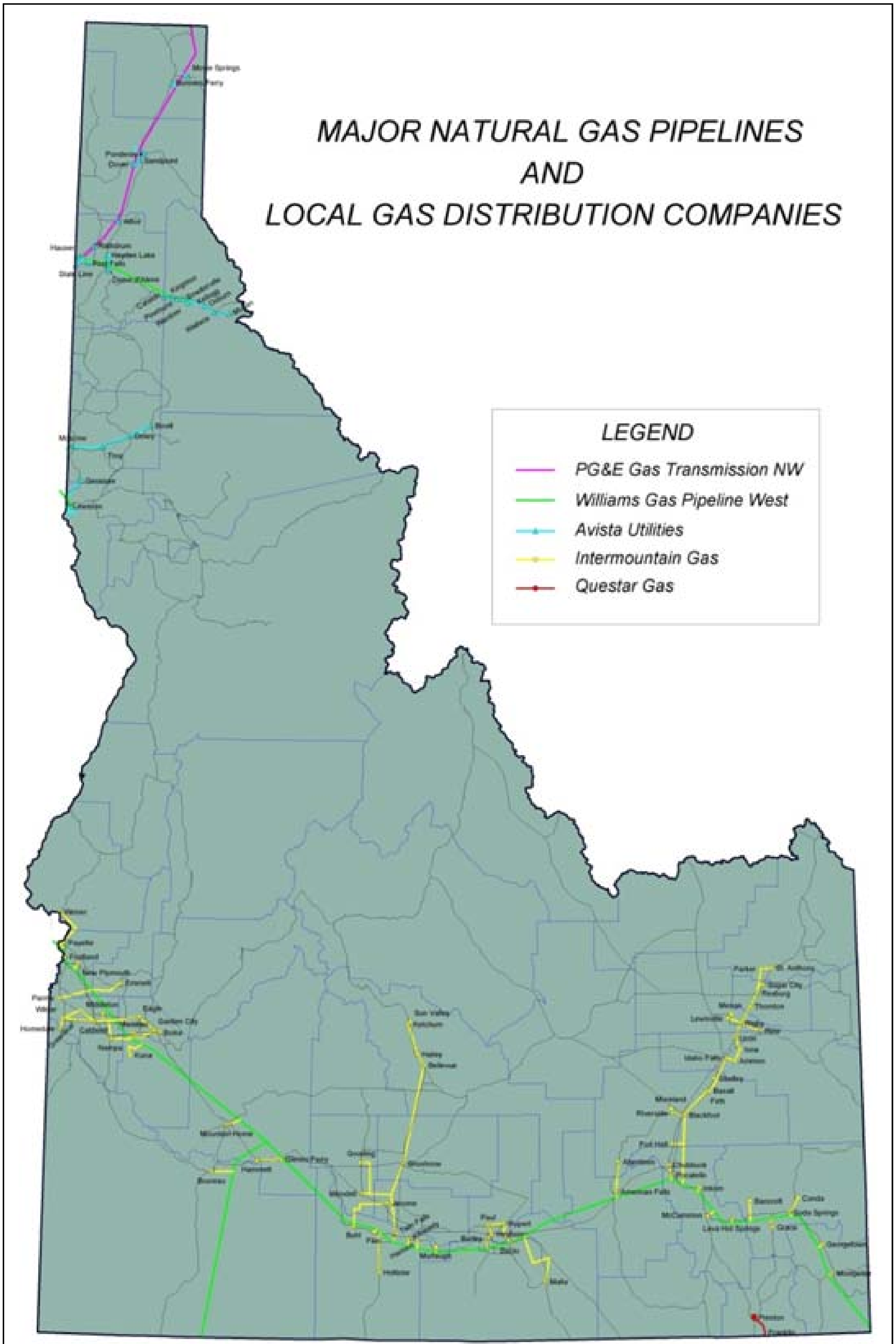


Figure 7. Major natural gas pipelines in Idaho (source: IPUC 2013).

Chapter 3. How are oil and gas resources developed? – Phases of Resource Extraction

The EPA (2000) has described oil and gas extraction in four major phases: exploration, well development, production, and site abandonment. To provide appropriate technical background for understanding terminology as well as the processes that policies are related to, each phase is briefly summarized below, with details following in subsections. **Exploration** involves the search for rock formations associated with oil or natural gas deposits, and involves geophysical prospecting and/or exploratory drilling. **Well development** occurs after exploration has located an economically recoverable field, and involves the construction of one or more wells from the beginning to either abandonment if no hydrocarbons are found, or to well completion if hydrocarbons are found in sufficient quantities (EPA 2000). **Production** is the process of extracting hydrocarbons and separating the mixture of liquid hydrocarbons, gas, water, and solids; removing the constituents that cannot be sold; and selling the liquid hydrocarbons and gas. **Site abandonment** involves plugging wells and restoring a site when a recently-drilled well lacks the potential to produce economic quantities of oil or gas, or when a production well is no longer economically viable (EPA 2000).

Exploration

Before exploration for oil or gas can begin, a person or company must own or lease the mineral rights to a piece of property. The mineral rights can be owned by the landowner of the surface, “fee simple estate,” or they can be owned by someone else, “split estate.” Mineral rights leasing arrangements vary depending on whether the rights are privately held or owned by the state or federal government.

The physical process of exploration begins with geophysicists searching for potential oil- or gas-bearing formations in the earth’s crust by taking advantage of the fact that seismic waves will travel through, bend, absorb, and reflect differently off of various layers of rock. The seismic waves are generated at the earth’s surface by a variety of methods including explosives that are detonated in holes drilled just below the surface and land vibroseis. In the vibroseis process, trucks are used to drop a heavy weight on hard surfaces such as a road in order to create seismic waves. Land vibroseis is typically used near populated areas and near sensitive environmental areas where detonations are not desirable. After a site has been judged to have a reasonable chance of discovering a sufficient amount of hydrocarbons an exploratory well is drilled.

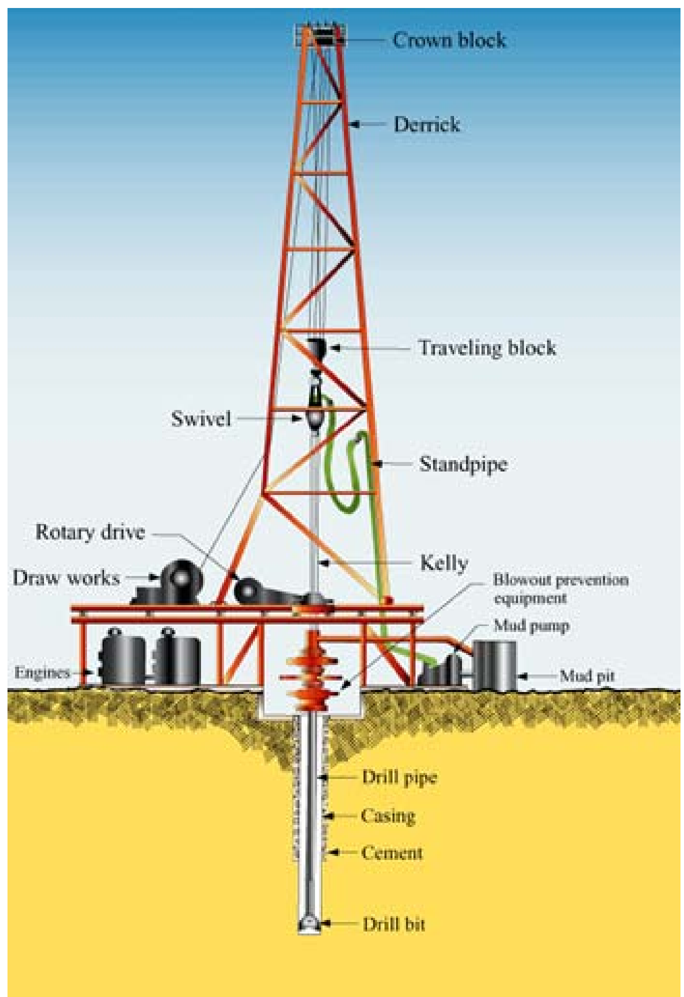


Figure 8. Typical drill rig (source: California Department of Conservation 2007).

Well Development

Figure 8 illustrates a typical rig used to drill for oil and gas, and **Figure 9** depicts an operating gas well. Together, **Figure 8** and **Figure 9** illustrate much of the following discussion about well development.

Drilling. Drilling is the process undertaken to reach the oil or gas deposit below the earth's surface. The drill itself is made up of numerous components (see **Figure 8**). The drill bit is the component in direct contact with the rock at the bottom of the hole, and increases the depth of the hole by chipping off pieces of rock. The drill bit is connected to the surface by several segments of hollow pipe, which together are called the drill string. A mud motor also may be used between the drill bit and drill string to rotate and steer the drill bit. Drilling fluid is pumped down through the drill string's center and returns to the surface through the space between the drill string and the rock formations or casing, called the annulus.

Drilling fluids. Drilling fluid is an important component in the drilling process. Some type of fluid is required in the wellbore (hole) and it performs four functions: (1) cool and lubricate the drill bit; (2) remove the rock fragments, or drill cuttings, from the drilling area and transport them to the surface; (3) counterbalance formation pressure to prevent formation fluids (i.e. oil, gas, and water) from entering the well prematurely, and (4) prevent the open (uncased) wellbore from caving in. Most drilling fluids are liquid-based fluids called drilling muds. In addition to liquid, drilling muds usually contain bentonite clay that increases the viscosity and alters the density of the fluid. Drilling mud may also contain additional additives that alter the properties of the fluid. For example, additives can give drilling muds strength to counter formation pressure. There are three general categories of drilling muds: water-based, oil-based, and synthetic-based.

Casing. Several different types of casing (see **Figure 9**) perform protective functions during both the drilling and production phases of operation. Casing prevents natural gas, oil, and associated brine from leaking out into the surrounding fresh-water aquifers, limits sediment from entering the wellbore, and facilitates the movement of equipment up and down the hole.

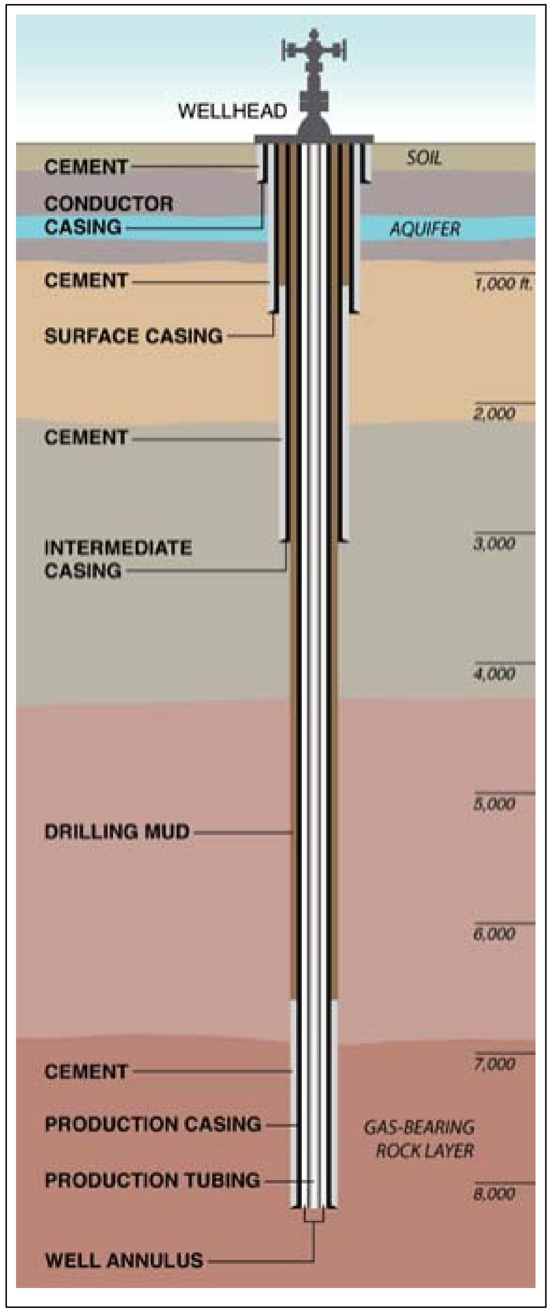


Figure 9. Anatomy of a gas well (source: ProPublica 2009).

As a hole is drilled, casing is placed in the well to stabilize the hole and prevent caving. The casing also isolates water bearing and hydrocarbon bearing zones. Different types and sizes of casings may be used depending on the depth and features of the well. In locations where surface soils may cave in during drilling, a "conductor" casing may be placed at the surface, extending only 20 to 100 feet below the surface. A "surface" casing begins at the surface and in Idaho typically penetrates 1,000 to 1,500 feet. The primary purpose of the surface casing is to protect surrounding freshwater aquifers from incursions of oil or brine. An "intermediate" casing begins at the surface and ends within a couple of thousand feet of the bottom of the wellbore. It prevents the hole from caving in and facilitates the movement of equipment used in the hole. A final "production" casing extends the full length of the wellbore and encases the production equipment used in the hole.

After each casing string has been installed, cement is forced out through the bottom of the casing up the annulus to hold it in place, and the surface casing is cemented to the surface. Casing is cemented to prevent migration of fluids behind the casing and to prevent communication of higher pressure productive formations with lower pressure non-productive formations. While the production process is being completed, perforations are made that will allow reservoir fluid to enter the wellbore. Tubing strings will carry the fluid to the surface, and packers (removable plugs) may be installed to isolate producing zones.

Drilling infrastructure. Because the majority of onshore drilling sites are accessed by road, much oil and gas development equipment is geared toward mobility. In many cases, the first on-site construction step is to build an access road. Next, if necessary, a footing for the equipment, usually gravel, is built in areas where the ground may be either unstable or subject to freeze/thaw cycles. Finally, the drilling rig is brought in. For shallow wells, the drill rig may be self-contained on a single truck; for deeper wells, the rig may be brought to the site in several pieces and assembled at the site.

A basic arrangement of the actual drilling equipment, or rig, includes the following (see **Figure 8**). The derrick (sometimes referred to as the mast) is the centerpiece of the operation, and is the frame from which the drill string is lifted, lowered, and turned. The hoisting equipment, kelly, and drill pipe connect the drill bit to the derrick. The drawworks and engines next to the derrick lift and drive the drill string, by turning the rotary table. The drilling mud is circulated through the wellbore via the mud hose (also called a gooseneck), down through the rotary hose, kelly, and drillpipe, out nozzles in the drill bit, and back up to the surface between the drill string and the wellbore. A mud pump moves the mud through the system; the mud is stored either in a mud (or reserve) pit or in mud tanks. Finally, blowout preventers are installed as a safety measure to prevent the drill pipe and subsurface fluids from being blown out of the hole if a high-pressure formation is encountered during drilling. Rigs will often have much more equipment, including a shale shaker that separates rock cuttings, a desander and desilter, which remove smaller particles, and a vacuum degasser that removes entrained gas.

Pits also may be constructed as part of well development. Their uses include evaporation pits which dispose of produced water, and sediment pits, which store solids that have settled out in storage tanks.

Well drilling completion. When drilling has been completed, several steps may be needed before production begins. First, testing is performed to verify whether the hydrocarbon-bearing formations are capable of producing enough hydrocarbons to warrant well completion and production.

When the production casing is cemented in the wellbore, the casing is sealed between the casing and the walls of the well. For formation fluid (oil, gas, and water) to enter the well, the casing must be perforated. Small, directed explosive charges are detonated at the depth of the producing formation, thereby perforating the casing, cement, and formation. The result is that formation fluid enters the well, yet the rest of the well's casing remains intact.

Flow stimulation—hydraulic fracturing. Some formations may have a large amount of oil as indicated by coring and logging, but may have a poor flow rate. This may be because the production zone does not have sufficient permeability, or because the formation was damaged or clogged during drilling operations. In these cases, pores are opened in the formation to allow fluid to flow more easily into the well. The hydraulic fracturing method (commonly called "fracking") involves introducing liquid at high pressure into the formation, thereby causing the formation to crack. Sand or a similar porous substance is then emplaced into the cracks to prop the fractures open. Another method of stimulation, acidizing, involves pumping acid, most frequently hydrochloric acid, to the formation, which dissolves soluble material so that pores open and fluid flows more quickly into the well. Stimulation may be performed during well completion, or later during maintenance, if oil-carrying channels become clogged over time.

Drilling rig removal. When drilling, casing, and testing operations are completed, the drilling rig is removed and the production rig is installed. In most cases, tubing is installed in the well which carries the liquids and gas to the surface. At the surface, a series of valves, collectively called the Christmas tree because of its appearance, is installed to control the flow of fluid from the well. Pumps are added if the formation pressure is not sufficient to force the formation fluid to the surface. Equipment is usually installed on site to separate natural gas and liquid phases of the production and remove impurities. Finally, a pipeline connection or storage container (tank) is connected to the well to facilitate transport or store the product. In the case of natural gas, which cannot be stored easily, a pipeline connection is necessary before the well can be placed in production.

Production

The major activities of petroleum production are bringing the fluid to the surface (*recovery*), separating the liquid and gas components (*crude oil separation*), and removing impurities (*natural gas conditioning*). Periodic *maintenance* is also part of the production process. Each of these activities is described below.

Recovery. Primary recovery is the first stage of hydrocarbon production, and natural reservoir pressure is often used to recover the oil and gas. When natural pressure is not sufficiently capable of forcing hydrocarbons to the surface, artificial lift equipment, such as a pump, may be employed.

Secondary recovery enhances the recovery of liquid hydrocarbons by repressurizing the reservoir and reestablishing or supporting the natural water drive. Usually water that is produced with the oil is reinjected, but other sources of water may also be used. Produced water injection for enhanced recovery of crude oil and natural gas is recognized as a form of recycling of this waste.

A final method for removing the last extractable oil and gas is tertiary recovery. In contrast to primary and secondary recovery techniques, tertiary recovery involves the addition of materials not normally found in the reservoir. In most cases, a substance is injected into the reservoir, mobilizes the oil or gas, and is removed with the product. Examples include, (1) thermal recovery, in which the reservoir fluid is heated either with the injection of steam or by controlled burning in the reservoir, which makes the fluid less viscous and more conducive to flow; (2) miscible injection, in which an oil-miscible fluid (something capable of being mixed with oil), such as carbon dioxide or an alcohol, is injected to reduce the oil density and cause it to rise to the surface more easily; (3) surfactants, which essentially wash the oil from the reservoir; and (4) microbial enhanced recovery, in which special organic-digesting microbes are injected along with oxygen into the formation to digest heavy oil, thereby allowing lighter oil to flow.

Crude oil separation. When the formation fluid is brought to the surface, it may contain a spectrum of substances including natural gas, water, sand, silt, and any additives used to enhance extraction. The general order of separation with respect to oil is the following: the separation of gaseous components, the removal of solids and water, and the breaking up of oil-water emulsions.

The removal of gaseous components primarily is intended to remove natural gas from the liquid; however, gaseous contaminants such as hydrogen sulfide (H_2S) also may be produced in some fields during this process. The gases are removed by passing the pressurized fluid through one or two decreasing pressure chambers; less and less gas will remain dissolved in the solution as the pressure is lowered.

The liquids and solids that remain are usually a complex mix of water, oil, and sand. Water and oil are generally incapable of being mixed; however, the extraction process is usually very turbulent and may cause the water and oil to form an emulsion, in which the oil forms tiny droplets in the water (or vice versa). Fluid separation often produces a layer of sand, a layer of relatively oil-free water, a layer of emulsion, and a small layer of relatively pure oil. The oil-free water and sand are usually removed by gravity-based processes, but emulsions are broken down by either heating or chemicals. Following separation, the oil is pure enough for storage or transportation to the refinery.

Natural gas conditioning. Natural gas conditioning is the process of removing impurities from the gas stream so that it is of high enough quality to pass through transportation systems. Conditioning is not always required, as gas from some formations emerges from the well sufficiently pure that it can pass directly to the pipeline. As the natural gas is separated from the liquid components, it may contain impurities that pose potential hazards or problems. The most significant is hydrogen sulfide (H_2S), which may or may not be contained in natural gas. H_2S is toxic, and potentially fatal at certain concentrations, to humans and corrosive for pipes; it is therefore desirable to remove it as soon as possible in the conditioning process.

Another concern is that posed by water vapor. At high pressures, water can react with components in the gas to form gas hydrates, which are solids that can clog pipes, valves, and gauges. Nitrogen and other gases may also be mixed with the natural gas (methane) in the subsurface. These other gases must be separated from the methane prior to sale. At cold temperatures the water can freeze, also clogging pipes, valves, and gauges. High vapor pressure hydrocarbons that are found to be liquids at surface temperature and pressure (benzene, toluene, ethylbenzene, and xylene, or BTEX) are removed and processed separately. Two significant natural gas conditioning processes are dehydration and sweetening.

Dehydration is performed to remove water from the gas stream. Three main approaches toward dehydration are the use of a liquid or solid desiccant, and refrigeration. When using a liquid desiccant, the gas is exposed to a glycol that absorbs the water. The water can be evaporated from the glycol by a process called heat regeneration, and the glycol can then be reused. Solid desiccants, often materials called molecular sieves, are crystals with high surface areas that attract the water molecules. The solids can be regenerated simply by heating them above the boiling point of water. Finally, particularly for gas extracted from deep, hot wells, simply cooling the gas to a temperature below the condensation point of water can remove enough water to transport the gas. Of the three approaches mentioned above, glycol dehydration is the most common when processing occurs in the field (at or near the well). At natural gas plants, solid desiccants are most commonly used.

Sweetening is the procedure in which H_2S and sometimes CO_2 are removed from the gas stream. The most common method is amine treatment. In this process, the gas stream is exposed to an amine solution, which will react with the H_2S and separate it from the natural gas. The contaminant gas solution is then heated, thereby separating the gases and regenerating the amine. The sulfur gas may be disposed of by flaring, incinerating, or when a market exists, sending it to a sulfur-recovery facility to generate elemental sulfur as a salable product. Another method of sweetening involves the use of iron sponge, which reacts with H_2S to form iron sulfide that later is oxidized and then buried or incinerated.

Maintenance. Production wells periodically require significant maintenance sessions, called workovers. During a workover, several tasks may be undertaken: repairing leaks in the casing or tubing, replacing motors or other downhole equipment, stimulating the well, perforating a different section of casing to produce from a different formation in the well, and painting and cleaning the equipment. The procedure often requires bringing in a rig for the downhole work.

Site Abandonment

Production may be stopped for several reasons. In some states, if the production stoppage is temporary, the well may be shut-in. If the closure is to be permanent, the well can either be converted to a UIC Class II injection well, or it is plugged and abandoned.

In Idaho, a well is either active or inactive. Active wells include those used for production, disposal, injection, or other permitted activity and that have not been idle for more than 24 continuous months. An inactive well is an unplugged well that has no reported production, disposal, injection, or other permitted activity for a period of greater than 24 continuous months, and for which no extension has been granted. Idaho does not allow a temporary shut-in or temporary abandonment.

In states that allow it, a temporary shut-in is an option when the conditions causing the interruption in production are anticipated to be short-term. Examples include situations when the well may be awaiting a workover crew or a connection to a pipeline, or there may be a (temporary) lack of a market. A well is shut in by closing the valves on the Christmas tree. Depending on the duration, the stoppage may be called a temporary abandonment, and regulatory approval and testing, including a mechanical integrity test, may be required in order to be idle. It is much more desirable to shut-in a well rather than plug it if production is still viable, because once the well is permanently plugged and abandoned, it is highly impractical to re-access the remaining oil in the reservoir.

If the well is part of a production field with many nearby wells still in production, the well may be converted to a Class II injection well, which is regulated under the federal Safe Drinking Water Act. Such a well can be used either for disposal of the produced water from these other wells, or may be part of a coordinated enhanced oil recovery effort in the field.

Once production has ceased, the final option is to plug and abandon the well. The goal of this procedure is to prevent fluid migration within the wellbore, which could contaminate aquifers or surface water. Oil and gas producing states all have specific regulations governing the plugging and abandonment of wells. When a well is plugged, the downhole equipment is removed and the perforated parts of the wellbore are cleaned of fill, scale and other debris. A minimum of three cement plugs are then placed, each of which are 100 to 200 feet long. The first is pumped into the perforated (production) zone of the well, in order to prevent the inflow of fluid. A second is placed in the middle of the wellbore. A third plug is placed within a couple hundred feet of the surface. Additional plugs may be placed anywhere within the wellbore when necessary. Fluid with an appropriate density is placed between the cement plugs in order to maintain adequate pressure. During this process, the plugs are tested to verify plug placement and integrity. Finally, the casing is cut off below the surface, capped with a steel plate welded to the casing, and surface reclamation is undertaken to restore natural soil consistency and plant cover.

Chapter 4. What state policies affect exploration for and development of oil and gas resources in Idaho?

State regulation of oil and natural gas exploration and production activities are approved under state laws that typically include a prohibition against causing harm to the environment. This premise is at the heart of the regulatory process. According to the Groundwater Protection Council (GWPC 2009), the regulation of oil and gas field activities is managed best at the state level where regional and local conditions are understood and where regulations can be tailored to fit the needs of the local environment. Hence, the experience, knowledge and information necessary to regulate effectively most commonly rests with state regulatory agencies. Many state agencies use programmatic tools and documents to apply state laws including regulations, formal and informal guidance, field rules, and best management practices (BMPs). They are also equipped to conduct field inspections, enforcement/oversight, and witnessing of specific operations like well construction, testing and plugging. (GWPC 2009)

For the most part, state policies regulate exploration for and development of oil and gas resources. In Idaho these policies are designed to encourage and promote oil and gas resource development by providing uniformity and consistency. If oil and gas resources are located on federal lands or the federal government owns the mineral rights to oil or gas deposits, then federal agencies become more directly involved with their own sets of policies. Federal agency roles are examined in more detail in **Chapter 5**.

The physical stages of oil and gas exploration and development are explained in some detail in **Chapter 3**. A simple, step-by-step explanation of policies affecting each stage is difficult because some policies and/or policy topics apply to several stages. For example, water quality protection policies are important and in place throughout all exploration and development phases. This chapter provides a general description of the state policies affecting oil and gas development in Idaho. Specific requirements can be found in the **References Cited** (**Appendix E**).

Exploration and Development

Idaho Code (Title 47, Chapter 3, Mines and Mining) is the statutory basis for regulation of oil and gas development in the state. As a policy objective, Idaho law declares that it is in the public interest to "foster, encourage and promote the development, production and utilization of natural resources of oil and gas in the state of Idaho" (Idaho Code § 47-315), and the law applies to all lands regardless of ownership (Idaho Code § 47-319). Statute prohibits the waste of either oil or gas (Idaho Code § 47-316), and in the event of a conflict between regulation of exploration, production, protecting correlative rights, and preventing waste, the last of these is paramount (Idaho Code § 47-319).

Idaho law assigns responsibility for creating most policies related to oil and gas development to the Idaho Oil and Gas Conservation Commission (Idaho OGCC). Before July 1, 2013, the Idaho OGCC consisted of the same five elected officials as the Idaho State Board of Land Commissioners. As a result of the passage of S1049 during the 2013 Idaho legislative session, the Idaho OGCC is now comprised of five members appointed by the governor with the advice and consent of the Idaho senate. The members of the Idaho OGCC are identified on the commission's website (see Idaho OGCC 2013).

Currently, the Idaho Department of Lands (IDL) administers the policies of the Idaho OGCC. The 2013 legislation that took effect July 1 states that the Idaho OGCC may continue to contract with the IDL for services, or it may employee its own personnel. The commission's regulations for oil and gas exploration and development, administered by the IDL, are in the *Rules Governing Oil and Gas Conservation in the State of Idaho* (IDAPA 20.07.02).

Leasing. Before someone can explore for or develop oil or gas resources, he or she must own or lease the mineral rights associated with the parcel(s) of land he or she wishes to explore or develop. If the land and mineral rights are owned by the state of Idaho, lease procedures and terms are set in the *Rules Governing Oil and Gas Leasing on Idaho State Lands* (IDAPA 20.03.16; for more detail, see **Appendix A**). If the land or mineral rights are owned by the federal government, leasing procedures and terms are set by the U.S. Bureau of Land Management (BLM; for more detail, see **Appendix A**). Lease terms between private parties are not specially regulated for oil and gas development.

Surface owner protections. If the owner of the surface rights (landowner) and the owner of the mineral rights are not the same, the situation is called a "split estate" and the IDL's regulations require that the mineral rights owner or developer attempt to reach a surface use agreement with the surface owner. The surface use agreement must address how the surface owner will be compensated for lost agricultural income and lost value of improvements directly caused by oil and gas exploration and production. In the event that a surface use agreement cannot be reached, regulations outline procedures for establishing the amount of a surety bond (see ***Bonding*** section below).

Protection of correlative rights. Because oil and gas pools below the earth's surface extend across property boundaries and oil and gas can flow freely between adjoining properties, the protection of the rights of a person to access the resources below a piece of property to which he or she owns mineral rights are called "correlative rights." It is policy of the Idaho OGCC and the IDL to allow a reasonable opportunity for each person entitled to recover or receive oil or gas from his or her property without being required to drill unnecessary wells or to incur other unnecessary expenses to recover or receive that oil or gas. The IDL has regulations for well spacing and directional drilling that help protect correlative rights. Vacuum pumps are not allowed, and a single well cannot access oil or gas from multiple pools without permission from the IDL. Statute (Idaho Code § 47-323) and the IDL's regulations allow for the cooperative development of oil and gas pools and fields in order to prevent waste and protect correlative rights.

Bonding. Bonding is a way of ensuring that financial resources are available to repair or mitigate damages caused by activities. The IDL's regulations require operators to post bonds for several stages of oil and gas exploration and development. The regulations also set the amount of the bonds. In the absence of a surface use agreement, a minimum surface use bond of $5,000 is required. Geophysical operations require a bond of at least $10,000. Wells require a bond of at least $10,000, plus $1 per foot of planned well length. Bond rates covering all wells in the state are: $50,000 for up to 10 wells, $100,000 for 11 to 30 wells, and $150,000 for more than 30 wells. Similar bond requirements exist for inactive wells, but blanket bonding covering all wells is not available. The IDL has the authority to impose additional bond amounts for sufficient reason.

Penalties. Violations of statutes and regulations related to oil and gas exploration and development can result in both civil and criminal penalties (Idaho Code § 47-325). Failure to comply can result in civil penalties of up to $10,000 for each violation, and each day a violation continues is considered to be a separate violation. Violators may also be charged with a misdemeanor with a penalty of not more than $5,000, or not more than 12 months in jail, or both. The IDL has the authority to give warnings when regulations are violated.

Geophysical exploration. Before anyone can conduct seismic operations in the state of Idaho, he or she must obtain a permit from the IDL. No seismic source generation from vibroseis, shot holes, surface shot, or other methods can be conducted within 200 feet of a residence, water well, oil well, gas well, injection well or other structure without written permission of the owners, and the permit holder is responsible for any resulting damages. The IDL's regulations also cover the use of explosives near structures, vegetation damage and replacement, fence repair, and debris disposal.

Drilling. A permit from the IDL is required to drill. All applications for permits to drill are subject to a 15-day public comment period prior to the IDL's decision to approve or deny the permit. A drill permit is valid for one year, with the possibility of a six month extension.

All drilling fluids (muds) must be properly stored either in tanks or lined pits and properly disposed of when no longer needed. All casings and cementing must meet industry standards. Blowout preventers must be installed. Operators must have a spill prevention, control and countermeasure plan.

All water-bearing zones encountered during drilling must be reported to the IDL. After drilling, interim site cleanup is required within 6 months.

Any gas escaping from a well during drilling operations must be, as far as practicable, transported to a safe distance from the well site and burned.

Well treatments. Any plans for well treatment must be disclosed in the well-drilling permit application, if they are known at that time. If the need for treatment was unknown at the time of permitting, before any treatment can begin the permit must be amended and approved by the IDL. Although actions to clean casings or perforations are not considered well treatments, the IDL must be notified when they take place.

The IDL's regulations include an extensive list of requirements for plans that include well treatments, including groundwater protection provisions. Public notice of well treatments is required in a local newspaper, and landowners in the area must be provided with the opportunity to have their groundwater tested before and after the treatment at the operator's expense. The IDL may conduct inspections prior, during, and after well treatments, and the operator is required to submit a report on the treatment to the IDL within 30 days after treatment.

Hydraulic fracturing treatments have additional requirements, including reporting of detailed information on the stimulation fluid(s) and limits on volatile organic and BTEX (benzene, toluene, ethylbenzene, and xylenes) compounds and petroleum distillates. Well integrity tests are required prior to stimulation, and pressure monitoring is required during stimulation. Additional requirements for reporting hydraulic fracturing activities must be included in the post-treatment report to the IDL.

Well completion. An operator must submit a well completion report to the IDL within 30 days of well completion. An oil well is considered completed when the first new oil is produced through wellhead equipment into a lease tank from the ultimate producing interval after the production casing has been run. A gas well is considered completed when the well is capable of producing gas through wellhead equipment from the ultimate producing zone after the production casing has been run.

Well integrity. Mechanical integrity testing is required at least once every five years, regardless of whether a well is active or inactive. Results must be submitted to the IDL within 30 days of testing.

Production equipment and verification. All well-head equipment must be in excellent condition. All meter equipment must be properly sized, fitted, and calibrated. Meters must be visible so the IDL can read them. Standardized methods for measuring the amount of oil and gas being produced are in place.

Idaho does not require operators to report maintenance work prior to commencement of those operations.

Well and site abandonment. All wells that no longer are used for the purpose they were intended must be plugged. A notice of intention to abandon a well must be filed with the IDL before work on abandonment begins. The IDL has extensive requirements for well plugs, and a report must be filed with the IDL within 30 days after abandonment.

After plugging and abandonment, site reclamation must be completed within 12 months. All debris must be removed within 3 months of plugging. Burning or burial of material must be done within applicable local, state, and federal solid waste disposal and air quality regulations, and can only be done on premises with the surface owner's consent. All access roads must be removed and re-contoured, unless specified otherwise in the surface use agreement. Remaining roads must be properly graded to minimize erosion. In most cases, other features such as drill pads will be re-graded to original contour, compacted areas will be cross-ripped, and stockpiled topsoil redistributed. Vegetation comparable with what existed on site before oil and gas operations will be replanted. Alternative contouring, vegetation, and other site reclamation features can be done with agreement of the IDL, the surface owner, and the operator as long as fresh water is unaffected.

Protecting Water Resources

Protection of water resources is a specific area of concern with oil and gas development that cuts across all its stages. This section provides a list of questions and responses about potential effects of oil and gas exploration and development on water resources. Our responses are based on the *Rules Governing Oil and Gas Conservation in the State of Idaho* (IDAPA 20.07.02).

• ***How do the rules address the use of carcinogenic substances for well treatments?*** Administrative rules do not specifically address carcinogens, but do prohibit fluids from being injected at concentrations that exceed water quality standards. Additives to water used for well treatments must be disclosed, and a plan for management, storage, and disposal of well treatment fluids is required.

• ***Do the rules address ground water protection?*** Owners and operators engaged in the exploration and extraction of oil and natural gas must comply with Idaho's water quality standards, including ground water quality rules, administered by the Idaho Department of Environmental Quality. In addition, they must comply with rules related to injection wells, administered by the Idaho Department of Water Resources. Modern drilling equipment and techniques have evolved to minimize waste of oil and gas when they escape from drill casings, which will also limit impacts to ground water. Idaho's administrative rules require adherence to American Petroleum Institute industry standards for drill casings and cementing.

• ***Can water in an oil and gas reservoir be used for irrigation or other purposes?*** The water in an oil or gas reservoir is trapped just as the oil and gas are trapped. The water likely contains salts and other naturally occurring materials that make it unusable. This condition is common for waters used in production at conventional oil and gas wells.

• ***Are open pits allowed?*** Yes, if they are constructed with liners and follow other design requirements. If properly designed and constructed, pits are an effective way to manage drilling fluids and other fluids used or produced during oil and gas operations. Oil, however, may not be stored in open pits.

• ***How are the fluids in pits disposed of?*** If fluids will not be reused at another site, then the fluids and residual solids must be properly handled and disposed of. Fluids may be evaporated partially or entirely. The remaining fluids and solids must then be tested to determine where they may be disposed of. A local landfill may be able to accept these materials, depending on the test results and the type of landfill. If fluids contain hazardous wastes, they must be taken to a hazardous waste facility for disposal.

• ***When is water monitoring required, and how will it be done?*** Monitoring is required for all well treatments, including hydraulic fracturing. The operator is required to identify all water wells within ¼ mile of the treated oil or gas well in the application. The operator then must notify the owners of the nearby wells that they may have an opportunity to get their water tested at the operator's expense. A notification in the local newspaper also will be published. The operator's application also must include a proposed monitoring plan, which will be reviewed by the Idaho Department of Environmental Quality and the IDL. The agencies will evaluate the proposed plan to ensure that it will give reliable information concerning potentially affected aquifers. If the agencies determine that existing water wells are not representative of the ground waters that could be impacted, then the agencies may require the owner or operator to install one or more groundwater monitoring wells at the owner's or operator's expense. Sampling must occur before and after the proposed well treatment.

• ***What chemicals are used for hydraulic fracturing?*** The types and amounts of materials and chemicals used depend on the purpose of the proposed well treatment and the conditions in the oil and gas reservoir. The operator must disclose all material and chemicals in the application so the agencies may make an informed decision. The post-treatment report must include the actual amounts of chemicals used. Trade secrets may be protected from public disclosure under the provisions of Idaho Code § 9-340(D).

Other Policies

In addition to regulations specific to *Rules Governing Oil and Gas Conservation in the State of Idaho* (IDAPA 20.07.02), owners and operators engaged in the exploration and extraction of oil and gas resources must comply with other applicable state and federal laws and rules, including but not limited to:

- Idaho water quality standards and waste water treatment requirements, administered by the Idaho Department of Environmental Quality (IDEQ);
- Idaho air quality standards, administered by the IDEQ;
- Requirements and procedures for hazardous and solid waste management, including rules regulating the disposal of radioactive materials not regulated under federal law, also administered by the IDEQ;
- Provisions of and rules established under the Idaho Stream Channel Protection Act (Idaho Code § 42-3801 et seq.), administered by the Idaho Department of Water Resources (IDWR);
- Provisions of and rules established under the Injection Well Act (Idaho Code § 42-3901 et seq.), also administered by the IDWR;
- Dam safety rules, administered by the IDWR.

Additional details of the roles of the IDL, IDEQ, IDWR, and other state agencies in administering oil and gas development regulations are discussed in **Appendix A**.

Chapter 5. What roles do federal and local governments have in regulating oil and gas exploration and development?

Federal Government

Several federal agencies have responsibilities for administering federal lands assigned to the agency by the United States Congress in various land management systems and under various statutory provisions. In total, federal lands comprise 28 percent of the land area in the nation, and almost 64 percent in Idaho. The agencies' responsibilities include comprehensive long-range planning of land and resource management activities, as well as analyzing environmental impacts of such plans and, in addition, environmental analysis of projects designed by managers to implement the plans. Details of the land management agencies' responsibilities related to oil and gas development are outlined in **Appendix A**.

In addition to land management agencies, other federal agencies have responsibilities for implementing federal statutes designed to protect environmental quality. Congress has provided these agencies with the authority to write rules and regulations for implementing the provisions of the agencies' statutory responsibilities. Details of the environmental regulatory agencies' responsibilities related to oil and gas development are outlined in **Appendix A**.

Federal statutes related to the well development and production phases of oil and gas development as they pertain to hydraulic fracturing ("fracking") are illustrated in **Figure 10**.

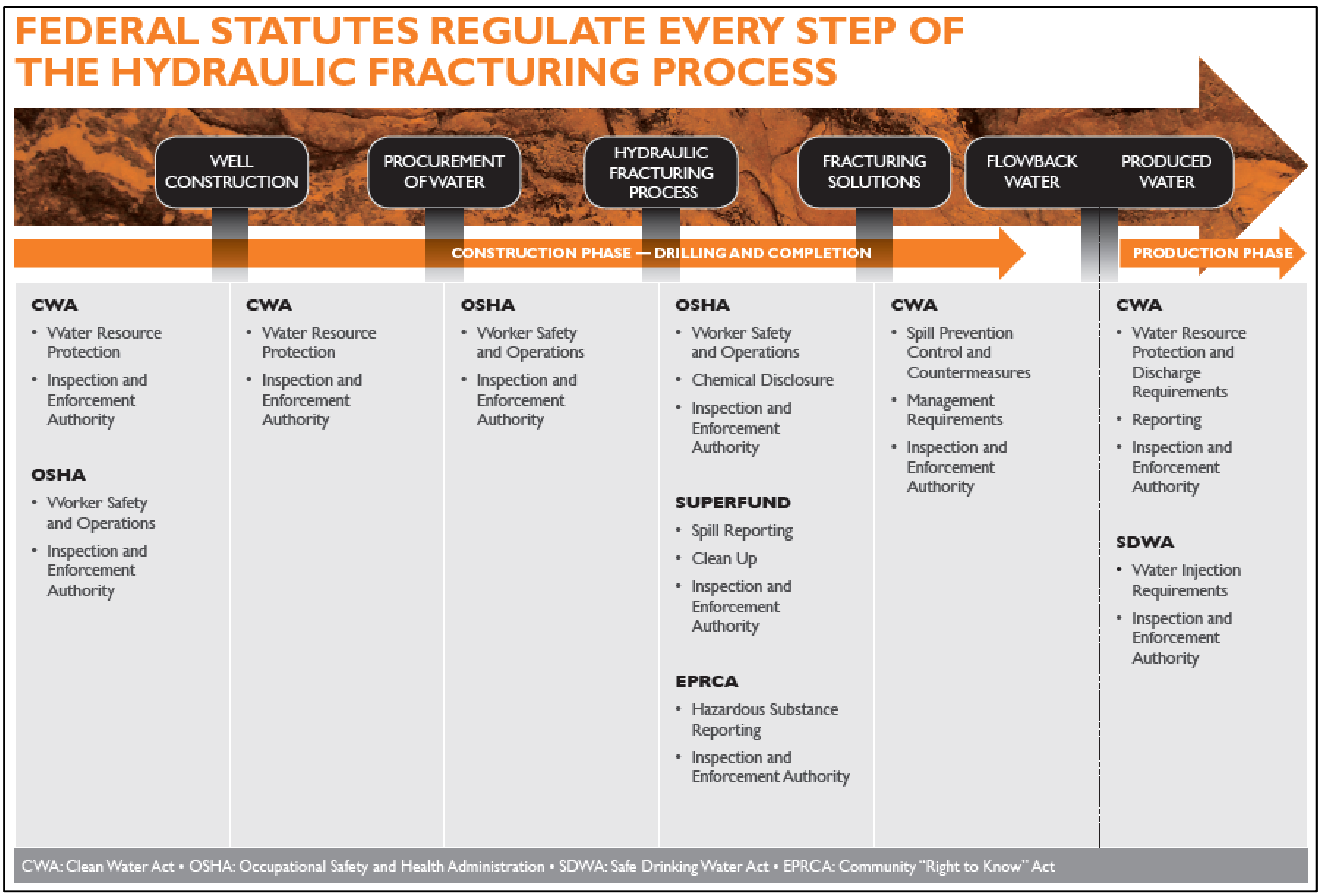


Figure 10. Federal statutes regulating well development utilizing hydraulic fracturing (source: Energy in Depth 2011).

A brief explanation of the federal statutes identified in **Figure 10** follows (IPC 2011):

- CWA (Clean Water Act) regulates surface water discharges and storm-water runoff.
- OSHA (Occupational Safety and Health Act) sets standards to help keep workers safe. These include requiring Material Safety Data Sheets be maintained and readily available onsite for chemicals used at that location.
- Superfund is the name given to the environmental program established to address abandoned hazardous waste sites. It is also the name of the fund established by the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (CERCLA statute)
- EPRCA (Emergency Planning & Community Right-to-Know Act) requires storage of regulated chemicals in certain quantities to be reported annually to local and state emergency responders.
- SDWA (Safe Drinking Water Act) regulates the disposal of fluid waste deep underground.

Additional federal statutes that shape the regulatory environment for oil and gas development include:

- CAA (Clean Air Act) sets rules for air emissions from engines, gas processing equipment and other sources associated with drilling and production activities.
- NEPA (National Environmental Policy Act) requires permits and environmental impact assessments for drilling on federal lands.
- NPSA (National Pipeline Safety Act) sets standards for pipeline construction, operation and maintenance administered by U.S. Department of Transportation.

Local Government

In 2012, the Idaho Legislature amended several provisions of Idaho Code with H464. This bill limited the ability of county and city governments to make decisions about how and where oil and gas development can be done. Except for limited planning and zoning authority under Idaho's Local Land Use Planning Act (Idaho Code § 67-6501 et seq.), local issues associated with oil and gas exploration and development are under the control of the state through the Idaho Oil and Gas Conservation Commission (Idaho OGCC). As mentioned in **Chapter 4** and **Appendix A**, the Idaho OGCC consists of five members appointed by the governor. The general provisions of H464 as they now appear in Idaho Code § 47-317 are:

- The Idaho OGCC provides notice and a copy of application materials to respective city or county when an application for exploration is received.
- Cities and counties are not able to prohibit oil and gas extraction, but may pass reasonable public ordinances that protect public health, public safety, public order, or which prevent harm to public infrastructure or degradation of the value, use and enjoyment of private property.
- Any ordinance regulating extraction under the Idaho Local Land Use Planning Act must provide for administrative permitting within 21 days, unless extended by agreement of the parties or upon showing good cause.
- Cities and counties are not able to prohibit construction or operation of facilities and infrastructure needed for post-extraction processing and transport of gas and oil. However, such facilities and infrastructure are subject to local regulation under the Idaho Local Land Use Planning Act.

Chapter 6. What are the potential positive impacts of oil and gas development in Idaho?

The primary positive impacts of oil and gas development in Idaho are economic. These benefits include employment and wages, royalty payments to landowners, and a variety of taxes. There are also environmental benefits and national security benefits.

Economic Benefits

Considerable sums of money are expended to lease mineral rights from private landowners who own their minerals and from mineral interest owners whose mineral rights have been severed from the surface ownership. There is usually a front-end bonus paid along with an annual rental. Frequently, bonuses for allowing seismic exploration and offers to lease are made in areas without proven oil and gas reserves (Hawk, review comments).

Some lease and bonus income may be spent in the local economy on, for example: housing, fuel, groceries, automobiles, tractors, college, entertainment, and support of local philanthropic or religious organizations (Hawk, review comments). In addition to providing income to private landowners and mineral interest owners, lease and bonus payments are subject to income taxes under the regulations of the U.S. Internal Revenue Service and the Idaho Tax Commission.

The organizations and people who are engaged in lease acquisition, geophysical surveys, drilling, and pipeline construction also may contribute to local economies. For example, those involved in exploration and development in the Western Idaho Basin have hired local real estate agents to secure the leases, local geologists knowledgeable about the rocks and geologic history of the area, a retired Intermountain Gas Company manager of engineering, local well drillers capable of drilling to 8,000 feet, local surface contractors, local roustabouts, and a host of other part-time employees. They have purchased gravel, fuel, meals and lodging locally. These local economic activities have positive impacts (Hawk, review comments).

A market for the produced natural gas may exist locally with Intermountain Gas Company and/or Idaho Power Company which may remove the need for all the gas to flow to a market via Northwest Pipeline and be subject to the transportation charges. If so, this would increase the value of the gas to the producer and may reduce the cost to the buyer (Hawk, review comments).

The discovery in Idaho of geologic reservoirs of commercial natural gas, under the right physical conditions, could lead to the development of an underground natural gas storage field as the original reservoir becomes depleted. Currently, the natural gas needs of Idahoans are partially met through the use of underground storage facilities in Oregon at the Mist Field (a partially depleted natural gas reservoir), in Washington at the Jackson Prairie storage field, and in Utah at the Clay Basin field (a depleted natural gas reservoir). These storage fields allow companies to purchase and store gas when prices or demand is lower and use it when prices or demand is higher or when there are pipeline delivery problems or constraints (Hawk, review comments).

The following points summarize economic benefits and provide an estimate of potential revenues and taxes:

- Idaho currently imports 70 percent of its energy needs from neighboring states and does not have a substantial energy production sector now (Idaho Legislative Council 2012). Imports account for all of the state's natural gas and liquid petroleum requirements.
- At current prices, natural gas is less expensive than other fossil fuels, thus use of natural gas reduces energy bills for Idaho citizens.
- Oil and gas development potentially could bring high-paying jobs and associated economic impacts to Idaho. Nationally in 2012, oil and gas industry jobs paid an average of $107,200

annually, compared to an average annual wage across all private sector industries of $48,900 (TIPRO 2013).

- Results in other western states suggest that each million dollars in gas production as a result of the recent boom creates 2.35 jobs in the county of production (Weber 2012).
- Taxes and royalties from oil and gas production and land leasing provide substantial financial resources in Montana, Utah, and Wyoming. If the discoveries in southwestern Idaho produce what the Idaho Petroleum Council has estimated, the annual value of production would be approximately $206 million (IPC 2011).
- Using the estimate of potential revenue (IPC 2011) and jobs per million dollars of revenue in other western states (Weber 2012), there could be 484 new jobs in Payette County.
- Idaho has a 2.5 percent severance tax on oil and gas produced in the state (Idaho Code § 47-330). Sixty percent of the funds collected via the severance tax would go to the Idaho OGCC to be used to offset the expenses of regulating oil and gas activity, with the excess amount going to the state's general fund. Forty percent of the funds collected via the severance tax would go to the counties and cities where the oil and gas is produced and to public schools. The Idaho Petroleum Council estimates current expected production to provide $5.1 million per year in severance taxes (IPC 2011).
- Royalty rates are negotiated by mineral rights owners with oil and gas developers, thus royalty rates can be expected to vary by owner. The state currently would receive a 12.5 percent royalty on oil and gas production from state-owned mineral rights (IDAPA 20.03.16).
- Oil and gas leases on state lands are offered through competitive bidding (IDAPA 20.03.16). There are currently 214 active oil and gas leases on state-owned lands (IDL 2013).
- Although Idaho Petroleum Council estimates of production value, severance taxes, and royalties are provided above, the potential magnitude of such benefits, along with employment, is unknown. Ascertaining these values would depend first of all on successful exploration and development of commercially viable supplies, and second on the cost of regulation, which is a function of policy decisions by the Idaho Legislature and the Idaho OGCC.
- In addition to severance taxes and royalties estimated above, the state would benefit from income tax on royalties paid to private landowners, as well as sales tax, property tax, and employment tax (IPC 2011).

Environmental Benefits

A significant benefit of oil and gas development is the relatively small above ground surface footprint required compared to production of many other forms of energy. When production ceases to be commercially viable, the oil and gas wells are plugged according to the appropriate standards, and the land is reclaimed so there is little evidence that the project was there (Hawk, review comments).

Natural gas is a highly efficient form of energy. It is composed chiefly of methane—the simple chemical composition of natural gas is a molecule of one carbon atom and four hydrogen atoms (CH_4)—and when methane is burned completely, the principal products of combustion are carbon dioxide (CO_2) and water vapor (H_2O) (AGA 2013). Compared with other fuels, natural gas has fewer impurities, it is less chemically complex, and its combustion generally results in less pollution. In most applications, using natural gas produces less of the following substances than oil or coal: carbon dioxide (CO_2), which is a primary greenhouse gas; sulfur dioxide (SO_2), which is the primary precursor of acid rain; nitrogen oxides (NOx), which are the primary precursors of smog; and particulate matter, which can affect visibility and human health. Technological progress allows cleaner energy production for all fuels, although the inherent cleanliness of gas means that environmental controls on gas equipment, if required, tend to be far less expensive than those for other fuels (AGA 2013).

Natural gas' favorable environmental qualities include:

- Using natural gas to replace less environmentally benign fuels can help address simultaneously a number of environmental concerns, such as smog, acid rain and greenhouse gas emissions.
- Natural gas is highly efficient. About 90 percent of the natural gas produced is delivered to customers as useful energy. In contrast, only about 30 percent of the energy converted to electricity in conventional generating facilities reaches consumers.
- Natural gas is cleaner than other fossil fuels, especially coal, and thus could supply the state with more clean energy, depending on whether gas extracted in the state is used here or exported.
- Natural gas produces fewer greenhouse gases per unit of energy produced than does coal.
- Natural gas is versatile; like coal, it can be used to generate electricity, and it is widely used to heat residential, commercial, and industrial buildings. It can also be compressed and used as a transportation fuel or liquefied for shipment where pipelines are not feasible, such as overseas.

National Security Benefits

National security has been linked to secure supplies of energy (Leiby 2008, Conway 2012, Flaherty and Filho 2013, Littlefield 2013). Energy security has been a goal of U.S. presidents and Congress for more than 100 years (Below 2013). Like his predecessors, President Barack Obama has made it a policy goal to set the U.S. on a path to a cleaner and more secure energy future (The White House 2013). Since 2008 oil and gas production in the U.S. has increased each year, while oil imports have fallen to a 20 year low. The President is directing new policies and investments to set the U.S. on a course to cut net oil imports in half by the end of the decade, relative to 2008 levels (The White House 2013).

Increased domestic production of natural gas is part of the vision for a secure energy future for the nation(Greenstone et al. 2012). President Obama has committed the nation to safer production and cleaner electricity from natural gas. The President's FY 2014 budget proposed investing more than $40 million in research to ensure safe and responsible natural gas production. The President's budget also includes a new $25 million prize for the first, natural gas combined cycle power plant to integrate carbon capture and storage (The White House 2013).

Chapter 7. What are the potential negative impacts of oil and gas development in Idaho?

The environment is the most important issue in developing Idaho's oil and gas resources (IPC 2011). Responsible development of oil and gas resources offers important economic, energy security, and environmental benefits, and federal and state policies are designed to help ensure that oil and gas extraction does not come at the expense of public health and the environment (EPA 2012b). All land and resource management activities involve risk of negative consequences. The key to avoiding negative consequences is to minimize risks through careful planning and implementation, adequate regulation and enforcement, and requiring mitigation for adverse impacts that do occur.

The significance of the impacts of oil and gas development and the potential for negative impacts depends upon many factors and varies greatly. Most potential negative impacts of oil and gas development can be categorized into one of three categories: ***air***, ***water***, and ***land use*** (EPA 2008). In some areas impacts on ***wildlife*** can be a management concern. Each is discussed below.

Air. Emissions affecting air quality can occur during numerous phases of oil and gas development, including exploration, drilling, and production (EPA 2000, TEEIC 2013). The amounts and types of emissions affecting air quality will vary by production area, field, and well (Hawk, review comments). Such emissions can include criteria pollutants regulated under the Clean Air Act (CAA): ozone (O_3), particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOx), and sulfur dioxide (SO_2) (EPA 2008). These criteria pollutants are also regulated under the CAA as haze precursors. Emissions also include hazardous air pollutants (HAPs), primarily volatile organic compounds (VOCs), also regulated under the CAA (EPA 2008). Idaho implements its CAA regulatory responsibilities through its state implementation plan (SIP; IDEQ 2011), and participates in the Western Regional Air Partnership (WRAP 2010) to address regional haze issues.

Oil and gas development also produces greenhouse gases, including carbon dioxide (CO_2) and methane (CH_4). The EPA is currently developing a regulatory framework for smaller emitters of greenhouse gases such as oil and gas development activities, but it is not expected to be implemented until at least 2016 (EPA 2010). The amount of fugitive methane emissions associated with oil and gas production is currently being debated (EPA 2013b; Miller et al. 2013).

Water. Impacts on water resources vary during stages of development and the types of geologic formations where the oil or gas is located and their relationship to freshwater aquifers. As mentioned in **Chapter 2** (see **Figure 2**) the sandstone formations of interest for gas development in the Western Idaho Basin are much deeper than the freshwater aquifers used for human and agricultural purposes, thus minimal impacts to water resources would be anticipated from exploration activities.

The Tribal Energy and Environment Information Center (TEEIC 2013) provides a general overview of potential impacts, portrayed as worst-case event scenarios. For example, improperly constructed exploratory wells could lead to negative effects (Gillerman, review comments; Hawk, review comments) by providing a pathway for surface contaminants to reach groundwater or for waters from subsurface formations to commingle. Exploratory wells also may decrease pressure in water wells and affect their quality (TEEIC 2013). However, this has a low probability of occurring. Wells are constructed to keep formation water out of the borehole and to decrease the invasion as quickly and as completely as possible. Drilling mud is used to form a mudcake on the borehole to prevent invasion. Holes are drilled using water in the well bore to prevent invasion, and mud is used if an over-pressured aquifer or zone is encountered (Hawk, review comments).

Very little produced water is likely to be generated during exploration. Most water needed to support drilling operations would be trucked in from off-site (TEEIC 2013). Water required for drilling can come from a variety of sources such as municipal water treatment facilities, river water, irrigation water, drinking water, and private wells. It is usually purchased locally and reused when and where possible for other drilling opportunities (Hawk, review comments).

Current water quality conditions and the potential for harmful effects from oil and gas development will vary by area. The Idaho Department of Water Resources maintains the Idaho Environmental Data Management System which is part of the Statewide Ground Water Quality Monitoring program and contains water quality information for ground water wells throughout Idaho. Site-specific research on current water quality conditions in areas of potential oil and gas development is beyond the scope of this report.

Some research has found increased seismic activity (earthquakes) linked to injection wells used for oil and gas development (see, e.g., Keranen et al. 2013), and also found that hydraulic fracturing fluids have the potential to contaminate groundwater (Mooney 2011, AWWA 2013, TEEIC 2013). To be useful in underpinning regulations, the potential for such events needs to be quantified through risk analysis. Such risk analysis is beyond the scope of this report. (For additional information see **Appendix D. Annotated Bibliography — Water Resources**.)

Land use. Negative impacts from surface disturbance associated with oil and gas development can occur (EPA 2008, TEEIC 2013). Vegetation and soils are disturbed while a site is occupied but with proper precautions during operations and adequate reclamation, the surface disturbances are temporary and can be minimized and mitigated. Inconveniences to surface owners and operations, such as noise or interruptions to farm operations, can occur, but are usually temporary. Split estates, where surface rights owners do not own mineral rights, may exacerbate the negative impacts of surface disturbances. Surface and shallow disturbances may put cultural or archeological resources at risk.

If more commercially viable gas resources are found in Idaho, more pipeline infrastructure may be needed in environmentally sensitive areas. There is some existing infrastructure in southern Idaho (see **Figure 7**), but it may need expansion (NWGA 2013).

Drilling wastes and their disposal also have potential for negative impacts. Oil and gas production generally produces drilling waste that contains mud, rock fragments and cuttings from the wellbore, and chemicals added to improve the properties and performance of drilling muds and fluids. Methods exist to reuse and/or reduce drilling waste as well as to diminish its toxicity of various drilling waste, but concerns about impacts still exist (EPA 2008, Colborn et al. 2011).

Although current knowledge of resource potential indicates that oil and gas development in Idaho is likely to be limited, oil and gas “booms” can have negative impacts on rural communities and their physical infrastructure and social well-being (Brasier et al. 2011, Putz et al. 2011, Schafft et al. 2013). Workers in oil and gas development also face potential negative impacts to their health and safety. These risks to workers are regulated by the federal Occupational Safety and Health Administration (OSHA 2013).

Oil and gas development as an economic development strategy is not without risks (Headwaters Economics 2008). Given appropriate information and analysis, policymakers can weigh the quantified risk of negative social and economic impacts against potential benefits of oil and gas development before committing to a course of action. In addition, the rights of private individuals to have access to and extract the minerals they own is a paramount right that must figure into any policy being created by others (Hawk, review comments).

Wildlife. Oil and gas development can impact wildlife habitat. In Idaho the species of concern are mule deer and greater sage-grouse, both characterized by declining populations. Before September 2015, the U.S. Fish and Wildlife Service will determine whether greater sage-grouse and their 15 million acres of habitats in Idaho should be protected by the Endangered Species Act. If so, land management where oil and gas exploration may occur could become more complicated. According to Hawk and Gillerman (review comments), in the Western Idaho Basin, none of the expected development is in sage-grouse habitat areas.

Natural gas drilling in Wyoming has been identified as a major threat to sage-grouse in that state. However, oil and gas operations in Wyoming are at a greater intensity than foreseen in Idaho. Furthermore, operations can be adjusted to meet sage-grouse needs as established by state and federal wildlife management authorities. For mule deer, timing of operations during mating and birthing seasons can be adjusted to meet such needs. (For additional information see **Appendix D. Annotated Bibliography — Wildlife Resources**.)

Chapter 8. What policy alternatives exist to further oil and gas development in Idaho while protecting surface rights and other resources?

Current state and federal policies address many of the concerns related to environmental effects of oil and gas development. The key to realizing the potential of these policies is adequate implementation, monitoring, and enforcement. Professional oversight of development by the state will generally require either an experienced petroleum geologist employed by a state agency or the state contracting for such services.

As knowledge increases about the effects of oil and gas development on other resources and human well-being, an adaptive management approach to policy development would be useful for incorporating new information into policy. For example, during 2014 the U.S. Environmental Protection Agency is expected to complete its national study on the impact of hydraulic fracturing on drinking water resources (see EPA 2012b). The findings of this national study may or may not provide a basis that could lead to the development and implementation of improved policies to protect water quality. At this writing the BLM is in the process of developing regulations for the practice of hydraulic fracturing on federal and Indian lands. The Western Governors Association feels such regulations are redundant because states have demonstrated that they can effectively regulate this practice and protect environmental and public health (Hickenlooper and Sandoval 2013). A report by Resources for the Future, however, points out that BLM's proposal addresses some apparent gaps in state-level regulation—use of lined pits and disclosure of fracking fluids in those states that do not impose similar requirements—and that, generally, BLM rules do not appear to impose significant requirements beyond existing state regulations (Feiden et al. 2013).

The effects of oil and gas development on ecosystems are dependent on the characteristics of those ecosystems. Policies and protocols for oil and gas development can be tailored to reflect ecosystem conditions (see, e.g., Boone et al. 2011).

State policies related to oil and gas development focus on individual resources and not the combined impacts on an individual site nor the cumulative impacts over many sites. Policies that require a more broad-ranging and comprehensive environmental review before undertaking development, such as the NEPA-like environmental protection acts in Montana and Washington, may lower the risks of unforeseen negative consequences. However, the costs of such analysis may or may not outweigh benefits. Regardless of the benefit-cost relationship, such a law provides a disincentive for oil and gas resource developers (Hawk, review comments).

While some private businesses would see economic returns from oil and gas development, it is unclear whether the amount of the severance tax on oil and gas (2.5%) and its distribution in part (40%) to local governments where the oil or gas is produced would provide funds sufficient to offset increased public services related to operations (e.g., increased wear of roadways) and an influx of temporary workers (e.g., housing, schools, health care). As Hawk (review comments) points out, that as development occurs, and its size and scope becomes known, then policy makers can look to the impacts and determine if any adjustments need to be made.

Under current policies in situations where there is a split estate—i.e., the surface and mineral rights have different owners—the mineral estate always takes precedence. Although mineral rights owners and oil and gas developers are required to work with surface owners to reach agreement about how the surface will be managed during and after oil and gas operations, surface owners must allow oil and gas operations to take place, and in doing so are forced to assume some of the risks of negative consequences related to development. It is unclear whether current levels of bonding are adequate for the risks imposed. Alternative bonding policies may be appropriate, as well as other types of policies that protect surface owners.

Debates about state vs. local control are associated with the recent history of oil and gas development in Idaho. The state has clarified that it, rather than units of local government, is responsible for oil and gas development policies. Although such policies create uniformity and consistency for developers across the state, the state might not be as responsive to local concerns as would local governments. However, due to the fear of expensive legal proceedings with the state, local governments may be reluctant to implement local land use planning policies that are within their power. Nonetheless, as Hawk (review comments) points out, legislators may pay more attention to local government concerns than those of developers.

Although more cooperative policies between the state and local governments may produce better results, a look at how Idaho policy makers have chosen to regulate a variety of other natural resource-based industries reveals an emphasis on state-wide programs. Oil and gas development is not being treated any differently.

Consider also that the state and federal governments, not county or city, also have primacy in Idaho water resource regulation (water rights/quantity and water quality), mineral and geothermal resources, timber, air quality, health concerns, etc. These regulatory programs are costly and require technical expertise. Analysis of the resources needed to run these regulatory programs at the state level might convince local interests that the state should run them, and it might provide background for legislators to provide adequate funding for those regulatory programs, whether through state tax-derived funds or user fees (Gillerman, review comments). Such analysis is beyond the scope of this report.

Appendix A. Additional details on state and federal government agencies and their roles in regulating oil and gas development

General roles for state government roles in regulating oil and gas development were provided in **Chapter 4**, and for the federal government in **Chapter 5**. This appendix provides additional details that were omitted from those chapters to reduce their bulk.

State Government Agencies and Roles

Idaho Oil and Gas Conservation Commission (Idaho OGCC)

Idaho Code § 47-317 identifies the duties and authorities of the Idaho OGCC which, as of July 1, 2013, is comprised of five members appointed by the governor with the advice and consent of the senate. (See **Chapter 4** for more details.) In brief, the Idaho OGCC is responsible for the following duties:

- regulating oil and gas well drilling and construction standards;
- regulating well treatment practices, including hydraulic fracturing;
- coordinating with the Idaho Department of Water Resources (IDWR) and the Idaho Department of Environmental Quality (IDEQ) to ensure water resources are adequately protected;
- determining proper well spacing;
- reviewing requests for directional drilling; and
- evaluating unitization agreements, which consolidate mineral interests in a pool so that the resource can be developed efficiently while protecting correlative rights.

Idaho Department of Lands (IDL)

The IDL is the administrative arm of the Idaho OGCC. Under the provisions of S1049, which became law July 1, 2013, the Idaho OGCC may continue to contract with the IDL for services to carry out duties related to oil and gas development in the state, or it may hire its own personnel. S1049 also provided the Idaho OGCC with a choice of continuing to have the IDL Director serve as secretary to the Idaho OGCC, or the Idaho OGCC can appoint another person. As of this writing, the IDL continues to be the administrative arm of the Idaho OGCC, and the IDL Director continues to serve as secretary to the Idaho OGCC. IDL's *Rules Governing Oil and Gas Conservation in the State of Idaho* (IDAPA 20.07.02) apply to all lands regardless of ownership and are covered in **Chapter 4**.

Regardless of changes to the Idaho OGCC, the IDL Director will continue to serve as secretary to the Idaho State Board of Land Commissioners (Land Board), and the IDL will continue to be the administrative arm of the Land Board. The duties of the Land Board and the IDL related to oil and gas development will continue to include administering the oil and gas leasing program for Idaho's 2.5 million acres endowment lands (see PAG Report No. 1, 2nd edition, O'Laughlin et al. 2011) and all other state agencies as directed by Idaho Code, Title 47, Chapter 8 and implemented via *Rules Governing Oil and Gas Leasing on Idaho State Lands* (IDAPA 20.03.16). If the state owns the mineral rights and those rights are held in public trust (such is the case with the Idaho Department of Fish and Game lands), the revenue generated from the leasing of the rights goes to the specific agency that owns the mineral rights.

Oil and gas leases on state lands are awarded via competitive bidding, with an initial lease term of 10 years. If after 10 years oil or gas is still being produced, or the leaseholder is continuing drilling operations, the lease is extended. The annual rental fee for each acre under lease cannot be less than $0.25 per acre, and the royalty payment is 12.5% on any oil or gas produced.

Before any exploration with motorized equipment on state lands is allowed, a permit must be obtained from the IDL that proscribes conditions to protect surface uses and the resources of the state. A bond of $1,000 is required before entering state lands with motorized equipment, and a bond of $6,000 is required before drilling. In lieu of the individual bonds, an operating firm may put up a $50,000 bond to cover all leases and operations on state lands.

The lessee of state lands is required to take reasonable precautions to prevent injury or damage to people, property, and the surrounding environment, including vegetation, livestock, fish and wildlife and their habitats, streams, rivers, lakes, timber, forests, and agricultural resources. The lessee must compensate the state for damages resulting from failure to take reasonable precautions. Lessees must comply with all applicable environmental laws, rules and regulations, including the *Rules Governing Oil and Gas Conservation in the State of Idaho* (IDAPA 20.07.02). The IDL is allowed to enter the leased lands and inspect operations and products obtained.

Idaho Department of Environmental Quality (IDEQ)

The IDEQ implements provisions of the federal Clean Air Act and Clean Water Act under programs of cooperative federalism with the U.S. Environmental Protection Agency (EPA). The IDEQ is responsible for air quality permitting (IDAPA 58.01.01) and assuring compliance with surface water standards for maintaining water quality (IDAPA 58.01.02). The IDEQ has authority for groundwater protection through state statute authorizing rules to protect the environment and human health (Title 39 Idaho Code) and the Idaho Ground Water Quality Rule (IDAPA 58.01.11). The IDEQ and other state, federal, and local agencies implement groundwater quality protection through the *Idaho Ground Water Quality Plan* (Ground Water Quality Council 1996). The IDEQ is also responsible for developing and implementing rules for hazardous wastes (IDAPA 58.01.05) and other solid wastes (IDAPA 50.01.06).

Idaho Department of Water Resources (IDWR)

The IDWR protects and manages water rights of both surface water and ground water resources. In addition, the IDWR is responsible for protecting groundwater quality through its regulation of Class II injection wells (IDAPA 37.03.03), which inject fluids underground either for enhanced oil and gas recovery, liquid waste disposal, or liquid hydrocarbon storage. The construction or use of any Class II injection well requires a permit from the IDWR.

Idaho Department of Fish and Game (IDFG)

The IDFG is responsible for protecting the state's interest in and managing its fisheries and wildlife. Perhaps the issue of most concern related to oil and gas development is management of sage-grouse populations, which are being considered for listing under the federal Endangered Species Act.

Idaho Governor's Office of Species Conservation

As a part of the Idaho Governor's Office, the Office of Species Conservation coordinates policies and programs related to the conservation of threatened, endangered, and candidate species in Idaho. Greater sage-grouse face a potential listing as a threatened species. Should oil and gas exploration and development opportunities coincide with primary sage-grouse habitat, activities will need to be carefully regulated.

Idaho Public Utilities Commission (IPUC)

The IPUC oversees and regulates oil and gas pipeline safety (IDAPA 31.31.01).

Idaho State Tax Commission

The Idaho State Tax Commission collects a 2.5% severance tax on all oil and gas produced, and distributes it as proscribed in Idaho Code § 47-330. Sixty percent of the severance tax revenues are used to defray the expenses of the Idaho OGCC and its regulation of oil and gas development, with excess revenues going to the state's general fund. Forty percent of the severance tax revenues are distributed as follows: 28% to the county where the oil or gas was produced, 28% to cities within the county where the oil and gas was produced, 28% to the public school income fund, and 16% to the local economic development agency in counties experiencing economic hardship due to cutbacks or closure of businesses and industry associated with oil or gas production.

Idaho Governor's Office of Energy Resources

As part of the Idaho Governor's Office, the Office of Energy Resources (OER) coordinates the state's energy planning and policy development efforts. The OER assists with coordination and cooperation between federal and state agencies, departments and divisions, and local governments on issues concerning the state's energy requirements, supply, transmission, management, conservation and efficiency efforts.

Federal Government Agencies and Roles

This section identifies environmental and land use management agencies and their roles in regulating oil and gas development.

United States Environmental Protection Agency (EPA)

The EPA has responsibility for implementing the federal Clean Air Act and Clean Water Act. Under a cooperative federalism design, the EPA provides oversight of the Idaho Department of Environmental Quality's programs for protecting air quality and water quality as they are affected by nonpoint sources of pollution. In Idaho, the EPA is responsible for regulating and managing point source pollution into surface waters through the National Pollutant Discharge Elimination System (NPDES). The EPA's standards and regulations represent a federally required minimum level of control. States have the flexibility to put their own programs in place or implement existing programs as long as they are at least as protective as the federal standards.

The EPA's most recent air quality regulations for oil and gas development were issued August 16, 2012 (77 FR 49490), and include the first federal air quality standards for natural gas wells that are hydraulically fractured. The regulations also specify requirements for several other sources of pollution in the oil and gas industry that were not previously regulated at the federal level. The rules for hydraulic fracturing of gas wells rely on proven, cost-effective technology and practices that industry leaders are using today at about half of such wells in the U.S. Implementation of the new regulations is expected to yield a nearly 95 percent reduction in volatile organic compounds (VOCs) emitted from more than 11,000 new gas wells developed by hydraulic fracturing in the past few years (EPA 2012a).

The EPA created its first regulations regarding wastewater from oil and gas extraction in 1979, with updates in 1993, 1996, and 2001 (40 CFR 435). The regulations cover wastewater discharges from exploration, drilling, production, well treatment, and well completion activities and are part of the NPDES (EPA 2013a).

Specific to oil and gas development, hydraulic fracturing, and water quality, the EPA is currently conducting a national study to better understand potential impacts on drinking water resources. The study is comprised of 18 research projects, and a draft of the study for public and peer review is expected in 2014. The EPA has designed the study around the five stages of the hydraulic fracturing water cycle: water acquisition, chemical mixing, well injection, flowback and produced water, and wastewater treatment and waste disposal (EPA 2012b).

United States Department of the Interior, Bureau of Land Management (BLM)

The BLM manages about 12 million surface acres of federal lands in Idaho, primarily in the southern part of the state. These lands are managed in accordance with the Federal Land Policy and Management Act of 1976 (FLPMA; 43 USC 1701 et seq.). Lands administered by the BLM have a multiple-use mandate, and are to be managed for "…renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific and historical values…" The BLM is required by FLPMA to develop resource management plans that guide how the agency's lands and resources in each planning area will be used.

In addition to its administrative responsibilities for approximately 12 million surface acres of federal land in Idaho, the BLM also has ultimate authority for oil and gas leasing on all federal lands, including those lands managed by other federal agencies. Nationwide the BLM administers the leasing of oil and gas resources found beneath 258 million surface acres managed by the agency, 57 million surface acres where subsurface rights are owned federally but the surface is in non-federal ownership, and another 385 million acres whose surface is managed by other federal agencies.

The BLM describes its development process for onshore federal oil and natural gas resources in five phases: land use planning, parcel nominations and lease sales, well permitting and development, operations and production, and plugging and reclamation (BLM 2009). Each is described below.

Land-use planning. Resource management plans (RMPs) developed under FLPMA establish which areas on BLM land are open to oil and gas leasing. The areas open for leasing are analyzed for impacts of reasonably foreseeable development, and the RMP spells out any stipulations needed to provide extra protection for sensitive resources in the plan area. In addition, the BLM works cooperatively with the U.S. Forest Service on areas identified as open to oil and gas leasing in its Land and Resource Management Plans (LRMPs) developed pursuant to the National Forest Management Act (NFMA), a process described in the last section of this chapter.

In his review comments, Hawk opined as follows: "The BLM in Idaho has been extremely slow in developing an RMP for public comment and eventual acceptance determining which areas are appropriate and suitable in southern Idaho for oil and gas activities including leasing. This work, or discussion of the need for the same, has been ongoing for at least seven years with no firm timetable for leasing to begin on the horizon. That is the reason significantly more federal leases have not been acquired in Idaho as of this date. The explanations have included a lack of available employee time due to range emergencies to a lack of priority rating. The BLM currently has a proposal for standards for fracking on federal land out for review and comment. Keeping in mind, fracking has occurred on federal lands for many years and is occurring today throughout the west" (Hawk, review comments).

Parcel nomination and lease sales. Parcels in areas identified in an RMP as open for leasing may be nominated for leasing. Anyone can nominate lands by sending a written expression of interest to the BLM State Office for the area where the lands are located. Nominated parcels are not automatically placed on sale. The BLM reviews each nomination to ensure that parcels are, in fact, available, and stipulations from the RMP are attached before the lease is placed on sale.

Leases are sold at competitive auction. States with BLM lands or mineral rights hold lease sales at least quarterly. Lease sales are open to the public and are announced in advance. The successful bidder obtains the right to explore and drill for, extract, remove, and dispose of deposits of oil and gas found on the lease. Leases are valid for 10 years or as long as there is at least one producing well. Exploring, drilling, extracting, removing and disposing must cause no more disturbance to the surface or to other resources than is necessary.

Well permitting and development. The leaseholder, or an operator hired by the leaseholder, must file an application for permit to drill (APD) and a surface use plan of operations. Permitting is subject to National Environmental Policy Act (NEPA) requirements that result in either an environmental assessment (EA) or more detailed environmental impact statement (EIS). The APD process begins with an onsite inspection that helps the BLM identify concerns and potential environmental impacts that may require conditions of approval and/or implementation of best management practices. The surface of the parcel remains undisturbed during APD review.

The BLM's regulations allow for unitization agreements where different leaseholders have rights to a common reservoir of oil and/or gas (BLM 2013a). Unitization provides for the exploration, development, and operation of a geologically defined area by a single operator so that drilling and production may proceed in an efficient and economical manner without the need to develop unnecessary wells.

The BLM either approves, approves with conditions, denies, or defers action on the APD. An approved APD is valid for two years or until the lease expires, whichever occurs first. Market conditions and other factors determine when the leaseholder drills a well.

Operations and production. The BLM performs periodic inspections during construction and operations to ensure that the terms and conditions of the approved APD are being implemented. An initial inspection establishes baseline conditions before any surface disturbance can occur. During production, the BLM inspects producing leases at least once every three years. Potential health and safety issues, environmental concerns, potential conflicts with other resources, and compliance history help prioritize inspections. Inspectors assess whether the operation is clean and safe, whether mitigation measures are effectively addressing resource impacts, and whether interim reclamation is being implemented appropriately. Inspectors inform operators of any violations of lease terms or of the approved APD. Production inspections also ensure that production volumes are being accurately reported so that proper royalties can be collected.

Plugging and reclamation. Reclamation helps ensure that the effects of oil and gas development on the land and on other resources and uses are not permanent. A reclamation plan is included in the surface use plan of operations, which must be approved before any construction can begin.

Partial reclamation of drilling areas must occur during production. Reclamation must begin as soon as possible after the surface is disturbed and continue until the BLM determines that successful reclamation has been achieved.

The ultimate objective of reclamation is ecosystem restoration, including restoration of the natural vegetation community, hydrology, and wildlife habitats. In most cases, this means a condition equal to or closely approximating that which existed before the land was disturbed. Reclamation restores the original landform or creates a landform that blends in with the surrounding landform. Successful reclamation, over time, allows the area to regain its original productive and scenic potential and for local native species to re-establish on the site.

During reclamation and abandonment, inspections ensure that the well is being properly plugged and reclamation is being completed correctly. The BLM continues to monitor the site over the long term to ensure that it remains stable and that ecosystem function is fully restored (BLM 2009).

The BLM's regulations for oil and gas leasing are extensive (see 43 CFR 3100 et seq.). In addition to regulations codified in the Code of Federal Regulations, the BLM also conducts oil and gas operations in accordance with seven Onshore Oil and Gas Orders (BLM 2012a). These seven orders cover the following subjects: 1) approval of operations, 2) drilling operations, 3) site security, 4) measurement of oil, 5) measurement of gas, 6) hydrogen sulfide operations, and 7) disposal of produced water. Notices to Lessees are also un-codified regulations that can be issued nationally or by state offices (BLM 2013b). The BLM Manual (BLM 2013c), handbooks (BLM 2013d), instruction memoranda (BLM 2012b), and information bulletins (BLM 2012c) all assist managers in implementing the agency's oil and gas regulations. To assist operators in complying with regulations, the BLM, in cooperation with the U.S. Forest Service, developed *Surface Operating Standards and Guidelines for Oil and Gas*

Exploration and Development, commonly referred to as "The Gold Book" (BLM and USFS 2007).

The BLM reports that only four oil and gas leases covering 7,355 acres were in effect in Idaho at the end of fiscal year 2012 (BLM 2013e). None of these leases were producing oil or gas.

United States Department of the Interior, Fish and Wildlife Service (USFWS)

The USFWS is both a land management and a regulatory agency. It is responsible for administration of the National Wildlife Refuge System, which has several units in Idaho. In general, on national wildlife refuges outside Alaska, oil and gas exploration and development are not compatible uses with the purposes for which the refuges were established, and therefore not allowed. However, split estates—where mineral rights are privately owned—exist on some refuges in the U.S., and in those cases, oil and gas exploration and development are done in accordance with the agency's *Service Manual* (USFWS 2012a) and *Management of Oil and Gas Activities on National Wildlife Refuges Handbook* (USFWS 2012b).

The USFWS has a regulatory responsibility for administration of the Endangered Species Act (ESA; 16 USC § 1531 et seq.). When a species is listed as threatened or endangered, populations and habitats are protected by the ESA. When populations or habitats occur on federal land, the needs of the species take precedence over other activities, and the land management agency is required to cooperate with the USFWS to obtain approval of its planned actions to ensure they do not cause "jeopardy" to the species or adversely modify habitats. The USFWS is required to develop a recovery plan detailing actions that need to be taken to meet the quantitative recovery goals it must establish. The USFWS is responsible for monitoring threatened and endangered species populations, including after recovery goals have been met and the species has been "delisted" or removed from the threatened or endangered list (see PAG Report No. 25, McClure et al. 2005).

The ESA issue of most concern related to oil and gas development throughout the Interior West, including Idaho, is management of greater sage-grouse populations, which are being considered for ESA listing. Oil and gas development activities can negatively affect sage-grouse habitats (USFWS 2013). Experience in Wyoming, where oil and gas development is a major threat, shows that careful planning of development activities can be accomplished along with sage-grouse conservation.

United States Department of Agriculture, Forest Service (USFS)

The USFS is responsible for approximately 20.4 million surface acres of National Forest System lands in Idaho. As a federal agency, the USFS cooperates with the BLM to administer oil and gas development activities on USFS lands. Oil and gas development activities on USFS lands must follow agency land-use planning mandates under the National Forest Management Act (NFMA; 16 USC § 1600 et seq.) and its implementing regulations (36 CFR § 219.1 et seq.), as well as National Environmental Policy Act (NEPA; 42 USC § 4321 et seq.) procedures. The USFS and the BLM have cooperatively developed *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*, commonly referred to as "The Gold Book" (BLM and USFS 2007), to assist oil and gas operators in complying with regulations.

Each planning unit of the National Forest System develops a land and resource management plan (LRMP) to meet NFMA requirements. With the participation of the BLM, the USFS planning unit must identify which lands are available for oil and gas leasing. An oil and gas environmental impact statement (EIS) must be prepared in accordance with NEPA. After identifying which National Forest System lands are available for leasing, the oil and gas industry can submit expressions of interest in leasing to the BLM. The BLM forwards the expressions of interest to the USFS for NEPA review. The USFS makes recommendations to the BLM about which lands to include in competitive oil and gas lease sales. The BLM holds a competitive lease sale and awards leases to the highest bidder, with any stipulations developed by the USFS attached. Before exploration or development can proceed, the lessee must submit to the USFS an exploration or development proposal or permit to drill application, including a surface plan of operations. The USFS, with cooperation of the BLM, must conduct site-specific NEPA analysis about the development activities. Once the USFS recommends to the BLM that the surface operations plan and drilling permit application are acceptable, the BLM can issue the permit to drill, and on-site exploration or drilling activities can begin. The USFS inspectors ensure that all surface plan operations requirements are being met. The BLM inspectors ensure that all drilling and well operations requirements are being met. The USFS is responsible for inspecting site reclamation, but final approval of site abandonment is with the BLM.

Appendix B. How does the structure and membership of the Idaho Oil and Gas Conservation Commission compare to those of other states in the region?

At the time this question was posed, the Idaho Oil and Gas Conservation Commission (Idaho OGCC) consisted of the top five elected officials in the state—the Governor, Secretary of State, Attorney General, State Controller, and Superintendent of Public Instruction—the same members as the Idaho State Board of Land Commissioners (Land Board). Subsequently, the 2013 session of the Idaho Legislature passed S1049 which changed the composition of the Idaho OGCC, as described in **Chapter 4**, **Appendix A**, and below.

The new composition and general duties of the Idaho OGCC are described first, then comparable information is presented for similar institutions in other states in the region: Montana, Nevada, Oregon, Utah, Washington, and Wyoming. Like Idaho, Oregon and Washington have a scarcity of oil and gas resources compared with the other states in the region.

Idaho

As of July 1, 2013, the Idaho Oil and Gas Conservation Commission (Idaho OGCC) is comprised of five members appointed by the governor with the advice and consent of the senate. One member is to possess knowledge in matters of oil and gas, another in geological matters, and a third in water matters. The fourth and fifth members are landowners, one who owns mineral and surface rights in a county with oil and gas, and the other who does not own mineral rights. The term of each member is four years, except for three members of the first set of appointees whose terms are shorter so that in future years at least one new member is appointed each year. The Director of the Idaho Department of Lands (IDL) is secretary to the Idaho OGCC, unless the commission appoints someone else to perform those duties. Members of the Idaho OGCC can be identified on the commission's website (see IOGCC 2013).

The Idaho OGCC is responsible for regulating the exploration, drilling and production of oil and gas resources on private, state and federal land in Idaho. The efficient recovery of oil and gas, protection of correlative rights, and protection of fresh water supplies are duties of the commission as described in state law (Idaho Code § 47-317). (For more detail, see **Chapter 4** and **Appendix A**.)

Montana

The Montana Board of Oil and Gas Conservation (MBOGC) consists of seven members, three of whom are from the oil and gas industry and have at least three years of experience in the production of oil and gas (Montana Code § 2-15-3303). Two of the board members must be landowners residing in oil- or gas-producing counties of the state but not actively associated with the oil and gas industry. One of the two landowners must be someone who owns the mineral and surface rights and the other must be someone who owns surface but not mineral rights. One of the seven members must be an attorney.

All seven Board members are appointed to four-year terms by the governor and are subject to confirmation by the Montana senate. Four members are appointed when the governor takes office; the others, two years later. The governor selects the presiding officer of the Board.

The Board's regulatory actions serve three primary purposes: (1) to prevent waste of oil and gas resources, (2) to conserve oil and gas by encouraging maximum efficient recovery of the resource, and (3) to protect the correlative rights of the mineral owners, i.e., the right of each owner to recover its fair share of the oil and gas underlying its lands. The board also seeks to prevent oil and gas operations from harming nearby land or underground resources. It accomplishes these goals by establishing spacing units, issuing drilling permits, administering bonds (required to guarantee the eventual proper plugging of wells and restoration of the surface), classifying wells, and adopting rules (Montana Code § 82-11-111).

The MBOGC also repairs old, abandoned, problem wells. The Board also maintains a library of well cutting samples and core samples. Since 1993, the Board has performed the certification required for companies to receive tax incentives available for horizontal wells and enhanced recovery projects. The MBOGC has primary regulatory jurisdiction over the injection or disposal wells.

Nevada

The Commission on Mineral Resources oversees mineral exploration and development in Nevada, including oil- and gas-related activities (Nevada Revised Statutes § 513 et seq.). The Commission consists of seven members appointed by the governor for four-year terms. Commission members include two people familiar with large-scale mining, one person familiar with production of oil and gas, one person familiar with exploration for and development of minerals, one person familiar with situations unique to small-scale mining and prospecting, one person familiar with the development of geothermal resources, and one member to represent the general public.

The Division of Minerals is the administrative arm of the Commission on Mineral Resources. It encourages and assists in the exploration for and production of oil and gas, and administers Nevada's statutes and administrative regulations related to oil and gas. Nevada also has a Mining Oversight and Accountability Commission that provides oversight of compliance with Nevada laws for the activities of the Commission on Mineral Resources and the Division of Minerals (Nevada Revised Statutes § 514A et seq.).

Oregon

Oregon currently has only one producing gas field, in Columbia County, and does not produce oil. The Oregon Department of Geology and Mineral Industries administers oil and gas development policies for the state (Oregon Revised Statutes § 520). The Department is governed by a board consisting of five citizens appointed by the governor and confirmed by the senate. The board sets policy and oversees general operations for the department. Every six years the board develops a strategic plan to help guide the department's mission and objectives.

Utah

The Utah Board of Oil, Gas and Mining is the policy-making body for the Division of Oil, Gas and Mining (Utah Code § 40-6). The Board consists of seven members appointed by the governor, with the advice and consent of the senate. No more than four members may be from the same political party, and the members must have the following qualifications: two members knowledgeable in mining matters; two members knowledgeable in oil and gas matters; one member knowledgeable in ecological and environmental matters; one member who is a private land owner, owns a mineral or royalty interest, and is knowledgeable in those interests; and one member who is knowledgeable in geological matters.

Washington

Washington has very little oil and gas production. The Washington Department of Natural Resources (WDNR), through the Division of Geology and Earth Resources, regulates activities under the Oil and Gas Conservation Act and Department of Natural Resource rules (Revised Code of Washington § 78.52). In 1994, the Legislature dissolved the Oil and Gas Conservation Committee and assigned its regulatory responsibilities to the WDNR. In the event of a discovery, the WDNR would also regulate production to assure equitable distribution of the proceeds.

Wyoming

In Wyoming, the five-member Oil and Gas Conservation Commission consists of the governor, the director of the office of state lands and investments, the state geologist, and two members from the public at large who are appointed by the governor, with the consent of the state senate. The governor is chairperson of the Commission. The two Commission members appointed by the governor must be citizens and residents of Wyoming and qualified to serve the oil and gas industry of the state in some capacity. The term of the governor-appointed members is two years, with one member initially appointed for one year at the beginning of a governor's term. The governor may remove any member he or she appoints. The duties of the commission (Wyoming Statutes, Title 20, Chapter 5) are similar to those of the Montana Board of Oil and Gas Conservation.

Appendix C. How does Idaho's oil and gas regulatory environment compare with other states in the region?

Information on the structure of Idaho's regulatory environment was presented in **Chapter 4**. As in Idaho, all other states in the region have departments dealing with environmental quality, natural resources, fish and game, water use rights, water quality protection, and mining regulation. Agencies responsible for such activities play roles in the regulatory environment for oil and gas resource exploration and development. Repeating the details of each state's regulations for every aspect of oil and gas development is beyond the scope of this report. Instead, this chapter provides Worldwide Web links to rules and regulations for the other states in the region, in alphabetical order: **Montana**, **Nevada**, **Oregon**, **Utah**, **Washington**, and **Wyoming**. A link to a compilation of **Federal Statutes and Regulations** is also provided. The **Interstate Oil and Gas Compact Commission**, which is a multi-state organization that assists member states with creating regulatory environments that promote conservation and efficient recovery of oil and gas resources, is also profiled.

Our analysis concludes that all states are quite similar in their regulations of oil and gas development, with only a few differences. One such exception is that two states in the region—Montana and Washington—have environmental policy acts designed along the lines of the National Environmental Policy Act of 1969 (NEPA). NEPA and NEPA-like state statutes require agencies to take a detailed look at potential impacts of planned projects involving major actions and document their findings in either a less-detailed environmental assessment (EA) or a more-detailed environmental impact statement (EIS). Such a policy for the state of Idaho would certainly add additional costs of information reporting to projects on lands in the state, and given others laws and regulations to protect environmental quality, the benefits may not outweigh the costs.

Montana

Rule Chapter 36.22 — Oil and Gas Conservation.
http://www.mtrules.org/gateway/ChapterHome.asp?Chapter=36.22

Montana Code Annotated 2011, Title 82 – Minerals, Oil and Gas.
http://data.opi.mt.gov/bills/mca_toc/82.htm

Montana Constitution provisions pertaining to the environment.
Article II, Section 3 — "a clean and healthy environment";
Article IX, Section 1 — Protection and Improvement;
Article IX, Section 2 — Reclamation; and
Article IX, Section 4 — Cultural Resources.

Montana Environmental Policy Act (MEPA).
http://leg.mt.gov/css/Services%20Division/Lepo/default.asp

Oil and gas drilling permitting process on state and private lands (see **Figure C-1**).
http://leg.mt.gov/content/Publications/Environmental/permit-primers/oil-drilling-water-wells.pdf

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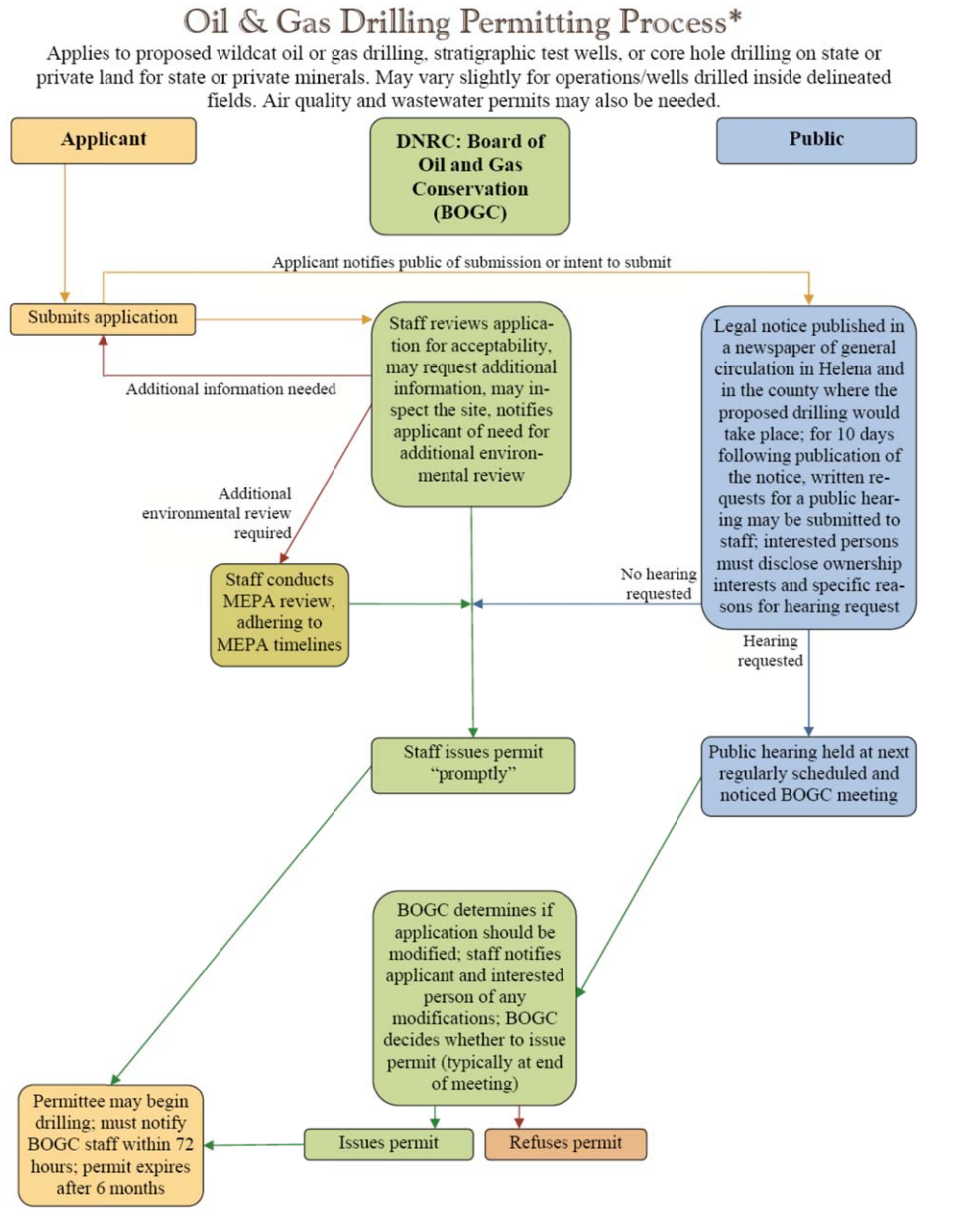

*Published by the Montana Legislative Environmental Quality Council in 2012 as a reference. For legal purposes, always refer to statute and rule.

Figure C-1. Montana oil and gas drilling permitting process.
(Nowakowski & Stockwell 2012)

Nevada

Nevada Revised Statutes Annotated, Title 46 – Mines and Minerals.

Chapter 513. Commission on Mineral Resources.
http://leg.state.nv.us/NRS/NRS-513.html

Chapter 514A. Mining Oversight and Accountability Commission.
http://leg.state.nv.us/NRS/NRS-514A.html

Chapter 522. Oil and Gas.
http://leg.state.nv.us/NRS/NRS-522.html

Nevada Administrative Code

Chapter 522. Oil and Gas.
http://leg.state.nv.us/NAC/NAC-522.html

Oregon

Mineral Land Regulation & Reclamation.
http://www.oregongeology.org/mlrr/oilgas.htm

OAS Chapter 520 (Conservation of Gas & Oil).
http://www.leg.state.or.us/ors/520.html

OAR Division 15 (Information and Seismic Test Holes).
http://arcweb.sos.state.or.us/pages/rules/oars_600/oar_632/632_015.html

OAR Division 10 (Oil and Gas Rules).
http://arcweb.sos.state.or.us/pages/rules/oars_600/oar_632/632_010.html

Utah

Legislative Title 40 – Mines and Mining, Chapter 6 – Board and Division of Oil, Gas and Mining.
http://le.utah.gov/UtahCode/section.jsp?code=40-6

Legislative Title 40 – Mines and Mining, Chapter 7 – Oil and Gas Compact

Bonding of Disposal Facilities
http://www.rules.utah.gov/publicat/code/r649/r649-009.htm#T9

Bonding of Wells
http://www.rules.utah.gov/publicat/code/r649/r649-003.htm#T1

Quick References on Bonding (and other "Quick Reference" links on left side of webpage)
http://oilgas.ogm.utah.gov/Quick_Refs/qref_bonds.htm

Washington

Oil and Gas Conservation Act and the Department of Natural Resource rules
(Chapter 78.52 RCW and Chapter 344-12 WAC).

Underground natural gas storage (80.40 RCW).
http://www.dnr.wa.gov/BusinessPermits/Topics/MiningEnergyResourceRegulation/Pages/energy_regulation.aspx

Washington State Environmental Policy Act (SEPA).
http://www.ecy.wa.gov/programs/sea/sepa/e-review.html

Wyoming

Legislative Title 30 – Mines and Minerals, Chapter 5 – Oil and Gas.
http://legisweb.state.wy.us/statutes/statutes.aspx?file=titles/Title30/T30CH5.htm

Federal Statutes and Regulations

Compilation of federal oil and gas statutes and regulations.
http://www.oilandgasbmps.org/laws/federal_law.php

Interstate Oil and Gas Compact Commission

All states with oil and gas production belong to the Interstate Oil and Gas Compact Commission (Interstate OGCC) headquartered in Oklahoma City, Oklahoma (http://www.iogcc.state.ok.us/). Idaho is an Associate State of the Interstate OGCC. There are numerous international affiliates as well as federal agencies with affiliate status. The Interstate OGCC assists member states with developing sound regulatory practices that efficiently maximize oil and gas resources while protecting health, safety, and the environment. The Commission focuses on current issues affecting oil and gas development in the states.

An example of the Interstate OGCC's work is FracFocus.org (http://fracfocus.org/), which is managed jointly with the Ground Water Protection Council. The site was created to provide the public with access to reports of chemicals used for hydraulic fracturing in their areas. The primary purpose of the site is to provide factual information concerning hydraulic fracturing and groundwater protection. The site is not intended to replace or supplant state governmental information systems, but it is being used by 10 states (but not Idaho) as a means of official state chemical disclosure for hydraulic fracturing.

Appendix D. Annotated Bibliography

(Note: all Internet links were current in December 2013)

Herein we provide references to more in-depth knowledge of policies and issues affecting oil and gas exploration and development, each with either a short paragraph describing the contents in the article or report, or short quotations from it. We have deleted cited references to other works unless they are also in this appendix. Several **General Reference Works** on oil and gas development policy are listed, followed by reference works on **Idaho Oil & Gas Resources**. The bibliography has two sections focusing on the potential impacts of oil and gas development on **Water Resources**, especially hydraulic fracturing or "fracking" to free natural gas deposits, and on **Wildlife Resources**, especially sage-grouse and mule deer.

General Reference Works

Bibikos, G.A., and J.C. King. 2008. A primer on oil and gas law in the Marcellus Shale states. *Texas Journal of Oil, Gas & Energy Law* 4:155-194.

In this article, two lawyers discuss oil and gas law in the Marcellus Shale states of Pennsylvania and New York, which have seen one of the largest booms in natural gas reserve production in the 21st century. Discussed are the general rules governing the relationship between lessors and lessees, performance of implied duties in each of the Marcellus Shale states, and how royalties are calculated in each state.

Economides, M.J., and D. Wood. 2009. The state of natural gas. *Journal of Natural Gas Science and Engineering* 1(1-2):1-13.

As global energy demand rises, natural gas now plays an important strategic role in energy supply. It is more difficult to transport and store gas than oil and consequently it lagged behind that commodity for a considerable period. Over the last couple of decades this has changed and gas markets continue to expand more rapidly than those of other fossil fuels. Natural gas is the cleanest and most hydrogen-rich of all the hydrocarbon energy sources and it has high energy conversion efficiencies for power generation. Of more significance is that gas resources discovered but as yet unexploited remain plentiful. The sector is poised for considerable growth over the next two decades and some believe that it may even overtake oil as the prime fuel between 2020 and 2030. This paper examines the limitations and potential sources of natural gas, and technological and commercial challenges in increased natural gas consumption.

Hilyard, J.F. 2012. *The oil and gas industry: A nontechnical guide.* Pennwell Corporation, Tulsa, OK. 332 p.

This book provides nontechnical information on: the equipment and processes used in exploring new resources; evaluating promising formations; drilling wells; managing oil and gas production; converting oil and gas into products; and transporting oil and gas.

Nowakowski, S., and H. Stockwell. 2012. *Permitting in Montana: Department of Natural Resource Conservation – Groundwater and oil & gas drilling.* Legislative Environmental Policy Office, Montana Environmental Quality Council (MEQC), Helena, Montana. 5p. http://leg.mt.gov/content/Publications/Environmental/permit-primers/oil-drilling-water-wells.pdf

This brochure provides brief text and diagrams that make for a simple, visual guide outlining the responsibilities of the applicant, the regulatory agency, and the public in permitting processes. The purpose is to assist lawmakers and the public in understanding environmental permitting processes.

Idaho Oil and Gas Resources

Bond, J.G., J.D. Kauffman, B.C. Rember, and D.J. Shiveler. 2011. Weiser Basin evaluation. Idaho Geological Survey Technical Report 11-1, University of Idaho, Moscow. 36p. + appendices. http://www.idahogeology.org/PDF/Technical_Reports_(T)/TR-11-1.pdf

The Weiser River Basin encompasses approximately 3,000 square miles of west-central Idaho. Its uplifted margins are bordered by the Salmon River Mountains in the east, the Seven Devils Mountains in the north and mountains paralleling the Snake Canyon in the west. The Weiser Basin is truncated in the south by the down-dropped Snake River plain. Previous petroleum exploration and drilling has discovered no commercial accumulations of oil or gas in the Weiser Basin or in nearby portions of the western Snake Plain.

IGS (Idaho Geological Survey). 2013. Oil and gas webpage. http://www.idahogeology.org/

The Idaho Geological Survey is based at the University of Idaho in Moscow. The IGS maintains files on more than 150 oil and gas wells in the state; their locations are presented in **Figure D-1**. Although the map's fine details do not reproduce well in this report's small format, the concentration of wells in southwest and southeast Idaho should be evident.

McLeod, J.D. 1993. The search for oil and gas in Idaho. Idaho Geological Survey GeoNote 21, University of Idaho, Moscow, Idaho. 2p. http://www.idahogeology.org/PDF/GeoNotes_(G)/geonote_21.pdf

This short article describes the history of oil and gas exploration in Idaho and has an easy-to-read description of the areas in Idaho that are ripe for natural gas production, including geological explanations why.

Water Resources

Arthur, J.D., B. Bohm, B.J. Coughlin, and M. Layne. 2009. Evaluating the environmental implications of hydraulic fracturing in shale gas reservoirs. Paper SPE 121038, presented at the 2009 Society of Petroleum Engineers, America's Environmental and Safety Conference, March 23-25, San Antonio, Texas. http://all-llc.com/publicdownloads/ArthurHydrFracPaperFINAL.pdf

Horizontal drilling in conjunction with hydraulic fracturing has made development of the shale gas resource an economically viable venture. Continued development of unconventional shale gas resources should help to decrease the U.S. dependence of foreign imports of fossil fuels. This paper is a primer on the practice of hydraulic fracturing in the U.S. (see also GWPC & ALL Consulting, below), and provides examples from several geographic areas. Authors are consulting engineers and conclude that shale gas development poses many challenges, including water availability and water disposal. As more wells are drilled and development increases, it is anticipated that companies will continue designing leading edge technological solutions to water availability and disposal including expanding the volume of water that is re-used.

Arthur, J.D., B. Bohm, and M. Layne. 2009. Considerations for development of Marcellus Shale gas. *World Oil* (July): 65-68. http://all-llc.com/publicdownloads/WO0709Arthur.pdf

The potential for impacts to surface water and groundwater quality from Marcellus Shale development in the Appalachians is expected to be minimal because of the regulatory requirements from state oil and gas agencies involved and the practices operators are implementing to ensure that fluids are contained.

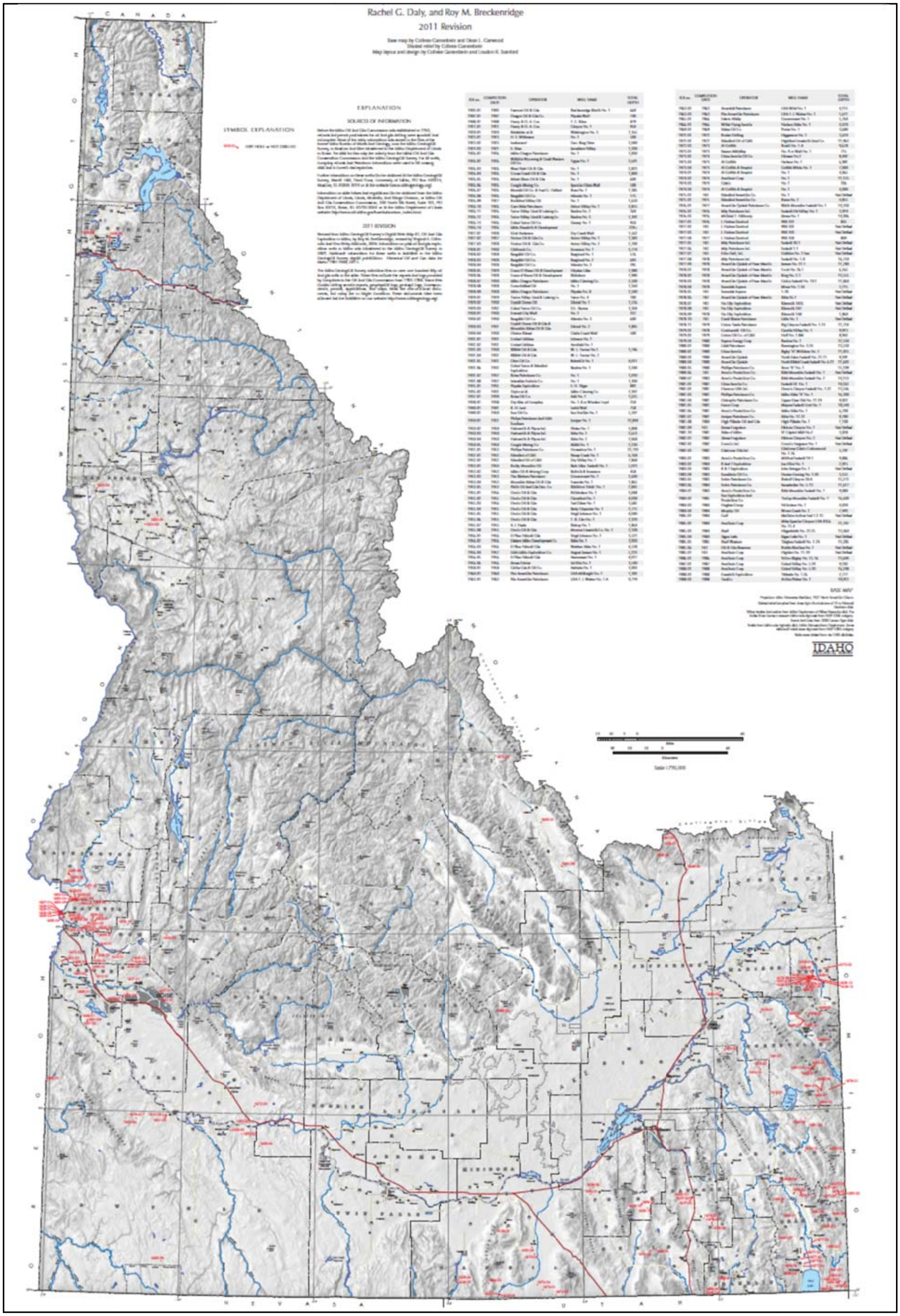

Figure D-1. Oil and gas exploration wells in Idaho (source: IGS, revised 2011).

Beck, R.E. 2010. Current water issues in oil and gas development and production: will water control what energy we have? *Washburn Law Journal* 49:423-455.

Natural gas production, especially via hydraulic fracturing, uses large amounts of water that cannot be readily used again, thus removing large quantities of water from the water cycle. This paper reviews these concerns, gives an historical overview of the relationship between mineral production and water, and raises water law questions about acquiring water resources for oil and gas production.

Colburn, T., C. Kwiatkowski, K. Schultz, and M. Bachran. 2011. Natural gas operations from a public health perspective. *Human and Ecological Risk Assessment* 17(5):1039-1056.

This article discusses the chemicals used during natural gas operations. Of the 632 chemicals considered by the authors, more than 75% of them could affect the skin, eyes, and other sensory organs, and the respiratory and gastrointestinal systems. Slightly less than half could affect the brain and nervous system, immune and cardiovascular systems, and the kidneys; 37% of the chemicals could affect the endocrine system; and 25% could cause cancer and mutations. These findings imply that many of the chemicals used in hydraulic fracturing may have long-term health effects that are not immediately expressed, such as cancers. The article also discusses the risks of waste evaporation pit residuals which contain numerous chemicals considered dangerous. Highlighted in the authors' conclusions is a discussion on the difficulty of developing effective water quality monitoring programs. The authors provide recommendations on public health protection.

Gregory, K.B., R.D. Vidic, and D.A. Dzombak. 2011. Water management challenges associated with the production of shale gas by hydraulic fracturing. *Elements* 7:181-186.

Water management has emerged as a critical issue in the development of on-shore gas reserves where hydraulic fracturing is used to free gas from the geologic beds it resides in. Following hydraulic fracturing, large volumes of water containing high concentrations of total dissolved solids (TDS) return to the surface. The TDS concentration in the wastewater can reach five times that of seawater. Economical production of these gas resources will require management of wastewater to ensure protection of ground and surface water resources. With global and local concerns over access to fresh water, natural gas development needs to be environmentally stable. This paper discusses some of the challenges to keeping water clean, and offers some suggestions to water managers in areas where hydraulic fracturing is used.

Ground Water Protection Council; ALL Consulting (GWPC & ALL Consulting). 2009. Modern shale gas development in the United States: A primer. U.S. Department of Energy Office of Fossil Energy and National Energy Technology Laboratory. http://all-llc.com/publicdownloads/ShaleGasPrimer2009.pdf

This primer was commissioned by the U.S. Department of Energy through the Ground Water Protection Council (GWPC). It is an effort to provide sound technical information on and additional insight into the relationship between today's fastest growing, and sometimes controversial, natural gas resource development activity, and environmental protection, especially water resource management. Hydraulic fracturing has been a key technology for making shale gas an affordable addition to the nation's energy supply, and the technology has proven to be a safe and effective stimulation technique. Ground water is protected during the shale gas fracturing process by a combination of the casing and cement that is installed when the well is drilled and the thousands of feet of rock between the fracture zone and any fresh or treatable aquifers. Taken together, state and federal requirements, along with the technologies and practices developed by industry, serve to protect human health and to help reduce environmental impacts from shale gas operations.

Osborn, S.G., A. Vengosh, N.R. Warner, and R.B. Jackson. 2001. Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing. *Proceedings of the National Academy of Sciences* 108(20):8172-8176.

Directional drilling and hydraulic fracturing technologies are dramatically increasing natural gas extraction. This article documents systematic evidence for methane contamination of drinking water associated with hydraulic fracturing in aquifers overlaying the Marcellus and Utica shale formations of northeastern Pennsylvania and upstate New York. The conclusions show that in active gas-extraction areas, average and maximum methane concentrations in drinking water wells increased with proximity to the nearest gas wells. There was no evidence found for contamination of drinking water samples with deep saline brines or hydraulic fracturing fluid.

United States Environmental Protection Agency (EPA). 2012b. Study of the potential impacts of hydraulic fracturing on drinking water resources: Progress report, December 2012, 278p. Report is available from the EPA webpage on "Natural Gas Extraction - Hydraulic Fracturing" at http://www2.epa.gov/hydraulicfracturing

In 2011, the EPA began research under its "Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources." The purpose of the study is to assess the potential impacts of hydraulic fracturing on drinking water resources, if any, and to identify the driving factors that may affect the severity and frequency of such impacts. Scientists are focusing primarily on hydraulic fracturing of shale formations to extract natural gas, with some study of other oil-and gas-producing formations, including tight sands, and coal beds. This report describes 18 research projects underway to answer five research questions and presents the progress made as of September 2012 for each of the projects. Information presented as part of ***this report cannot be used to draw conclusions about potential impacts to drinking water resources from hydraulic fracturing***. (Emphasis added.)

Wiseman, H. 2009. Untested waters: The rise of hydraulic fracturing in oil and gas production and the need to revisit regulation. *Fordham Environmental Law Review* 20: 115-171.

A prevalent method of removing natural gas from rock deposits is hydraulic fracturing, which is the pumping of fluids into a wellbore. This article describes the process of hydraulic fracturing, existing studies of the environmental effects of hydraulic fracturing, and the laws and regulations that apply to the practice. The author argues that there is no direct federal regulation of the hydraulic fracturing process, that court guidance in this area is limited, and that state regulations differ substantially. Although other general regulations apply to the practice, the author argues that in light of the dearth of regulation specific to hydraulic fracturing in some areas, more study of the potential environmental and human health effects of hydraulic fracturing is needed in order to determine whether current regulation is sufficient. [See EPA 2012b above.]

Wildlife Resources

The two species of greatest concern during oil and gas development activities throughout the western states are mule deer and greater sage-grouse. Sections for each species follow the review of a more general book immediately below. In short, conservation of sage-grouse habitat will benefit mule deer (Smith 2011a, 2011b). Because the sage-grouse is a landscape-scale species, large-scale conservation planning is needed, but site-specific information is necessary to develop and test effective best management practices as creative solutions (see Naugle et al. 2011). Several studies (see Harju et al. 2010, Ramey et al. 2011) have demonstrated that energy development and viable sage-grouse populations can successfully coexist when reasonable mitigation measures are utilized during exploration, development and producing activities. The State of Idaho has developed best management practices for energy development in sage-grouse habitat (see Idaho Governor's Office 2012).

Naugle, D.E. (ed.). 2011. *Energy development and wildlife conservation in western North America*. Island Press, Washington, DC.

This book is an edited volume of 23 chapters. According to the publisher, it "offers a road map for securing our energy future while safeguarding our wildlife heritage. Contributors show how science can help craft solutions to conflicts between wildlife and energy development by delineating core areas, identifying landscapes that support viable populations, and forecasting future development scenarios to aid in conservation design. The book frames the issue and introduces readers to major types of extraction, quantifies the pace and extent of current and future energy development, provides an ecological foundation for understanding cumulative impacts on wildlife species, synthesizes information on the biological response of wildlife to development, discusses energy infrastructure as a conduit for the spread of invasive species, and compares impacts of alternative energy to those of conventional development. The final section calls for a shift away from site-level management that has failed to mitigate cumulative impacts on wildlife populations toward broad-scale planning and implementation of conservation in priority landscapes. The book concludes by identifying ways that decision makers can remove roadblocks to conservation, and provides a blueprint for implementing conservation plans."

According to a reviewer, "The articles have a strong technical foundation, but they're well written and understandable for anyone with an interest in the subject. Chapters on sage-grouse, hoofed mammals, songbirds, and invasive plants offer a wealth of detail on the interaction between traditional energy development and the western environment; a chapter on wind energy and biofuels details the impacts 'green' energy can have on wildlife and wild places. … The last third of the book considers the approaches The Nature Conservancy has taken to minimize damage either at the site of the development or in similar habitats nearby."

Riley, T.Z., E.M. Bayne, B.C. Dale, D.E. Naugle, J.A. Rodgers, and S.C. Torbit. 2012. Impacts of crude oil and natural gas developments on wildlife and wildlife habitat in the Rocky Mountain region. Technical Review 12-02, The Wildlife Society, Bethesda, MD. http://wildlife.org/documents/technical-reviews/docs/Oil%20and%20Gas%20Technical%20Review_2012.pdf

"Crude oil and natural gas developments are widespread throughout North America and continue to expand due to the reliance of our society on these resources. As development continues, it is important to identify the impacts of this industry on various species of wildlife, and recognize that these effects likely are cumulative. This report summarizes information on the impacts of the oil and gas industry on wildlife in the Rocky Mountain region of North America, and identifies the current extent of developments, processes used to develop oil and gas resources, direct and indirect impacts to habitats of multiple species, cumulative impacts, and mitigation."

Mule Deer (*Odocoileus hemionus*)

Idaho Department of Fish and Game (IDFG). 2010. Mule Deer Initiative action plan 2010 Update. Boise, Idaho, 33p. https://fishandgame.idaho.gov/content/system/files/groups/2013/3/21/Mule%20Deer%20Initiative%20Action%20Plan%202010.pdf

The mule deer is an icon of the state of Idaho and the West. Mule deer populations over their entire range have suffered declining populations over the past two decades. Idaho's Mule Deer Initiative (MDI) was developed to begin to help mule deer populations recover, find ways to enhance mule deer habitat, increase public knowledge of mule deer biology and management and to eventually restore and maintain healthy mule deer populations in Idaho. Mule deer are another species that would potentially be impacted by oil and gas development in southeastern Idaho. As a keystone species, mule deer habitat needs to be a key concern in any comprehensive oil and gas policy laid out by the state.

This action plan is the guiding document to focus IDFG efforts to achieve the goals of the Mule Deer Initiative.

Riley, T.Z., E.M. Bayne, B.C. Dale, D.E. Naugle, J.A. Rodgers, and S.C. Torbit. 2012. Impacts of crude oil and natural gas developments on wildlife and wildlife habitat in the Rocky Mountain region. Technical Review 12-02, The Wildlife Society, Bethesda, MD.

"... some ungulate species have recently experienced significant population declines. Research conducted throughout the West identified a reduction in the quality and quantity of habitat as a likely reason for observed declines in mule deer populations, whereas the role of predation and other factors had little or no noticeable impact. Mule deer declines are magnified further by threats to habitat that stem from human development, particularly unregulated energy resource extraction on quality habitats, which also might interfere with doe and fawn habitat fidelity. ... Big game species have demonstrated varying degrees of avoidance around areas of energy development. The collective area of disturbance might encompass just 5-10% of the land; however, the influence of each facility (e.g., well pad, road, overhead power line) extends to a larger surrounding area, where the proximity of disturbance causes stress and avoidance by wildlife. For mule deer, alert and flight reactions have been detected up to 0.3 miles from the source of disturbance, whereas habitat avoidance responses might extend to distances of 2.5-4.3 miles. ... As densities of well pads, roads, and facilities increase, habitats within and near well fields become progressively less attractive until most animals no longer use them. ... The cumulative effects of development on habitat probably represent the greatest threat to ungulate populations. The magnitude of effects (i.e., biological significance) is directly related to the intensity of the specific development."

Sawyer, H., F. Lindzey, D. McWhirter, and K. Andrews. 2002. Potential effects of oil and gas development on mule deer and pronghorn populations in western Wyoming. *Transactions of the North American Wildlife and Natural Resources Conference* 67:350-365.

While urban expansion, habitat loss, disease and changes in vegetation contribute to management concerns, extensive energy development is thought to pose the most serious threat to mule deer and pronghorn populations. Determining the impacts of energy development on wildlife populations requires long-term manipulative studies, where pre-development data on survival and reproduction are available. Simply documenting a behavioral response (i.e., avoidance, acclimation, dispersal, etc.) to a disturbance does not add to our knowledge of the impact, since it cannot be linked to the survival or reproductive success of the species involved. Oil and gas development in mule deer habitat will result in additional roads, pipelines, habitat loss, well pads, fences and increased human disturbance on winter ranges used by mule deer. How, when and to what degree mule deer populations will be impacted is unknown. However, reduction in effective winter range size, potentially caused by extensive natural gas development may increase deer density on remaining winter ranges, reducing forage quality, fawn survival and overwinter carrying capacity.

Smith, D. 2011a. Sage-grouse and mule deer: Landscape-scale habitat conservation (part 1 of 2-part series). *Mule Deer Foundation Magazine* 34:21-22, 24, 26-27. http://www.cas.umt.edu/facultydatabase/FILES_Faculty/1136/MDF%20partners%20with%20SGI.pdf

This article focuses on the voluntary landscape-scale conservation underway for sage-grouse in response to a potential Endangered Species Act listing. If the current level of activity is maintained, the sage-grouse conservation movement could be very important for mule deer habitat conservation. The article highlights the Sage-Grouse Initiative of the U.S. Dept. of Agriculture's Natural Resources Conservation Service (NRCS), illustrated with case examples in Oregon.

Smith, D. 2011b. Energy development, mule deer conservation, and sage-grouse core areas (part 2 of 2-part series). *Mule Deer Foundation Magazine* 35:12-14, 16-17. http://www.cas.umt.edu/facultydatabase/FILES_Faculty/1136/Mule%20Deer%20&%20SGI%20Part2.pdf

This article focuses on the relationship between energy development and sage-grouse populations, and how the use of sage-grouse population core areas could reduce future impacts to mule deer. It features the State of Wyoming's approach.

Greater Sage-Grouse (*Centrocercus urophasianus*)

Beck, J.L., C.W. LeBeau, A.M. Mason, and K.R. Simpson. 2010. Reducing impacts of energy development to sagebrush wildlife habitats in Wyoming. Bulletin B-1209, Cooperative Extension Service, University of Wyoming, Laramie, WY. 12 p. http://www.wyomingextension.org/agpubs/pubs/B1209.pdf

"Greater sage-grouse (*Centrocercus urophasianus*) cannot tolerate increased human activities (e.g., Doherty et al., 2008). In general, energy development projects with small footprints and minimal human disturbances are more conducive for native wildlife and the habitats they rely upon. Principal considerations for wildlife habitats in areas undergoing energy development are to: (1) limit the amount of physical disturbance to the landscape to conserve wildlife habitat and promote future habitat restoration (i.e., reduce direct habitat loss), and (2) minimize factors during development and production phases such as roads, traffic, noise, dust, and visual obstructions that create conditions that lead to wildlife avoidance of otherwise suitable habitats (i.e., reduce indirect habitat loss)."

Braun, C.E., O.O. Oedekoven, and C.L. Aldridge. 2002. Oil and gas development in western North America: Effects on sagebrush steppe avifauna with particular emphasis on sage-grouse. *Transactions of the North American Wildlife and Natural Resources Conference* 67:337-349.

Because of the interest in rapid expansion and development of oil and gas reserves, this paper examines what is known about the effects of energy exploitation on bird species (including sage-grouse) that are dependent on sagebrush-steppe ecosystems and what might be logically expected during and after exploration, facilities development, and extraction. Case history examples are provided from Alberta, Colorado, and Wyoming. The authors believe the immediate effects of development are clearly negative because of loss of habitat and disturbances associated with structures, roads, and noise, especially during the breeding season. They hypothesize that numbers of individual birds of each species decrease with initial development, and then increase to some unknown level below that prior to development.

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage-grouse populations and their habitats. *Wildlife Society Bulletin* 28(4):967-985.

The status of sage-grouse populations and habitats has been a concern to sportsmen and biologists for more than 80 years. Despite management and research efforts that date to the 1930s, breeding populations of this species have declined throughout much of its range, including southeastern Idaho, where oil and gas drilling is proposed. If oil and gas development is to be successful in Idaho, it must be accompanied by proper management of land in order to leave sage-grouse habitat as undisturbed as possible, or to mitigate any adverse repercussions from oil and gas exploration. This paper summarizes the current knowledge of the ecology of sage-grouse and, based on this information, provides guidelines to manage sage-grouse populations and their habitat.

"Thus, short-term and long-term habitat loss appears to result from energy development and mining. … Although mining and energy development are common activities throughout the range of sage-grouse, quantitative data on the long-term effects of these activities on sage-grouse are limited. However, some negative impacts have been documented. Thus, these activities should be discouraged in breeding habitats, but when they are unavoidable, restoration efforts should follow procedures outlined in these guidelines. … Adjust timing of energy exploration, development, and construction activity to minimize disturbance of sage-grouse breeding activities. Energy-related facilities should be located >3.2 km from active leks whenever possible. Human activities within view of or <0.5 km from leks should be minimized during the early morning and late evening when birds are near or on leks."

Dzialak, M.R., C.V. Olson, S.M. Harju, S.L. Webb, J.P. Mudd, et al. 2011. Identifying and prioritizing greater sage-grouse nesting and brood-rearing habitat for conservation in human-modified landscapes. *PLoS ONE* 6(10): e26273. doi:10.1371/journal.pone.0026273

"Balancing animal conservation and human use of the landscape is an ongoing scientific and practical challenge throughout the world. We investigated reproductive success in female greater sage-grouse relative to seasonal patterns of resource selection, with the larger goal of developing a spatially-explicit framework for managing human activity and sage-grouse conservation at the landscape level. We integrated field-observation, Global Positioning Systems telemetry, and statistical modeling to quantify the spatial pattern of occurrence and risk during nesting and brood-rearing. We linked occurrence and risk models to provide spatially-explicit indices of habitat-performance relationships. As part of the analysis, we offer novel biological information on resource selection during egg-laying, incubation, and night. The spatial pattern of occurrence during all reproductive phases was driven largely by selection or avoidance of terrain features and vegetation, with little variation explained by anthropogenic features. Specifically, sage-grouse consistently avoided rough terrain, selected for moderate shrub cover at the patch level (within 90 m^2), and selected for mesic habitat in mid and late brood-rearing phases. In contrast, risk of nest and brood failure was structured by proximity to anthropogenic features including natural gas wells and human-created mesic areas, as well as vegetation features such as shrub cover. Risk in this and perhaps other human-modified landscapes is a top-down (i.e., human-mediated) process that would most effectively be minimized by developing a better understanding of specific mechanisms (e.g., predator subsidization) driving observed patterns, and using habitat-performance indices such as those developed herein for spatially-explicit guidance of conservation intervention. Working under the hypothesis that industrial activity structures risk by enhancing predator abundance or effectiveness, we offer specific recommendations for maintaining high-performance habitat and reducing low-performance habitat, particularly relative to the nesting phase, by managing key high-risk anthropogenic features such as industrial infrastructure and water developments."

Doherty, K.E., D.E. Naugle, B.L. Walker, and J.M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. *Journal of Wildlife Management* 72(1):187-195.

Recent energy development has resulted in rapid and large-scale changes to western shrub-steppe ecosystems without a complete understanding of its potential impacts on wildlife populations. Despite increased concern for their populations, little effort has gone into measuring landscape-scale winter habitat selection by greater sage-grouse. This paper presents the results of a study done to model winter habitat use by female greater sage-grouse in the Powder River Basin of Wyoming and Montana. The paper discusses the effects of natural gas development on winter habitat selection. The authors conclude that sage-grouse avoidance of energy development in winter shows that a comprehensive strategy is needed to maintain suitable habitats in all seasons. Identifying and setting aside areas of undeveloped, high-quality habitat within the project area should be top priority.

Harju, S.M., M.R. Dziliak, R.C. Taylor, L.D. Hayden-Wing, and J.B. Winstead. 2010. Thresholds and time lags in effects of energy development on greater sage-grouse populations. *Journal of Wildlife Management* 74(3):437-448; 2010; DOI: 10.2193/2008-289

"Rapid expansion of energy development in some portions of the Intermountain West, USA, has prompted concern regarding impacts to declining greater sage-grouse populations. We used retrospective analyses of public data to explicitly investigate potential thresholds in the relationship between lek attendance by male greater sage-grouse, the presence of oil or gas wells near leks (surface occupancy), and landscape-level density of well pads. We used generalized linear models and generalized estimating equations to analyze data on peak male attendance at 704 leks over 12 years in Wyoming, USA. Within this framework we also tested for time-lag effects between development activity and changes in lek attendance. Our results suggest that, although sage-grouse have persisted in areas undergoing increases in human activity, oil and gas development plans and BLM stipulations must be assessed critically on a local or regional basis and should account for synergistic effects from other sources including agriculture, changes in habitat quality and configuration, the potential for diseases such as West Nile Virus, and for new information on physical thresholds and time lags that was not available when current BLM stipulations were formulated.”

Hess, J.E., and J.L. Beck 2012. Disturbance factors influencing greater sage-grouse lek abandonment in north-central Wyoming. *Journal of Wildlife Management* 76(8):1625-1634; DOI: 10.1002/jwmg.417

“Detecting the disappearance of active leks is the most efficient way to determine large declines in greater sage-grouse populations; thus, understanding factors that influence lek abandonment is critical. We evaluated factors that may have influenced the probability of sage-grouse lek abandonment in the Bighorn Basin (BHB) of north-central Wyoming from 1980 to 2009. Our objective was to examine lek abandonment based on landscape characteristics that explain differences between occupied and unoccupied leks. We evaluated lek abandonment from 144 occupied and 39 unoccupied leks from the Wyoming Game and Fish Department lek database with sufficient data for our 30-year analysis. Our study supports findings from other studies that demonstrate energy development increases lek abandonment.

“Our findings indicate conservation efforts should be focused on minimizing well development and implementing wildfire suppression tactics near active sage-grouse leks. Conservation efforts should be focused on mitigating disturbances associated with energy development, roads, and wildfire to stem the decline of sage-grouse leks. Wildfire suppression and minimizing well construction strategies are needed in areas with larger numbers of sage-grouse leks. The BLM in Nevada has prioritized wildfire suppression around leks and have developed precautionary measures to reduce risks associated with wildfire to sage-grouse including localized habitat maps, suppression tactics, training programs, avoiding leks when creating wildfire suppression facilities, and proper cleaning of field vehicles to prevent spread of noxious weeds into sage-grouse habitat. Although we do not provide specific management recommendations, we do suggest that managers must understand that areas with less anthropogenic development may also affect sage-grouse populations. We thus recommend focusing management concerns on multiple disturbance factors in areas with increasing human development and developing and assessing stipulations and management strategies based on small (<1.0 km) and larger scales (>1.0 km) around leks to avoid lek abandonment.”

Holloran, M.J. 2005. Greater sage-grouse (*Centrocercus urophasianus*) population response to natural gas field development in western Wyoming. Ph.D. dissertation, University of Wyoming, Laramie. 223 p.

Sage-grouse populations have declined dramatically throughout the western United States since the 1960s. Increased gas and oil development during this time has potentially contributed to the declines. This doctoral dissertation investigates impacts of development of natural gas fields on greater sage-grouse breeding behavior, seasonal habitat selection, and population growth in the upper Green River Basin of western Wyoming. Given that the health of sagebrush-dominated ecosystems is paramount to maintaining viable populations of many species of wildlife, the reaction of greater sage-grouse populations to habitat alterations caused by energy development could imply reactions of a wide array of wildlife species. The author addresses concerns that need to be considered when making oil and gas policy in southeast Idaho, which also has a large sage-grouse habitat that will be disturbed if development proceeds.

Idaho Governor's Office. 2012. Federal alternative of Governor C.L. "Butch" Otter for greater sage-grouse management in Idaho: Infrastructure (energy development) best management practices. http://fishandgame.idaho.gov/public/wildlife/SGtaskForce/alternative.pdf

"The best available information indicates that wildfire, invasive species and infrastructure – defined as discrete, large-scale anthropogenic features, including highways, high voltage transmission lines, commercial wind projects, energy development (e.g., oil and gas development, geothermal wells), airports, mines, cell phone towers, landfills, residential and commercial subdivisions, etc. – are the primary threats to sage-grouse in Idaho. The State aided by the valuable contributions of the Task Force developed a suite of regulatory measures to address these primary threats as well as some activities identified by the Service as secondary threats (e.g., recreation, improper livestock grazing and West Nile virus). The State believes that implementation of these measures will provide significant conservation benefits to sage-grouse, other sage-steppe obligate species, and should be sufficient to preclude a listing under the ESA in Idaho. ... Recognizing that maintaining and improving sage-grouse populations within the CHZ is important to the State's overall population objective, the balance between the economic value of future infrastructure projects and conserving the species to prevent an ESA listing clearly tilts in favor of the species within this the management zone.

Infrastructure—Best Management Practices.

1. For proposed actions authorized in the CHZ and IHZ, the following best management practices are applicable:

i. Utilize existing roads, or realignments of existing routes to the extent possible.

ii. Construct new roads to minimum design standards needed for production activities.

iii. To the extent possible, micro-site linear facilities to reduce impacts to sage-grouse habitats.

iv. Locate staging areas outside the CHZ to the extent possible.

v. To the extent possible, co-locate linear facilities within one kilometer of existing linear facilities.

vi. New transmission lines, excluding those lines under (viii), will be deemed co-located and/or permissible if construction occurs between July 1 and March 14 (or between July 1 and November 30 in winter concentration areas) and within one kilometer either side of existing 115-kilovolt (kV) or larger transmission lines to create a corridor no wider than two kilometers.

vii. New transmission lines, excluding those lines under (viii), outside of this two kilometer corridor can only be constructed where it can be demonstrated that the activity will not cause declines in sage-grouse populations or if the activity reduces cumulative impacts and/or avoids other important natural, cultural or societal resources.

viii. Locate essential public services, including but not limited to, distribution lines, domestic water lines and gas lines, at least one kilometer from active sage-grouse leks. If one kilometer avoidance is not possible, construct lines outside of March 15 to June 30.

ix. In addition to the applicable best management practices (i-viii), wind energy development, projects must also comply with the 2012 U.S. Fish and Wildlife Service's Wind Energy Guidelines.

2. For oil and gas leases issued after the effective date of the record of decision, the following best management practices are applicable:

i. Evaluate the affected area in accordance with the process outlined in the State of Wyoming's Executive Order 2011-5.

ii. For development within the CHZ, surface disturbance will be limited to three percent of suitable habitat per an average of 640 acres. Development within the IHZ will be limited to five percent of suitable habitat per an average of 640 acres.

iii. There shall be no surface occupancy ("NSO") within one kilometer of the perimeter of occupied sage-grouse leks; provided this distance is supported by the best available science at the time the development undergoes site-specific environmental analysis.

iv. Activity (production and maintenance activity exempted) will be allowed from July 1 to March 14 outside of the one kilometer perimeter of a lek where brood rearing, nesting and early brood-rearing habitat is present.

v. Areas solely used as winter concentration areas, exploration and development activity will be allowed March 14 to December 1.

vi. Locate main roads used to transport production and/or waste products >1.5 kilometers from the perimeter of occupied sage-grouse leks. Locate other roads used to provide facility site access and maintenance >1.5 kilometers from the perimeter of occupied sage-grouse leks. Construct roads to minimum design standards needed for production activities.

vii. New noise levels, at the perimeter of a lek, should not exceed 10dBA above ambient noise (existing activity included) from 6:00 PM to 8:00 AM during the initiation of breeding (March 1-May 15). Ambient noise level should be determined by measurements taken at the perimeter of a lek at sunrise.

viii. Absent some demonstration to the contrary, the proposed sagebrush treatment associated with this activity will not reduce canopy cover to less than 15 percent.

Lyon, A.G., and S.H. Anderson. 2003. Potential gas development impacts on sage-grouse nest initiation and movement. *Wildlife Society Bulletin* 31(2):486-491.

The decline of greater sage-grouse over the last 50 years has raised concern over how natural gas development might affect sage-grouse populations. The authors examined the effects of vehicular activity due to gas-well development near Pinedale, Wyoming on productivity and movements of sage-grouse. The authors note there is no evidence that populations attain their predisturbance levels, and population reestablishment could require 20-30 years after disturbance from mining and development of gas and oil wells.

Moseley, C. (Public Lands Advocacy, Denver, CO), A. Casper, (Colorado Oil and Gas Association), S. Dempsey (Colorado Petroleum Association), D. Naatz (Independent Petroleum Association of America), W. Rosenbusch (International Geophysical Contractors Association), D. Galt (Montana Petroleum Association), R. Ness (North Dakota Petroleum Association), B. Hinchey (Petroleum Association of Wyoming), and L. Peacock (Utah Petroleum Association). 2012. Joint oil and gas industry comments on NOI for RMP amendments for sage-grouse. Public Lands Advocacy, Denver, Colorado. 10 p. http://www.ipaa.org/wp-content/uploads/downloads/2012/05/Sage_grouse_comments_3-23-12.pdf

"We acknowledge that BLM is under tremendous pressure to develop conservation measures for the greater sage-grouse within an exceptionally short period of time as an effort to ward off listing of the species. However, in addition to our concern that BLM is jettisoning its commitment to multiple-use of public lands, we are alarmed that the conservation measures outlined in the Report on National

Greater Sage-Grouse were summarily adopted without public vetting and input. The purported 'Platinum Standards' were established by a Sage-Grouse National Technical Team (NTT) that worked with a singular focus without benefit of others with exemplary expertise in the field, most notably the state of Wyoming which has developed a collaborative management approach to managing sage-grouse and its habitat. It also ignored comments from the Colorado Division of Wildlife which raised concerns regarding the methods utilized.

"Before moving forward with this extremely narrow and injudicious approach, we recommend that BLM rely upon efforts led by states to utilize a collaborative technical team consisting of not just federal agencies but the oil and gas industry, mining, cattlemen associations or ranchers, along with other stakeholders to formulate a sensible strategy which can clearly define and implement priority habitat selection criteria and disturbance calculation criteria. These state-derived plans must serve as the basis for all preferred alternatives since they will support state-derived population goals for the birds they own.

"The intent is 'to maintain, enhance, or restore conditions that meet greater sage-grouse life historic needs.' Since federal agencies manage wildlife habitat resources in cooperation with States and partners in an effort to restore habitat for big game and improving habitat quality for a large variety of wildlife species, it is important for the agencies to recognize that the oil and gas industry has been an active participant in a number of such efforts. Industry has gone to great lengths to document the effectiveness of mitigation and conservation measures it has implemented in Colorado, Montana, Utah and Wyoming in order to minimize potential impacts to the sage-grouse.

"Contrary to the conclusions reached in other studies [e.g., Doherty et al. 2008, Naugle et al. 2011], findings contained in these studies [Harju et al. 2010, Ramey et al. 2011] clearly demonstrate that energy development and viable sage-grouse populations can successfully coexist when reasonable mitigation measures are utilized during exploration, development and producing activities. As such, claims that oil and gas activities result in significant sage-grouse population decline and habitat are completely unfounded. Given that the energy industry has plainly demonstrated its long-term commitment to finding ways to diminish impacts from its operations on sage-grouse through BLM-approved best management practices and to utilize effective mitigation measures, we urge that all analyses to focus upon management options that provide flexibility that would not be available if the species were listed under the Endangered Species Act.

"Furthermore, numerous conservation measures and programs have already been implemented in nine states and others are in various stages of preparation in several counties and states which contain sage-grouse habitat through the Western Association of Fish and Wildlife Agencies (WAFWA). These efforts are taking into account site-specific conditions to ensure their effectiveness. Since BLM and the Forest Service are cooperating agencies in these efforts, we urge that these program efforts be carefully and fully considered in the analysis process."

Naugle, D.E., K.E. Doherty, B.L. Walker, M.J. Holloran, and H.E. Copeland. 2011. Energy development and greater sage-grouse. Pp. 489-502 in *Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats*, Knick, S.T., and J.W. Connelly (eds.). Studies in Avian Biology (vol. 38). University of California Press, Berkeley, CA.

"Rapidly expanding energy development in western North America poses a major new challenge for conservation of greater sage-grouse. Our goal was to synthesize the biological response of sage-grouse to energy development and evaluate whether mitigation at the local scale can sustain populations as cumulative impacts from energy development increase at the landscape scale. We address this question by using coal-bed natural gas development in the Powder River Basin in northeast Wyoming as a case study to quantify changes in landscape features detrimental to sage-grouse that result from energy development. We reviewed the scientific literature documenting biological responses of sage-grouse to development, quantified changes in landscape features detrimental to sage-grouse that result from development, examined the potential for landscape-level expansion of energy development within sage-grouse range, and outlined recommended landscape-scale conservation strategies.

"Sage-grouse respond negatively to three different types of energy development, and conventional densities of oil and gas wells far exceed the species' threshold of tolerance. These patterns were consistent among studies regardless of whether they examined lek dynamics or demographic rates of specific cohorts within populations. Severity of current and projected impacts indicates the need to shift from local to landscape conservation. The immediate need is for planning tools that overlay the best remaining areas for sage-grouse with the extent of current and anticipated development. This will allow stakeholders to consider a hierarchy of set-aside areas, lease consolidations, and more effective best-management practices as creative solutions to reduce losses. Multiple stressors, including energy development, must be managed collectively to maintain sage-grouse populations over time in priority landscapes.

"Following initial implementation [of a landscape-scale strategy], site-specific information, including that of seasonal habitat use, will be necessary to test and refine the strategy. Ultimately, multiple stressors—not just energy development—must be managed collectively to maintain populations over time in priority landscapes. Integrated analyses should consider how additional factors such as habitat loss, restoration, range management, disease, invasive weeds, and other ecological threats such as climate change will cumulatively affect sage-grouse populations over time.

"A scientifically defensible strategy can be constructed, and the most reliable measure of success will be long-term maintenance of sage-grouse populations in their natural habitats. The challenge will be for federal and state governments and the energy industry to implement solutions at a sufficiently large scale across multiple jurisdictions to meet the biological requirements of sage-grouse. One approach to conserving large populations may be to forgo development in priority landscapes until new best-management practices proven to safeguard populations are implemented. New best management practices can be applied and rigorously tested in landscapes less critical to conservation. Practices to reduce impacts may include a combination of unitization, phased development, consolidation of well pads per unit area, and remote instrumentation to reduce traffic volume. Accelerated restoration programs may increase the probability of reestablishing populations in landscapes that are developed for energy production. We have the capability and opportunity to reduce future losses, but time is becoming critical, and the need for interjurisdictional cooperation is paramount."

Ramey, R.R, II, L.M. Brown, and F. Blackgoat. 2011. Oil and gas development and greater sage-grouse (*Centrocercus urophasianus*): A review of threats and mitigation measures [funded by American Petroleum Institute]. *Journal of Energy and Development* 35(1&2):49-78.

"The purpose of this paper is to move beyond the description of sage-grouse responses to energy development and review current information in an attempt to understand why these responses may occur. To achieve this objective, we review previous research that identified the general threat categories of oil and gas development to sage-grouse. We selected six direct and indirect threats from oil and gas to sage grouse, based on a review of published information as well as plausible cause-and-effect mechanisms: noise, human activity, predation, habitat fragmentation and/or loss, strike hazards, and West Nile virus. For each of these threats we (1) identify the specific sources of each threat, (2) the likely cause-and-effect mechanisms that could lead to a behavioral and/or demographic impact, and (3) recommend specific mitigation measures that could be implemented to minimize these effects in an adaptive management framework. Next, we treat the specific sources of threats (number 1 above) as working hypotheses in terms of their congruence (or lack thereof) with existing data or, where there are currently little or no data, their plausible effect on sage-grouse populations. We then propose experimental approaches that could be used to test the efficacy of potential mitigation (as suggested by Naugle et al. 2011) and discuss the potential value of this and current mitigation measures.

“The significance of this strategy to sage-grouse conservation is threefold. First, it allows for a more efficient allocation of conservation effort by focusing on threats that matter most to the conservation of local populations affected by oil and gas development. Second, it allows for the design of mitigation that is tailored to the circumstances, rather than relying on one-size-fits-all buffer zones or timing restrictions. And third, the effectiveness of mitigation measures can be evaluated using a hypothesis-testing approach, which is at the philosophical core of science-based adaptive management. In other words, are there additional ways in which mitigation measures could be implemented to minimize the impact of oil and gas developments on sage-grouse?

“Current stipulations and regulations for oil and gas development in sage grouse habitat are largely based on studies from the Jonah Gas Field and Pinedale anticline. These and other intensive developments were permitted decades ago, using older, more invasive technologies and methods. The density of wells is high, largely due to the previous practice of drilling many vertical wells to tap the resource (before the use of directional and horizontal drilling of multiple wells from a single surface location became widespread), and prior to concerns over sage-grouse conservation. This type of intensive development set people’s perceptions of what future oil and gas development would look like and what its impact to sage-grouse would be. These fields, and their effect on sage-grouse, are not necessarily representative of sage grouse responses to less intensive energy development. Recent environmental regulations and newer technologies have lessened the threats to sage grouse.

“Presently, there is no central repository of information on mitigation measures implemented on behalf of sage grouse, nor their outcomes. In our view, this is a critical data gap that hampers sage-grouse conservation and the effective mitigation of oil and gas development in sage-grouse habitat. It is difficult to learn from the experiences of others if those experiences are not shared.

“To facilitate testing the effectiveness of mitigation measures, a more systematic approach is needed. Currently, when mitigation is required by governmental agencies, monitoring for compliance is customary. If greater effort were channeled towards monitoring the effectiveness of mitigation measures (i.e., sage-grouse responses), it would allow for a more rapid development of conservation measures.

“Several authors [e.g., Naugle et al. 2011] have stated that federal and state governments and industries need to implement solutions on a large scale (i.e., ‘landscape-level’ management). They suggest that one approach is to forgo development in priority landscapes until new ‘best management practices’ are implemented. This is reasonable, but implementation requires sharing of information and trust. However, Connelly et al. (2000) note that, although mining and oil and gas development can have negative impacts on sage-grouse, populations can recover after the development has ceased. The critical point is that both temporal and spatial management is needed. Development with subsequent restoration of areas with oil and gas resources can occur over time to maintain populations over the range of the species. Coupled with development of more effective mitigation and recent, less-invasive technologies, this approach would allow multiple objectives to be achieved without permanently excluding oil and gas extraction from large areas.

“If sage-grouse and energy development are to coexist successfully in the long term and effective management be developed in a timely manner, it is imperative that both threats and management actions be treated as potentially falsifiable hypotheses, rather than as certain knowledge. In other words, even hypothetical threats can be prioritized and subsequently investigated in a scientific manner. In cases where quantitative data are lacking, threats may be initially ranked based on their plausible cause-and-effect mechanisms and revised as additional data become available. In this process, mitigation measures that have been designed to address a specific threat may be treated as alternative hypotheses and their effectiveness tested against quantitative thresholds. These can be laid out in a series of “if—then” statements in adaptive management plans. This same strategy can be used to set ‘triggers’ for additional or alternative management actions. Such a scientific approach to adaptive management increases the likelihood that conservation effort will be allocated in a way to provide the greatest benefit."

Riley, T.Z., E.M. Bayne, B.C. Dale, D.E. Naugle, J.A. Rodgers, and S.C. Torbit. 2012. Impacts of crude oil and natural gas developments on wildlife and wildlife habitat in the Rocky Mountain region. Technical Review 12-02, The Wildlife Society, Bethesda, MD.

Previously widespread, the sage-grouse has been extirpated from approximately half of its historic range, and populations have declined by 1.8%-11.6% annually over the past four decades in about half of the populations studied. Energy development has emerged as a major issue in conservation because areas currently under development contain some of the highest densities of sage-grouse and other sagebrush obligate species in western North America. Sage-grouse need large, intact sagebrush habitats to maintain robust populations. As a result, the size of sage-grouse breeding populations often is used as an indicator of the overall health of the sagebrush ecosystem. Naugle (2011) and colleagues found 14 studies that reported negative impacts from energy development on sage-grouse, and none of the studies reported any positive influences on populations or habitat. … Protective measures, such as not allowing energy infrastructure within varied distances around leks and timing restrictions on drilling, have failed to maintain populations, and it has become apparent that sage-grouse conservation and energy development are incompatible in the same landscapes. … Identification of core areas provides a biological foundation for implementing community-based landscape conservation. Landscape-scale conservation in priority areas is the most defensible and realistic solution to the dilemma between energy development and sage-grouse conservation in the West. Maintaining large landscapes with minimum disturbance is paramount to sage-grouse conservation and will require collaborative efforts from a diverse group of stakeholders. … Tools to manage sage-grouse populations will vary across the species' range with biotic and abiotic characteristics of different landscapes and local constraints to populations. Some populations might benefit from changing grazing regimes, removing conifers, or managing invasive species, yet ultimately these will depend on the site."

"Recommendations: (1) Core areas containing clumped distributions of populations should be utilized by decision makers to assist in prioritizing conservation targets. The use of core areas will help foster industry partnerships and allow the forecasting of development scenarios to be used as a tool for conservation design. (2) Continuing research in sage-grouse genetics and in using GPS technology to monitor sage-grouse movements is needed for a better understanding of connectivity between and among sage-grouse populations. This research will help indicate limitations that may be required of the oil and gas industry to protect sage-grouse populations. (3) Using birds as the currency in combination with landscape-level conservation planning can improve mitigation of energy development impacts on sage-grouse.

U.S. Fish and Wildlife Service. 2013. Greater sage-grouse (*Centrocercus urophasianus*) conservation objectives: Final report. U.S. Fish and Wildlife Service, Denver, CO. http://www.fws.gov/mountain-prairie/species/birds/sagegrouse/COT/COT-Report-with-Dear-Interested-Reader-Letter.pdf

"The conservation objectives identified in this report are targeted at maintaining redundant, representative, and resilient sage-grouse habitats and populations. Due to the variability in ecological conditions and the nature of the threats across the range of the sage-grouse, developing detailed, prescriptive species or habitat actions is not possible at the range-wide scale. Specific strategies or actions necessary to achieve the following conservation objectives must be developed and implemented at the state or local level, with the involvement of all stakeholders.

"Threat Reduction: The following threat reduction objectives and measures are targeted at the habitat threats facing the greater sage-grouse, as identified in the 2010 warranted but precluded finding (75 FR 13910). Successful achievement of these objectives across the species' range will ameliorate the threats to greater sage-grouse, including the Bi-State DPS, and allow for the long-term conservation of the species. In the development of conservation plans to achieve these threat reduction objectives, entities (states, federal land management agencies, etc.) should coordinate with FWS. This will help to ensure that the conservation plans adequately address the threats contributing to the 2010 warranted but precluded finding.

"Energy Development: The increasing demand for renewable and non-renewable energy resources is resulting in continued development within the greater sage-grouse range, resulting in habitat loss, fragmentation, direct and indirect disturbance. Development results in sage-grouse population declines. Conservation Objective: Energy development should be designed to ensure that it will not impinge upon stable or increasing sage-grouse population trends. Addressing energy development and any subsequent successful restoration activities in sagebrush ecosystems will require consideration of local ecological conditions, which cannot be prescribed on a range-wide level. Where state sage-grouse management plans have already identified an effective strategy for energy development that meets the above objective, the strategies in those plans should be implemented. In all other situations, the following measures should be considered to avoid, reduce, or mitigate impacts from energy development.

Conservation Measures:

1. Avoid energy development in PACs (Priority Areas for Conservation). Identify areas where leasing is not acceptable, or not acceptable without stipulations for surface occupancy that maintains sage-grouse habitats.

2. If avoidance is not possible within PACs due to pre-existing valid rights, adjacent development, or split estate issues, development should only occur in non-habitat areas, including all appurtenant structures, with an adequate buffer that is sufficient to preclude impacts to sage-grouse habitat from noise, and other human activities.

3. If development must occur in sage-grouse habitats due to existing rights and lack of reasonable alternative avoidance measures, the development should occur in the least suitable habitat for sage-grouse and be designed to ensure at a minimum that there are no detectable declines in sage-grouse population trends (and seek increases if possible) by implementing the following:

    a. Reduce and maintain the density of energy structures below which there are not impacts to the function of the sage-grouse habitats (as measured by no declines in sage-grouse use), or do not result in declines in sage-grouse populations within PACs.

    b. Design development outside PACs to maintain populations within adjacent PACs and allow for connectivity among PACs.

    c. Consolidate structures and infrastructure associated with energy development.

    d. Reclamation of disturbance resulting from a proposed project should only be considered as mitigation for those impacts, not portrayed as minimization.

    e. Design development to minimize tall structures (turbines, powerlines), or other features associated with the development (e.g., noise from drilling or ongoing operations).

Appendix E. References Cited

(Note: all Internet links were current in December 2013)

AASG (Association of American State Geologists). 2012. Hydraulic fracturing. Fact Sheet. 2 p. http://www.stategeologists.org/download.php?id=4111

AGA (American Gas Association). 2013. Environmental benefits of natural gas. Webpage: http://www.aga.org/our-issues/issuesummaries/Pages/EnvironmentalBenefitsofNaturalGas.aspx

AWWA (American Water Works Association). 2013. Water and hydraulic fracturing. White paper. 16 p. http://www.oilandgasbmps.org/docs/GEN189-AWWAFracking.pdf

Barker, R. 2013. Idaho on verge of natural gas production. *Idaho Statesman*, Boise, Idaho, July 13. http://www.idahostatesman.com/2013/07/13/2652675/idaho-on-verge-of-natural-gas.html

Below, A. 2013. Obstacles in energy security: An analysis of congressional and presidential framing in the United States. *Energy Policy* 62:860-868.

BLM (Bureau of Land Management, U.S. Department of the Interior). 2009. Leasing of onshore federal oil and gas resources. http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/leasing_of_onshore.html

_____. 2012a. Onshore oil and gas orders/notices to lessees. http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/onshore_oil_and_gas.html

_____. 2012b. National instructional memoranda. http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_instruction.html

_____. 2012c. National information bulletins. http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_information.html

_____. 2013a. Unitization. http://www.blm.gov/mt/st/en/prog/energy/oil_and_gas/reservoir_management/unitization.html

_____. 2013b. Regulations and enforcement. http://www.blm.gov/co/st/en/BLM_Programs/oilandgas/leasing_regulations.html

_____. 2013c. BLM manual. http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/blm_manual.html

_____. 2013d. BLM handbooks. http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/blm_handbooks.html

_____. 2013e. Oil & gas statistics. http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/statistics.html

_____ and USFS (Forest Service, U.S. Department of Agriculture). 2007. Surface operating standards and guidelines for oil and gas exploration and development, fourth edition. http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/oil_and_gas.Par.18714.File.dat/OILgas.pdf

Boone, R.B., J.J. Taylor, D.M. Swift, P.H. Evangelista, and E. Hollowed. 2011. Developing a resource management and monitoring protocol for a semiarid landscape with extensive oil and gas development potential. BLM Technical Note 439. http://www.blm.gov/nstc/library/pdf/TN439.pdf

Brasier, K.J., M.R. Filteau, D.K. McLaughlin, J. Jacquet, R.C. Stedman, T.W. Kelsey, and S.J. Goetz. 2011. Residents' perceptions of community and environmental impacts from development of natural gas in the Marcellus Shale: A comparison of Pennsylvania and New York cases. *Journal of Rural Social Sciences* 26(1):32-61.

California Department of Conservation. 2007. Picture of a drill rig. http://www.conservation.ca.gov/dog/picture_a_well/Pages/qh_drill_rig.aspx

Colborn, T., C. Kwiatkowski, K. Schultz, and M. Bachran. 2011. Natural gas operations from a public health perspective. *Human and Ecological Risk Assessment* 17:1039-1056.

Conway, J.P. 2012. A crude reality: Exploring the interdependencies of energy (oil), the macro-economy, and national security. U.S. Army War College, Carlisle, PA. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA568438

Energy in Depth. 2011. Webpage: Federal statutes regulate every step of the hydraulic fracturing process. http://energyindepth.org/wp-content/uploads/2009/03/Federal-Hydraulic-Fracturing-Process.pdf

EPA (U.S Environmental Protection Agency). 2000. Profile of the oil and gas extraction industry. EPA Office of Compliance, Sector Notebook Project, EPA/310-R-99-006. http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/oilgas.pdf

_____. 2008. An assessment of the environmental implications of oil and gas production: A regional case study. http://www.epa.gov/sectors/pdf/oil-gas-report.pdf

_____. 2010. Regulations and standards: Final GHG tailoring rule. http://www.epa.gov/nsr/actions.html#may10

_____. 2012a. Overview of final amendments to air regulations for the oil and natural gas industry. http://www.epa.gov/airquality/oilandgas/pdfs/20120417fs.pdf.

_____. 2012b. Natural gas extraction–hydraulic fracturing. http://www2.epa.gov/hydraulicfracturing (see entry for this reference in **Appendix D: Annotated Bibliography**).

_____. 2013a. Oil and gas extraction effluent guidelines. http://water.epa.gov/scitech/wastetech/guide/oilandgas/

_____. 2013b. Inventory of U.S. greenhouse gas emissions and sinks: 1990 – 2011. EPA 430-R-13-001. http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf

Feiden, M., M. Gottlieb, A. Krupnick, and N. Richardson. 2013. Hydraulic fracturing on federal and Indian lands: An analysis of the Bureau of Land Management's revised proposed rule. Discussion Paper DP 13-26, Resources for the Future, Washington, DC. 25 p. http://www.rff.org/RFF/Documents/RFF-DP-13-26.pdf

Flaherty, C., and W. Leal Filho. 2013. Energy security as a subset of national security. P. 11-25 in *Global Energy Policy and Security*, W. Leal Filho and V. Voudouris (eds.), Springer-Verlag, London.

Gillerman, V.S., and E.H. Bennett. 2011. Idaho mining and exploration, 2010. S-11-1, Idaho Geological Survey, University of Idaho, Moscow. 30 p. http://www.idahogeology.org/PDF/Staff_Reports_(S)/2011/IdahoMiningandExploration_2010_S-11-1.pdf

_____ and _____. 2012. Idaho mining and exploration, 2011. S-12-3, Idaho Geological Survey, University of Idaho, Moscow. 26 p. http://www.idahogeology.org/PDF/Staff_Reports_(S)/2012/IdahoMiningandExploration_2011_S-12-3.pdf

Greenstone, M., D. Koustas, K. Li, A. Looney, and H. Marks. 2012. Energy policy opportunities and continuing challenges in the presence of increased supplies of natural gas and petroleum. Brookings Institution, Washington, DC. http://www.brookings.edu/~/media/research/files/papers/2012/6/13%20energy%20greenstone%20looney/06_energy_greenstone_looney.pdf

GWPC (Groundwater Protection Council). 2009. State oil and gas regulations designed to protect water resources. Groundwater Protection Council, Oklahoma City, OK. 62 p. http://www.gwpc.org/sites/default/files/state_oil_and_gas_regulations_designed_to_protect_water_resources_0.pdf

Ground Water Quality Council. 1996. Idaho ground water quality plan. http://www.deq.idaho.gov/media/462972-idaho_gw_quality_plan_final_entire.pdf

Haimes, Y.Y. 2009. *Risk modeling, assessment, and management*, 3rd ed. Wiley, New York. 1040 p.

Headwaters Economics. 2008. Fossil fuel extraction as a county economic development strategy: are energy-focusing counties benefitting? Energy and the West series paper. Headwaters Economics, Bozeman, MT. http://headwaterseconomics.org/pubs/energy/HeadwatersEconomics_EnergyFocusing.pdf

Hickenlooper, J., and B. Sandoval. 2013. Letter commenting on BLM's proposed hydraulic fracturing rules for federal and Indian lands to Sally Jewell, Secretary, U.S. Dept. of the Interior, from the Chair and Vice Chair, Western Governors Association, Denver, CO. http://www.westgov.org/policies/doc_download/1754-govs-letter-to-jewell-on-fracking

IDEQ (Idaho Department of Environmental Quality). 2011. Air quality planning in Idaho. IDEQ, Boise, Idaho. http://www.deq.idaho.gov/air-quality/planning.aspx

IDL (Idaho Department of Lands). 2013. Idaho's oil and gas industry has big plans in 2013. IDL Newsletter, Boise, Idaho (April 16).

Idaho Legislative Council. 2012. *2012 Idaho energy plan*. Idaho Legislative Council, Boise, Idaho. 132 p. + appendices. http://www.energy.idaho.gov/energyalliance/d/2012_idaho_energy_plan_final_2.pdf

Idaho OGCC (Idaho Oil and Gas Conservation Commission). 2013. Idaho OGCC Website. http://www.idl.idaho.gov/bureau/Minerals/min_leasing/iogcc.html

INR (Idaho Natural Resources Corp). 2012a. Western Idaho Basin recent developments. http://www.idnrc.com/recentdevelopments.html

_____. 2012b. Western Idaho: Geological summary. http://www.idnrc.com/geologicalsurvey.html

_____. 2012c. History. http://www.idnrc.com/history.html

IPC (Idaho Petroleum Council). 2011. "Education. Environment. Economy." http://www.legislature.idaho.gov/sessioninfo/2011/interim/energy0712_0713_holly.pdf

IPUC (Idaho Public Utilities Commission). 2013. Major natural gas pipelines and local gas distribution companies. http://www.puc.idaho.gov/fileroom/maps/gas.pdf

Keranen, K.M., H.M. Savage, G.A. Abers, and E.S. Cochran. 2013. Potentially induced earthquakes in Oklahoma, USA: Links between wastewater injection and the 2011 M_w 5.7 earthquake sequence. *Geology*. http://geology.gsapubs.org/content/early/2013/03/26/G34045.1.abstract

Kirschbaum, M.A., R.R. Charpentier, R.A. Crovelli, T.R. Klett, R.M. Pollastro, and C.J. Schenk. 2004. Assessment of undiscovered oil and gas resources of the Wyoming Thrust Belt Province, 2003. USGS Fact Sheet 2004–3007. http://pubs.usgs.gov/fs/2004/3025/fs-2004-3025.pdf

Leiby, P.N. 2008. Estimating the energy security benefits of reduced U.S. oil imports: Final report. Oak Ridge National Laboratory, Oak Ridge, TN. http://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=504469

Littlefield, S.R. 2013. Security, independence, and sustainability: Imprecise language and the manipulation of energy policy in the United States. *Energy Policy* 52:779-788.

McClure, M., P.S. Cook, and J. O'Laughlin. 2005. *Delisting endangered species: Process analysis and Idaho case studies*. Policy Analysis Group Report No. 25, College of Natural Resources, University of Idaho, Moscow. 73 p. http://www.uidaho.edu/~/media/Files/orgs/CNR/PAG/Reports/PAGReport25

McLeod, J.D. 1993. The search for oil and gas in Idaho. Idaho Geological Survey GeoNote 21, University of Idaho, Moscow, Idaho. http://www.idahogeology.org/PDF/GeoNotes_(G)/geonote_21.pdf

Miller, S.M., S.C. Wofsy, A.M. Michalak, E.A. Kort, A.E. Andrews, et al. 2013. Anthropogenic emissions of methane in the United States. *Proceedings of the National Academy of Sciences.* http://www.pnas.org/cgi/doi/10.1073/pnas.1314392110

Mooney, C. 2011. Fracturing a deep shale layer one time to release natural gas might pose little risk to drinking-water supplies, but doing so repeatedly could be problematic. *Scientific American* 305(5):80-85.

NWGA (Northwest Gas Association). 2013. Natural gas infrastructure in the Pacific Northwest. http://idahopetroleumcouncil.com/wp-content/uploads/2013/01/NWGA-infrastructure.pdf

Nowakowski, S., and H. Stockwell. 2012. Permitting in Montana: Department of Natural Resource Conservation–groundwater and oil & gas drilling. Legislative Environmental Policy Office, Montana Environmental Quality Council (MEQC), Helena, Montana. http://leg.mt.gov/content/Publications/Environmental/permit-primers/oil-drilling-water-wells.pdf

O'Laughlin, J., S.F. Hamilton, and P.S. Cook. 2011. *Idaho's endowment lands: A matter of sacred trust.* Policy Analysis Group Report No. 1, 2nd ed. College of Natural Resources, University of Idaho, Moscow, 35 p. http://www.uidaho.edu/~/media/Files/orgs/CNR/PAG/Reports/Endowment%20Lands%20Report%208-7-11

OSHA (Occupational Health and Safety Administration). 2013. Oil and gas well drilling, servicing and storage. http://www.osha.gov/SLTC/oilgaswelldrilling/

Peterson, J.A. 1995. Idaho-Snake River Downwarp Province. Website, U.S. Geological Survey. http://certmapper.cr.usgs.gov/data/noga95/prov17/text/prov17.pdf

Prentice, G. 2011. Getting "mini"-fracked: New Plymouth wells will undergo controversial technique. *Boise Weekly*, April 27. http://www.boiseweekly.com/boise/getting-mini-fracked/Content?oid=2214652

ProPublica. 2009. Anatomy of a gas well. http://www.propublica.org/article/anatomy-of-a-gas-well-426

Putz, A., A. Finken, and G.A. Goreham. 2011. Sustainability in natural resource-dependent regions that experienced boom-bust-recovery cycles: Lessons learned from a review of the literature. Center for Community Vitality, North Dakota State University. http://www.visionwestnd.com/pdf/Boom-bust%20communities.pdf

Schafft, K.A., Y. Borlu, L. Glenna. 2013. The relationship between Marcellus shale gas development in Pennsylvania and local perceptions of risk and opportunity. *Rural Sociology* 78(2):143-166. DOI: 10.1111/ruso.12004.

SROG (Snake River Oil + Gas). 2013. Website. http://www.snakeriveroilandgas.biz/

The White House. 2013. President Obama's blueprint for a clean and secure energy future. Fact Sheet (March 15). http://www.whitehouse.gov/the-press-office/2013/03/15/fact-sheet-president-obama-s-blueprint-clean-and-secure-energy-future

TEEIC (Tribal Energy and Environmental Information Clearinghouse). 2013. Oil and gas production webpage: A discussion of oil and gas production, its potential environmental impacts, and appropriate mitigation measures. U.S. Dept. of the Interior, Asst. Secretary of Indian Affairs' Office of Indian Energy and Economic Development, Washington, DC. http://teeic.anl.gov/er/oilgas/impact/index.cfm

TIPRO (Texas Independent Producers & Royalty Owners Association). 2013. State of energy report. http://www.tipro.org/UserFiles/Media/State of Energy Report.pdf

U.S. Energy Information Administration. 2012. What is shale gas and why is it important? http://www.eia.gov/energy_in_brief/article/about_shale_gas.cfm

USFWS (U.S. Fish and Wildlife Service). 2012a. Service manual, section 612 FW 2, oil and gas. http://www.fws.gov/policy/612fw2.html

_____. 2012b. Management of oil and gas activities on national wildlife refuge system lands. http://www.fws.gov/policy/ManagementofOilandGasActivitiesHandbook.pdf

_____. 2013. Greater sage-grouse. http://www.fws.gov/mountain-prairie/species/birds/sagegrouse/

USGS (U.S. Geological Survey). 2012. National oil and gas assessment 2012 assessment updates. http://energy.usgs.gov/OilGas/AssessmentsData/NationalOilGasAssessment/AssessmentUpdates.aspx

_____. 2013. Energy glossary & acronym list. http://energy.usgs.gov/GeneralInfo/HelpfulResources/EnergyGlossary.aspx

USGS Eastern Great Basin Assessment Team. 2007. Executive summary—Geologic assessment of undiscovered oil and gas resources of the Eastern Great Basin Province, Nevada, Utah, Idaho, and Arizona. U.S. Geological Survey Digital Data Series DDS–69–L. http://pubs.usgs.gov/dds/dds-069/dds-069-l/REPORTS/69_L_CH_1.pdf

WRAP (Western Regional Air Partnership). 2010. Welcome to the WRAP website. http://www.wrapair2.org/default.aspx

Weber, J.G. 2012. The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming. *Energy Economics* 34:1580-1588.

Wood, S.H. 1994. Seismic expression and significance of a lacustrine delta in Neogene deposits of the western Snake River Plain, Idaho. *American Association of Petroleum Geologists Bulletin* 78:102-121. http://earth.boisestate.edu/swood/files/2010/08/Wood-1994-AAPG.pdf

_____, and D.M. Clemons. 2002. Geologic and tectonic history of the western Snake River Plain, Oregon and Idaho. P. 69-103 in *Tectonic and magmatic evolution of the Snake River Plain Volcanic Province*, Bonnichsen, B., C.M. White, and M. McCurry, M. (eds.). Idaho Geological Survey Bulletin 30, University of Idaho, Moscow. http://earth.boisestate.edu/swood/files/2010/08/WOODCLEM-2002.pdf

Zepelin, S. 2013. Natural gas drilling begins in Payette County. KTVB-TV, Boise, Idaho, July 18. http://www.ktvb.com/home/Natural-gas-drilling-beginning-in-Payette-County-216103261.html