Oil and Gas at Your Door?

A Landowner's Guide to Oil and Gas Development

Second Edition

OIL & GAS ACCOUNTABILITY PROJECT

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About the Oil & Gas Accountability Project (OGAP)

OGAP was founded in 1999 to build the collective power of people who find themselves face to face with huge energy corporations that can drill for oil and gas a stone's throw from a home or in a pristine expanse of public lands. OGAP brings together more than 120 organizations across the United States and Canada to advocate for greater corporate and governmental accountability, responsibility and respect for people and places in the course of oil and gas development. OGAP is the only organization in the United States with the sole mission of protecting tribal and rural communities and the environment from the devastating impacts of oil and gas development. OGAP's multi-tiered approach involves people who are directly affected by the impacts of oil and gas development in working for strong reforms. Our campaigns include media, public education and community organizing components.

OGAP coordinates four program areas:

- **Citizen and Community Support**
- **Governmental Reform**
- **Promoting Best Practices**
- **Public Health and Toxics**

OGAP is working to change the laws and policies — from the local level on up — that allow the oil and gas industry to develop oil and gas resources without regard to people's health, the environment or communities. Our overall goal is to only allow corporations to drill and process natural gas if they can do so without threatening people and contaminating the air, water and soil. OGAP works with the citizens of rural communities and Indian tribes who face the impacts of oil and gas development every day in working for lasting change.

OGAP has prepared this guide to assist those facing oil and gas development on their land and in their communities.

For more information on OGAP, please visit our website at www.ogap.org, or contact:

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"Working with communities to prevent and reduce the social, economic and environmental problems caused by oil and gas development."

Acknowledgements and Disclaimer

The Oil & Gas Accountability Project would like to thank Lisa Sumi for accepting the challenge of writing this comprehensive guide. The months of research and writing and redrafting are greatly appreciated and we are proud to have such a valuable resource to pass along. We would also like to thank those who have helped make this publication possible by giving their time and providing information, answering questions and reviewing draft text. Their contributions have helped improve both the scope and accuracy of this guide. In particular we thank the following:

REVIEWERS: Bruce Baizel, OGAP; Mel Frost, Greater Yellowstone Coalition; Jennifer Goldman, OGAP; Josh Joswick, La Plata County Commissioner; Gwen Lachelt, OGAP; Carolyn Lamb, OGAP; Patrick McMahon, Attorney; G.R. Bob Miller, Attorney; Dan Randolph, San Juan Citizens Alliance; Wilma Subra, Subra Company.

INDIVIDUALS (who provided photos or materials): John Amos (Skytruth), Linda Baker, Tom Darin, Dan Heilig, Gwen Lachelt, Jill Morrison, Dan Randolph, Jonathan Selkowitz, Travis Stills.

LANDOWNER STORIES: Laura Amos, Tweeti Blancett, Terry Fitzgerald, Peggy Hocutt, Dan and Barbara Renner, Curt Swanson, and Bruce Thomson. Story courtesy of the Powder River Basin Resource Council: Ron Moss. Stories courtesy of Western Organization of Resource Councils: Jeanie Alderson, Pete Dube, Phil Hoy, Nancy and Robert Sorenson, Ed Swartz.

ORGANIZATIONS (that provided materials): Durango Herald, East of Huajatolla Citizens Alliance, Michigan Land Use Institute, Northern Plains Resource Council, Powder River Basin Resource Council, San Juan Citizens Alliance, Western Organization of Resource Councils, and Wyoming Outdoor Council.

All photographs not credited in the text were provided by OGAP and San Juan Citizens Alliance.

OGAP would like to extend our thanks to the following foundations for their financial support of this project: Ballantine Family Fund, Educational Foundation of America, Harder Foundation, Jessie Smith Noyes Foundation, Maki Foundation, New-Land Foundation, Norcross Wildlife Foundation, Inc., and Unitarian Universalist Veatch Program at Shelter Rock.

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Introduction

Oil and gas development is something that most citizens do not encounter on a daily basis. Depending on where you live, however, it may be a current or potential concern.

Oil and gas development continues to occur at a rapid pace across the United States, and in some areas, like the Powder River Basin of Montana and Wyoming, development has exploded in the past few years. Not surprisingly, in many regions of the country this form of industrial development has increasingly come into conflict with other land uses, e.g., ranching, farming, recreational activities, and enjoyment of private property.

As a landowner living in an area of current or potential oil and gas development, you may be approached by a representative of an oil and gas company wanting to drill for oil and gas on your property. This can be a troubling experience if you do not own the rights to the minerals beneath your land. It can be intimidating to have companies knock on your door and tell you that they are going to come onto your land and drill for oil or gas, and that there is nothing you can do to stop them. Or, if you are a landowner living adjacent to or downstream from a property where drilling is going to occur, you may feel powerless to influence the behavior of the oil and gas companies. Even if you own the mineral rights you may feel pressured by company representatives who bring with them promises of royalties, but want you to sign an agreement on the spot.

Admittedly, the legal and technical issues around oil and gas development can be overwhelming for people who have not had prior contact with the industry. The purpose of this guide is to provide information that will help you to better understand and deal with the oil and gas industry.

WHAT'S INSIDE?

Chapter I of this guide contains a description of the oil and gas development process, and information on issues related to development that may be of concern and importance to landowners. Chapter II contains legal and government regulatory information that may help landowners to prevent serious impacts from oil and gas development on their lands and lives. Chapter III provides additional tips on how to deal with the oil and gas industry, e.g., through negotiation of surface use agreements. Chapter IV contains stories from landowners who have already experienced development on or near their property. Finally, Chapter V contains lists of additional resources that may help to further prepare landowners for oil and gas development.

Because this is a guide for landowners, the content focuses primarily on on-shore oil and gas development, as opposed to offshore drilling operations. And it highlights issues with private as opposed to public lands. For more information on oil and gas issues and impacts on public lands, readers are referred to the guide, *Preserving Our Public Lands*. (See Chapter V for details.)

SHOULD YOU BE CONCERNED ABOUT OIL AND GAS DEVELOPMENT?

If you own some land, but aren't presently dealing with oil and gas development, you may be wondering whether or not you need to read this guidebook. The following questions may shed some light on this issue.

What is the future of oil and gas production in the U.S.? In the United States, approximately four million wells have been drilled in the search for oil and gas, which started in this country in the early 1800s.[1]

Between 1992 and 2002, the number of producing domestic natural gas wells increased from approximately 202,000 to 262,000. Meanwhile, the number of domestic oil wells declined from 396,000 wells in 1992 to 319,000 wells in 2002.[2]

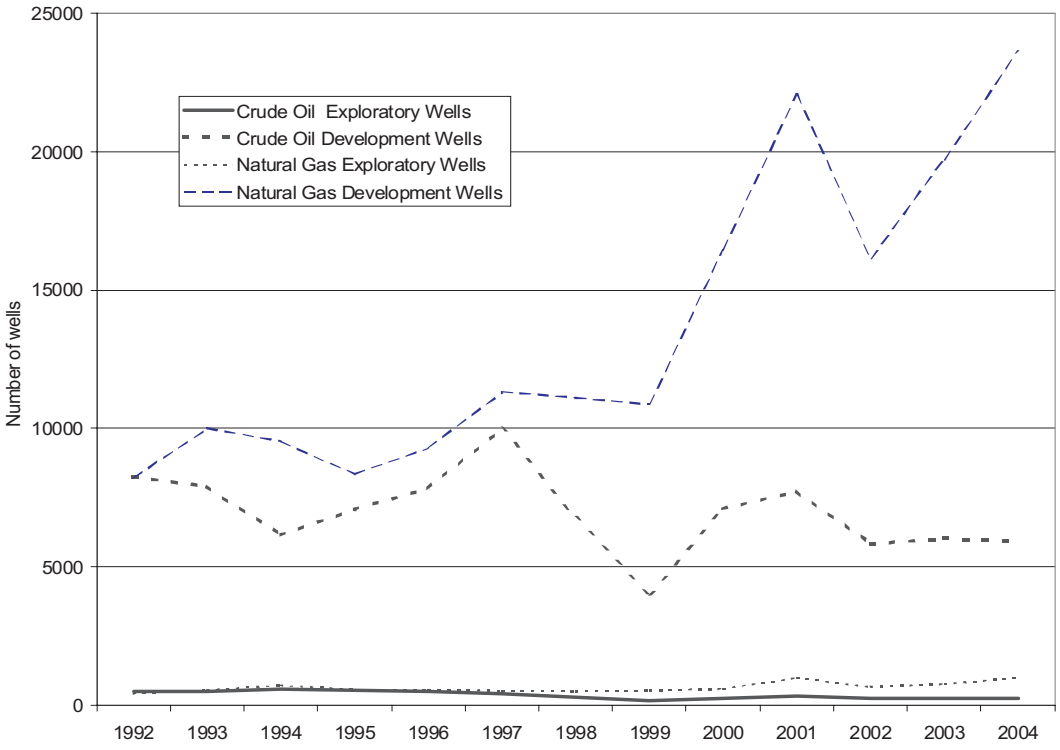


FIGURE i-1. NEW CRUDE OIL AND NATURAL GAS WELLS DRILLED IN THE U.S. BY YEAR.
Source: Energy Information Administration. U.S. Department Of Energy.[3]

Figure i-1 shows the number of oil and gas wells drilled per year in the U.S. since 1992. It is clear that the drilling of natural gas wells has skyrocketed since about 1999.

All signs point to the fact that drilling—at least for natural gas—is not going to slow down in the near future. The U.S. Department of Energy predicts that domestic natural gas production in the country is going to increase from 19.1 trillion cubic feet (2003) to 21.8 trillion cubic feet (2025).[4] Crude oil production is predicted to experience slower growth, and any increase is expected to come from offshore oil reserves.

The current administration contends that increasing our domestic energy supply is necessary to protect our national security.[5] In a 2001 speech on U.S. Energy Strategy, Vice President Cheney stated that:

For the oil we need, unless we choose to accept our growing dependence on foreign suppliers—and all that goes with that—we must increase domestic production from known sources. . . For the natural gas we need, we must lay more pipelines—at least 38,000 miles more—as well as many thousands of miles of added distribution lines to bring natural gas into our homes and workplaces.[6]

The United States will eventually deplete its oil and gas resources, but this is unlikely to occur in our lifetime. As development continues, more and more conflicts between oil and gas developers and landowners are sure to arise because of impacts to land, water and public health and safety, all of which are threatened by increased oil and gas extraction.

Do we "need" so much oil and gas? The United States is the number one consumer of oil—Americans use 23.5 million barrels per day.[7] There is the perceived need to increase oil production because the U.S. Department of Energy has forecast that our consumption will increase by 1.8% (423,000 barrels per day) every year until 2050.[8] Current government policy, however, is focused on increasing production rather than decreasing consumption. If a shift occurred in federal government priorities, the "need" to develop more wells, faster, would diminish.

For example, because nearly 70% of this country's oil consumption is currently used for transportation, the United States could reduce consumption if it focused on reducing oil use in the transportation sector. According to a report by the National Environmental Trust,[9] the U.S. government easily could implement a program to decrease U.S. oil demand by:

- Encouraging Americans to keep their engines tuned up and their tires properly inflated. This would cut U.S. oil consumption by a million barrels per day!
- Increasing federal fuel economy standards for cars and trucks to 40 miles per gallon by 2010. This would eliminate the projected growth in U.S. oil imports by that date. This is a reasonable recommendation, as U.S. auto companies have already committed to meeting this standard for cars exported to Europe by 2010. They simply need to implement the same standard here in the U.S.

With engines tuned and tires properly inflated, oil consumption would be decreased by 1,000,000 barrels per day

— National Environmental Trust

As for natural gas, the United States is the country with the second largest consumption rate in the world.[10] In June 1999, an article in *Oil & Gas Journal* reported that in Texas, a state that produces 1/3 of the nation's gas, 6,400 new wells must be drilled each year to keep its production stable. But Americans' demand for natural gas is not stable.[11] According to the U.S. Department of Energy, U.S. consumption is forecast to increase by 2.2% every year.[12] So, even if we continue to increase our drilling of natural gas wells, we are not going to meet our "needs."

What is really needed is an energy policy that provides incentives for reducing our demand for oil and natural gas, and promotes the development of less polluting, renewable energy sources.

Where will the oil and gas come from? Since it is likely that oil and gas development will continue to be promoted in the United States, information on the known locations of oil and gas reserves will help landowners know whether or not they are living in areas where oil or gas exploration and drilling may either begin to occur or intensify.

Known deposits of oil occur in more than 30 states, with the majority of current onshore oil production concentrated in Texas, Oklahoma, Louisiana, Wyoming, California, Kansas and New Mexico.[13] The majority of ***proved reserves*** of oil, however, have a slightly different geographic distribution. (The U.S. Department of Energy defines ***proved reserves*** as the volumes of oil or gas that geological and engineering data have demonstrated with reasonable certainty to be recoverable in the future, under existing economic and operating conditions.)[14] As seen in Figure i-2, Texas, Alaska, California, Louisiana, New Mexico and Oklahoma are the states with the largest on-shore proved reserves of oil.

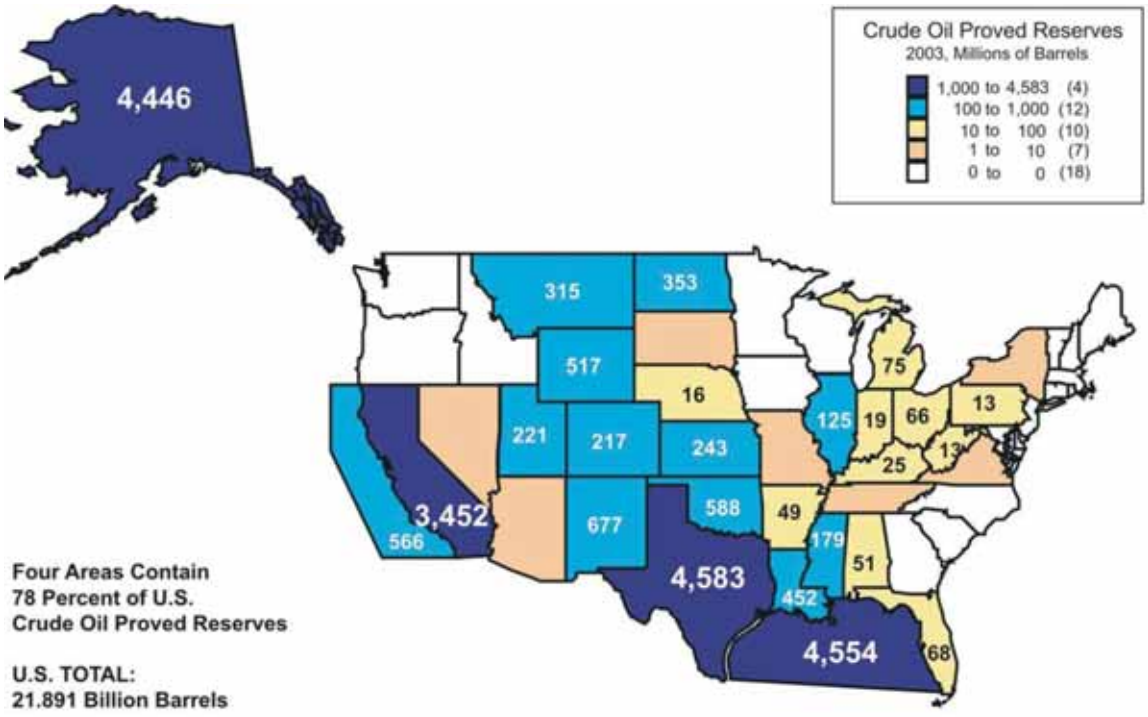


FIGURE i-2. 2003 U.S. CRUDE OIL PROVED RESERVES.
Source: Energy Information Administration, U.S. Department of Energy. [15]

The geographic distribution of natural gas is similar to that of oil, as natural gas often occurs in association with oil deposits. In terms of current production, three States (Texas, Louisiana, and Oklahoma) produce more than half of the natural gas in this country. New Mexico, Wyoming, Colorado and Kansas are also major gas-producing states.[16]

Large deposits of natural gas exist in half of the 50 states, but the deposits in Alaska, Texas, Louisiana, New Mexico and Oklahoma make up approximately half of the known U.S. dry natural gas proved reserves. See Figure i-3. ***Dry natural gas*** is almost entirely methane, with few impurities or other hydrocarbons.

With the recent boom in extraction of natural gas from coal beds (i.e., coalbed methane development), landowners should also be aware of the areas where coalbed methane development may potentially occur. See Figures i-4 and i-5.

In most regions of the country where oil and gas reserves exist, the federal government has plans to ramp up oil and gas production. For example, in New Mexico's San Juan Basin there are currently 18,000 producing wells, but the federal Bureau of Land Management (BLM) is proposing an additional 12,500 new wells to be drilled in one portion of the basin alone.[17] In Wyoming and Montana, the BLM is proposing that 77,000 new wells be drilled in the Powder River Basin.[18]

If you live in these regions, or other regions of proved reserves, you may have a visit from an oil or gas company representative in your future.

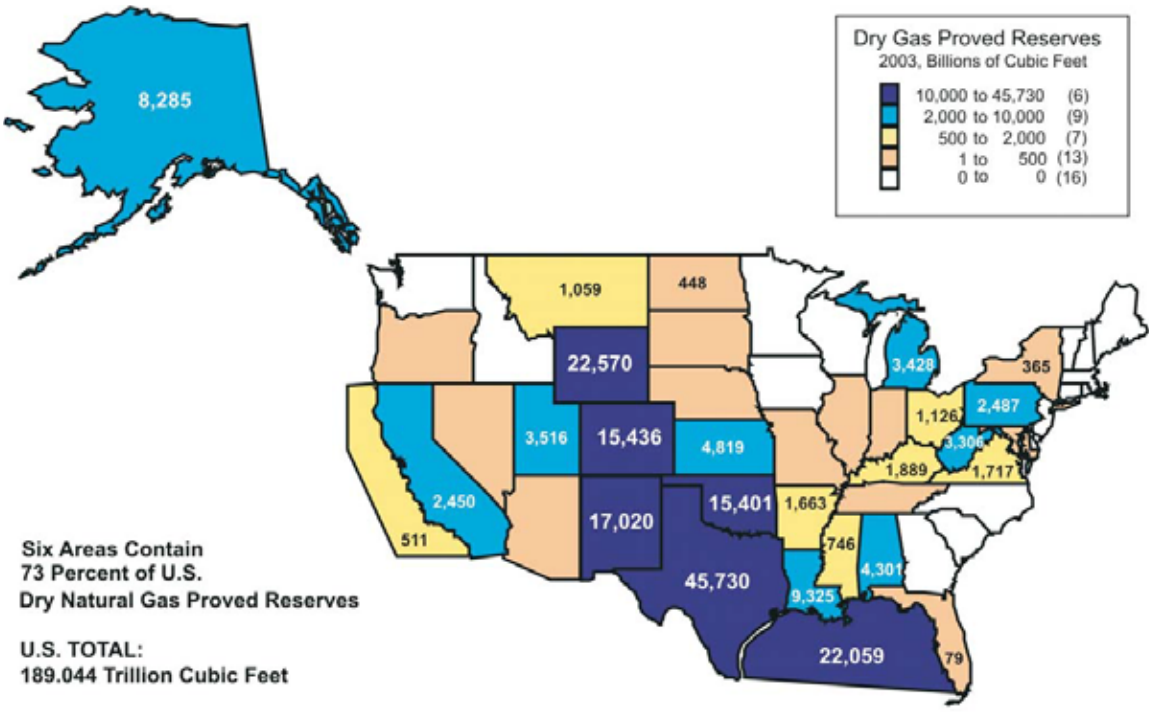


FIGURE i-3. 2003 U.S. DRY NATURAL GAS PROVED RESERVES.
Source: Energy Information Administration, U.S. Department of Energy. [19]

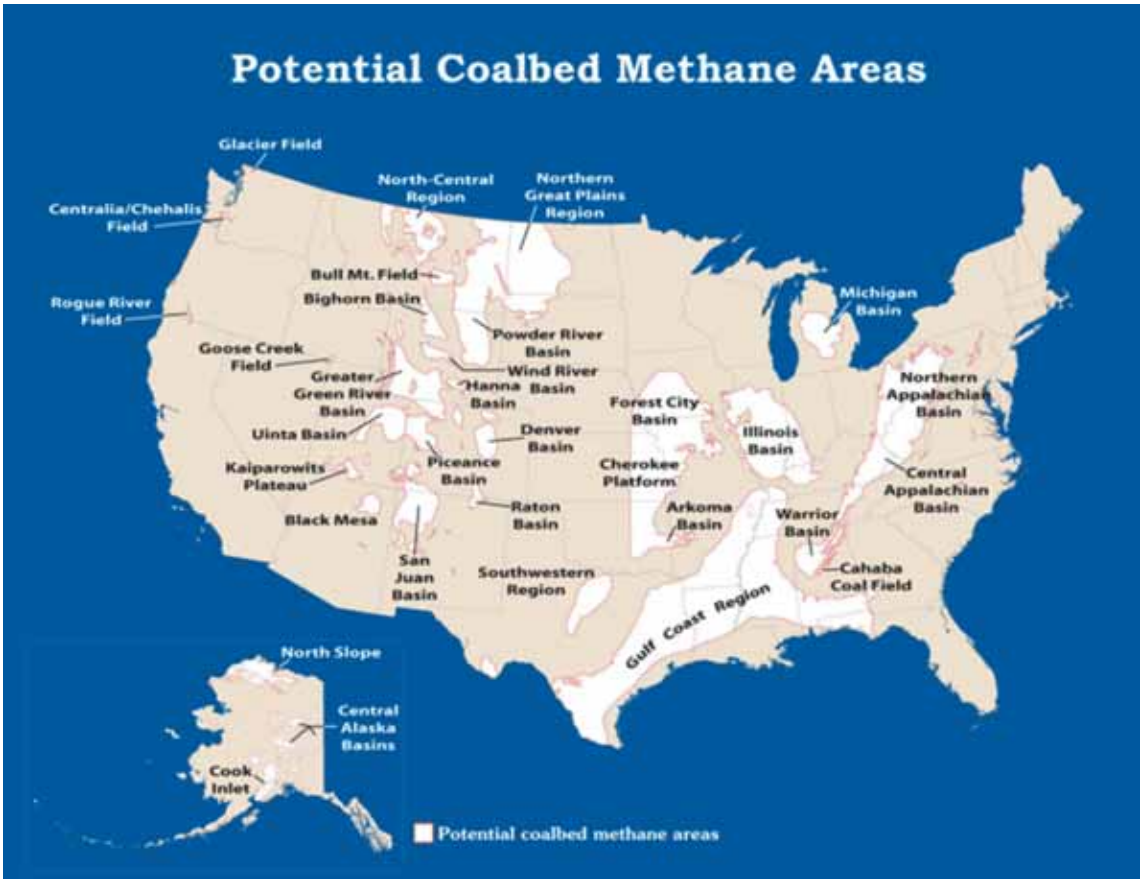
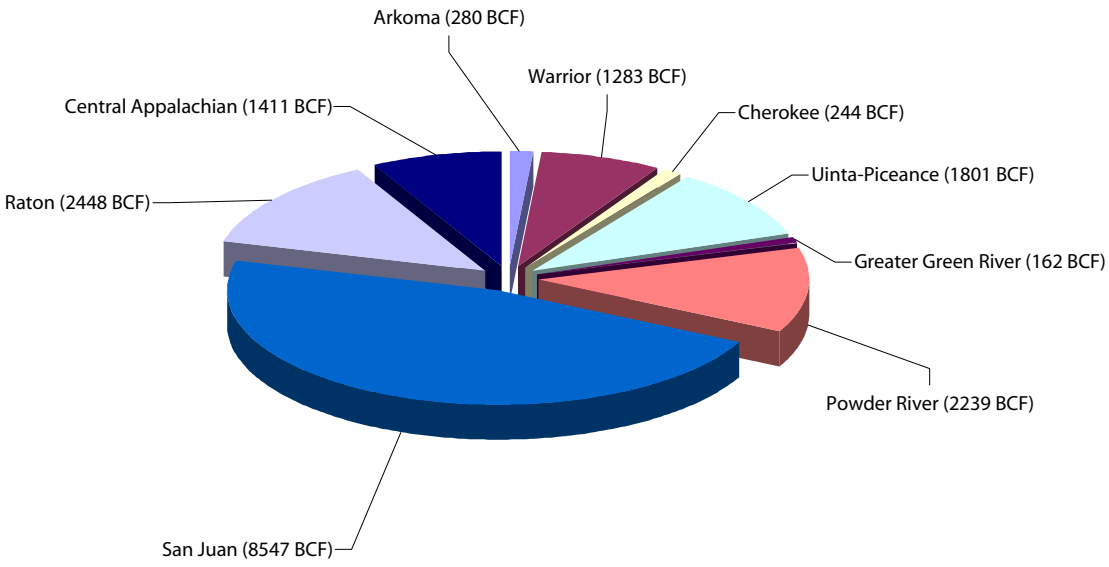


FIGURE i-4. POTENTIAL COALBED METHANE BASINS IN THE UNITED STATES.
Source: Interstate Oil and Gas Compact Commission.[20]



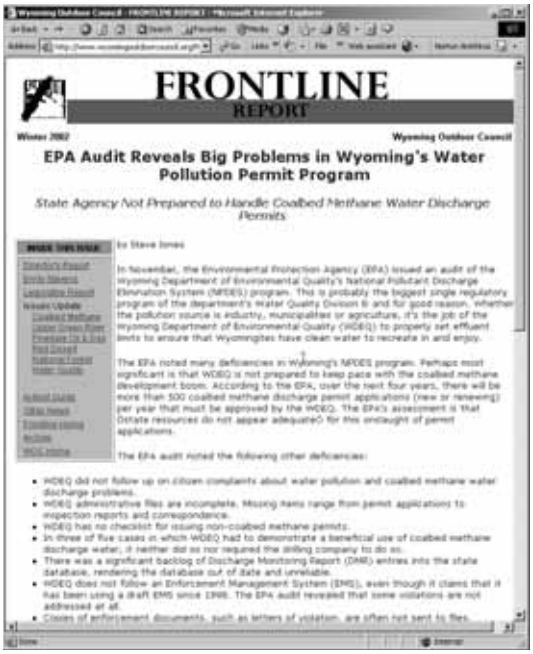
BCF - billion cubic feet of methane

FIGURE i-5. 2002 PROVED COALBED METHANE RESERVES.
Source: Energy Information Administration, U.S. Department of Energy.[21]

Do you own the minerals associated with your land? You may own a piece of land, but do you own everything that is underneath it? Today, the reality is that many landowners own only the surface—not the subsurface—portion of land. This is mainly because previous owners retained ownership of the minerals when they sold the surface property.

Consequently, it is possible that a landowner may own some, all or none of the rights to the minerals, oil and gas that lay beneath the surface of their property. In Colorado, for example, only 15 percent of landowners also own the rights to the minerals under their lands.[22]

Many conflicts involving oil and gas development are rooted in this "severance" of land title, where property is divided into the "surface estate" and the "mineral estate." In many cases, surface owners are unaware that someone else owns rights to the minerals underneath their property. Even surface owners who are aware that they do not own the minerals may not realize that the mineral owner may have a legal right to enter the property, build roads, drill wells, install flow lines and maintain operations—all without permission from the surface owner or compensation for most damages caused by oil and gas development.


FRONTLINE
REPORT
Winter 2002
Wyoming Outdoor Council
EPA Audit Reveals Big Problems in Wyoming's Water Pollution Permit Program
State Agency Not Prepared to Handle Coalbed Methane Water Discharge Permits
by Steve Jones
In November, the Environmental Protection Agency (EPA) issued an audit of the Wyoming Department of Environmental Quality's National Pollutant Discharge Elimination System (NPDES) program. This is probably the biggest single regulatory program of the department's Water Quality Division II and for good reason. Whether the pollution source is industry, municipalities or agriculture, it's the job of the Wyoming Department of Environmental Quality (WDEQ) to properly set effluent limits to ensure that Wyomingites have clean water to recreate in and enjoy.
The EPA noted many deficiencies in Wyoming's NPDES program. Perhaps most significant is that WDEQ is not prepared to keep pace with the coalbed methane development boom. According to the EPA, over the next four years, there will be more than 500 coalbed methane discharge permit applications (new or renewing) per year that must be approved by the WDEQ. The EPA's assessment is that Ostate resources do not appear adequate© for this onslaught of permit applications.
The EPA audit noted the following other deficiencies:
- WDEQ did not follow up on citizen complaints about water pollution and coalbed methane water discharge problems.
- WDEQ administrative files are incomplete. Missing items range from permit applications to inspection reports and correspondence.
- WDEQ has no checklist for issuing non-coalbed methane permits.
- In three of five cases in which WDEQ had to demonstrate a beneficial use of coalbed methane discharge water, it neither did so nor required the drilling company to do so.
- There was a significant backlog of Discharge Monitoring Report (DMR) entries into the state database, rendering the database out of date and unreliable.
- WDEQ does not follow an Enforcement Management System (EMS), even though it claims that it has been using a draft EMS since 1998. The EPA audit revealed that some violations are not addressed at all.
- Copies of enforcement documents, such as letters of violation, are often not sent to files.

Government may not be able to effectively enforce regulations.
For the complete story, go to: www.wyomingoutdoorcouncil.org

- If you are fortunate enough to own the minerals beneath your land, you have a lot more power to determine if and how development will proceed. And you may reap some financial benefits if oil or gas is found under your property.
- If someone else (an individual, company, tribe, or state/federal government) owns the minerals, and a company becomes interested in developing oil or gas there, it is unlikely that you will be able to stop that development from occurring on your property. You may, however, be able to affect the manner in which development proceeds.

All of these ideas will be elaborated on in Chapter II.

Are you concerned about maintaining clean air, water and healthy landscapes? There are potential impacts associated with each stage of oil and gas development — exploration, drilling, production, product treatment, and plugging and abandonment of wells. Impacts may include: loss of land value due to surface disturbance, contamination, erosion or sedimentation; destruction or alteration of livestock and wildlife habitat; and human or animal health effects related to groundwater and surface water contamination, air pollution, or soil contamination.

In this guide, you will find more information on the potential impacts related to the various stages of oil and gas development.

There is no doubt that oil and gas development will have some impact on surrounding land, water and air. There are, however, a number of factors that can influence the extent or severity of the impacts. All of the following issues will be touched upon in this guide:

1. Location of the development (e.g., geology, topography, proximity to homes).
2. The financial situation and values of the company running the operation (e.g., do they have the money and the desire to mitigate the impacts).
3. The desires and values of the surface owners, and the ability of surface owners to influence the development.
4. Government regulations, and governmental willingness and capacity to enforce the regulations.

IF YOU ARE A LANDOWNER FACING IMMINENT OIL AND GAS DEVELOPMENT

Chapters III and IV of this guide feature tips for landowners, as well as stories from landowners who have lived with oil and gas developments on or near their properties. Here are four basic tips to consider right away:

FOUR BASIC TIPS:
1. Don't panic
2. Get educated
3. Find allies
4. Understand which government agencies are involved.

1. Don't panic or feel pressured to sign anything (e.g., leases or surface use agreements) before you feel comfortable. It is important to understand the range of potential effects—positive and negative—before making decisions. This is especially important if you are going to sign a lease or an agreement, since you will have to live with the consequences.
2. Take time to educate yourself about your rights, the company's rights, the oil and gas industry, and oil and gas development. Read this guide and other resources. You may want to consult an attorney.
3. Find allies. While you may be able to accomplish certain things alone, there truly is strength in numbers. Strategies may develop from talking with a wide range of people. And you may need the emotional support. Fortunately, there are many who have been down this road before. Talk with your neighbors. Get support from local community and environmental groups. Talk about your concerns at homeowner association meetings. Find out where agricultural and ranching organizations, as well as local and state government agencies, stand on oil and gas development.
4. Understand which government agencies are involved in regulating oil and gas (federal, state, county, municipal). Communicate often with the agencies, and if possible, build relationships with agency staff. Familiarize yourself with the laws and regulations. And remember: often, the squeaky wheel does get the grease. So be persistent if companies are not acting in a responsible manner.

Chapter I

Oil and Gas Development and Impacts

TERMS AND CONCEPTS
This first section is designed to introduce readers to some key terms and concepts related to oil and gas.

STAGES OF DEVELOPMENT
The chapter continues with explanations of the various stages involved in oil and gas development: from mineral leasing to the abandonment of oil and gas wells. Also included are some of the issues and impacts associated with these stages of development that may be of concern to landowners.

DEVELOPMENT OF NONCONVENTIONAL OIL AND GAS
This section introduces readers to the development of various forms of nonconventional oil and gas. These types of oil and gas deposits are likely to become more heavily exploited in the future.

IMPACTS OF OIL AND GAS DEVELOPMENT
This section provides information for landowners on some of the potential effects of oil and gas development on their lands, livelihoods and quality of life.

ALTERNATIVE TECHNOLOGIES—MINIMIZING IMPACTS
The final section provides an overview of some of the "best practices" or alternatives that are available to companies to minimize the impacts that their operations will have on the environment and the lives of landowners and nearby residents.

Terms and Concepts

Crude oil is the term for unprocessed oil, and it is also known as ***petroleum***. It is a mixture of molecules that are composed primarily of hydrogen and carbon atoms (***hydrocarbons***). Petroleum got its name from the fact that hydrocarbons are found in rock. The Latin words for rock and oil are *petra* and *oleum*.

Hydrocarbons are formed from dead plant and animal (i.e., organic) matter. Over time, these materials are covered by layers of sediment. The slow decay of the organic matter, aided by high temperatures and pressures, completes a long and complex process of transforming the organic material into hydrocarbons such as coal, oil and natural gas.

We often envision oil and gas reservoirs as being underground lakes of oil capped by natural gas (which is less dense, and therefore rises above the oil). In reality, oil and gas are most often located in the pores of rock. The beds of sedimentary rock in which the petroleum is formed are called the source rocks, and usually these are dark grey or black shales. Because petroleum is a fluid, it is able to migrate through the earth. Through time, the oil and gas migrate from the source shales, which are not very porous, into more porous or permeable rocks. Petroleum may end up in any porous rock, but it is most common to find large reservoirs of hydrocarbons in highly permeable, sedimentary rocks such as sandstone or limestone.

Most people have heard the saying "oil and water do not mix." When oil and gas encounter waterlogged formations, the oil and gas, because they are less dense than water, rise all the way through the water and settle as a layer on its surface. The hydrocarbons continue to move in an upward direction until they encounter a layer of material that is not porous, i.e., an impermeable layer. When this occurs, the oil or gas is said to be trapped. Occasionally, there may be a pathway (e.g., porous rocks or fractures) that extends all the way to the earth's surface. If this occurs (e.g., at a sedimentary rock "outcrop") hydrocarbons may be found seeping out of the ground.

Characteristics of Oil and Gas

Crude oil is a mixture of many different hydrocarbon compounds and other materials. Typically, crude oils contain: carbon (84%); hydrogen (14%); sulfur (1 to 3%); and nitrogen, oxygen, metals (e.g., nickel, iron, vanadium, copper, arsenic), and salts (less than 1%). Crude oil is processed to remove unwanted materials and produce useable "petroleum products" such as motor gasoline, diesel, jet and home heating fuels, waxes, asphalt, feedstock for petrochemicals, and other components.

The hydrocarbon molecules that make up crude oil can take on many different forms. The smallest hydrocarbon contains one carbon atom and four hydrogen atoms. It is known as ***methane*** (CH_4), and it is lighter than air. Longer chain hydrocarbons, with five or more carbon atoms, (e.g., pentane, CH_5) are liquids. Very long chains are solids like wax or tar.

In general, older and deeper hydrocarbon deposits contain oil that has: 1) low viscosity (which means it is more liquid than solid); 2) low density (which means it light); and 3) low sulfur content. These qualities make these old, deep deposits most desirable because they are easy to extract, they require little refining to remove sulfur, and they can be easily converted into high-quality products such as gasoline.[23]

Natural gas used by consumers is composed almost entirely of methane. When it comes out of the ground, however, raw natural gas is a mixture of gases and other substances. Methane is the predominant component of raw natural gas (70-90%), but the hydrocarbons ethane, propane and butane are also significant components (up to 20%). These hydrocarbons are often separated out at natural gas processing facilities.[24] Other substances may be present in raw natural gas such as water vapor, sand, oxygen, carbon dioxide, nitrogen, hydrogen sulfide, and rare gases (e.g., helium, neon).

Natural gas is considered ***dry*** when it is almost pure methane, having had most of the other commonly associated hydrocarbons and impurities removed. When other hydrocarbons are present, the natural gas is ***wet***.

Raw natural gas is produced from three types of wells: natural gas wells, oil wells and condensate wells. Natural gas wells primarily produce raw natural gas. In the other situations, natural gas is recovered along with either oil or condensate. ***Condensate*** is primarily composed of pentanes and higher hydrocarbons (e.g., hexanes, heptanes and octanes) that are in a liquid form when removed from the well. Condensate may also contain small amounts of the lighter hydrocarbons (e.g., ethane, propane, butane), as well as aromatic hydrocarbons (e.g., benzene, toluene, ethylbenzene and xylene), and hydrogen sulfide.[25]

When natural gas is produced from oil wells it is called ***associated gas***, while natural gas and condensate wells produce ***nonassociated gas***. Approximately 35% of natural gas recovered in the U.S. is associated with oil recovery.[26]

Sour gas is a highly undesirable type of gas to have produced near your property.[27] It contains high concentrations of hydrogen sulfide (H_2S), which is toxic, potentially fatal at certain concentrations, and has a vile odor, much like rotten eggs. If H_2S dissolves in water, it forms a mild acid that can corrode pipes, valves, meters and other gas handling equipment. Sour gas is commonly found in deep, hot, high pressure natural gas deposits such as the foothills of the Rocky Mountains in Alberta and northeastern British Columbia. In the United States, some production of sour gas occurs in Michigan and Texas. H_2S may also be associated with coalbed methane extraction. In Colorado and New Mexico, there have been numerous complaints related to H_2S contamination of water wells and migration into homes following coalbed methane development.[28] (For more information on sour gas, see the section on Impacts Associated with Oil and Gas Operations.)

Not surprisingly, the oil and gas industry has focused most of its attention on the deposits that are the easiest to find and extract, e.g., those in relatively shallow, highly porous rock formations. These are known as ***conventional*** accumulations, and they tend to exist in localized deposits. ***Nonconventional*** (also known as ***unconventional***) oil and gas deposits tend to occur over large geographic areas rather than in localized accumulations.

Historically, it was not possible to develop nonconventional deposits since the technology to do so did not exist, or it was much too expensive to access and process the oil and gas. Over the past two decades, however, improvements in technology have occurred largely as a result of government subsidies. As a result, nonconventional gas deposits have become a noticeable source of total U.S. domestic production.

The U.S. Energy Information Administration (EIA) predicts that natural gas production from nonconventional sources (tight sands, shale, and coalbed methane) is going to increase more rapidly than conventional production in the U.S. The EIA predictions show nonconventional gas production from the lower 48 states growing from 6.6 trillion cubic feet (tcf) in 2003 (35% of natural gas production in lower 48) to 8.6 tcf in 2025 (44% of lower 48 natural gas production). Industry experts expect a much faster growth in nonconventional gas production, predicting that more than 10 tcf will be produced in 2005.[29]

This guide focuses primarily on the development of conventional oil and gas deposits. Recognizing, however, that development of nonconventional resources is on the rise, Chapter 1 includes a section on Development of Nonconventional Oil and Gas.

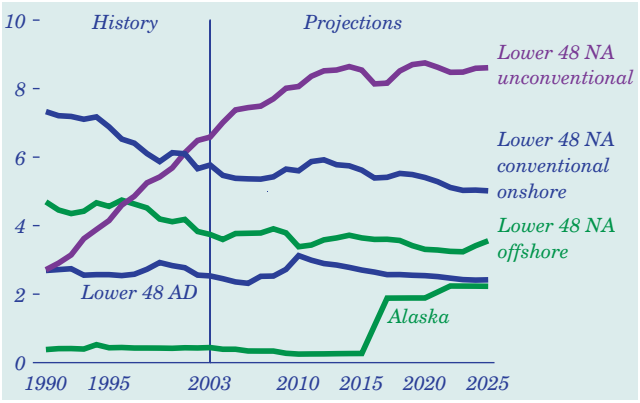


FIGURE I-1. NATURAL GAS PRODUCTION (CONVENTIONAL VS. UNCONVENTIONAL), 1990-2025. Note: AD stands for gas that is associated (dissolved) with crude oil production. Energy Information Administration.[29a]

Stages of Oil and Gas Development, 1.2.3.4.

Prior to the start-up of an oil and gas exploration or development project there are certain legal steps that companies take to prepare themselves. First, they must acquire the mineral rights to the targeted oil or gas deposit. Once the legal work has been taken care of, the technical work can begin.

The stages of oil development are similar to gas development, and include: 1) exploration; 2) field organization; 3) production; and 4) site abandonment. During exploration, a company will search for oil or natural gas deposits. If the company finds an economically viable deposit, production may occur. Prior to production, however, there may be an administrative stage that involves organizing the area where exploration has proved successful. During this period, efforts are made to ensure that as much oil or gas as possible will be extracted from the area. This is often referred to as field organization. When production occurs, the oil or gas is brought to the surface, and processing and refining take place. Finally, site abandonment, which typically involves plugging the well and doing some on-site restoration work, occurs when a well is no longer producing enough oil or gas to be economically profitable.

The oil and gas development process can span several decades, as some property owners have found out (see Terry Fitzgerald's story in Chapter IV). Below you will find detailed explanations of the processes involved in extracting oil and gas, as well as information on what you may experience if a company wants to develop a well on or near your property.

There are many publications and resources that provide greater detail on the oil and gas development process. For a listing of these resources, see Chapter V.

Obtaining Mineral Rights

Before companies may legally enter your property for exploration purposes, they typically must own or have leased the right to explore for minerals that are under your land, or have permission from the mineral owner to conduct exploratory tests.[30]

If you own the minerals

If you own the minerals beneath your land, you have a greater ability to determine if and how oil and gas development on your property will proceed than if you do not own the minerals. In order to explore or drill for oil or gas, the company will have to lease your mineral rights. You may refuse to lease those rights, or you may negotiate lease provisions that will help to protect your interests.

Mineral owners will often receive more than one offer to lease their mineral rights. This often happens well in advance of any actual development. Long before earth is moved or governments are involved, investors usually begin speculating about the next big oil or gas play, and may try to purchase the mineral rights over a large area.[31] The investors can then sell these mineral rights to exploration and development companies should the area prove to be a viable oil or gas field.

If you live in an area of known oil and gas deposits, it is possible that speculators have already leased the rights to minerals from prior owners (or your family members) under or near your property. Depending on when the leasing occurred, it is also possible that the lease terms may expire before development has a chance to occur. If this is the case, interested companies will have to obtain new leases before development may legally occur.

It should be noted that even if you own your land and the minerals beneath it, there are times when you may not be able to prevent exploration and development from occurring on your land.

In most states, something called force (or compulsory) pooling exists. In this chapter, the section on Field Organization provides information on forced pooling. Chapters II and III provide more information on mineral leasing, including Tips on Negotiating Leases.

If you don't own the minerals

If landowners do not own mineral rights to the oil and gas beneath their land, they do not have the legal right to stop a company from coming onto their land to explore for or develop oil or gas. This seems to put the landowner at a great disadvantage when dealing with oil and gas companies.

According to the Real Estate Center of Texas, however, if you don't own the mineral rights you still have options:[32]

1. Attempt to purchase all or part of an interest in the minerals beneath your land. By doing so, companies may have to negotiate with you in order to lease the property. You'll have more power if you own at least some of the mineral rights.
2. If all or part of the minerals cannot be purchased from the mineral owners, you may attempt to purchase the right of ingress and egress from them. Giving up this right does not affect the ability of the mineral owner (i.e., the ***lessor***) to lease the minerals and collect royalty payments from the company. But it would require the company who has leased the minerals (i.e., the ***lessee***) to make arrangements with you before entering to explore or develop a well on your property.
3. Contact the party who does own the minerals, and attempt to work out a land-use agreement. For example, you may ask mineral owner to restrict the company's operations to a certain section of land. Remember, however, that the mineral owner is under no legal obligation to enter into such an agreement.
4. Contact the mineral owner and work out a surface-use and surface-damage clause to be included in future leases between the mineral owner and an oil or gas company.
5. Attempt to negotiate a Surface Use Agreement directly with the oil or gas company. In some states this is required by law. There is more information on Surface Use Agreements in Chapters II and III.

Landowners should be aware, also, that there are laws and regulations that require companies to behave in an environmentally responsible manner; there are agency processes (e.g., permits) that may provide surface owners with the opportunity to comment on proposed oil and gas developments; and there are legal cases that have led to increased surface owner rights and protections. Chapters II and III provide more information on these topics.

1. EXPLORATION

Only after minerals have been leased (or permission obtained from mineral owners) may an individual or company go out onto the land to explore for oil and gas deposits.

Remote sensing techniques, such as photography, radar, infrared images, and microwave frequency receivers, are used to identify potential production areas and predict the likelihood of significant reserves.[33] Geophysical exploration is the attempt to physically locate oil or gas-bearing geological structures. The mostly widely used technique in on-shore geophysical exploration is the seismic test.[34]

Seismic Exploration

Seismic tests are based on the fact that acoustic or seismic waves will travel through, bend, absorb, and reflect differently off of various layers of subsurface rock. Seismic waves can be generated in several ways:

1. by blasting dynamite from a hole drilled several hundred feet in the ground;
2. by dropping a heavy weight, known as a thumper, from a truck (called a thumper truck) onto hard ground surfaces such as paved roads. This technique is known as land vibroseis, and it is typically used near populated areas and in sensitive environmental areas where explosions are not desirable;[35] or
3. by shaking the ground with a device known as a vibrasizer.

Seismic waves travel downward and outward, and are reflected back at different rates and strengths, depending upon the underground structures encountered. The strength and timing of the reflected signals are measured at the surface by geophones, which are connected to a line laid along a predetermined course. The line is connected to a machine that records the signals.

In the 1990s, geologists began using high-powered computers that could analyze much greater numbers of seismic signals and display them on three-dimensional (3-D) maps. To increase the detail and accuracy of these 3-D maps, the seismic lines and geophones are spaced more closely together, which means that land disturbance also increases.[36]

FIGURE I-2. SEISMIC EXPLORATION
30-ton thumper trucks leave lasting impressions on the surface.

Seismic Exploration—Issues and Impacts

- Survey stakes for mapping out the exploration area should be wooden, and not wire pin flags, because farming activities like making silage or hay can shred the wire flags. The resultant metal bits can kill livestock that eat the feed. Also, all stakes and markers should be removed after exploration is completed, because livestock and wildlife can die from eating ribbons or flags.[37]
- Seismic lines will destroy vegetation and may cause erosion, which could lead to sediment entering surface waters.[38]
- 3-D tests tend to cause greater surface disturbance and companies use your land for longer periods of time than with two-dimensional surveys.

- If dynamite is used during exploration, the "shot" holes may intercept the water table, and water may begin to flow or seep to the surface. These flowing holes have caused problems for some landowners, e.g., by making the land so wet that farmers were unable to cut hay.[39] These holes need to be plugged from bottom to top. Ensure that the company properly plugs and abandons these holes.
- Seismic work crews may generate different types of waste (plastic, paper, containers, fuel leaks/spills, food and human wastes).

Seismic Exploration—Tips for Landowners

- Prior to any exploration, it is advisable to ask the company to show you, on a map and on an aerial photograph of your property, where they intend to conduct their seismic operations. To minimize damage, try to ensure that work is conducted as far away from surface waters as possible. Ask companies to avoid steep slopes, as this could lead to erosion. As well, request that the company avoid any areas of ecological sensitivity or importance to your use of your land.
- Landowners may want to negotiate more payment and negotiate stronger surface-damage provisions if they consent to 3-D seismic tests, due to a greater degree of surface disturbance caused by this type of testing.
- It is advisable to get water wells tested before and after seismic testing, because seismic shot holes can provide a path for surface contaminants to come into direct contact with groundwater. The seismic explosions may also create pathways for water to flow to the surface, which could decrease pressure in the reservoir and affect water quantity in water wells. You can request that the company pay for these water quality and quantity tests.
- After the company leaves, do some ground-truthing: ensure that holes have been properly filled; that no flags, pins or trash are left around to endanger livestock or wildlife; and that water is not flowing into or from any holes.
- Review the state regulations governing exploration (contact state agencies to obtain copies of any regulations pertaining to exploration). There will likely be a number of things that the company is required by law to do (e.g., plugging of seismic holes; notification of exploration; posting a bond to cover potential surface damages, etc.). The more you know, the more you can ensure that the company is acting responsibly. For example, if notification is required before a company can enter your property, you may want to use the opportunity to make some requests of the company, e.g., negotiate a surface damage agreement, or right-of-way (access) agreement. Chapter II provides some information on exploration regulations in select states.
- In Wyoming, split estate surface owners have been placed in a lose-lose situation: if they allow exploration companies to place explosives on their property, they risk losing their homeowner's insurance; but if they oppose the testing in order to maintain adequate insurance coverage, they risk condemnation by the seismic testing company (under the eminent domain laws in the State of Wyoming). For more information, see "Wyoming Landowners Face Condemnation or Loss of Homeowners Insurance," in Chapter IV.

You may want to get your own survey done. The company may be more receptive to your wishes if you can demonstrate that your preferred access route or drill pad site is a technically sound alternative to the company's preferred location.

It should be stressed that geophysical techniques and remote sensing cannot identify oil or gas accumulations directly; they can only indicate the potential for reserves. The presence of oil and gas can only be confirmed by actual drilling. So, if the preliminary tests indicate a high likelihood of oil and gas, the company may decide to drill an exploratory well.

If the exploration activities have not provided sufficient indication of oil and gas accumulations, the exploration program will likely come to an end, and the leases held in the area will likely be dropped.[40]

Exploratory Drilling

The purpose of exploratory drilling is to verify: 1) if the geological formations have accumulations of hydrocarbons, and 2) if the site can produce enough oil and gas to make it economically viable to proceed with further development.

There are a number of steps in a drilling program. These include drill site selection; drill site preparation; rigging up; spudding in (i.e., drilling the well); and analysis of drilling data.

Drill Site Selection: Companies will choose a drilling site that allows them to easily (and cheaply) access the target geological formations. Surface conditions may affect where drilling can occur. Wells are usually drilled where there is a fairly level ground surface of sufficient size (several acres, typically) to accommodate the drilling rig, reserve pits, and storage space for the materials and equipment used during the drilling program.

Drill site selection can be an important issue for landowners. Landowners may not want to hear or see the drilling operations, or live with the noise or pollution associated with the heavy equipment. Also, the company's preferred site may cause damage to important areas on a landowner's property, such as crops or ecologically sensitive areas. Some types of formations allow for considerable flexibility in drill site location (e.g. coalbed methane) while others require more precision to hit the resources (e.g. some tight sands).

You may want to get your own survey done. The company may be more receptive to your wishes if you can demonstrate that your preferred access route or drill pad site is a technically sound alternative to the company's preferred location. See Alternative Technologies and Practices later in this chapter for information on directional drilling.

Drill Site Preparation: Drill site or well pad preparation is when the most dramatic changes to the surface are likely to occur. There may be a number of private contractors (or subcontractors) on site during this period, and heavy equipment traffic tends to be intense during this phase of development.

To start off, access roads have to be built. Thus, one is likely to see bulldozers, road graders and gravel trucks in the early stages of drill site preparation. Once access is provided, the drill site will be cleared of vegetation and leveled. A pad for the equipment may be built (often out of gravel) if there is concern about ground instability or if the ground is subject to freeze/thaw cycles.[41]

Pits may be constructed to contain water for drilling operations, to store drilling fluids, and to dispose of drill cuttings and other wastes. If required by government regulations, some or all of these pits will be lined with a clay or a synthetic liner. Alternatively, tanks may be brought onsite to store products used during the drilling stage, as well as any waste created during drilling.

When this work has been completed, the drilling contractor will move in with all the equipment required for the drilling of the well.

Rigging up: Rigging up includes erecting the drilling rig; installing equipment to supply electricity, compressed air, and water; and setting up storage facilities.

Drilling rigs operate the hoist that raises and lowers the drill stem and bit. For shallow wells, the drill rig may be self-contained on a single truck. Deep-well rigs, however, may have to be brought to the site in several pieces and assembled at the site. The rig is located and leveled over the main well hole, and all associated engines, pumps, and rotating and hoisting equipment are connected or positioned close to the rig. Water and fuel tanks are filled, and additives for drilling fluid are stored on location. Then, the drilling contractor is ready to begin drilling operations.[42]

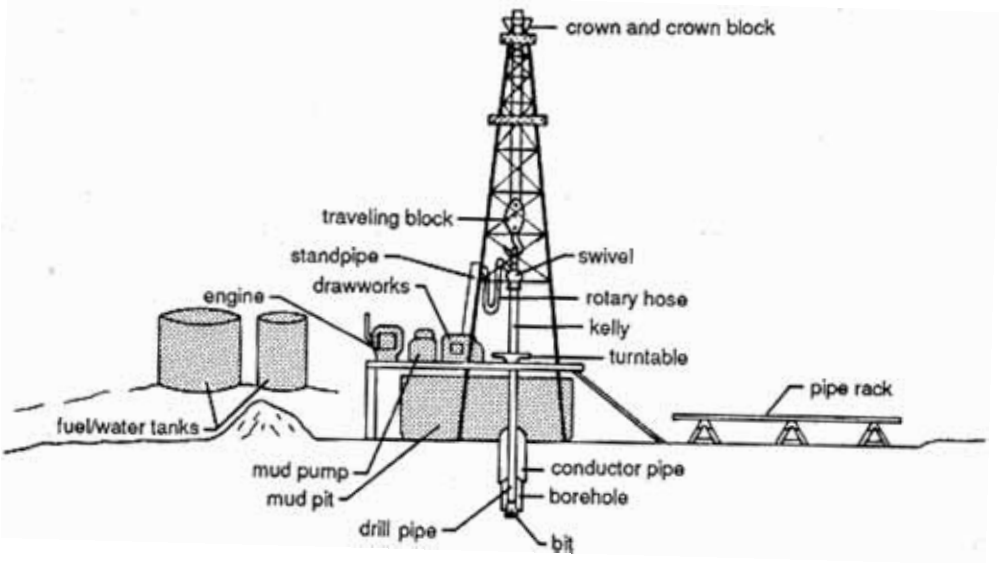


FIGURE I-3. A DRILLING RIG WITH ITS MAJOR COMPONENTS AND RELATED EQUIPMENT. Kansas Geological Survey[43]

Spudding in: Spudding in refers to the first stage of the actual drilling operation. When a well is spudded in, a large-diameter drill bit is used to drill a hole known as a ***well bore*** several hundreds or thousands of feet deep.

A system of pipes, flexible hoses and pumps draw drilling fluid from nearby tanks or a mud reserve pit. ***Drilling fluid***, also known as ***mud***, serves a number of purposes: 1) It is used to lubricate and cool the drilling equipment; 2) it circulates through the drilling system and returns to the surface, carrying ***drill cuttings***, which are fragments of rock generated by the drill bit; 3) it helps to prevent the fluids in the geological formations from entering the well prematurely; and 4) the pressure of the drilling fluid prevents the uncased well bore from caving in.[44]

Drilling fluids may be in the form of gases, foams or liquids. When drilling fluid is returned to the surface, it is piped to a device called a shale shaker, which separates the drill cuttings and solid materials from the drilling fluid. The fluid is usually returned to a mud tank or mud reserve pit to be re-used.[45]

Once the predetermined drilling depth is reached, the drill is removed from the well bore. The well bore is then lined with a steel tube (known as casing), in order to stabilize the hole and prevent caving. Casing should extend below the deepest freshwater zone, because another purpose of the casing is to protect underground fresh water sources from contamination by oil, gas or salty water that may flow through the well. Cement is pumped down into the space between the outside of the casing and the well bore. This is to further ensure the protection of groundwater, and to ensure that the casing is securely positioned.

A pressure test is then conducted on the casing and cement before drilling operations can be resumed. Also, a blowout preventer is attached to the top of the surface casing. This device is installed as safety measure to control the well if an abnormally high-pressure formation is encountered. If a high-pressure zone is hit, the blowout preventer can be closed to prevent gas, fluids and equipment from spewing out of the well bore.[46]

Once the surface casing has been tested and the blowout preventer installed, drilling operations can resume. The range in well depth is anywhere between 1,000 and 30,000 feet, with an average depth of all U.S. wells drilled in 1997 of 5,601 feet.[47]

Drilling Data Analysis: During drilling, there are a number of questions the company attempts to answer, such as: Is there oil and gas present, and if so, how much? How fast will the oil and gas flow? How do the oil- and gas-bearing formations vary from place to place? How much water is being encountered? (This last question is a big issue for coalbed methane development, because the water has to be pumped to get the gas out.) These questions must be answered before substantial investment is made in full-scale production facilities.

To answer these questions, the company's geologists will examine drill cuttings for signs of oil and gas. There are a number of additional tests that may be conducted to determine more detailed characteristics of the geological formations being drilled. These tests include coring, well logging, drill stem testing.[48]

If the company determines that there is not enough oil or gas to warrant production, all drilling equipment and materials should be removed from the drill site, and, depending on the state laws, the company may be required to restore the site as nearly as possible to its original condition.[49] Also, the drill hole should be cemented and plugged to prevent the contamination of groundwater and movement of fluids to the surface. In cultivated areas, the surface casing is often cut off below plow depth.

If the tests indicate that enough hydrocarbons are present to warrant commercial production, well production may begin.

For oil wells, it has been estimated that approximately only one exploratory well per every 10 drilled finds oil in sufficient quantities to justify production; and only one in 50 finds enough to repay the total costs of drilling the well and putting in the necessary infrastructure.[50] In coalbed methane fields the chances of drilling a producing, profitable well are much higher.

EXPLORATION STAGE—ISSUES AND IMPACTS

Surface and Other Disturbance

- There are various estimates of the amount of land disturbance associated with drilling for oil or gas. One oil or gas drill pad and the associated infrastructure may disturb anywhere from one to forty acres of land,[51] depending on the length of access roads, the size and number of storage and waste pits, etc.
- A study of oil and gas impacts on ranchers in New Mexico found that each pad removed between 2-4 acres from grass production.[52]
- Poorly constructed roads are prone to erosion, and heavy equipment causes soil compaction and decreased soil productivity. These impacts may be long term or even permanent.
- Quality of life may decline for landowners during the well drilling period, as 30-40 truckloads of equipment or water may be necessary to drill the well, and drilling operations tend to occur 24-hours a day (requiring lighting equipment at night), seven days a week until drilling is completed.[53] Heavy equipment used to construct the drill pad and access road will produce noise and dust. The noise level from equipment used during construction (if you are 500 feet away from the site) ranges from 60 to 70 decibels. That is somewhere between the noise that you hear if a car is passing you 25 feet away; or the sound you might hear in an urban shopping center.[54] Because construction often occurs through the night, this level of sound may be a nuisance to nearby landowners.
- The movement of equipment and vehicle traffic is a primary method of transporting seeds of noxious weeds and brush into an area. Furthermore, disturbed soils provide fertile ground for the establishment of weeds and brush.[55] Once they become established, non-native plant species can out-compete and eventually replace native species, thereby reducing forage productivity.[56]

FIGURE I-4. DUST

- Camps for workers may be set up on a surface owner's property.
- If drilling does not produce a viable well, it is important to ensure that wells are properly plugged, and the site satisfactorily reclaimed.

FIGURE I-5. IMPROPERLY FENCED DRILLING MUD RESERVE PIT
Poses threat to wildlife and livestock.

Air Emissions

- Drilling operations produce air emissions from diesel engines and turbines that power the drilling equipment. The air pollutants from these devices may include: nitrogen oxides, particulates, volatile organic compounds, and carbon monoxide. Additionally, hydrogen sulfide may be released during the drilling process.[57]

Wastes

- When improperly drilled or cased, or when the casing has corroded, wells can serve as pathways for contamination of aquifers.
- There are numerous wastes that are commonly associated with drilling. These include: pipe dope, hydraulic fluids, used oils and oil filters, rigwash, spilled fuel, drill cuttings, drums and containers, spent and unused solvents, paint and paint wastes, sandblast media, scrap metal, solid waste, and garbage.
- According to the American Petroleum Institute, approximately 146 million barrels of drilling waste were produced in the U.S. 1995.[58] Drilling fluids and drill cuttings are the largest sources of drilling wastes.[59]

Drilling Fluid/Mud

- Drilling fluids or muds are made up of a base fluid (water, diesel or mineral oil, or a synthetic compound); weighting agents (most frequently barite is used); bentonite clay to help remove cuttings from the well and to form a filter cake on the walls of the hole; chrome lignosulfonates and lignites to keep the mud in a fluid state; and various additives that serve specific functions, such as biocides, diesel lubricants and chromate corrosion inhibitors.
- Whether the drilling muds are water-based, oil-based, or synthetic-based largely depends upon the drilling conditions encountered.
- Water-based muds (WBMs) are used most frequently. They are the least expensive of the major types of drilling fluids. This is mainly because water-based drilling wastes are less toxic than the alternatives, and often can be discharged on site. For difficult drilling situations, such as wells drilled in reactive shales, deep wells, and horizontal and extended-reach wells, WBMs do not offer consistently good drilling performance. For these types of drilling situations at onshore sites, the industry relies primarily on oil-based muds (OBMs).[60]

FIGURE I-6. DEWATERED DRILLING MUD
Is often buried on-site.

- Oil-based muds commonly are used while drilling deep wells, high-pressure shales, or during high-angle directional drilling because oil components (such as diesel or mineral oil) can avoid the pore-clogging that may occur with water-based mud. The downside of OBMs is the high cost, as well as the cost of disposing of the oil-contaminated drill cuttings, which contain hazardous chemicals, e.g., polycyclic aromatic hydrocarbons (PAHs), which may cause cancer, organ damage and reproductive effects.[61]
- Since 1990, the oil and gas industry has been developing a number of synthetic-based muds (SBMs), which are less toxic than oil-based muds. Instead of diesel or mineral oils, SBMs use internal olefins, esters, linear alpha-olefins, poly alpha-olefins, and linear paraffins. SBMs are free of PAHs, which decreases the toxicity of these muds.[62] Under certain circumstances, SBMs are used in place of OBMs or WBMs.
- Muds usually contain bentonite clay and other additives. Bentonite is a very expansive soil

material. This may create a site with the potential for great soil volume change, and possibly damage to surface structures. The common practice for disposing of drilling muds is to either bury the mud reserve pit, or discharge the mud to the surface. For landowners who may want to build on what was previously a drill site, it is worth noting that in order to be eligible for FHA mortgage insurance, all unstable and toxic materials must be removed and the pit must be filled with compacted selected materials.[63]

- Wastes that may be associated with drilling fluid include oil derivatives (e.g., PAHs), spilled chemicals, and empty containers.[64] Drilling muds that circulate through the well and return to the surface may contain dissolved and suspended contaminants including cadmium, arsenic, and metals such as mercury, copper and lead; hydrocarbons; hydrogen sulfide and natural gas,[65] as well as drilling mud additives, many of which contain potentially harmful chemicals (e.g., chromate, barite).

Drill Cuttings

- The main toxic agents in drilling cuttings are oil and oil products. These accumulate in the solid phase of drilling cuttings when crude oil and oil-based drilling fluids contact cuttings during the drilling process.[66] Rock cuttings may also contain arsenic or metals depending upon the geology.[67]
- Cuttings may be spilled around the well pad due to high pressures, dangerous working conditions, and lack of government oversight of drilling operations.[68]
- In West Virginia, the Department of Mines, Minerals and Energy (DMME) received complaints from residents about soap bubbles flowing from residential faucets. The DMME attributed this to the drilling process associated with coalbed methane well installation. Soaps and other substances are used to extract drilling cuttings from the borehole because the foam expands and rises. As it rises, it carries the cuttings to the surface. During drilling of the shallow portion of the well (and before the required groundwater casing is cemented in place) these drilling fluids may migrate from the borehole into the groundwater zone that supplies private wells. In the incidents of soap contamination in West Virginia, water was provided to the affected residents until the soaps were completely purged from the area surrounding their water well.[69]

Waste Disposal

- Onshore oil production operations produce quantities of cuttings and mud ranging from 60,000 to 300,000 gallons per day. Lined pits for disposal and storage are sometimes used, but mud, drill cuttings and other materials are often discharged into unlined pits, allowing potentially toxic substances to seep into the ground.[70] If improperly fenced, these pits can be a hazard for livestock and wildlife.
- While it is common for oil and gas companies to drain off fluids from drilling mud pits, it is very common for companies to simply bury the remaining solids in place or spread them on the lease site.[71]

Blowouts

- Well blowouts are rare, but can be extremely serious. Blowouts have been known to completely destroy rigs and kill nearby workers. They are most likely to occur during drilling, but can occur during any phase of well development including production (especially during well workover operations). If the pressure exerted by the geological formation is much higher than that exerted by the drilling fluid, then the gas, oil or other fluids in the well may rise uncontrollably to the surface. Equipment that is within the well may also be thrust to the surface. If there is a significant quantity of natural gas in the blowout materials, the fluid may ignite from an engine spark or other source of flame. Some blowouts are controlled in a matter of days, but others have taken months to cap and control.[72] The section on Impacts Associated with Oil and Gas Operations has more information on blowouts.

Surface and Other Disturbances—Tips for Landowners

- Revegetation of the pad surface and pipeline rights-of-way with native grasses is one of the best methods for controlling the spread of noxious weeds.[73]
- Lined pits or preferably tanks should be used to store spent mud, drill cuttings and solids, water used to wash any machinery, and surface runoff from the drilling area. These waste materials should be transported to a proper disposal site.
- Pitless or closed-loop drilling, which does not require pits for disposal of drilling wastes, is an option that reduces the potential for soil and water contamination. More details on pitless drilling are included in Alternative Technologies and Practices later in this chapter.
- Some traditional drilling fluid additives are toxic, but substitutes do exist: 1) replacement of chrome lignosulfonate dispersants with chrome-free lignosulfonates and polysaccharide polymers; 2) use of amines instead of pentachlorophenols and paraformaldehyde as biocides; 3) lubrication with mineral oil and lubra-beads instead of diesel oil.[74]
- Instead of disposing of drilling fluids in pits on-site, companies can use filtration processes to recondition the mud, so that it can be used for multiple wells before being discarded. Other possible uses for used drilling fluids include using it to plug unproductive wells or to spud in new wells.[75]

2. FIELD ORGANIZATION

This stage is primarily administrative, and usually involves government regulators. The purpose of field organization is to make the development of the oil or gas field more financially lucrative by creating a system for efficiently extracting the oil and gas from a particular region or field. Well spacing, pooling, and unitization are examples of organizational techniques that are applied during this stage.

It is during this stage of development that many citizens become involved because the impacts are broadly distributed over a geographic area (i.e., the oil or gas field), and governments often provide the public with an opportunity to comment on how the development might occur.

Well Spacing

Through well testing and geologic analyses it is possible to estimate the volume of oil and gas in a particular reservoir that can be drained by a single well, and then estimate how many wells will be needed to drain all of the oil or gas from the reservoir. Using these types of calculations, state governments determine how close together the wells need to be located (i.e., the well density) to most efficiently and economically drain the reservoir. The state agencies then define the number of wells that can be drilled in a specified surface area (usually per acre). The area allocated by the state for the drilling of an oil or gas well is sometimes referred to as the ***drilling unit.***

Typically, states enact spacing laws on a state-wide basis. States may also adopt different rules for particular fields.

- For example, in Colorado an operator can generally drill one well per 40 acres per formation anywhere in the state, unless there is an existing field rule in place, like the Ignacio-Blanco field rule in Southwestern Colorado. As of May, 2005, the Ignacio-Blanco field rule allows only one well to be drilled into the Fruitland Formation per every 160 acres.

Spacing rules apply to geological formations. That means if there are two or more formations that produce gas or oil in an area, then it is possible to end up with many more wells.

- For instance, in Southeast Colorado there are two major producing formations for coalbed methane: the Vermejo and Raton formations. In that region, an operator is allowed to drill

two wells per 40 acres – one well to access the methane in the Vermejo formation, and one to access methane in the Raton formation. In that situation, however, the wells must be located on the same pad unless the operator gets a variance or exception to the rule.

Spacing requirements vary drastically from state to state. For example, in California, wells can be spaced as closely as one well per acre; while in Florida, gas wells are spaced at one well per 640 acres.[76] Shallow wells are usually spaced more closely together than deep wells. For more information on spacing requirements, the Interstate Oil and Gas Compact Commission has produced a summary of the various spacing requirements on a state-by-state basis.[77]

Downspacing and Public Health and Safety Concerns

In the 30,000-acre Jonah conventional natural gas field in Wyoming, industry hopes to use 20-acre well spacing (32 well pads per section of land) instead of the current 40-acre spacing. The industry proposal would increase six-fold the number of permitted natural gas wells in the Jonah Field (from about 500 to more than 3,000). If this were to occur, it is likely that air quality for the entire area would fail both national and Wyoming ambient air-quality standards. Consequently, in order to protect public health and safety, federal Bureau of Land Management officials have been discussing closing all public roads into the Jonah Field and forbidding any hunting or discharge of firearms in the 30,000-acre area.

Photo at right shows Jonah Field with 40-acre spacing of gas wells.

Adapted from: Taylor, Meredith. Fall, 2003. "Industry Stakes its Claim to the Upper Green's Public Lands,"[78] Photo credit: Image by SkyTruth for the Upper Green River Valley Coalition.

Well Spacing—Tips for Landowners

- Landowners should be aware that it is not uncommon for well spacing densities to change over time. While the state sets the initial well density requirements for an area, it is common for companies to later request that the wells be more closely spaced together. When states increase the number of wells that can be located in an area, it is referred to as ***infilling*** or ***downspacing***. Landowners who buy land thinking that there will not be oil and gas development on their property (based on current well density regulations) may be shocked to find that a few years after buying property the spacing regulations have changed, and that there are wells proposed on their land. See the story "County officials say residents ignored," in Chapter IV for an example of downspacing.
- Additionally, companies are sometimes exempted from the spacing requirements. A state's spacing regulations usually mention the conditions under which a company may be exempted from the spacing rules.
- Within the drilling unit, some states may designate a ***drilling window***, which is an area within a drilling unit where wells may be drilled. The location of the drilling window is dependent on a number of factors. In many states, wells cannot be drilled within a certain distance of homes. So, if there are a number of homes within a drilling unit, there may be a limited number of areas that can be used for drilling. In many states, however, it is not uncommon for com-

panies to apply for waivers, which allow them to drill outside the drilling window. Sometimes the waiver requires that if drilling occurs at a surface location outside the drilling window, the company must still hit the targeted drilling window at a certain depth (e.g., by using directional or horizontal drilling techniques).

Mineral Pooling

Often, mineral leases cover much smaller areas than the drilling units designated by the state. If this is the case, a company may pool two or more leases to create a tract that is sufficient in size to form a drilling unit for a single well.

- For example, in Colorado, an operator needs 40 acres to drill a well (unless there is a field-wide spacing rule in place). To obtain the 40 acres, the operator may have to lease minerals from 4 contiguous mineral owners that each own 10 acres. In addition to acquiring a minimum of 40 acres, those 40 acres may have to be located in a particular area. Typically, the 40 acres represent a quarter-quarter section of land (to ensure that drilling occurs in a uniform pattern of 4 wells per quarter section or 16 wells per section).

When mineral leases are pooled into a drilling unit, the mineral owners share proportionately in the proceeds from oil and gas production. For instance if you own 10 acres and are in a 40 acre unit, your income will be figured as 1/4 of the unit's production multiplied by your royalty interest.

Before a company can develop on a pooled unit, approval must be obtained from state agencies. It is sometimes the case that not all mineral owners within a drilling unit want to pool their minerals to allow for oil and gas extraction. For example, they may want to wait until gas prices are higher before they develop their minerals, or wait until technologies can be developed that cause less impact on the surface property. Unfortunately, for mineral owners who want to resist development of oil and gas, many states have what are known as ***force pooling*** laws. These laws allow mineral properties to be pooled into a drilling unit and developed without the consent of all of the mineral owners.

Force pooling laws can be of assistance to mineral owners who are concerned that their oil and gas resources are being removed without any compensation. When companies drill for oil or gas on a particular property, they will usually drain the resources that are located adjacent to that property. If mineral owners suspect that a well on a neighboring property is draining the oil or gas on their property, they can go to the state agencies (usually oil and gas boards or commissions) and request that the company be forced to pool their minerals with their neighbor's minerals, thereby allowing them their share of the profits.

Mineral Pooling—Tips for Mineral Owners

Participate in pooling hearings. When a pooling application is filed by a company, a hearing is held by the state to determine whether the pooled unit complies with the pertinent laws. These are the hearings that mineral and surface owners should attend if they want to protest the pooling terms. If mineral owners do nothing, they will be deemed to have accepted the terms approved in the hearing.[79]

In many states, these hearings are not held in the mineral owner's community, but rather, are held in a larger city (often the state capital), which does not make it easy for mineral owners to participate. In Michigan, a bill was passed in 1998 that helped to lessen the burden on mineral owners who were being force pooled by energy companies. This law moved the administrative hearings from the larger city to a community in the mineral owners' region.[80]
If mineral owners have not yet leased their mineral rights, and they are approached by a company about leasing, they are usually presented with three options.

1. Negotiate and sign a lease and take the offered bonus and royalty interest.
2. Decide to not sign and likely be force pooled under terms established by the state.
3. Elect to participate in the well and pay their proportionate share of the drilling and completion costs in order to receive their pro rata payout as a working interest owner.

It is important to look into the pooling laws in the state where your property is located, or talk with a lawyer, in order to evaluate which of these options works best for you.

For more resources on force pooling, see references to East of Huajatolla Citizens Alliance information sheets in Chapter V. And for landowner experiences with force pooling, refer to Chapter IV stories: "Threats and Intimidation—This is Called Negotiation? Force Pooling an Affront"; "State Could Force Property Owners to Allow Drilling"; and Terry Fitzgerald's story.

Unitization

Unitization is the process of bringing together a group of drilling units (see pooling above) to form a large operating area. Typically, there are several operators in the operating area. Unitization takes place through an order from a state agency, and participation by operators may occur either voluntarily or involuntarily. Unitization orders may specify things such as well spacing or extraction rates in order ensure that all operators are working together to efficiently and effectively remove the oil or gas from the operating area. Unitization often occurs when an older field's production has begun to decline and it is necessary to utilize secondary recovery practices such as water or CO_2 flooding techniques to stimulate more production. As a result of a compulsory unitization statute for oil and gas reservoirs, Louisiana's oil and gas wells are, on average, one-third more productive than those in Texas, which does not require unitization.[81]

For more information on spacing, pooling and unitization (including federal units), visit the OGAP website (www.ogap.org).

3. PRODUCTION

The first step in production is to complete the well and start the well fluids flowing to the surface. Stimulation techniques may be used to enhance the flow of fluids during well completion. Once the fluid begins flowing, it must be separated into its components of oil, gas, and water. Finally, the oil and gas are treated, measured, and tested before being transported to the refinery. In addition to extracting and transporting the oil and gas, other tasks carried out during the production stage include: production enhancement, which uses techniques similar to those used to stimulate wells; well servicing, which includes routine maintenance operations such replacing worn or malfunctioning equipment; and well workover, which is more extensive equipment repair.

Well Completion

To begin completing a well, casing material (usually steel pipe) is inserted into the well bore. As with the casing used during the drilling stage, the casing material is supposed to prevent the oil or gas from contaminating groundwater, and stop the walls of the hole from collapsing. Cement is pumped down the casing to fill the space between the casing and the walls of the drilled hole. This is done to protect the casing and to further decrease movement of oil, gas or other fluids into ground water or rock formations.

When cementing of the casing is completed, the drilling rig and other associated equipment are removed from the site, and a smaller rig (a workover or completion rig) is moved over the well bore to finish the well completion. This rig is used to puncture or perforate the casing at specific locations where the casing comes in contact with the formations that contain oil or gas. The oil and gas can then enter the well through these perforations.

Next, tubing, which will carry the oil or gas to the surface, is threaded into the casing. At the surface, a well head (sometimes referred to as a Christmas tree) is installed, which has valves that control the flow of oil or gas from the well. The valves connect the well to equipment that will separate the oil, gas and water, and remove impurities. Finally, a pipeline connection or storage tank is connected to the well to allow for transport or storage of the product. In the case of natural gas, which cannot be stored easily, a pipeline connection is necessary before the well can be placed into production.

If there is not enough pressure in the reservoir to force the oil, gas or produced water to flow naturally to the surface, pumping is necessary.[82] Pumping equipment is installed at the lower end of the tubing. There are many different types of pumps that can be used: beam pumps; gas lift: piston pumps; submersible pumps; jet pumps and pneumatic pumps. The power to operate these pumps may be supplied by a gas or diesel engine or an electrical motor.

A number of pits may be constructed at this stage. These may include a skimming pit, which reclaims residual oil removed with produced water; a sediment pit, which stores solids that have settled out in storage tanks; or a percolation or evaporation pit, to dispose of produced water.[83]

Stimulation

Often an oil- or gas-bearing formation may contain large quantities of oil or gas, but have a poor flow rate due to low permeability, or from damage or clogging of the formation during drilling.[84] This is particularly true for tight sands, oil shales and coalbed methane, discussed later in this chapter. Stimulation techniques may be used prior to production, or during maintenance operations that take place after the well has been put into production. In later years, when the flow of oil or gas from a well begins to decline, stimulation techniques, as well as other enhancement techniques, may be used to encourage oil or gas to flow to those wells. Some of the more common stimulation techniques include: hydraulic fracturing; acidizing; and cavitation, which will be described in the section on coalbed methane.

Hydraulic fracturing (also known as fracing, which rhymes with cracking) is a technique used to create fractures that extend from the well bore into rock or coal formations. These fractures allow the oil or gas to travel more easily from the rock pores, where the oil or gas is trapped, to the production well.[85] Typically, in order to create fractures a mixture of water, proppants (sand or ceramic beads) and chemicals is pumped into the rock or coal formation. Eventually, the formation will not be able to absorb the fluid as quickly as it is being injected. At this point, the pressure created causes the formation to crack or fracture. The fractures are held open by the proppants, and the oil or gas is then able to flow through the fractures to the well.[86] Some of the fracturing fluids are pumped out of the well during the process of extracting oil, gas and any produced water, but studies have shown that anywhere from 20-40% of fracing fluids may remain underground.[87]

FIGURE I-7. CHRISTMAS TREE
The wellhead of a gas well. The first step as natural gas leaves the ground. Photo by OGAP.

FIGURE I-8. MUD RESERVE PIT
Torn liners can lead to groundwater contamination.

FIGURE I-9. WASTE PIT
Waste pits for fluids and sediments associated with gas processing. These can contain water, sand, hydrocarbons, glycol and other chemicals.

Acidizing involves pumping acid (usually hydrochloric acid), into the formation. The acid dissolves some of the rock material so that the rock pores open and fluid flows more quickly into the well. Fracing and acidizing are sometimes performed simultaneously, in an acid fracture treatment.[88]

Stimulation—Issues and Impacts

Potential Groundwater Contamination—Coalbed fracture treatments use anywhere from 50,000 to 350,000 gallons of various stimulation and fracturing fluids, and from 75,000 to 320,000 pounds of proppant during the hydraulic fracturing of a single well.[89] Many fracturing fluids contain chemicals that can be toxic to humans and wildlife, and chemicals that are known to cause cancer. These include potentially toxic substances such as diesel fuel, which contains benzene, ethylbenzene, toluene, xylene, naphthalene and other chemicals; polycyclic aromatic hydrocarbons; methanol; formaldehyde; ethylene glycol; glycol ethers; hydrochloric acid; and sodium hydroxide.[90] Very small quantities of chemicals such as benzene, which causes cancer, are capable of contaminating millions of gallons of water.

FIGURE I-10. FRAC PIT
Unlined pits may allow toxic fracing fluids to seep into soil and contaminate groundwater.

As mentioned previously, hydraulic fracturing is used in many coalbed methane (CBM) production areas. Some coal beds contain groundwater of high enough quality to be considered ***underground sources of drinking water*** (USDWs). According to the U.S. Environmental Protection Agency (EPA) ten out of eleven CBM basins in the U.S. are located, at least in part, within USDWs. Furthermore, EPA has determined that in some cases, hydraulic fracturing chemicals are injected directly into USDWs during the course of normal fracturing operations.[91]

Calculations performed by EPA show that at least nine hydraulic fracturing chemicals may be injected into or close to USDWs at concentrations that pose a threat to human health. These chemicals may be injected at concentrations that are anywhere from 4 to almost 13,000 times the acceptable concentration in drinking water.[92] (See Peggy Hocutt's letter and Laura Amos' story in Chapter IV, to read landowner stories about how hydraulic fracturing of coalbeds and other geological formations has affected drinking water.)

Not only does the injection of these chemicals pose a short-term threat to drinking water quality, it is quite possible that there could be long-term negative consequences for USDWs from these fracturing fluids. According to the EPA study, and studies conducted by the oil and gas industry,[93] between 20 and 40% of the fracturing fluids may remain in the formation, which means the fluids could continue to be a source of groundwater contamination for years to come.

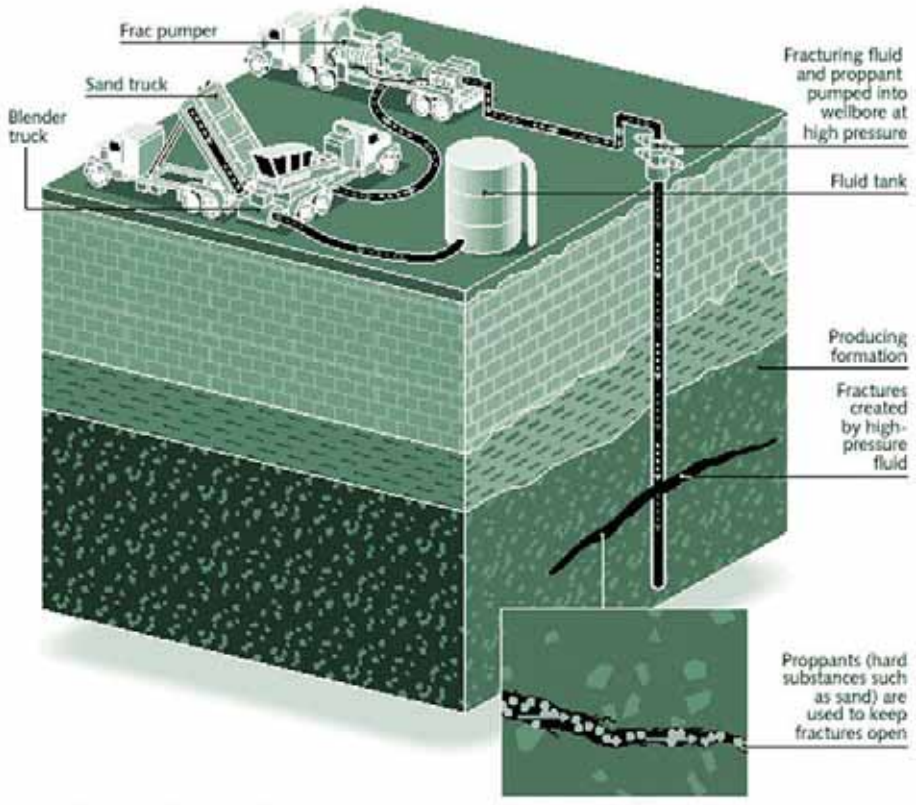
The potential long-term consequences of dewatering and hydraulic fracturing on water resources have been summed up by professional hydrogeologist who spent 32 years with the U.S. Geological Survey:

> *At greatest risk of contamination are the coalbed aquifers currently used as sources of drinking water. For example, in the Powder River Basin (PRB) the coalbeds are the best aquifers. CBM production in the PRB will destroy most of these water wells; BLM predicts drawdowns...that will render the water wells in the coal unusable because the water levels will drop 600 to 800 feet. The CBM production in the PRB is predicted to be largely over by the year 2020. By the year 2060 water levels in the coalbeds are predicted to have recovered to within 95% of their current levels; the coalbeds will again become useful aquifers. However, contamination associated with hydrofracturing in the basin could threaten the usefulness of the aquifers for future use.*[94]

One potentially frustrating issue for surface owners is that it may not be easy to find out what chemicals are being used during the hydraulic fracturing operations in your neighborhood. According to the Natural Resources Defense Council, attempts by various environmental and ranching advocacy organizations to obtain chemical compositions of hydraulic fracturing fluids have not been successful because oil and gas companies refuse to reveal this "proprietary information."[95]

As mentioned above, anywhere from 20-40% of fracing fluids remain in the ground. Some fracturing gels remain stranded in the formation, even when companies have tried to flush out the gels using water and strong acids.[96] Also, studies show that gelling agents in hydraulic fracturing fluids decrease the permeability of coals, which is the opposite of what hydraulic fracturing is supposed to do (i.e., increase the permeability of the coal formations). Other similar, unwanted side effects from water- and chemical-based fracturing include: solids plugging up the cracks; water retention in the formation; and chemical reactions between the formation minerals and stimulation fluids. All of these cause a reduction in the permeability in the geological formations.[97]

From a public health perspective, if hydraulic fracturing stimulation takes place, the best option is to fracture formations using sand and water without any additives, or sand and water with non-toxic additives. Non-toxic additives are being used by the offshore oil and gas industry, which has had to develop fracturing fluids that are non-toxic to marine organisms.[98]



High-pressure fluid creates cracks extending 300 metres (990 feet) or more into the producing formation. Sand props open the cracks, which are typically five to ten metres high but only two to six millimetres wide (0.078 to 0.236 inches).

FIGURE I-11. DIAGRAM OF HYDRAULIC FRACTURING OPERATION.
Source: Petroleum Communication Foundation. (Canadian Centre for Energy Information). 1999.[99]

It is common to use diesel in hydraulic fracturing fluids. This should be avoided, since diesel contains the carcinogen benzene, as well as other harmful chemicals such as naphthalene, toluene, ethylbenzene and xylene. According to the company Halliburton, "Diesel does not enhance the efficiency of the fracturing fluid; it is merely a component of the delivery system."[100] It is technologically feasible to replace diesel with non-toxic "delivery systems," such as plain water. According to the EPA, "Water-based alternatives exist and from an environmental perspective, these water-based products are preferable."[101]

Stimulation—Tip for Landowners

The law requires that all employees have access to a Material Safety Data Sheet (MSDS), which contains information on health hazards, chemical ingredients, physical characteristics, control measures, and special handling procedures for all hazardous substances in the work area. The MSDSs are produced and distributed by the chemical manufacturers and distributors. It should be noted that MSDSs may not list all of the chemicals or chemical constituents being used (if they are trade secrets).[102] Landowners may be able to obtain copies of MSDSs from company employees, the chemical manufacturers, or possibly from state agency representatives.

For more information on impacts associated with hydraulic fracturing, and alternative fracturing techniques, please visit the Oil and Gas Accountability web site: http://www.ogap.org .

Well Testing

After the well has been drilled, and before production begins, the reservoir pressure is tested. Prior to testing, however, large volumes of debris, fluids and gases must be cleaned out of the well bore. For example, any fluid, rock debris and sand remaining in the well bore and surrounding reservoir from stimulation activities (e.g., cavitation or hydraulic fracturing) has to be cleaned out. The conventional method for doing this is to pump air down the well bore to lift the sand and fracturing fluid up and out.[103] These wastes are usually dumped into earthen pits.

Natural gas is mixed in with the air, sand and liquids exiting the well bore. These gases are either "blown off" (i.e., vented to the atmosphere) or "burned off" (i.e., flared).

During the well test, the gas in a newly drilled well is allowed to flow freely for a number of days while the rate-of-flow and pressure of the gas in the reservoir are measured. According to the Pembina Institute for Appropriate Development, "a company can normally get enough data in one to three days, [therefore] well testing should be minimized and not exceed three days, especially when there is flaring or direct venting to the atmosphere."[104]

Well Testing—Tips for Landowners

- To minimize potential environmental impacts from the storage of solid and liquid wastes that flow from the well, "flowback units" rather than earthen pits should be used. Also, "flareless completions" or "green completion" techniques can be used to minimize the air pollution from the venting or flaring of natural gas during the well clean-up and testing phases.
- For more information on both of these technologies, see the section on Alternative Technologies and Practices, later in this chapter.

Oil and Gas Treatment and Conditioning

The fluids that flow or are pumped to the surface from conventional oil or gas wells include a mixture of oil, water, various gases and dissolved and suspended solids.[105] Before oil and natural gas can be marketed, the fluids must go through a ***treatment*** process to separate out water and remove dangerous gases and other impurities. Some of the treatment can occur at the well site (***field processing***). After initial treatment, however, the crude oil or natural gas is sent through a pipeline to a centralized processing facility such as an oil battery or a gas plant.

Gathering is the movement of bulk oil or gas from a production well to the treatment facility.

Below is a general overview of some of the processes involved in preparing the oil and gas for sale.

If crude oil is being recovered: Some separation of associated natural gas from the raw crude oil may occur at the wellhead. The most basic type of separator is known as a conventional separator. It consists of a simple closed tank, where the force of gravity serves to separate the heavier liquids like oil, and the lighter gases, like natural gas. The natural gas may be captured and sold, but often it is simply flared or vented to the atmosphere. Flowlines or gathering lines move the raw crude oil to an oil battery, for additional conditioning before sending the oil to a refinery. At the oil battery, the fluids pass through a production separator, which separates gases from the oil and water. The oil and water then go to a heater treater, where the oil is separated from the water and any solids that are present. The crude oil is at least 98% free of solids after it passes through this treatment.[106] The oil is then piped to a storage facility, where it remains until it is transported offsite by either trucks or by pipeline.

If a gas pipeline or gas transportation vehicles are present, the gases may be transported to a gas plant for processing into products such as methane, ethane, propane, and butane. Alternatively, the gases may be treated as a waste product, and be vented or flared.[107] The water and solids removed may be piped to a pit, a tank, or into a flowline leading to an underground disposal well.[108]

If natural gas is being recovered: Natural gas conditioning methods will be used to remove impurities from the gas so that it meets the quality required to be accepted by gas transportation systems. This is not always necessary, as some natural gas is pure enough to pass directly into the pipeline. Often, the most significant impurity is hydrogen sulfide (H_2S). Other impurities that may have to be removed include: water vapor, natural gas liquids, sand, nitrogen, and aromatic compounds such as benzene, toluene, ethylbenzene, and xylene.

Sweetening removes H_2S from the gas. The most common method of sweetening involves exposing the gas to an amine solution, which reacts with H_2S and separates it from the natural gas. The H_2S may be disposed of by flaring, incineration, or, if a market exists, by sending it to a sulfur-recovery facility. Another sweetening method uses an iron sponge, which reacts with H_2S to form iron sulfide. The iron sulfide is oxidized, then buried or incinerated.[109]

Dehydration removes water from the gas. The most common dehydration method used at the wellhead is glycol dehydration. In this method, gas is exposed to glycol, which absorbs the water. The water can be evaporated from the glycol so that the glycol can be reused. If the gas is sent to a natural gas plant for processing, solid desiccants are more commonly used to remove the water. Solid desiccants are crystals that have large surface areas that attract water molecules. Like glycol, these desiccants can be reused after water has been removed from them. If gas is extracted from deep, hot wells, simply cooling the gas to a low enough temperature can remove enough water to allow it to be transported.[110]

FIGURE I-12. NATURAL GAS DEHYDRATOR. Source of benzene.

FIGURE I-13. GAS PROCESSING PLANT. Source of NO_X.
Photo by Dan Randolph

FIGURE I-14. WELLHEAD COMPRESSORS
With and without sound abatement.

FIGURE I-15. COMPRESSOR STATION Source of NO_X.

FIGURE I-16. SEPARATOR AND STORAGE TANK FOR THE SEPARATED LIQUIDS

Natural gas coming directly from a well contains many natural gas liquids (NGLs), e.g., ethane, propane, butane, iso-butane, and natural gasoline. NGLs often have a higher value when sold as separate products, making it economical to remove them from the gas stream. The removal of natural gas liquids usually takes place in a centralized processing plant, and uses techniques similar to those used to dehydrate natural gas.[111]

In addition to the processes mentioned above, scrubbers and heaters are installed either at or near the wellhead. The scrubbers remove sand and other large-particle impurities. The heaters ensure that the temperature of the gas does not drop too low and form natural gas ***hydrates***, which are solid or semi-solid compounds that resemble ice crystals. Should these hydrates accumulate, they can impede the passage of natural gas through valves and gathering systems. In addition to wellhead heaters, small natural gas-fired heating units are typically installed along the gathering pipe wherever it is likely that hydrates may form.[112]

While some of the processing can be accomplished at or near the wellhead, the complete processing of natural gas takes place at a processing plant. The extracted natural gas is transported to these processing plants through a network of gathering pipelines, which are small-diameter, low pressure pipes. Some gathering systems are quite complex, consisting of thousands of miles of pipes that connect the processing plant to as many as 100 wells in the area. Should natural gas from a particular well have high sulfur and carbon dioxide contents, a specialized sour gas gathering pipe must be installed.

If the natural gas is being piped into larger pipelines, such as interstate pipelines, it must be compressed. To ensure that the natural gas flowing through any one pipeline remains pressurized, compressor stations are usually placed at 40-100-mile intervals along the pipeline. The natural gas enters the compressor station, where it is compressed by a gas-powered turbine, electric motor, or gas powered engine.

It is not uncommon for a certain amount of water and hydrocarbons to condense out of the gas stream while in transit. Thus, in addition to compressing natural gas, compressor stations often contain a liquid separator that has scrubbers and filters to remove liquids or other undesirable particles from the natural gas in the pipeline.

In some regions, such as the Appalachian states, natural gas might not require sweetening or extensive dehydration. Therefore, the gas may be piped directly from the wellhead to a main transmission line and, in some cases, directly to the customer. Compressor stations are located as needed along the pipelines that run between the wellhead and the main transmission line or the customer to maintain pressure in the lines.[113]

Compressors vary in size. Some compressors serve an individual well (wellhead compressors); others may serve a number of wells.

Production Enhancement

A variety of techniques are used to enhance the flow of oil or gas during operations. Some of these techniques are the same ones used to stimulate flow during well completion, e.g., hydraulic fracturing and acidizing.

For enhancement of oil production, a common technique is known as waterflooding. This technique enhances oil recovery by injecting water to build up the pressure in the reservoir, thus, forcing more oil into the well.

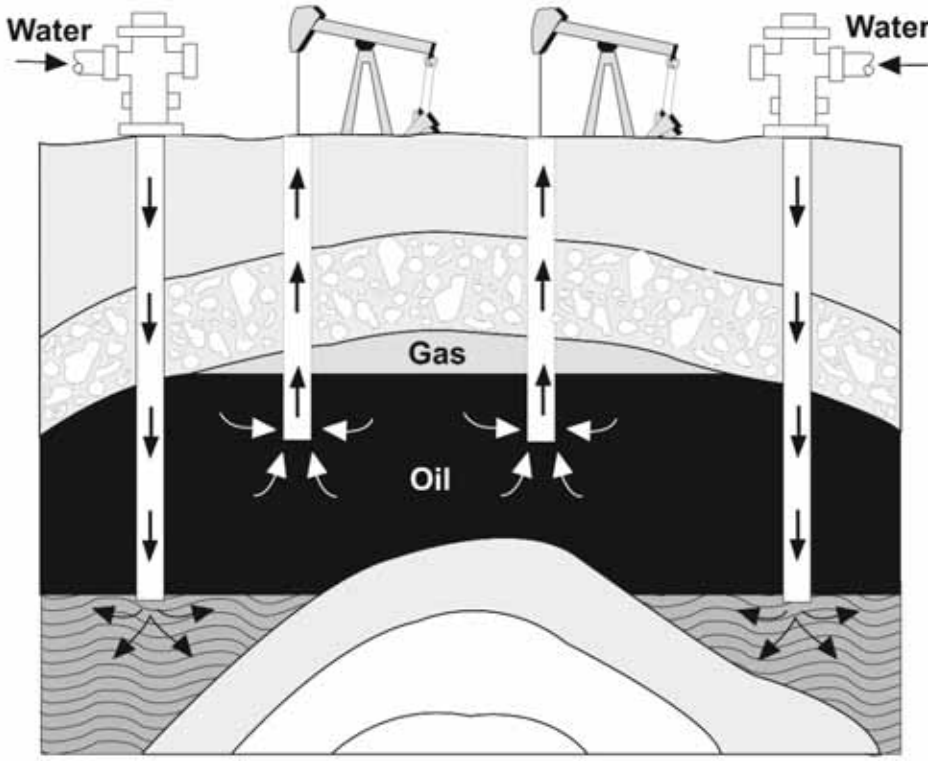


FIGURE I-17. OIL PRODUCTION ENHANCEMENT USING THE WATERFLOODING TECHNIQUE.
Source: Energy Information Administration, Department of Energy, 1991.[114]

Often, produced water is used for the waterflooding operation. Produced water should be thoroughly treated before injection so that it is free of solids, bacteria, and oxygen, all of which could contaminate the oil reservoir and, in the case of sulfur-reducing bacteria, could lead to increased hydrogen sulfide concentrations in the extracted oil.[115]

Other methods of enhancement may be used, but are often more expensive and energy intensive than waterflooding. Examples include:[116]

- Thermal recovery, where the reservoir fluid is heated through the injection of steam or by controlled burning within the reservoir. Heating makes the fluid less viscous and more conducive to flow. This technique is used to stimulate the flow of heavy oils from oil shales and tar sands.
- The injection of carbon dioxide or alcohol, which reduce oil density, allowing the oil to rise to the surface more easily.
- The injection of surfactants, which are substances that essentially wash the oil from the reservoir.
- Microbial enhanced recovery, where oxygen and microbes capable of digesting heavy oil and asphalt are injected into the formation, freeing up the lighter oil to flow to the surface.

Maintenance Procedures

Production wells require ongoing maintenance, such as replacing worn or malfunctioning equipment and painting and cleaning the equipment. Periodically,oil and gas operations require significant maintenance, called workovers. During a workover several tasks may be undertaken such as: repairing leaks in the casing or tubing; stimulating the well; perforating a different section of casing to produce from a different formation in the well; applying corrosion-prevention compounds; and removing accumulated salts (scale) and paraffin from production tubing, gathering lines, and valves.

Oil and Gas Processing, Refining and Transportation

There are a host of issues related to large oil and natural gas processing facilities, refineries and pipelines. It is beyond the scope of this guide to go into detail on all of the issues related to oil or gas once it leaves a surface owner's property. For more information, refer to the resources in Chapter V.

FIGURE I-18. SURFACE DISTURBANCE CREATED BY PIPELINE CORRIDORS

PRODUCTION STAGE—ISSUES AND IMPACTS

Surface Disturbance

- Additional land disturbance may occur as a result of the construction of production facilities and infrastructure such as compressors, pipelines, etc.
- Reclamation of areas disturbed during the drilling process should be conducted during the production stage. This is known as ***interim reclamation***.

Air Pollution

There are a number of pollutants that are associated with the production stage. These include volatile organic compounds (VOCs), nitrogen oxides, sulfur dioxide, carbon monoxide, benzene, toluene, ethylbenzene, xylene, polycyclic aromatic hydrocarbons, hydrogen sulfide, particulate matter, ozone and methane. For more information on these air emissions, read about Impacts Associated with Oil and Gas Operations.

In 2001, the oil and gas industry in the U.S. vented and flared about 86 billion cubic feet of gas.[117] Not only do venting and flaring waste natural gas (which should be a concern for mineral owner who would have received royalties on the gas), these emissions also contribute to air pollution and greenhouse gases in the atmosphere.

FIGURE I-19. VENTING OF GAS WELL
Source of methane, a greenhouse gas.

Venting of natural gas may occur during:

- Well testing.
- Oil and gas processing. Solution gases from oil wells, batteries or tanks, and natural gas from compressor vents, instrument gas stations, pneumatic devices, dehydrators and storage tanks may be intentionally or unintentionally released.
- Pipeline maintenance operations. Prior to any work on a pipeline, gases in the line are purged and may be vented directly to the atmosphere.

FIGURE I-20. FLARING DURING COMPLETION OF A COALBED METHANE WELL.
Photo by OGAP.

Flaring of natural gas may occur during:

- Well testing.
- Cavitation and hydraulic fracturing (see flareless completions in the section on Alternative Technologies and Practices later in this chapter)
- Oil processing. It occurs at batteries where oil is processed and stored. These flares burn constantly, because gas is a by-product of oil production. Known as solution gas, this gas is the largest source of flaring in Alberta, Canada.[118]
- Gas processing. At processing plants, gas by-products that have no market are burned off. Gas may also be flared during emergency situations.
- Pipeline maintenance operations. Prior to work on a pipeline, gases in the line are purged and may be flared.

It has been argued that flaring is better than allowing the gases to be vented directly into the atmosphere because of the health threats posed by some of these substances (e.g., H_2S). While it is true that flaring can

greatly reduce the concentrations of H_2S that would otherwise be vented to the atmosphere, it must be noted that flaring still allows low levels of that compound to be emitted. Moreover, it has been demonstrated that only 66-84% of flared gases are fully combusted.[119] Research has shown that incomplete combustion from flaring releases as many as 250 hazardous air pollutants that include: nitrogen oxides, sulfur dioxide, benzene, toluene, ethylbenzene and xylene, polycyclic aromatic hydrocarbons (PAHs) and, in the case of sour gas, hydrogen sulfide and carbon disulfide. Some of these, such as benzene and some PAHs are cancer-causing, while others (e.g., toluene, ethyl benzene, xylenes) are also known to affect human health (e.g., reproduction, respiratory systems).[120]

Emissions from flaring, especially during well testing, can result in high ground-level concentrations of pollutants. Depending on the levels, these substances may affect the health of humans and other animals and vegetation. For more information on air pollution from flaring, read about Impacts Associated with Oil and Gas Operations, in this chapter, and landowner stories in Chapter IV.

The following alternative practices may be used to reduce venting and flaring:[121]

- Well testing: In some cases, the need for well test flaring may be eliminated by conducting in-line testing through a pipeline to a processing facility. If, however, test flaring cannot be avoided, the use of improved well-logging instrumentation, and the use of existing reservoir data from previous well tests should be able to significantly shorten the duration of the test.
- Gas Processing: Gases that would be flared can be piped to microturbines, to generate electricity for local use. Or, the gas can be injected deep into the ground, where it will not come in contact with fresh water aquifers.
- Pipeline maintenance: If more valves are installed on the pipeline, a smaller section will have to be purged to perform the maintenance activities, which reduce the releases to the atmosphere.
- Decreasing emissions of hazardous compounds: If more efficient burners or incinerators on flare stacks are installed, there will be more complete combustion, and fewer pollutants emitted to the atmosphere.

If the regulations regarding flaring and venting are not very stringent in your state, you may want to negotiate with the companies to establish large setbacks from the well to your home. If your home is in a low-lying area, setbacks may not fully protect you from the harmful emissions, since airborne substances like hydrogen sulfide can settle in depressions in the landscape. Furthermore, setbacks may not protect livestock or wildlife in the area. Consequently, you should push hard to get companies to adopt alternative practices and minimize flaring and venting from their operations.

Noise

Landowners often complain about noise levels associated with natural gas compressors. The noise level varies with the size of the compressor and distance from the compressor; and it changes with shifts in wind direction and intensity. According to the Powder River Basin Resource Council, "Depending on the wind direction, the roar of a field compressor can be heard three to four miles from the site. Near the compressor stations, people need to shout to make themselves heard over the sound of the engines."[122]

For more information on the impact of noise on landowners, read about Impacts Associated with Oil and Gas Operations, and landowner stories in Chapter IV.

Water Use

- Typically, hundreds of thousands of gallons of water are required to drill and complete a conventional well.[123]
- Large quantities of water may (50,000 to millions of gallons) be used to stimulate or enhance

production from oil and gas wells. This water may be fresh, or companies may re-use produced water from their operations.

Wastes

Associated wastes are wastes other than drilling wastes and produced water. Examples are:

- Wastes associated with flowing wells, which include paraffin, slop oil, scale, treating chemicals, sand and paint.[124]
- Wastes associated with pumped wells, which include used lubrication oil and filters, gas lift engine fuel, released crude oil, paraffin, slop oil, scale, treating chemicals, sand, and paint.[125]
- Wastes associated with maintenance operations, which include chemicals used to remove scale (highly concentrated hydrochloric and hydrofluoric acids, organic acids, and phosphates); corrosion inhibitors (ammonium bisulfite, zinc); paint solvents; cleaning solvents; and workover fluid, which is similar to drilling fluid.[126] These compounds usually end up in produced water, after production resumes. Any acids should be neutralized before produced water is discharged to watercourses.
- Other associated wastes include trace contaminants such as barium, strontium, and radium associated with scale that is removed during maintenance; volatile organic compounds (VOCs), which are air pollutants; and high concentrations of salts and metals.[127]
- The American Petroleum Institute estimated that in 1995, the annual volume of associated wastes was 22 millions barrels.[128] The majority of associated wastes produced at conventional oil and gas sites are disposed of through injection wells.[129]

Produced water may accompany the oil and gas when pumping is necessary to bring oil and natural gas to the surface. It is also produced during coalbed methane extraction.

- Produced water is the largest volume waste generated in oil and gas extraction operations.[130] Typically, about 3 barrels of produced water are pumped for each barrel of oil.[131] Natural gas wells produce much less water than do oil wells, with the exception of certain types of gas resources such as coalbed methane or Devonian/Antrim shales.[132] It is estimated that the United States oil and gas industry generates 20 to 30 billion barrels of produced water every year.[133]

- The water produced with conventional oil or gas operations is generally unsuitable for most domestic or agricultural purposes, either because it is extremely salty or due to the presence of toxic or radioactive compounds.
- It is important that produced water be disposed of properly, since it may contain a variety of contaminants such as benzene, phenols, toluene and xylene, salts, metals and naturally occurring radioactive materials (NORM).[134]
- For more information about produced water, see Impacts Associated with Oil and Gas Operations, below.

Produced sand consists of sands and other particles generated during production, including those used in hydraulic fracturing. Other solid wastes include sludge remaining after various chemicals are removed during produced water treatment. Produced sand typically contains crude oil, which can comprise as much as 19 % by volume. Depending upon the location, produced sand may also contain naturally occurring radioactive material (NORM),[135] which is discussed in more detail below.

Spills of oil may come from leaking tanks, leaking flowlines, valves, joints, or gauges.[136] Other chemicals used during the production stage (e.g., solvents, workover fluids) may be spilled due to human error. Spilled oil and chemicals may contaminate soils, groundwater and surface watercourses.

Waste Management

- Open pits used to store wastes pose a health threat to livestock and wildlife. The wastes often contain hydrocarbons, and seepages from waste pits may contaminate soils, groundwater and surface watercourses. If open pits are used, they should be lined, with a leak detection system, to prevent seepages. And the pits should be fenced-in, and nets or other devices installed to prevent birds and wildlife from coming in contact with the wastes.
- In Wyoming, citizen complaints forced the U.S. Environmental Protection Agency to conduct studies into potential contamination of their drinking water wells. Studies revealed that wastes from an oil field service area and an unlined waste pond at a natural gas processing facility had seeped into the ground and contaminated the drinking water wells with volatile halogenated hydrocarbons. The site was declared a Superfund site in 1990. Residents were provided with alternative sources of drinking water (they were hooked up to the nearest municipal drinking water system), and the companies involved were required to remove and treat the soil, and pump and treat the contaminated groundwater.[137]

FIGURE I-21. TORN LINER ON AN OPEN PIT.

- Many materials used during maintenance procedures, such as solvents used for cleaning, are classified as hazardous wastes after they are used. Non-hazardous alternatives, which are safer for the environment and present fewer regulatory concerns for the company, are available. Substitutes include: citrus-based cleaning compounds or steam instead of hazardous solvents; a high flash point Varsol to replace the solvent Varsol (also called petroleum spirits or Stoddard solvent) to reduce this solvent's ignitability hazardous waste characteristic; and water-based paints instead of solvent-based paints, which reduces or eliminates the need for solvents and thinners.[138]

4. SITE ABANDONMENT

When a well is no longer economic to operate, it is abandoned. When an oil or gas well is abandoned it should be plugged or converted into an injection well, and the site should be reclaimed.

Sometimes a well will appear to be abandoned when in reality it is simply experiencing a temporary halt in production. For temporary work stoppages, the well will be shut in, which is accomplished by closing the valves at the wellhead. During this period, the well is considered to be idle. Wells may be idle for a few days, for example, to conduct well workovers or install new pipeline connections; or wells may be idle for a much longer duration, for example, if there is a downturn in the global market for oil or gas. If production is still technically viable, it is much more desirable to shut in a well rather than plug it because once the well is permanently plugged and abandoned it is highly impractical to re-access any remaining oil or gas in the reservoir.[139]

Plugging Wells

Before a company permanently leaves a well site, the well should be plugged or capped. The purpose of plugging is to prevent formation water from migrating into and contaminating aquifers or surface water.

All oil and gas producing states have specific regulations governing the plugging and abandonment of wells.[140] Generally, however, when a well is plugged there are a number of steps that are taken. First, the downhole equipment is removed and the perforated sections of the well bore are cleaned of scale and other wastes. Then, a minimum of three cement plugs, each between 100-200 feet in length, are placed into the well. Plugs should be placed: 1) into the perforated zones of the well, in order to prevent the inflow of fluid; 2) in the middle of the wellbore; and 3) within a couple hundred feet of the surface. Also, fluid with an appropriate density is placed between the cement plugs in order to maintain adequate pressure in the voids. Finally, the casing is cut off below the surface and capped with a steel plate welded to the casing. Surface reclamation should then be undertaken to restore natural soil consistency and plant cover.

FIGURE I-22. LEFT-RIGHT: PLUGGED WELL, NOT RECLAIMED. PLUGGED WELL, RECLAIMED. Photo at right used with permission of Vermejo Park Ranches.

Conversion to an Injection Well

If the well is located in an area where a company has many nearby wells still in production, the company may decide to convert the well to an injection well. If this occurs, the well will be regulated by the federal government as an *Underground Injection Control (UIC) Class II Injection well*, and will be subject to the federal *Safe Drinking Water Act and Underground Injection Control Regulations*.[141] Such a well can be used either for disposal of the produced water from other wells, or as part of oil enhancement operations in the production field.

Reclamation

Federal, state, and sometimes local rules and regulations describe how reclamation is supposed to occur when a site is abandoned. In some states, companies are required to provide financial assurance (e.g., bonds) to ensure that some funds are available to plug the wells and carry out the reclamation activities. Reclamation clauses in surface use agreements negotiated during the early stages also come into play at this stage.

Full reclamation should leave the land, air and water in the same condition as before oil and gas development was carried out. This is rarely the case. In many states, the unwillingness of companies to completely restore the original environment is accepted by state governments. Consequently, operators are required only to reclaim the land "as nearly as is possible" to it predevelopment condition.

Reclamation activities typically include: removal of all well-related equipment; re-grading of roads and other surfaces; removal of trash and debris; road closures; closure and remediation of pits and contaminated soils; and site revegetation. While this stage appears at the end of the development process, there are interim reclamation activities that can and often must be performed by operators at other stages of development. An example of interim or "annual" reclamation requirements can be found in the Vermejo Park Ranch Mineral Extraction Agreement in Chapter III.

SITE ABANDONMENT—ISSUES AND IMPACTS

Orphaned and Idle Wells

Surface owners should be aware that as a well becomes less and less profitable, some larger companies will sell these wells to smaller companies. Eventually, these wells may become the responsibility of the state, for example, if the smaller company does not have the funding to properly plug the wells and reclaim the site. If a company goes bankrupt and has no assets available to be used for proper well abandonment the well is considered to be an ***orphan well***.[142] The term orphan well also applies to the situation where the operator is unknown (e.g., in the case of wells drilled in the early part of the century).

Idle wells are wells that have ceased production but have not been plugged. In most states, wells require regulatory approval to be idle.[143] Most states allow some period of time of inactivity (usually six months to one year) without approval. When this initial time has elapsed, states may require a statement of the operator's intentions, which may include extensive geological and engineering information and a schedule for returning the well to production.[144] Also, a state may require periodical mechanical integrity tests to ensure that the well does not pose a threat to the environment.[145]

- In 1995, there were 134,000 wells in the U.S. that had stopped production yet had neither been plugged nor received government approval to be idle.[146]
- Orphan wells and idle wells that do not have government approval may present a groundwater contamination hazard. With many of these wells, the integrity of the casing is not known, and so there is a possibility that reservoir fluids or gases are contaminating or will contaminate nearby fresh water aquifers. Not all wells will cause contamination, but until the wells are evaluated, the risk that they pose is unknown.
- Most oil- and gas-producing states have a program for addressing orphan wells, which includes: prioritizing wells (because states do not have the funding to assess and properly plug all orphan wells); programs to plug dangerous orphan wells; and clean up of any contamination that may have already occurred.
- There is no guarantee that a state will have adequate funding to properly plug and reclaim orphan sites; leaving the surface owner with concerns about long-term risk of contamination. See "Bankrupt companies walk away from oil wells in Texas," Chapter II.
- One source of information that can help inform state regulators of the risks posed by orphan or idle wells comes from area of review (AOR) studies that are required for the approval of new underground injection wells. Under this requirement, the operator of the new well must study all active, idle and abandoned wells within an area (often a ¼ mile radius) to determine whether they pose a risk of contamination.[147]

Improperly Plugged and Abandoned Wells

- Improperly completed and abandoned wells may allow contaminants such as pesticides to be transferred from the surface to groundwater.

- Oil, gas, and salt water can leak from abandoned, unplugged, or improperly plugged oil and gas wells, especially older wells, and pollute groundwater resources,[148] or migrate to the surface. In Colorado, Oil and Gas Conservation Commission (COGCC) staff believe that increased methane concentrations found in water wells and buildings in some areas are partially due to old, improperly abandoned gas wells and older, deeper conventional gas wells that were not completely isolated. According to COGCC officials, a mitigation program focused on sealing old, improperly abandoned gas wells appears to have reduced methane concentrations in approximately 27 percent of the water wells sampled.[149]
- Additionally, improperly closed sites can be a safety hazard to humans and livestock.

Tips for Landowners

- Surface owners should work with state agencies to ensure that abandonment is satisfactorily completed.
- Owners may want to consider pressuring companies to use native species in their re-seeding projects, as these may be better able to combat noxious weed species.
- The company should have saved topsoil during the drilling and production stages for use in their reclamation efforts.
- Almost all states require companies to set aside funds to properly plug and abandon their wells. There is more information on financial assurance (or bonding) in Chapter II.

Ideally, full reclamation should leave vegetation, soil, air and water in the same condition that existed prior to oil and gas development. This rarely occurs.

Development of Nonconventional Gas and Oil

Forward-thinking landowners may want to investigate the possibility of unconventional reservoirs beneath their land, since it is likely that more non-conventional oil and gas deposits will be developed in the near future. This is certainly happening with the nonconventional coalbed methane gas deposits.

Nonconventional gas includes gas trapped in coal formations (***coalbed methane***); and low-permeability sandstone (***tight sands***) and shale formations (***gas shales***). These three types of natural gas are currently being exploited in some areas of the U.S., and will be discussed in this section. Other nonconventional natural gas resources, such as gas hydrates, are not likely to become commercially viable for decades to come.[150] Consequently, they will not be discussed in this guide.

Nonconventional oil deposits include ***heavy oils***, ***tar sands*** and ***oil shales***. As mentioned previously, petroleum is a broad term for hydrocarbons that includes gases, highly fluid "light" oils, viscous "heavy" oils, tars and bitumens. Today, light oils comprise approximately 95 % of petroleum production.[151] As will be discussed later in this section, when compared to conventional deposits and methods, the amount of work required to produce an equivalent amount of crude oil from tar sands or oil shales makes it cost prohibitive under most circumstances.[152]

COALBED METHANE (CBM)

As many landowners in Wyoming, Montana, Colorado, New Mexico and Alabama can attest, an increasingly significant source of natural gas is coalbed methane (see the Introduction chapter for a map of CBM producing areas). Two decades ago, coalbed methane was not a highly profitable source of natural gas. By the year 2004, however, CBM accounted for more than 8% of natural gas production in the U.S.[153]

According to the CBM Association of Alabama, 13% of the land in the lower 48 United States has some coal under it, and in all coal deposits methane is found as a byproduct of the coal formation process. Historically, this methane was considered a safety hazard in the coal mining process and was purposely vented to the atmosphere. Recently, however, companies have begun to capture the methane found in coal mines, as well as recover methane from coalbed deposits that are too deep to mine.[154]

Coal beds are an attractive prospect for development because of their ability to retain large amounts of gas—coal is able to store six to seven times more gas than an equivalent volume of rock common to conventional gas reservoirs.[155] On a daily basis, however, CBM wells typically do not produce as much gas as conventional wells.[156] In most regions of the U.S., coalbed methane wells produce between 100 and 500 thousand cubic feet (Mcf) per day, while the average conventional well in the lower 48 states produces approximately 1.7 million cubic feet (MMcf) per day.[157] There are, however, some extremely productive coalbed methane areas, such as the San Juan basin in Colorado and New Mexico, where some wells produce up to 3 MMcf of methane per day.[158]

The amount of methane in a coal deposit depends on the quality and depth of the deposit. In general, the higher the energy value of the coal[159] and the deeper the coal bed, the more methane in the deposit.[160]

Methane is loosely bound to coal—held in place by the water in the coal deposits. The water contributes pressure that keeps methane gas attached to the coal. In CBM development, water is removed from the coal bed (by pumping), which decreases the pressure on the gas and allows it to detach from the coal and flow up the well.

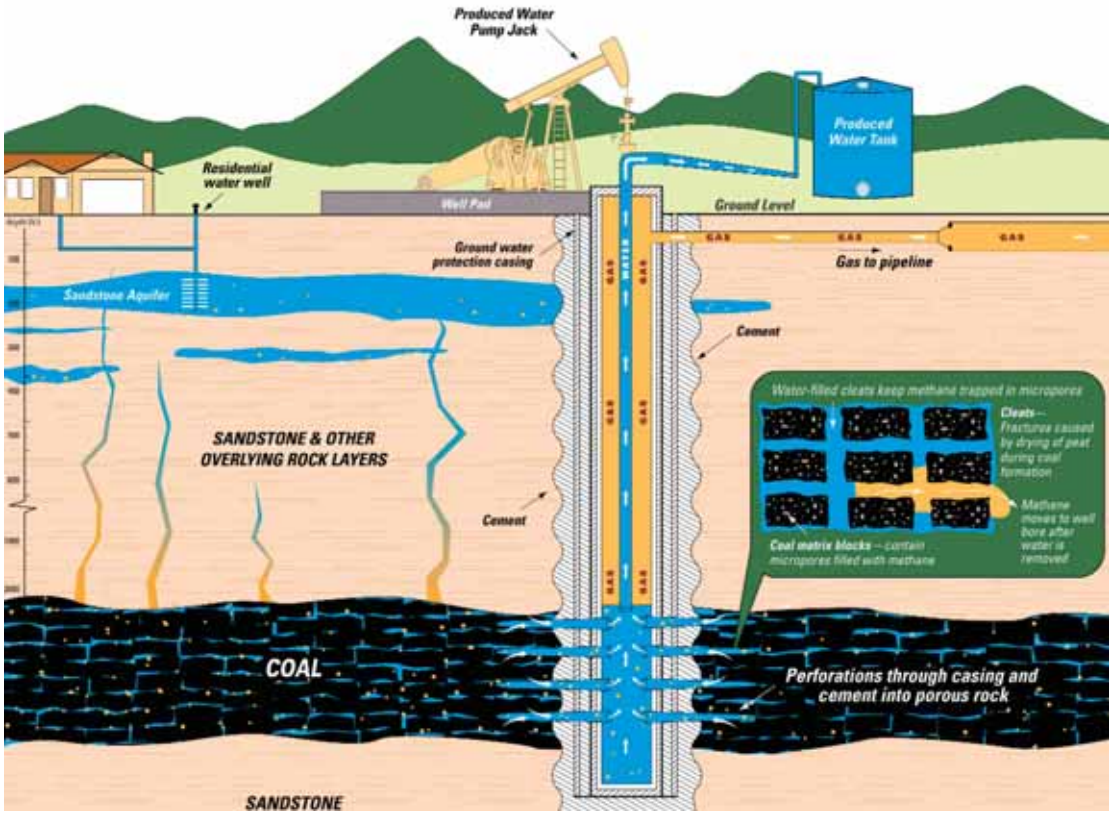


FIGURE I-24. TYPICAL COALBED METHANE WELL. Source: Ecos Consulting.

In the initial production stage of coalbed methane, the wells produce mostly water. Eventually, as the coal beds near the pumping well are dewatered, the volume of pumped water decreases and the production of gas increases.[161] Depending on the geological conditions, it may take several years to achieve full-scale gas production. Generally, the deeper the coal bed the less water present, and the sooner the well will begin to produce gas.

Water removed from coal beds is known as produced water. The amount of water produced from most CBM wells is relatively high compared to conventional gas wells because coal beds contain many fractures and pores that can contain and move large volumes of water.[162]

CBM wells are drilled with techniques similar to those used for conventional wells. In some regions where the coal beds are shallow, smaller, less expensive rigs, such as modified water-well drilling rigs, can be used to drill CBM wells, rather than the more expensive, specialized oil and gas drilling rigs.[163]

As with conventional gas wells, hydraulic fracturing is used as a primary means of stimulating gas flow in CBM wells.[164] Another gas stimulation technique, unique to CBM wells, is known as ***cavitation*** (also known as open-hole cavity completion).

Cavitation is a similar phenomenon to opening a shaken pop bottle, only on a much larger scale.[165] Water, and air or foam are pumped into the well to increase the pressure in the reservoir. Shortly thereafter, the pressure is suddenly released, and the well violently blows out, spewing gas, water, coal and rock fragments out of the well. This action is sometimes referred to as "surging," and it is accompanied by a jet engine-like noise, which can last up to 15 minutes.[166]

The coal fragments and gas that escape from the well are directed at an earthen berm, which is supposed to prevent the materials from entering the greater environment. The gas is burned or flared, and the coal fines and fluids initially collect in a pit at the base of the berm. Some loose rock and coal materials remain in the well. They are cleaned out by circulating water (and often a soap solution or surfactant) within the well and pumping the material into a pit. The coal refuse is then typically burned on-site in a pit, which is either referred to as a "burn pit" or "blooie pit." (See Figure I-25.)

The cavitation process is repeated several dozen times over a 2-week period.[167] This results in an enlargement of the initially drilled hole (well bore) by as much as 16 feet in diameter in the coal zone, as well as fractures that extend from the well bore.[168] If the cavitation fractures connect to natural fractures in the coal, they provide channels for gas to more easily flow to the well.

At the present time, cavitation is not widely practiced. The U.S. Department of Energy reported that in 2000, the only "cavity fairway" in the United States was located in the central San Juan Basin, in Colorado and New Mexico.[169]

FIGURE I-25. CAVITATION BURN PIT.

COALBED METHANE—ISSUES AND IMPACTS

Produced Water

Produced water quality varies depending primarily upon the geology of the coal formation. Typically, saltier water is produced from deeper coal formations. Produced water may contain nitrate, nitrite, chlorides, other salts, benzene, toluene, ethylbenzene, other minerals, metals and high levels of total dissolved solids.[170]

Depending on which state you live in, produced water may be: discharged onto land, spread onto roads, discharged into evaporation/percolation pits, reinjected into aquifers, discharged into existing water courses (with the proper permit), or disposed of in commercial facilities. In some states, standards for produced water disposal are becoming more rigorous, and certain disposal practices are losing favor. Surface discharge, for example, is a controversial method of disposal, as it can lead to a build-up of salts and other substances in the soil, and affect the productivity of the land. In some states, re-injection is the only option for disposal.[171] See section on Impacts Associated with Oil and Gas Operations for more information on produced water disposal options.

In some areas, coal beds may be important local or regional aquifers (natural underground water storage zones), and important sources for drinking water.[172] It is important, therefore, that landowners find out how companies are planning on disposing of produced water, and what impact its removal and disposal might have on water supplies.

Water Quality and Methane/Hydrogen Sulfide Migration

A study conducted by the US Environmental Protection Agency (EPA) documents a number of examples of water quality impacts and other issues encountered after CBM extraction occurred.[173] These include reported incidents of:

- Explosive levels of hydrogen sulfide and methane under buildings and inside homes
- Death of vegetation (possibly due to seepage of methane and decreased air in root zones)
- Increased concentrations of methane and hydrogen sulfide in domestic water wells
- Cloudy well water with increased sediment concentrations following hydraulic fracturing
- Strong odors and black coal fines in water wells
- Brown, slimy well water that smelled like petroleum
- Decrease in well water levels and surface water flows following hydraulic fracturing
- The discharge of produced water creating new ponds and swamps that were not naturally occurring in particular regions

A decline in water quality may be created by hydraulic fracturing fluids. The EPA has stated that

> *"if coalbeds are located within underground sources of drinking water (USDW), then any fracturing fluids injected into coalbeds have the potential to contaminate the USDW... Stimulation fluids in coal penetrate from 50 to 100 feet away from the fracture and into the surrounding formation. In these and other cases, when stimulation ceases and production resumes, these chemicals may not be completely recovered and pumped back to the coalbed methane well, and, if mobile, may be available to migrate through an aquifer."*[174]

Water Quantity

Rural residents across the country have experienced decreases in the levels of their drinking water wells, as well as the drying up of springs.[175] Monitoring wells maintained by the federal Bureau of Land Management in the Powder River Basin of Wyoming/Montana have indicated a drop in the aquifer of more than 200 feet.[176] Estimates are that the water levels could drop to a total of 600-800 feet over the course of CBM development in that basin.[177]

Spontaneous Combustion of Dewatered Coalbeds

The EPA has reported the spontaneous combustion and continued burning of completely dewatered coalbeds as a concern related to CBM development.[178] When water is pumped out of coal seams, coal becomes exposed to oxygen, and coal fires are possible. This can occur spontaneously, or from lightning strikes or ignition by grass fires or wildfires. The areas most likely to be the site of a coal fire are along the edges of basins where coal is close to the surface and oxygen can most easily enter the coal when water is removed. At least one coal fire is burning north of Sheridan, Wyoming. This old fire could expand as dewatering lowers the groundwater level (thus exposing more coal to oxygen).[179] If coal fires occur, by-products, such as polycyclic aromatic hydrocarbons (PAHs), from the underground fires could potentially lead to contamination of underground sources of drinking water.[180]

Compaction/Subsidence

Water is part of the fabric of a geologic formation—it holds the rock open. When water is removed from the rock, the pore spaces are left open, and the rock can collapse. In parts of the world, there have been incidents where enormous quantities of water have been removed from shallow aquifers, followed by as much as a 40-foot drop (or subsidence) in the surface of the land. The consequences of the subsidence have included the rupturing of utility lines (gas, sewage, water, electric), collapse of buildings, and damage to roads.[181]

Noise

From exploration through site abandonment, noise is generated by truck traffic, heavy equipment, seismic explosions, drilling rigs, motors that power pumps, and gas compressors. The noise from all of the equipment may be a frustration for landowners. The constant noise from pumps and compressors, however, can greatly affect a landowner's quality of life, and have negative impacts on livestock and wildlife. (Read Impacts Associated with Oil and Gas Operations, later in this chapter and landowner stories in Chapters IV for more information on noise.)

FIGURE I-26. IMPROPERLY CONTAINED CAVITATION PRODUCTS.
A worker attempts to remove coal dust from trees.

Cavitation

The coal brought to the surface (100 tons on average) during cavitation is burned on site, which can last anywhere from 7 to 10 days. The pollution from burning this waste coal can be a concern for nearby residents, especially because oil and gas well "completion techniques" like cavitation are largely unregulated (e.g., they are exempt from certain environmental laws like the *Clean Air Act)*.

Cavitation Fire

In 2001, a fire outside of Durango, Colorado, was ignited during the cavitation of a coalbed methane well. When the well was surged the escaping gas ignited a grass fire, which quickly spread to surrounding trees. Fortunately, the fire did not reach any of the nearby residences. The total cost of the fire suppression was estimated by the Bureau of Land Management to be $500,000.

— Pearson, Mark. October, 2003. "Coalbed Methane Well Ignites Forest Fire."[182]

- Pollution normally associated with coal burning includes: nitrogen oxides, carbon dioxide greenhouse gases, sulfur dioxide, lead and mercury.
- The noise associated with cavitation is a major concern for landowners, livestock and wildlife. As mentioned above, jet-like noises can last for up to 15 minutes. If no notice is provided to landowners, the abrupt and shocking sound can startle livestock and residents.
- According to one landowner, cavitation is one of the most "intimidating, dramatic and disruptive gas well processes that impacts the living conditions" of residents in the Ignacio-Blanco gas field in Colorado and New Mexico.[183] He describes: huge plumes of coal dust and methane, which is then flared, producing an enormous fireball blast, often larger than the height of the drilling rig; the blast also creates shock waves; the material removed from the cavity is almost entirely coal, which is burned in a "blooie pit," creating fire balls of the size mentioned above.

It is possible that coal debris could find its way into local drinking water wells. The underground explosions are not contained, and consequently, could come in contact with groundwater flows.

Decline in property values of 22%
La Plata Country, CO

Decline in Property Values

A study in La Plata County, Colorado, found that the location of a coalbed methane well on a property at the time of sale led to a net reduction in selling price of approximately 22%.[184]

TIGHT SANDS AND GAS SHALES

The methods used to extract the gas from sands and shales are similar to those used for coalbed methane, i.e., drilling of a well, followed by a period of dewatering, and then gas production. As with coalbed methane, developers of tight sands and gas shales are fairly certain that they will encounter gas when drilling.

The main issue for companies seeking to extract gas from tight sands and gas shales is that more than 90 % of wells require some form of stimulation to achieve commercial production rates. This tends to make most operations uneconomic. Should highly efficient technologies for extracting gas from tight sands ever be developed, the potential for tight sands development is enormous, as most geologic basins contain some tight-sands gas.[185]

Many drilling, completion and stimulation technologies for tight sands and gas shales were developed during the 1980s and 1990s, when industry received a tax credit on nonconventional natural gas production.[186] Numerous stimulation experiments were conducted in an attempt to increase the flow of gas by creating fractures in the tight-sand formations. Massive hydraulic fracturing projects and stimulation using nuclear explosions were undertaken, with some success. The tax incentives were critical in the development of both gas shales and tight sands. When the tax credit expired, there was a decline in the drilling of tight sands and gas shale wells.

Five basins currently dominate tight sands activity in the US: South Texas, East Texas, San Juan (Colorado/New Mexico), Permian (Texas and New Mexico) and the Green River basin of Wyoming. In 1999, annual tight sands gas production was 2,900 billion cubic feet (Bcf), up from 1,500 Bcf in the mid 1970's.[187]

Today more than 28,000 gas shale wells produce nearly 380 Bcf of gas yearly from five U.S. basins: Appalachian (New York, Kentucky, West Virginia, Ohio), Michigan, Illinois, Fort Worth (Texas) and San Juan (Colorado and New Mexico)[188] More than 17,000 productive gas shales wells were drilled between 1978 and 1999, with a peak of 1,799 gas shale wells in 1992, the last year wells could quality for tax credits.[189]

The major issues related to tight sands and gas shales are similar to CBM: impacts associated with drilling; produced water; and methods used to stimulate gas flow (e.g., hydraulic fracing). These issues are discussed elsewhere in this document.

TAR SANDS AND OIL SHALES

Nonconventional oil deposits include heavy oils, tar sands and oil shales. As mentioned previously, petroleum is a broad term for hydrocarbons that includes gases, highly fluid "light" oils, viscous "heavy" oils, tars and bitumens. Today, light oils comprise approximately 95 % of petroleum production.[190] As will be discussed below, when compared to conventional deposits and methods, the amount of work required to produce an equivalent amount of crude oil from tar sands or oil shales makes it cost prohibitive under most circumstances.[191]

Tar sands (also known as oil sands) are grains of sand that are intermixed with bitumen (heavy, black, viscous, asphalt-like oil). Often, the bitumen is much too viscous to be recovered by conventional methods.

There are two primary methods of extracting heavy oils and bitumen from tar sands:

1. The deposits are mined, the oil removed, and the sands returned to the pit or disposed of in another manner. Approximately two tons of tar sands must be dug up, moved and processed

to produce one barrel of oil,[192] and about 75 % of the bitumen can be recovered from the sand.

2. In situ (i.e., in place) recovery is used for bitumen deposits buried too deeply for mining to be practical (usually more than 250 feet, and frequently more 1000 feet below the surface). Recovery involves injecting substances such as steam or hot solvents, which heat up the sands and cause the bitumen to become viscous enough to be pumped.

After the heavy oils and bitumen are extracted, they are thinned using another petroleum product. This enables the product to flow through a pipeline. Some upgrading (removal of some substances and addition of others) also occurs to produce a higher quality crude oil. Upgrading is responsible for 60 % of the costs, emissions and energy-use involved in the production of synthetic crude oil from bitumen.[193]

At the present time, tar sands are being mined extensively in the Athabasca oil sands in northeastern Alberta, Canada. Mining operations there produce the equivalent of 350,000 barrels of crude per day, while in situ methods produce 150,000 barrels per day. In the U.S., small deposits of tar sands are located in Utah, Kentucky, Kansas, Missouri, California, and New Mexico, but these are not presently being exploited.[194]

In the 1970s, the availability of $88 billion in federal subsidies for synthetic fuel production created a rush on tar sand development in the Book Cliffs of northern Utah. But when the subsidies ran out in the early 1980s, the tar sands development ended.

Oil shale, essentially a hybrid of oil and coal,[195] is a fine-grained rock that contains a hydrocarbon material called kerogen. Similar to tar or oil sands, the recovery of oil from oil shale uses two primary methods:

1. Mining techniques bring the oil shale to the surface. Oil is then recovered from the oil shale using retort methods (i.e., heating shale in the absence of air) at temperatures approaching 950° F. This converts kerogen into oil and gas, and yields between six and 50 gallons of oil per ton of shale.
2. An in situ retorting technique is used where hot gases and air are injected into holes that have been bored into the underground shale deposit. The kerogen is converted to oil underground, and is extracted using conventional oil extraction techniques.[196]

The largest and some of the richest deposits of oil shales are located in western Colorado, eastern Utah, and southern Wyoming. If an economic recovery method could be developed, it is estimated that these deposits alone could yield between 500 billion[197] and 1.5 trillion barrels of oil.[198] This is a phenomenally large resource, considering that there is general consensus that current global conventional reserves of oil are approximately 1,000 billion barrels.[199]

At today's petroleum prices, however, oil shale exploitation is not economically competitive with extraction from conventional reservoirs.[200] During the so-called "energy crisis" of the 1970s, when the cost of conventional oil soared, interest in mining oil shales also increased. As mentioned previously, billions of dollars in federal subsidies were offered to encourage nonconventional fuel production. Several oil shale leases on federal lands in Colorado and Utah were issued to private companies, large-scale mining facilities were developed on the properties, and experimental in situ retorting was carried out on one of the lease tracts. The Exxon Corporation went so far as to begin constructing entire new towns to support their developments, but when petroleum prices began to fall in the 1980s, their projects were abandoned. Unocal operated the last large-scale experimental mining and retorting facility in western United States, which closed in 1991.[201]

The Future of Oil Shale Development in the U.S.

The U.S. Department of Energy recommends that the U.S. establish a 2-million-barrel-per-day oil shale industry by 2020.

— U.S. DOE March 2004. www.fc.doe.gov/programs/reserves/npr/[202]

TAR SANDS AND OIL SHALES—ISSUES AND IMPACTS

Should the development of tar sands and oil shales become economically feasible (either due to global oil economics or governmental subsidies), the developments would create a number of environmental concerns.

- When tar sands or oil shales are mined, the operations create issues similar to those created by hardrock mining operations.[203] For example, the mining operations require the stripping thousands of acres of fertile ground to get at the bitumen 40 feet under the surface, often requiring the clearing of forests and destruction of wildlife habitat.
- Unless properly removed, the nitrogen and sulfur in oil shale oil can form nitrogen and sulfur compounds that contribute to air and water pollution.[204]
- Tar sands extraction and processing requires massive amounts of water (either from surface or groundwater sources) for steam-stripping and sand washing.[205]
- Direct discharges and fugitive emissions from the processing and refinery facilities generate major amounts of toxic and carcinogenic (cancer-causing) contaminants, which may spread for miles over human and animal habitats.[206]
- The sands and shales must be disposed of after the petroleum has been extracted. If improper disposal methods are used, oil and phenol contamination may occur.
- Other by-products and potential contaminants related to oil shale extraction include uranium, vanadium, zinc, alumina, phosphate, sodium carbonate minerals, ammonium sulfate, and sulfur.[207]
- Each stage of tar sand and oil shale processing and upgrading requires the use of significant quantities of energy, which mainly comes from burning fossil fuels (usually natural gas). "It takes so much energy to extract the sticky low-grade oil off of a grain of sand that it almost isn't worth it. If one were to do a net energy analysis, they would find that would it almost takes as much energy to mine, process, refine, and upgrade the bitumen oil out of tar sands as the oil-energy that would be produced from the tar sands. Thus, in the process you generate much more carbon dioxide emissions getting the tar sands oil out than you would from extracting and processing conventional oil."[208]
- It has been estimated that tar sands mining and processing generates between 5 to 10 times more carbon dioxide (CO_2) emissions than the extraction and processing of conventional oil.[209] The National Energy Board of Canada estimates that approximately 275 lbs of greenhouse gas emissions[210] are released per barrel of synthetic crude oil from tar sands;[211] approximately 200 lbs of which occur at the tar plant. The CO_2 emissions from a tar sands plant having a capacity of 150,000 barrels per day would equal putting another 1.35 million automobiles on the road.[212]

Impacts Associated with Oil and Gas Operations

Some impacts from oil and gas development may be positive for surface owners. The enjoyment of benefits depends upon a couple of factors:

1. Do you own the mineral rights?
2. Is some of the infrastructure associated with oil or gas development useful to you?

The primary benefit of oil and gas development to mineral owners is financial. If you own the mineral rights you will receive royalties on any oil or gas that are removed from your property. The extent of your financial gain, however, depends upon the productivity of the well, and what sort of royalty provisions you are able to negotiate in your leasing agreement. Secondary benefits may be derived from any compensation received for surface damages, as well as perceived benefits from improvements such as roads and fences.

In the 1980s, a study on the benefits and costs of oil and gas development to ranchers in New Mexico was conducted.[213] Below is a summary of the benefits and costs mentioned by the ranchers.

The authors of the study discussed the fact that almost all of the cash benefits (an average of $28,000 over the life of the well) occurred early in the exploration and development process, and that most were one-time payments. Meanwhile, the costs to ranchers averaged $5,750, per year, for the life of the oil or gas operation. The report concluded that for ranchers not receiving annual royalty payments: it is evident ***the rancher is a net income loser if the life of the oil field exceeds six years.***

Examples of benefits received by ranchers	Examples of costs to ranchers
• Lease payments (this only applied to those who owned their mineral rights) • Direct compensation payments for the disturbance of the land surface (e.g., loss of grazing land; roads; right-of-way easements; pipelines) • Payments for seismic tests • Purchase of fresh and brine water used for drilling • Purchase of gravel for road building • Subcontracting ranch labor, e.g., to reseed, build fence • Year-round road network (conversion of existing roads to all-weather status) • Cattle guard and gate installation • Conversion of dry oil and gas holes into productive wells for watering livestock.	• Long-term loss of land carrying capacity • Inadequate compensation for land disturbance • Additional labor hours • Increased cattle deaths • Reduced calving percentage • Reduced average market weight of cattle

If landowners do not own the minerals beneath their land, there is often no guarantee that they will be fairly compensated for property damage from oil and gas development. (See sections II and III for more information on compensation.) Many surface owners who have experienced oil and gas development wonder why their quality of life and livelihoods suffer, while the oil and gas industry reaps huge financial profits at their expense. This question was also addressed by Randy Udall, Director of Community Office for Resource Efficiency, when delivering the keynote address at a 2002 Coalbed Methane Conference in Montana:

> *A typical coalbed well will yield $1 million in gross revenues, so there's enough money to protect the environment, farmers, ranchers, and water quality. . . Why should their stockholders be the only ones that benefit from gas development on private property? With $1 million in revenue per well, gas producers could/should share some of it with the landowner.*[214]

Industry is not solely responsible for ensuring that surface owners are treated fairly. Federal and state governments share in the responsibility to ensure that property owners do not absorb a disproportionate amount of impacts and costs related to oil and gas development. Unfortunately, in many regions, governments do not live up to this responsibility.

> *The [Department of Environmental Quality] continues to exonerate itself with a laissez-faire attitude toward releases that cause evacuation and injury claiming it is "impossible to legislate or prevent accidental releases." The state's rationalization becomes that those who are gas victims simply live, through luck of the draw, in the wrong place, and will inevitably be subject to this additional "normal" hazard of life. "We do not live in a risk free society" as Fitch [Supervisor of Wells] reiterates. "The gas must be extracted from where it lies." In other words, gassed and displaced families are simply the sacrificial lambs whenever small independent, limited liability corporations choose to move in.*
>
> —Excerpt from *Survey of Accidental and Intentional Hydrogen Sulfide Releases Causing Evacuations and/or Injuries in Manistee and Mason Counties from 1980 to 2001.*[215]

The potential costs or impacts to surface owners from development of oil or gas on or near their property can be summarized in three categories: health, safety, and welfare (or quality of life).

FIGURE I-27.
IMPROPER NETTING AND FENCING
Can result in death of wildlife and livestock.

HEALTH, SAFETY AND QUALITY OF LIFE

The potential costs or impacts to surface owners (and communities as a whole) from the nearby development of oil or gas can be summarized in three categories: health, safety, and welfare (or quality of life).

Health impacts may result from: surface and groundwater contamination; dust and air pollution; soil contamination; noise pollution; light pollution (e.g., if drill rigs operate 24-hours-a-day); and stress related to living in an industrial zone.

Safety may be endangered due to: potential home fires and explosions (e.g., due to methane or hydrogen sulfide seepage); potential of fires or pollution from accidents or improper worker conduct in the field (e.g., blowouts; valves left open); flooding related to poor water and waste management practices; increased community crime resulting from an influx of new workers; and reckless driving by oil or gas workers.

A decline in quality of life may result from: economic issues that arise from energy development (e.g., decline in property values; attorney fees related to negotiations with companies); noise; water well depletion or loss; degradation of water quality; land disturbance and soil erosion; vegetation die-off; the presence of industrial facilities (unsightly buildings and odors); damage to roads; and traffic congestion.

Several of these issues are addressed in more detail below.

The following information on housing, crime, roads, and dust emissions related to coalbed methane (CBM) development comes from a study conducted in Wyoming. As part of the Wyoming Energy Commission Community Outreach Program, the Commission contracted with a consultant, Pedersen Planning Consultants, to perform community assessments related to CBM development in six counties – Campbell, Sheridan, Johnson, Sweetwater, Converse and Carbon.[216] The information below reflects insights and recommendations from various community leaders.

Soil erosion can be unsightly; it can lead to excessive turbidity in streams; and the loose soils can create problems with dust and decrease visibility.

Housing

Since 1998, the coalbed methane boom in Campbell, Sheridan and Johnson counties has increased housing costs and decreased availability of rental apartments and homes to purchase. The lack of housing frustrates workers who are working 12-hour shifts, as they have little time to make an extensive search for housing. Increased housing costs have increased the overall cost of living for most households in Campbell County. Law enforcement representatives point out that these stresses have contributed to more petty theft, domestic violence, and other criminal behavior.

Crime

Campbell County has experienced an increase in larceny, destruction of private property, family violence, and child abuse since CBM development came to the county. The heavy amount of shift work has resulted in children being left at home unsupervised. Other crimes are attributed to alcohol and drug problems, which are linked, in part, to the increase in CBM development – as more people in the community earn more income, greater drug usage occurs. Ninety-nine percent of all crimes in Johnson County tie back to drug or alcohol abuse. Police from the City of Gillette report that methamphetamines are a growing community concern because of the addictiveness of these drugs. As more money is needed to sustain the drug habit, both sellers and users often commit crimes to obtain money. Drug users are also more likely to be involved in marital and child abuse.

In Sheridan County, there has been an increase in population of at least 300 people since 1998. Many of the new residents are CBM workers and their dependents. The county has experienced an increase in aggravated assaults from 40 in 1998 to 90 assaults in 2000. Burglary and larceny crimes also increased considerably during that period.

In both Sheridan and Campbell counties, the CBM development has affected the ability of the sheriff's department to hold on to their employees. The higher wages offered by CBM companies have enticed many experienced crime prevention workers to leave their jobs and join the CBM industry. It is also more difficult to attract new police recruits, as the higher wages again draw more young men and women to the industry jobs.

Safety

There are no local or state-wide safety standards being applied in the coal bed methane exploration and production areas of Wyoming. Most of the larger CBM companies, however, have adopted their own operational and safety standards, but subcontractors do not necessarily follow them (and companies do no monitor their subcontractors to ensure that they are following

the company's safety standards). In the aftermath of some industrial accidents, the Campbell County Fire Chief has witnessed CBM contractor crews that were somewhat drunk and/or unprepared to carry out work safely.

Roads

In Sheridan County, 50% of county roads have been impacted by CBM development, while in Campbell county more than 25% have been affected. Increased road usage by the CBM industry and new residents has reduced the facility life of the roads, and has increased the cost of road operations and maintenance. In Sheridan County, some impacts on county roads are being mitigated by CBM companies that sign road "user agreements" with the county (in which the companies agree to: repair road damages beyond normal wear and tear; restore roads to existing condition; and provide labor and materials for road repairs). Even with these agreements, however, Sheridan County estimates that $8.7 million will have to be spent on road improvements in the county and City of Gillette.

Dust

Another consequence of CBM development is significant dust emissions along county roads. Horses in some areas of Sheridan County have experienced chronic coughing from increased dust emissions. Some ranchers in Campbell County have found that cattle do not eat grass that is within 0.25 miles of both sides of some county roads. Some counties are applying magnesium chloride to suppress dust; others are using gravel, which is thought to be a more effective dust suppressant. Campbell County, which does not have its own gravel source, imports gravel for dust suppression at a cost of $6/ton.

Property Values

In some Wyoming counties, housing values, in general, have increased due to the recent boom in CBM development combined with an overall housing shortage in those counties.

A study conducted in La Plata County in Colorado, found that despite an overall increase in housing values between 1990 and 2000, the selling price for properties that had an oil or gas well on them was 22% less than a similar property without a well on site.[217]

Interestingly, the study found that if a property did not have a well, but was located within 550 feet of a property with an oil or gas well, that the non-well-bearing property increased in value. The authors suggested that this occurred because buyers assumed that there was a low likelihood of two wells being drilled right next to each other. This assumption may have disappointing results for those buyers, however, because state agencies can and do change well spacing requirements – especially as the oil or gas field ages – and wells may eventually have to be drilled in between existing wells in order to get more oil or gas out of the formation. (Read about well spacing in the section on Field Organization earlier in this chapter)

Noise

Many landowners choose to live in rural areas because they want to live a peaceful life. Oil and gas development, however, can greatly affect the peace and tranquility of rural areas, and can become a major annoyance to those living close to oil and gas facilities. This, in turn, may affect a person's health and quality of life. The following section provides an overview of noise issues for landowners dealing with oil and gas development. See Chapter V for additional resources related to noise.

Noise from oil and gas development comes from a number of sources: truck traffic, drilling and completion activities, well pumps and compressors.

In general, the volume of a sound is measured in decibels (dB). According to the World Health

Organization, outdoor sound that exceeds 55 dB begins to be a nuisance to people.[218] During the nighttime hours (10 p.m. to 7 a.m.), sound levels in rural or quiet suburban areas are often as low as 25 to 35 dBA,[219] while urban areas may be 80 dB or more.[220]

Oil and Gas Development Noise

In a La Plata County, Colorado study[221] noise levels were reported for a number of oil and gas activities and equipment:

- A typical compressor station: 50 dBA* at 375 feet from the property boundary (noise emitted 24-hours-a-day)
- Pumping units: 50 dBA at 325 feet from the well pad (noise emitted 24-hours-a-day)
- Fuel and water trucks: 88 dBA at 50 feet; 68 dBA at 500 feet
- Crane (used to hoist rigging equipment): 88 dBA at 50 feet; 68 dBA at 500 feet
- Concrete pump (used during drilling): 82 dBA at 50 feet; 62 dBA at 500 feet
- Average well construction site: 85 dBA at 50 feet; 65 dBA at 500 feet

*Often, equipment used to measure sound is designed to account for sensitivity of human hearing to various frequencies. This is known as A-weighted correction, and the measurement is an A-weighted decibel (dBA).[222]

How Sound Travels—Sound is caused by changes in air pressure. For example, when a mallet strikes a drum the drumhead begins to move back and forth (vibrate). As the drumhead moves down, air is pulled toward it, and as the head bounces back up it pushes air away. This creates changes in air pressure that move (or propagate) away from the drum, eventually striking our eardrum. These changes in pressure are known as sound waves.

There are a number of factors that affect the propagation of sound. The most important include: distance from source; obstacles such as barriers and buildings; atmospheric absorption; wind direction and speed; temperature and temperature gradient; humidity; precipitation; reflections; and ground absorption.[223]

Prolonged periods of noise exposure to 65 dBA can cause mental and bodily fatigue.

It is important to understand that noise does not always decrease as one moves away from a noise source. The above factors can work to increase or decrease noise levels. For example, at short distances (up to 160 feet) the wind has a minor influence on the measured sound level. At distances greater than 1,000 feet from a noise source, noise can become louder on the downwind side by as much as 20 dB, while on the upwind side levels can drop by 20 dB (depending on wind speed and distance).[224]

Other things to consider include the fact that while barriers may act to reduce high frequency sounds, low frequency sounds are difficult to reduce using obstacles or barriers. Additionally, while soft ground surfaces and the atmosphere are effective at absorbing mid-frequency and high frequency noise, these factors do not tend to reduce low frequency noise to the same degree. This means that as one moves away from the source, low frequencies often become much more prominent.[225]

What Makes Certain Sounds Annoying?—Whether a noise is objectionable will vary depending on its type (tonal, impulsive, etc.), the circumstances (e.g., does the noise occur in an area where there are already loud noises versus a quiet rural setting), and the sensitivity of the indi-

vidual who hears it. Certain noise characteristics can greatly increase the annoyance and the health impacts associated with a noise. These factors include: 1) tonality; 2) impulsiveness 3) fluctuation or intermittence and 4) presence of low frequencies.

When a noise contains sound that has distinct frequency components (tones), e.g., noise from fans, compressors, or saws, the noise is generally far more annoying than other types of noise. *Most energy industry facilities typically exhibit either a tonal or impulse/impact component.*[226] Impulsive noise comes from impacts or explosions, e.g., from a pile driver, or pieces of pipe hitting one another. The noise is brief and abrupt, and its startling effect causes greater annoyance than would be expected from a simple measurement of the sound decibel level. Fluctuating noises, as well, may be far more annoying than predicted by average sound levels.[227] Oil and gas pump jacks can create fluctuating and intermittent noises. Pump jacks may operate and automatically shut off for specific periods of time. When improperly maintained, pump jacks can develop intermittent rubbing noises or squeaking noises that occur at regular intervals. Regular variations in noise have been found to increase the annoying aspects of the noise.[228]

FIGURE I-28. NOISE EXAMPLES
Left to right: Pump jack noise is intermittent; compressor noise is constant and long-term; noise from drill rigs is short-term but very loud.

Some jurisdictions have developed noise regulations that penalize individuals or industries that generate tonal, impulsive or fluctuating noises. For example, if a noise has an obvious tonal content, a "penalty" or correction may be added to account for the additional annoyance.[229] Currently, the penalty for tones varies between 0 dB (no penalty) and 6 dB.[230] The penalty is added to the measured decibel level, and this combined decibel level is compared to the acceptable decibel standard.

- For example, if the noise from a compressor is measured as 49 dBA, but it is determined that the noise has tonal components, a penalty of 6 dBA would result in a noise level of 55 dBA. If the acceptable noise standard is 50 dBA, the noise from the compressor would be out of compliance.

Low Frequency Noise—Low frequency noise is experienced by some landowners who live near oil and gas facilities. Low frequency noise does not have a consistent definition, but it is commonly defined as noise that has a frequency between 20 and 100 - 150 Hz (in other words, sound waves are vibrating between 20 and 150 times per second).

Low frequency noise can be generated by numerous sources during oil and gas production.[231]

- Low frequency noise is produced by machinery, both rotational and reciprocating, and all forms of transport and turbulence. Typical sources include pumps, compressors, and fans.
- The firing rate of many diesel engines is usually below 100 Hz, so road traffic noise can be regarded as low frequency.

- Combustion turbines are capable of producing high levels of low frequency noise. This noise is generated by the exhaust gas.[232]
- Burners (and flares) can emit broadband low frequency flame roar.

Low frequency noise creates a potential for
. It is well established, however, that the annoyance due to a given noise source is perceived very differently from person to person. For many humans, their ears are not very sensitive to low levels of low frequency sound. At low frequencies, however, noise may not be perceived as sound but rather may be "felt" as a vibration or pressure sensation.[233]

For those who are sensitive to low frequency sound the effects can be dramatic.[234] Complainants often describe the noise as:

- Humming or rumbling
- Constant and unpleasant
- Pressure in ears
- Affects whole body
- Sounds like large, idling engine
- Coming from far away

Researchers have conducted field measurements and laboratory studies of people who have complained of low frequency noise in their homes. Studies have found that:[235]

- Problems tend to arise in quiet rural or suburban environments
- The noise is often close to inaudibility, and is heard by a minority of people
- The noise is typically audible indoors and not outdoors
- The noise is more audible at night than day
- The noise has a throbbing and rumbly characteristic
- The complainants have normal hearing

FIGURE I-29. VENTING OF GAS WELL CAN BE PIERCINGLY LOUD.

Despite the fact that the World Health Organization has stated that, "The evidence on low frequency noise is sufficiently strong to warrant immediate concern," few noise regulations in the United States address low frequency noise. Some counties in northern Michigan have developed ordinances that reference low frequency noise as a separate than other noise issues.[236] Most of the research and regulation related to low frequency noise has taken place in European countries and Japan. See Chapter V for resources related to Low Frequency Noise.

Health Effects of Noise

There are adverse physical and mental effects from noise. For example, prolonged periods of exposure to 65 dBA can cause mental and bodily fatigue. Furthermore, noise can affect the quantity and quality of sleep; cause permanent hearing damage; contribute to the development or aggravation of heart and circulatory diseases; and transform a person's initial annoyance into more extreme emotional responses and behavior.[237]

According to the World Health Organization:[238]

> Noise annoyance is a *global phenomenon. A definition of annoyance is "a feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them."*

> *. . .apart from "annoyance", people may feel a variety of negative emotions when exposed to community noise, and may report anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation, or exhaustion.*
>
> *. . . Social and behavioural effects include changes in overt everyday behaviour patterns (e.g. closing windows, not using balconies, turning TV and radio to louder levels, writing petitions, complaining to authorities); adverse changes in social behaviour (e.g. aggression, unfriendliness, disengagement, non-participation); adverse changes in social indicators (e.g. residential mobility, hospital admissions, drug consumption, accident rates); and changes in mood (e.g. less happy, more depressed).*

The World Health Organization also reports that "a large proportion of low-frequency components in noise may increase considerably the adverse effects on health." In an epidemiological survey of sufferers from low frequency noise, the following health effects were documented:[239]

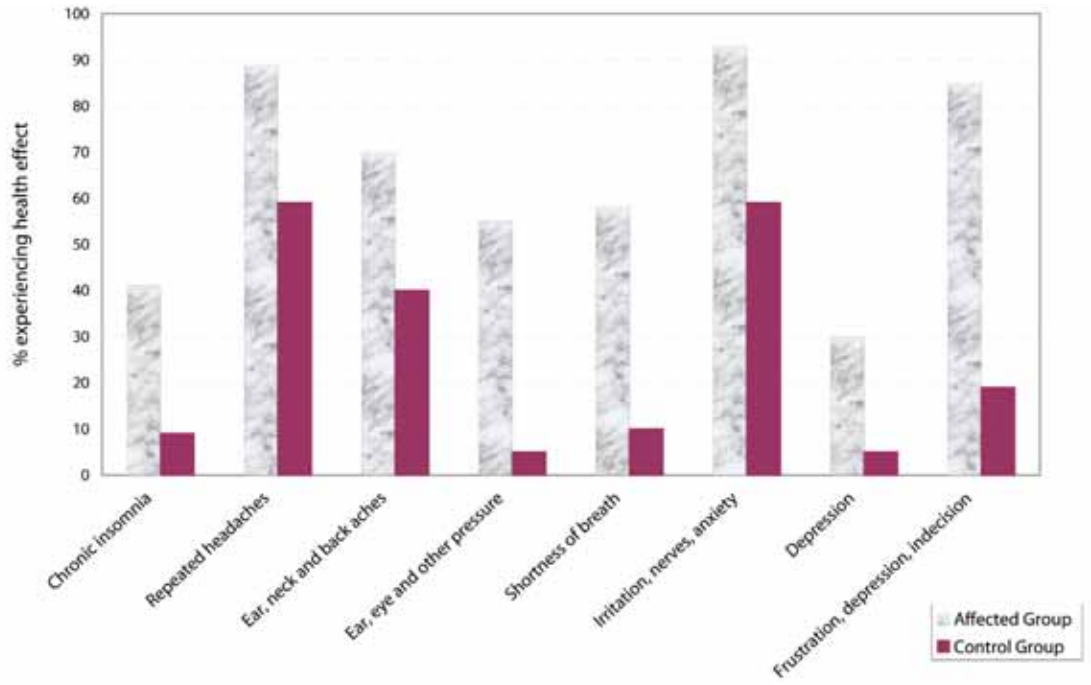


FIGURE I-30. HEALTH EFFECTS OF LOW FREQUENCY NOISE
Source: Mirowska, M. and Mroz, E. 2000.[240]

The above health effects were felt by people experiencing low frequency noise in their homes. The New Mexico Game and Fish states that even for human beings in a recreational setting, low frequency noise has been shown to cause stress reactions including raised blood pressure and increased muscle tension.[241]

Unfortunately, many of the health effects of noise due to oil and gas operations have not been scientifically documented. The lack of scientific study does not mean, however, that noise issues related to oil and gas are insignificant. The loud, continuous noise during the drilling phase; the loud short-term noises from flaring or hydraulic fracturing; the intermittent whine of poorly maintained pump jacks and other equipment; and the loud or low frequency noise from compressors are common complaints related to oil and gas development. Numerous citizens have reported disruption of sleep and increased anxiety caused by noise from oil and gas developments.[242]

To illustrate the frustration with noise generated by compressors, here is one landowner's experience:

> *Now comes the second phase. The dreadful noise generated by a nearby large compressor station. Noise that was so loud that our dog was too frightened to go outside to do his business without a lot of coaxing. Noise that sounds like a jet plane circling over your house for 24 hours a day. Noise that is constant. Noise that drives people to the breaking point. My neighbor called the sheriff, state officials and even the governor and was told nothing could be done about the noise. Like I said, the noise drives people to the breaking point, and my neighbor fired 17 rifle shots toward the station.*
>
> —Excerpted from CBM Destroys Retirement Dream.
> The full story from this landowner can be found in Chapter IV.[243]

For more landowner stories related to noise, see Chapter IV. See the section on Alternative Technologies and Practices later in the chapter for information on how to decrease noise levels.

CONTAMINANTS ASSOCIATED WITH THE OIL AND GAS INDUSTRY

The following table summarizes the types of wastes that are generated during the various stages of oil and gas development.

Of these wastes, there are some that pose more serious concerns for landowners than others. These include specific air emissions; hydrocarbon wastes; produced water; and naturally occurring radioactive materials (NORM). These are discussed in more detail on the following pages.

	Air Emissions	Waste Water	Residual Wastes	Oil and Gas Industry Contaminants That Are Hazardous to Human Health
Well Drilling and Completion	• fugitive natural gas • other volatile organic compounds (VOCs) • polyaromatic hydrocarbons (PAHs) • carbon dioxide • carbon monoxide • hydrogen sulfide • methane	• drilling muds • organic acids • alkalis • diesel oil • crankcase oils • acidic stimulation fluids (hydrochloric and hydrofluoric acids)	• drill cuttings (some oil-coated) • drilling mud solids • weighting agents • dispersants • corrosion inhibitors • surfactants • flocculating agents • paraffins	• arsenic • benzene • cadmium • chlorinated paraffin waxes • chromium • carbon monoxide • 1,2-dichloroethane • dichloromethane • ethylbenzene • hexachlorobenzene • hydrogen sulfide • lead • nickel • polycyclic aromatic hydrocarbons (PAHs) • polychlorinated dibenzodioxins • polychlorinated dibenzofurans • radon and radium • toluene • trichloroethylene • uranium • volatile organic compounds • xylene
Production	• fugitive natural gas • other VOCs • PAHs • carbon dioxide • carbon monoxide • hydrogen sulfide • methane migration • fugitive BTEX (benzene, toluene, ethylbenzene, and xylene) from natural gas conditioning	• produced water possibly containing: arsenic, sulfur, metals (e.g., lead, nickel, zinc, antimony, barium), radionuclides (uranium, radon, radium), dissolved solids, and high levels of salts (e.g., sodium, chloride, potassium, magnesium) • produced water also may contain additives such as biocides, lubricants and corrosion inhibitors • wastewater containing glycol, amines, salts, untreatable emulsions, and hydrocarbons (e.g., benzene, toluene and naphthalene)	• produced sand • elemental sulfur • spent catalysts • separator sludge • tank bottoms • used filters • sanitary wastes	
Maintenance	• volatile cleaning agents • paints • other VOCs • hydrochloric acid gas	• completion fluid • wastewater containing well-cleaning solvents (detergents and degreasers), paint and stimulation agents	• pipe scale • waste paints • paraffins • cement • sand	
Abandoned Wells, Spills and Blowouts	• fugitive natural gas • other VOCs • PAHs • particulate matter • sulfur compounds • carbon dioxide • carbon monoxide	• escaping oil produced water brine	• contaminated soils • sorbents	

Adapted from: Sittig, 1978; EPA Office of Solid Waste, 1987. [244]

AIR EMISSIONS

As seen in the table below, there are several types of air emissions in the drilling and production process. The following table provides information on air quality concerns related to oil and gas in different parts of the country.

Some of the key sources of air emissions include the following:

Regional Air Quality Concerns from Oil and Gas Development

Pollutant or Impairment	Gulf Coast	North Slope	San Joaquin Valley	Rocky Mountain Region	California Coast
Visibility	A concern	An issue	Serious impairment in summer & winter	Degradation a serious concern	A possible concern
Sulfur dioxide, sulfate				A concern	
Ozone	A serious concern		A serious concern	An serious issue in some areas; a potential in others	A concern
Acid Deposition				A new issue and serious concern	
PM-2.5; PM-10 (particulate matter 2.5 or 10 microns in diameter)	A concern		A serious concern	Potentially an issue	A potential concern
Carbon Monoxide		A concern			

Adapted from: the U.S. Department of Energy [245]

1. Fugitive emissions from leaking tubing, valves, tanks, and open pits, or intentional venting of natural gas may release volatile organic compounds (VOCs)[246] and hydrogen sulfide.
   - VOCs are carbon-containing substances that readily evaporate into the air. They can combine with nitrogen oxides to form ground-level ozone, which can cause respiratory ailments such as asthma, and decreased lung function (see following page for more information). Examples are benzene and toluene.
2. Particulate Matter is essentially small particles that are suspended in the air and settle to the ground slowly. These particles may be re-suspended if disturbed. The most common sources of particulate matter from oil and gas operations are dust or soil entering the air during pad construction or from traffic on access roads; and diesel exhaust from vehicles or engines used at oil and gas facilities.
   - PM_{10} particles (with diameters less than 10 micrometers or μm) are small enough to be inhaled and can cause adverse health effects.
   - $PM_{2.5}$ particles (with diameters less than 2.5 μm) can lodge deep within the lungs and cause serious health problems. $PM_{2.5}$ particles are the main cause of visibility impairment (haze). Secondary particles are formed through chemical reactions involving gases and other particles in the atmosphere. Particles formed in this manner are fine particles (< 2.5 μm). The most common precursor gases involved in these reactions are nitrogen oxides (NOx), sulphur dioxide (SO_2), volatile organic compounds (VOCs) and ammonia (NH_3).[247] SO_2, NO_x and VOCs are all emitted during oil and gas operations.
   - For residents living along unpaved roads or near well pads, dust can penetrate their homes causing a nuisance and health problems such as hay fever and allergies. Crops

Studies over the last 15 years show that low levels of ozone, most certainly at 50 to 60 parts per billion (34-24 ppb below the federal limit) are detrimental to health.

American Journal of Respiratory and Critical Care Medicine

and vegetation near unpaved roads can be covered with the airborne dust stunting their growth due to the shading effect and clogging of the plant's pores. As a result, cattle and wildlife may avoid this vegetation. For motorists using the unpaved roads the traffic-generated dust can reduce visibility and cause driving hazards.

Dust Suppression

WATER is probably the oldest of all dust suppressants. Typically, it is applied by spraying it over the road surface.
Drawbacks: Water's dust suppressing capacity is very temporary because of evaporation. Heavy applications of water can create soft mud or penetrate the road to the sub-base and causing major road failure. Consequently, several light applications are preferable to one heavy application.

CHLORIDE COMPOUNDS such as calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$) and the less popular sodium chloride ($NaCl_2$) are used because they attract and absorb moisture from the atmosphere and retain it for extended length of time, which significantly reduce the evaporation of moisture from the road surface. Thus, they are more effective dust suppressants than plain water.
Drawbacks: Chloride compounds have the disadvantage of dissolving in water, and therefore can be washed out during wet weather conditions. They are also corrosive.

LIGNIN DERIVATIVES include a variety of industrial waste products, animal fats, and vegetable oils; the most popular is ligninsulfonate, which is a waste product from the paper-making industry. When used as dust suppressant, the lignin polymers act as glue binding the soil particles together. According to the New Mexico State University Molecular Biologic Program, a by-product of the soybean crushing process, called soapstock, is now being used as dust suppressant on dirt and gravel roads throughout the Midwest. This alternative is said to be more environmentally safe in places where runoff is a concern, and supposedly lasts longer than most other alternatives.[248]
Drawbacks: Ligninsulfonate dissolves in water, and so it is easily washed away during wet weather conditions.

RESINOUS ADHESIVES include waste oils, tars, bitumen, and by-products from the plastic industry. Of all these products, cutback asphalt and asphalt emulsions are most widely used as dust suppressants.
Drawbacks: According to the Minnesota Pollution Control Agency, "When applied to roads, waste oil can seep into groundwater, runoff into surface waters or spread into the air with dust particles. Once in ground or surface waters even small amounts of used oil can contaminate large quantities of drinking water. . . Used oil reduces the amount of oxygen in water, damaging fish and other aquatic life."[249] Consequently, waste oils are prohibited from use as a dust suppressant in Minnesota.Very little quantitative information currently exists on the environmental impacts from the use of dust suppressants (other than water). Landowners should be aware that the application of dust suppressants has been noted to cause slipperiness on unpaved roads in wet weather conditions. The water quality effects of the use of dust suppressants are still not entirely known, however the chloride compounds and the lignin additives commonly used contain contaminants such as chlorides, heavy metals and organic compounds that are regulated by the U.S. Environmental Protection Agency.[250]

ALTERNATIVES TO WATER AND CHEMICAL DUST SUPPRESSANTS[251]

LOWERING SPEED LIMITS will decrease the amount of dust stirred up from unpaved roads and pads. Lowering the speed of a vehicle from 45 miles per hour to 35 miles per hour can reduce emissions by up to 22 %. Installation of speed bumps can reduce vehicle speeds.

UPGRADING UNPAVED ROADS (e.g., by improving particle size, shape, and mineral types that make up the surface and base materials) will increase a road's surface strength, and reduce dust emissions. Adding surface gravel can reduce the source of dust emission, but if gravel is added the amount of fine particles (i.e., those smaller than 0.075 mm) should be limited to 10 to 20 %. Also, improving drainage and crown can reduce dust emissions. Paving is the most expensive, but most effective road upgrade option.

Dust can affect human health, and the health of crops, livestock and wildlife.

3. The flaring of natural gas produced from the oil or gas wells may release carbon monoxide, nitrogen oxides, sulfur dioxide, benzene, toluene, ethylbenzene and xylene, polycyclic aromatic hydrocarbons (PAHs) and, in the case of sour gas, hydrogen sulfide and carbon disulfide.
    - Benzene and PAHs are carcinogenic (cancer-causing). Also, benzene has been shown to cause various adverse health effects other than cancer, such as blood disorders,

impacts on the central nervous system, and reproductive effects.[252] Toluene, ethyl benzene, xylenes can affect human reproduction and respiratory systems.[253]

- Nitrogen oxides combine with VOCs to form ground-level ozone.
- Hydrogen sulfide is a neurotoxin (poisonous to the brain—see below).

4. Fuel combustion associated with the use of machinery including pumps, heater-treaters, and diesel engines, turbines and motors may release nitrogen oxides, sulfur oxides, ozone, carbon monoxide, and particulates.
   - Nitrogen oxides combine with VOCs to form ground-level ozone.
   - High concentrations of ozone near ground level can be harmful to people, animals and crops. ozone can irritate the respiratory system and inflame and damage cells that line the lung. Also, ozone may aggravate asthma and chronic lung diseases such as emphysema and bronchitis, and reduce the immune system's ability to fight off bacterial infections in the respiratory system. And ozone may cause permanent lung damage, with the worst effects being felt in children and exercising adults.[254]

Ozone (O_3) is formed when volatile organic compounds (VOCs) and nitrogen oxides (NO_x) react in the presence of sunlight and heat.

$$VOCs + NO_x + (sunlight/heat) = O_3$$

San Juan County Ozone Alert—In San Juan County, New Mexico, there are approximately 18,000 oil and gas wells currently in production. Per year, these wells emit an estimated:

- 6,900 tons of VOCs (57% of all VOCs emitted in the county)
- 29,000 tons of NO_x (25% of all NO_x emitted in the county)

At these levels of emission, the area is very close to the EPA's maximum allowable ozone concentration of 84 parts per billion (ppb). But with the Bureau of Land Management predicting an additional 12,500 new wells, 12,000 new compressors and 319 large compressors stations for the region, San Juan county may exceed ozone levels of 84 ppb in the future. This would endanger the health of county residents, especially children, the elderly, and residents who do a lot of outdoor exercise.[255]

In San Juan County, New Mexico, a typical summer day has ozone levels higher than 50 ppb and frequently exceeds 70 ppb.

Data from NM Environment Dept., Air Quality Bureau, www.nmenv.state.nm.us/aqb/

5. Wastes generated during natural gas dehydration and sweetening may release glycols and benzene.
   - Glycols are volatile and can be hazardous if inhaled as a vapor.[256]

6. The extraction of produced water during coalbed methane development may lead to migration of methane gas to the atmosphere. (See produced water below.)
   - Methane can form an explosive mixture in air at levels as low as 5 percent. Symptoms of methane exposure include burning eyes, dizziness and headaches.[257]

7. Accidental and intentional releases of hydrogen sulfide may occur at sour gas well operations. When H_2S burns it forms sulfur dioxide and trioxide (SO_2 and SO_3, respectively), which contribute to air pollution and health problems. Furthermore, because H_2S is heavier than air, it often settles in low-lying areas, where it can accumulate in concentrations

that can injure or kill livestock, wildlife and human beings. As well, hydrogen sulfide gas has been found to migrate into surface soils, groundwater and into the atmosphere from coalbed methane production (in association with methane gas).[258]

- Common symptoms affecting those exposed to chronic, periodic or puff releases of low levels of H_2S include: headache, skin complications, respiratory and mucus membrane irritation, respiratory soft tissue damage and degeneration, confusion, impairment of verbal recall, memory loss and prolonged reaction time.[259] Brief exposures to H_2S are neurotoxic, effects are persistent, and exposures to low doses appear cumulative. . . downwind environmental exposure to H_2S can cause permanent impairment; "neighborhoods near refineries and other industrial sites where H_2S is released deliberately or inadvertently are unsafe."[260]
- Hydrogen sulfide has an effect on cattle at concentrations of 50 ppm, and can cause death to cattle at higher concentrations.[261]

Carol Browner, former Administrator of the U.S. Environmental Protection Agency (EPA) made no secret of the fact that hydrogen sulfide was eliminated from the Clean Air Act list of extremely hazardous substances by powerful last minute oil and gas lobbying.[262] *This elimination occurred in spite of the fact that the EPA study, Hydrogen Sulfide Air Emissions Associated with the Extraction of Oil and Natural Gas. . . documented a large number of oil and gas related accidents occurring in North America and concluded that accidental releases of H_2S pose the greatest risk to public health.*
—Excerpt from page 3, *Survey of Accidental and Intentional Hydrogen Sulfide Releases Causing Evacuations and/or Injuries in Manistee and Mason Counties from 1980 to 2001.*

For more resources on air emissions, see Chapter V.

HYDROCARBON WASTES

Hydrocarbons are compounds that are made primarily of carbon and hydrogen molecules. Examples of hydrocarbons associated with oil and gas operations include: crude oil, waste oils, natural gas, methane, BTEX, phenols, PAHs, and some solvents.

FIGURE I-31. BENZENE WARNING SIGN
A conventional gas operation in Wyoming. Photo by Wyoming Outdoor Council.

Health effects associated with hydrocarbons include: respiratory ailments, effects on neurologic, cardiac and gastrointestinal systems, and skin disorders. Some hydrocarbons are known to cause cancer (e.g., PAHs and benzene). The amount of exposure and how the exposure occurs (e.g., skin contact, ingestion, inhalation) influence which bodily systems are affected and the extent of damage to the systems.

Hydrocarbon spills and waste pits pose a health threat to wildlife and livestock. Waterfowl, wildlife and livestock may be attracted to pits and open tanks used to store oil, separate oil from produced water, or store produced water. The risks posed to wildlife by oil waste pits have been documented by numerous studies.[263]

- In Wyoming, the U.S. Fish and Wildlife Service have found deer, pronghorn, waterfowl, songbirds and rabbits in oil pits and tanks. Even if animals are not killed in the pits, the oil and chemicals in the pits may affect their health. For example, if animals absorb or ingest oil, they may become more susceptible to disease and predation.[264]
- Landowners should suggest that companies use closed containment systems (e.g., tanks). These require little or no maintenance and may be reused at other well operations. The

benefits for the companies are that these systems greatly reduce or eliminate soil contamination, thereby reducing remediation costs.

- Other measures to protect wildlife and livestock include systems to prevent oil from entering waste pits; immediately cleaning up any oil spills into open pits; adequate fencing around waste pits and tanks; and netting to keep birds from entering waste pits. If netting is not installed properly or maintained well enough (e.g., if there are tears in the netting or if it sags into the waste pit, which is common after it snows), the oil will be exposed. Nets should be installed four or five feet above the pits to allow for sagging.[265]

For example, a study conducted in 1994 documented the effects of a pipeline spill on livestock.[266] Cattle on two ranches were exposed to a mixture of gases including hydrocarbon vapors, sour gas, and sulfur dioxide. The study concluded that:

- there was an increase in illness and death in both herds
- calves suffered a "failure-to-thrive syndrome" (i.e., calves failed to nurse, had slow weight gain, and were prone to infection)
- open sores and other evidence of exposure to irritating substances were observed in the upper respiratory tracts of calves
- changes in maternal behavior were observed in both herds
- some cattle had difficulty in placement of their limbs

Releases of Hydrocarbons—Land and Water

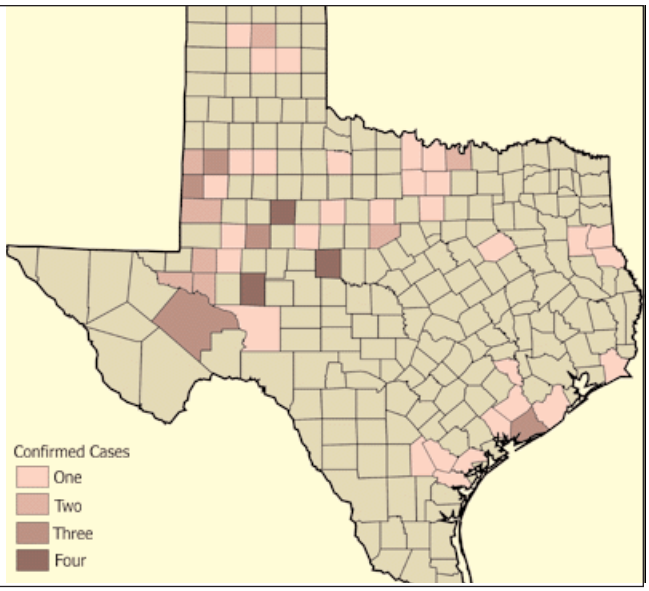
In addition to hydrocarbons being emitted into the air, releases of hydrocarbons can flow across the land surface, seep into the soils and groundwater or flow into surface waters. Releases of hydrocarbons may occur in a single event, e.g., a spill, or over longer periods of time, e.g., seepage from pits, or slow leaks from pipes and storage tanks. Spills are the most common type of release and are often small in quantity.[267] Spills and seepage may result from human error, equipment failure, improperly designed containment facilities, past oilfield practices, vandalism, or natural phenomena (e.g., lightning strikes, flood damage).

- Spills of hydrocarbons may come from several sources or operations at production and drilling sites: leaking tanks, pipes, flowlines, valves, joints, or gauges; blowouts (see box on next page); oil transfers; diesel from drilling operations; offloading of oily drilling muds and production chemicals.
- High concentrations of hydrocarbons are found in the bottoms of oil storage tanks (i.e., tank bottoms), which contain a mixture of crude oil, salt water, sand, and scale from the tank itself.

FIGURE I-32. SOUTHEAST NEW MEXICO: Left: produced water pit with layer of oil on top. Right: Leaking waste-oil tank. No netting and inadequate fencing allows access to these toxic hydrocarbon wastes. Photo by C. Johnson.

Groundwater Contamination

In Texas, groundwater has been affected by the thousands of Texas drilled for oil and gas exploration. When improperly drilled or cased, or when the casing has corroded, old oil, gas, and water wells serve as conduits for contamination of the aquifers below. Improperly completed and abandoned water wells may allow direct access from the surface to groundwater for contaminants such as pesticides, or they may facilitate the comingling of groundwater from one aquifer to another.[268]



Signs of hydrocarbon contamination include: dead vegetation, stained soil, oil in depressions or in pits, or an oil sheen on the surface of nearby ponds and streams. It is less easy to detect hydrocarbons that have soaked into the soil, and whether or not those hydrocarbons are interacting with groundwater.

Oil and gas exploration and production wastes are exempt from federal hazardous waste regulations.

Hydrocarbon Disposal

At the present time, oil and gas exploration and production wastes are exempt from federal hazardous waste regulations.[269] This leaves the decision of how to dispose of potentially hazardous hydrocarbon wastes in the hands of the oil and gas operator. Should contamination occur due to the mismanagement of hydrocarbon or other wastes, the company could be held liable for the clean-up costs.[270] This assumes, however, that either the federal government or landowner has the desire or economics means to take the company to court.

The federal ruling does not exempt oil and gas operators from waste regulations imposed at the state level. Unfortunately, some state waste regulations do not appear to be a great enough incentive to properly dispose of oil and gas wastes. For example, in New Mexico, the state Oil

Weld County Waste Disposal

The Weld County Waste Disposal, Inc. site was a 40-acre commercial waste disposal facility originally permitted to receive oil field brines and other petroleum related liquid waste generated from oil and gas exploration and production activities. Liquids received were transported in an aboveground pipe to a clay-lined impoundment where liquid hydrocarbons were separated from the produced water (brine) and recycled. The water was transferred to a second clay-lined impoundment where enhanced evaporation occurred as the primary water disposal method.[271]

Weld County Waste Disposal Inc., is currently undergoing site investigation and remediation under the federal government's Environmental Protection Agency (EPA) supervision. The site was found to represent an "imminent and substantial endangerment" to the environment under the Resource Conservation & Recovery Act (RCRA). Initially, it was targeted because the operator failed to keep the pond surface clear of oily residue, which led to the death of several great blue herons. Once the facility was brought under RCRA, however, EPA required a full site investigation. This investigation and the related remediation are expected to cost oil and gas operators that "contributed" waste to the facility some $3 million (the site operator declared insolvency).[272]

Conservation Division has been investigating contamination in two regions where there is oil and gas development. Out of 734 cases of soil or groundwater contamination statewide, 444 were at oil or gas field production locations.[273]

In New Mexico, about half of all exploration and production wastes (other than produced water and drilling muds and cuttings) are disposed in pits, about 45% are diverted to oil "reclaimers," and the remainder of the wastes are buried on-site.[274]

These disposal methods are typical for the industry. In addition to pit disposal and burial, landfarming (the process of spreading waste oil on soil) is a standard industry practice for disposing of hydrocarbon wastes. In many jurisdictions, oil companies may use a designated area for spreading oil or hydrocarbon-contaminated soils, as long as the land is not going to be used for agriculture.[275] Landfarming may involve the bioremediation of the soil, to decrease the levels of hydrocarbons. To achieve bioremediation, hydrocarbon-digesting microbes found naturally in soil are enhanced with fertilizers and moisture to degrade the material. The site is tilled periodically and watered to maintain proper amounts of air and moisture.[276]

Many oil and gas operators choose to send hydrocarbon wastes such as tank bottoms to commercial oil field waste disposal facilities, or reclaimers. The crude oil reclamation industry recovers marketable crude oil and other hydrocarbons from produced water, tank bottoms and other oily wastes that are generated by the production of oil and natural gas. Marketable crude oil is recovered from the waste materials by simple thermal and/or physical processes (e.g., heat and gravity separation). As with on-site waste pits, these off-site facilities pose a significant risk to migratory birds and other wildlife because they use large evaporation ponds to dispose of and treat oil and gas wastes. Commercial facilities that dispose of wastewater through deep well injection generally do not pose a risk to wildlife, but may pose a threat to groundwater resources.[277]

FIGURE I-33. LEAKING TANKS CAN THREATEN GROUNDWATER. Note the hydrocarbon stains on the soil.

Well Blowouts

A well blowout is defined as the uncontrolled flow of fluids from a well bore. These fluids, which include hydrocarbons, produced water, drilling fluids and others, can contaminate soils surrounding the well bore, seep into groundwater, and flow into nearby water courses.

Most commonly, a blowout occurs when there is insufficient pressure in a well bore to control subsurface pressures. During drilling, completion, or plugging and abandonment operations, proper well-bore pressure control is the key to preventing blowouts; the primary method is through hydrostatic pressure, which is created when a well is filled with fluid (e.g., drilling mud).[278]

According to the California Department of Conservation, there are three main causes of blowouts during drilling operations, all stemming from human error: 1) failure to maintain adequate drilling fluid weight; 2) failure to keep the hole full of drilling fluid; and 3) failure to prevent swabbing. These categories accounted for about 55 percent of the blowouts that occurred in California from 1950 to 1990.[279]

Between the years 1950 and 1990 there were 101,578 oil and gas wells drilled in California. During this period there were 135 blowouts from onshore operations (52 during drilling; 17 during completion; 10 during plugging and abandonment; 61 during other well operations).

- Blowouts lasted anywhere from a few minutes to 13 days
- Materials that were spewed from the wells during the blowouts included: oil, gas, mud, rocks, sand, gravel, water, saltwater, steam, and casing and tubing parts.
- There were injuries or deaths associated with 28 of the blowout incidents. In total, there were seven deaths and 52 injuries reported.[280]

PRODUCED WATER

There are a host of health and safety concerns associated with produced water. The quality and quantity of water removed present threats to human and ecological health; and the removal of water creates other issues such as potential for underground coal fires, and creation of pathways for methane to migrate to the surface. All of these issues are discussed later in this section.

Water Quality

Pumping oil and gas out of the ground produces large volumes of water, which often contains large amounts of dissolved salts (e.g., chloride, nitrate, nitrite, sodium, calcium, magnesium and potassium), inorganic substances (e.g., antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, lithium, mercury, nickel, silver and zinc);[281] hydrocarbons (benzene, ethylbenzene, naphthalene, toluene, phenanthrene, bromodichloromethane, and pentachlorophenol) and radionuclides (e.g., uranium, radon, and radium).

Most produced water has attributes that make it undesirable or unfit for human or agricultural use.

- Oil, sulfur and phenol can be smelled and tasted.
- Studies on produced water from California oilfields have revealed incidents where concentrations of phenols and arsenic posed a threat to human health.[282]
- As mentioned above, benzene is a known human carcinogen and can cause blood disorders, impacts on the central nervous system, and reproductive effects; and ethyl benzene and toluene are known to human reproduction and respiratory systems.
- In high enough concentrations, sodium, carbonates, phosphates, borates, sulfates, magnesium, potassium, iron, fluorine and organic chemicals found in produced water may all contribute to the deterioration of the water supply. For example, if chloride is present in high concentrations it can cause water to taste salty, and soap suds will not form as well. And boron, which is non-toxic to humans in low concentrations, can produce a laxative effect in animals (concentrations of 40 ppm).[283]
- Produced water often has high salinity (dissolved salt content). Total salinities of oil- and gas-field produced water range from about 1,000 milligrams per liter to more than 400,000 mg/L. The U.S. EPA's recommended safe drinking-water limit is 500 mg/L.[284] Waters with salinities between 0 and 400 mg/L are acceptable for all crops; and salinities above 5,000 mg/L are considered too saline for almost all crops.[285] Also, if produced waters are discharged onto land surfaces, the salts can build up in the soil and affect plant growth.

The concentration of contaminants in produced water varies from region to region and depends on factors such as the geology, depth of the production zone, age of the well, and well stimulation techniques.[286]

- Radionuclides in produced water are found only in some areas of the country (see discussion on NORM below).
- In most oil and gas producing areas, produced water from deeper wells has a higher salt content than water from shallow wells. In basins where the rocks consist mainly of shales or siltstones, however, fresher water may be found at greater depths.[287]
- If wells undergo acidization or hydraulic fracturing, residual chemicals will be removed along with produced water. The chemicals used vary be operator and geological formation.

Water Quantity

Every minute, a CBM well may pump as much as 15 gallons of produced water.[288] This may lead to significant drawdown of local and regional aquifers and reduction of ground and surface water supplies. As mentioned in the chapter on Coalbed Methane, some aquifers in coalbed methane producing areas have fallen by 200 feet or more.[289] The BLM estimates that groundwater levels in the Powder River Basin will drop by 600 to 800 feet, if that region develops their CBM resources at the BLM's intended rate.[290]

If regional groundwater levels become too depleted, local springs, streams, domestic and stock water wells, and subirrigated acreages will be affected.[291] Significant reduction in these waters would be harmful or fatal to aquatic life and wildlife; crop production could decrease; and carrying capacities and distribution patterns for livestock and wildlife could be significantly and adversely affected.[292] This could have a devastating impact on local/regional ecosystems and economies dependent on them.

Dewatering of Coal Beds

Coal will not burn as long as it is saturated with water. But when coal beds are dewatered, and especially if they are close to the surface, the coal may catch on fire from lightning strikes, wildfires and spontaneous combustion. This is a potential concern to landowners because once underground coal fires begin to burn, they are almost impossible to put out; the burning coal releases carbon monoxide; and the layers of rock and soil above the coal can collapse as the coal continues to burn.[293] Carbon monoxide can lead to fatigue in healthy people, chest pain in people with heart disease, and at higher concentrations, it can cause impaired vision and coordination; headaches; dizziness; confusion; or nausea.

Methane and Hydrogen Sulfide Migration

Massive dewatering of aquifers may also lead to increased methane or hydrogen sulfide (H_2S) migration to the surface. In some areas, dewatering (which releases methane from the coal), and the structure and layering of the geology create pathways that allow these gases to flow to the surface.[294] The escape of methane or H_2S can also result from inadequate well control procedures and faulty casing or plugging.[295] The gas can then collect in explosive levels in homes. Methane and H_2S seepage/venting may be one of the most disastrous problems facing landowners living in close proximity to CBM operations.[296]

> *EPA spoke with a former county employee, who worked for Exxon performing hydraulic fracturing jobs in an earlier career. As a county employee, he took measurements for methane and hydrogen sulfide inside homes in response to citizen complaints. According to his information, there were not significant problems until the shallowest formation, the Fruitland coal, began being developed. He believes that the main route of contamination is from older, poorly cemented wells. The county official estimated that hundreds of wells have been impacted. He said the biggest problem associated with the apparent effects of CBM development is explosive levels of methane and toxic levels of hydrogen sulfide in homes. In his opinion, this is due to removal of water rather than hydraulic fracturing.* — Excerpt from EPA's *DRAFT Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs.*[297]

Disposal of Produced Water

The United States produces 20 to 30 billion barrels of produced water every year.[298] Prior to the enactment of environmental regulations in the 1970s, produced water was disposed of using the most economical method. This often resulted in the intentional discharge of the water on the ground surface.[299] Today, the most common methods of disposal are injecting it into the

FIGURE I-34. HYDROGEN SULFIDE WARNING
Hydrogen sulfide may be associated with produced water.

subsurface, evaporating it in disposal ponds, and releasing it to watercourses such as rivers or ephemeral streams.

Injection/Reinjection: Approximately 90% of onshore produced water from conventional oil and gas sites is reinjected into a well for production enhancement, or disposed of by injection into a disposal well.[300]

Reinjection of produced water to enhance the recovery of oil or gas typically involves a closed system from the producing well bore to the injection well bore, so the potential for spills and soil contamination is minimized.[301] Production enhancement is discussed in the section on Stages of Oil and Gas Development.

When using disposal wells, produced water is usually required to be injected into known formations, such as a former producing formation, or aquifers known to have water quality that is worse than the quality of produced water.[302] If water is being injected into a formation, the formation must be capable of receiving the huge volumes of injected water. But subsurface geology is not always known or predictable, and there may be unintended consequences from injection of produced water. (See the box on BP-Amoco's reinjection problems.)

Produced water from CBM operations is not used to enhance methane recovery. Underground injection is, however, used as a method of disposal of CBM produced water.[303] Also, if the water is of good enough quality, produced water may be injected into a formation that will store the water, which will enable it to be retrieved at a later date.

Storage or Disposal in Evaporation Ponds or Percolation pits: Produced water may be placed in pits and allowed to either evaporate or percolate into the surrounding soil. According to the U.S. EPA, this approach is declining because of potential contamination of groundwater and the potential hazard posed to birds and waterfowl by residual oil in these open pits.[304]

Often, impoundments do not contain water effectively, and leaks are common. Water may end up in rivers and streams, increasing the salts in these watercourses. The water also evaporates from the pits, which wastes water that could otherwise be used to recharge aquifers.[306]

Swamping may also be an issue if produced water is held in ponds. Near Gillette, Wyoming, produced CBM water is often stored in ponds before it is discharged in drainage systems. In some cases, produced water has seeped from the ponds into near-surface sediments. Sediments can only absorb so much water, and if additional water cannot be transmitted fast enough to deeper soils surface swamping will occur.[307]

The oil and gas industry often talks about creating a beneficial use for produced water. One of these supposed beneficial uses is the creation of artificial ponds or reservoirs using produced water that is non-toxic to wildlife. This may seem like an environmentally sound option for the water, since the reservoirs can provide wildlife habitat, fish ponds and recreation areas. The problem is that over time, CBM water production will decline. When this happens, ponds and reservoirs will dry up, green areas will turn brown, and wildlife and fish that have come to rely on this source of water will lose their habitat. As one critic puts it: “Creating and then destroying environs in this callous fashion is an unacceptable impact to the land.”[308]

Discharge to Streams: For this disposal method the water is supposed to be treated to meet

At a BP-Amoco well southeast of Durango, Colorado, CBM produced water was reinjected into an aquifer that, unbeknownst to the company, connected to a natural fracture system. The produced water traveled underground and forced hot water that had been in deep aquifers up toward the surface. This caused a nearly 50 degree Fahrenheit temperature increase in a hot spring 1½ miles north of Durango. Water output at the hot spring also increased. The temperature at the hot springs decreased after BP-Amoco agreed to inject water into a different aquifer. Nancy Van Dover, a local resident, told the Colorado Oil and Gas Conservation Commission how disposal wells had caused her well-water temperature to rise to 100 degrees. The water also became highly mineralized and destroyed her sink, toilets and shower. [305]

standards for oil and grease content, and pass a toxicity test prior to discharge. There are some negative effects associated with this practice:

- Often, enormous quantities of CBM produced water are discharged all year long, which alters the seasonal nature and timing of natural flows. If such practices are allowed to continue, the water volume of some rivers may be doubled, and streamside trees and plants that have adapted to the previous water conditions may not be able to survive.[309]
- Dumping large volumes of produced water into streams can wash away stored nutrients, and without these food sources, aquatic organisms may not be able to survive.
- In Wyoming and Montana, it is common practice to dump produced water from CBM operations into streams. Often, however, discharges are permitted into streams and rivers without proper testing.[310] This poses a danger to aquatic life and landowners living downstream who use the water for irrigation, since the produced water may contain high concentrations of salts and dissolved solids.

Surface Discharge: Discharges of produced water on land may flood the property of landowners, which can lead to erosion and damage to soils and plants.[311] The effects of the surface disposal of produced waters can also include swamping; siltation of streams, lakes, and reservoirs; and contamination of soil, ground water and surface water by salts, hydrocarbons, metals, and radioactive materials.[312]

The discharge of produced water inappropriately onto soil can result in salinity levels too high to sustain plant growth. In some areas, however, produced water may contain low enough levels of salt that it may be used for beneficial use for irrigation or livestock watering.

Occasionally, produced water is spread on roads as a dust suppressant. Roadspreading is declining as a disposal option, however, and in 1995 it accounted for less than 1 % of produced water disposal.[313]

The U.S. EPA estimates that 30 % of producing oilfields in the United States have enough NORM to warrant health and environmental concerns.[316] One industry estimate suggests that if strict regulatory requirements for assessment and cleanup of NORM were put in place in the United States, 20 % of oil production and 8 % of gas production would become uneconomic. [317]

NATURALLY OCCURRING RADIOACTIVE MATERIALS (NORM)

Naturally occurring radioactive materials may be present in oilfield solid or liquid wastes. As well, radioactivity may be found on oil or gas industry equipment.[314]

Depending on the geology, subsurface formations may contain radioactive materials such as uranium and thorium and their daughter products, radium 226 and radium 228. Radionuclides are leached into groundwater or surface water when the water comes in contact with uranium- and thorium-bearing geologic layers. NORM can be brought to the surface in produced water from these formations. In addition, radon gas, a radium daughter, may be found in produced natural gas.[315]

The primary carrier of the NORM is the produced water from the reservoir. When the produced water is brought to the surface, the changes in temperature, pressure and salinity cause a scale to form.[318] For example, radium 226 and 228 found in produced waters may become concentrated by attaching to barium sulfate scale in well tubulars and surface equipment. Elevated concentrations of radium 226 and 228 may also occur in sludge that accumulates in oilfield pits and tanks.[319] Often, high concentrations of oil-and-gas-related NORM are associated with separator tanks, water storage tanks, and water lines where brine scale and tank sludge accumulate.[320] Consequently, workers employed in the area of cutting and reaming oilfield pipe, removing solids from tanks and pits, and refurbishing gas processing equipment may be exposed to radioactive materials that could pose health risks.[321] The main health risks for humans are direct gamma radiation from NORM-bearing soils and equipment, breathing of NORM-bearing dust, or breathing indoor radon in structures built on NORM-affected soils.[322]

Some study results:

- High concentrations of radioactivity associated with oil fields have been found in the Gulf Coast region, northeast Texas, southeast Illinois, Oklahoma, and south-central Kansas. Also, state agencies have identified radioactive oil-field equipment in northern Michigan and eastern Kentucky.[323]
- Among 14 sites studied in the Wildhorse field of Oklahoma, oilfield equipment radioactivity or radioactivity in soils or on road surfaces exceeded regulatory limits at 10 of them. Material interpreted to be tank bottom sludges discarded on soils at production sites consistently contained the highest radium. The authors of the study warned that as the contaminated soil material ages and weathers it may be transported downslope by slope wash processes, thus contaminating a greater area. Equipment radioactivity was highest on old pipe with thick scale.[324]

Disposal Options

In Texas, NORM-contaminated solids, such as pipe scale, may be disposed of on the site where they were generated by burial or placement in a well that is being plugged and abandoned.[325] Contaminated soil may be spread on land only under certain conditions.

Regulation of NORM

The U.S. EPA has not issued regulations limiting NORM contamination and radioactivity in oil and gas production operations. The agency is, however, assessing the extent of the problem in a wide number of industries that generate NORM, and the EPA and the Department of Energy are evaluating the health risk associated with NORM exposure in oil and gas operations.[326]

At least six states (Louisiana, Texas, Michigan, Mississippi, Arkansas, and New Mexico) have regulations that would govern some aspect of NORM in the oil and gas industry.

Alternative Technologies and Practices

Often, there are alternatives available to the standard technologies and practices used by the oil and gas industry. Sometimes companies are hesitant to use alternatives because they perceive these options as being more expensive, or the companies are simply used to doing things a certain way.

This section primarily focuses on the technologies and practices that affect the environment, and thus, affect landowners. Another realm of "Best Management Practices," however, involves policy and regulatory alternatives for developing oil and gas resources in a responsible manner that protects the rights of surface owners. These alternatives may include, for example, improving surface owner consent provisions; doing a better job of balancing surface owner and mineral owner rights; or enabling surface owners to have a greater say in the location of wells that are going to affect their property. Many of these issues are mentioned in Chapters II and III.

The Vermejo Park Ranch Mineral Extraction Agreement in Chapter III is an example of one of the better known Surface Use Agreements achieved by a landowner.

An excellent example of a template for responsible oil and gas development was produced by the Northern Plains Resource Council in Montana. Their report, *Doing It Right*, provides a proposal for how coalbed methane in that region has been developed in a way that industry, landowners and the public can live with. In summary, *Doing It Right* advocates for:

1. Effective monitoring of coalbed methane development and active enforcement of existing laws to protect private property rights, Montana citizens, and Montana's natural resources.
2. Surface owner consent, surface use agreements and reimbursement of attorney fees to help landowners better protect their property rights.
3. Use of aquifer recharge, clustered development, mufflers for compressor stations, and other low-impact, best-available technologies to minimize impacts on underground water reserves, rivers and streams, and surface resources.
4. Collection of thorough fish, wildlife, and plant inventories before development proceeds to protect habitat, followed by phased-in development to diffuse impacts over time.
5. Meaningful public involvement in the decision-making process.
6. Complete reclamation of all disturbed areas and bonding that protects Montana taxpayers from all cleanup liability costs.

The template can be used in other states, and can be applied to conventional oil and gas development. For more information on Northern Plains Resource Council and how to obtain the complete *Doing It Right* report, see Chapter V.

What will make companies use alternative technologies and practices?
In Chapter II you will learn that even though mineral owners and companies that lease mineral rights have the right to enter and use a surface owner's property to develop oil and gas, surface owners are not without rights. The use of "best management practices" is required in numerous states.[327] Courts have found that mineral owners may not cause unreasonable damage to the surface estate if there are reasonable alternative methods available to develop the minerals in a way that does not cause the damage.[328] Consequently, it is useful for surface owners to be aware of some of the alternative technologies and practices that are available. In many cases, these alternatives are already being used by some companies, so they may be considered reasonable alternatives.

Read the Landowner story "Bellflower Well" in Chapter IV for an example of how surface owners in Colorado managed to decrease the impact of a coalbed methane well on their lives by pressuring a company to use alternative practices. As the story illustrates, however, often it is not enough to simply ask companies to use alternative technologies. Typically, landowners have to diligently fight for the things that are important to them (e.g., a pollution-free, quiet, safe environment).

FIGURE I-35. BURIED TANK

Where can I find information on alternative technologies and practices?
Ultimately, surface owners will have to do some of their own research to find out about alternatives. Fortunately, there are a variety of resources available. For example, numerous organizations and government offices have developed "best management practices" for the oil and gas industry. For example, the state of Pennsylvania has developed best management practices for the development of well locations because of the hilly nature of the state and the desire to control erosion and sedimentation.[329]

Many industry web sites highlight "state-of-the-art" technologies. Industry groups and governments often provide awards to companies for implementing innovative technologies and practices. While many of these awards are simply pats on the back, it may be useful to look at some of them. You may be surprised to find that a company you have been dealing with has developed and used better technologies in other jurisdictions. If this is the case, you can try to pressure companies to apply their technologies across the board.

It is also useful to look at technologies used by companies that are active within city limits.

Often, the requirements for noise abatement, air quality and water quality are more stringent if oil or gas wells are located in densely populated areas, and as a result, companies are forced to use state-of-the-art equipment in those situations.

For example, in 2003, the Farmington, New Mexico City Council approved five gas wells only on the condition that the company agreed to: bury all condensate tanks; install double walled condensate tanks as a means of leak protection; enclose well pads with a six foot chain-link privacy fence; install sound abatement measures around all compressors and motorized equipment; and ensure that sound measurements would not exceed more than three decibels above ambient level at a distance of 300 feet from the compressor, or one decibel above ambient level at the nearest residence. The company also offered to pay for surrounding residents to stay in hotels during the drilling period, if requested.[330]

Below, you will find some examples of alternative technologies and practices. This list is by no means comprehensive, and the following practices will not be appropriate for all situations. These examples are meant to provide readers with an idea of the types of alternatives that are out there. Visit the Oil and Gas Accountability Project web site (http://www.ogap.org) and Chapter V of this guide for more information and additional resources on alternative technologies and practices that are available to oil and gas operators.

ALTERNATIVES USED DURING THE DRILLING AND COMPLETION PHASE

1. **Pitless or "closed-loop" drilling** can reduce the impact of waste pits. At a conventional drilling site, drilling fluid is circulated through the well bore, and then often deposited in a reserve pit dug next to the well. This pit is constructed prior to drilling. It is open to the atmosphere, and is used to store drilling fluid. A large storage capacity is typically required, because there are times when large amounts of drilling fluid are needed (e.g., when high pressure zones are encountered during drilling). A reserve pit can be the source of considerable costs at a drilling site because of the costs associated with properly closing pits. Also, there are health, environmental, and financial risks associated with pits, which can contaminate soils with hydrocarbons, metals and salts, and leak potentially toxic liquids into surface or groundwater.[331]

FIGURE I-36. CONVENTIONAL DRILLING SITE
This site, with reserve pits disturbs 3-4 acres of land.
Photo by Jonathan Selkowitz

Eliminating the need for earthen reserve pits is a viable option for oil and gas companies.[332] In pitless drilling, the drilled solids are separated from the mud during the drilling process, and are moved to a storage tank. The fluids are pumped to storage tanks. The drilling mud and water can be re-used throughout the drilling process. And at the end of the drilling process, the remaining water may be transported to the next drill site and used on the subsequent well.

The tanks represent an additional cost, but overall, pitless drilling can save an operator money because there is no need to construct a pit, there is a reduction in the amount of environmental releases, and the closed-loop system results in more efficient use of drilling fluid.[333]

> *A small independent operator in Texas was concerned that reserve pits for drilling fluid were increasing waste management costs and exposing it to liability for surface and ground water contamination due to pit failures. Because the wells to be drilled were relatively shallow and few complications were expected, the operator negotiated with the drilling contractors to use a closed-loop fluid system. The operator saved approximately $10,000 per well because the drill site construction and closure costs were greatly reduced, as were waste management costs. The operator's liability was also reduced.*[334]

Benefits of pitless drilling:[335]

- it eliminates unsightly and hazardous pits
- it reduces the time, energy and expense of building, fencing and reclaiming reserve pits
- it decreases the need for cuts in sensitive and hilly areas
- total surface disturbance associated with a well pad is reduced
- it eliminates risk of waterfowl and wildlife mortality related to pits
- it eliminates risk of damaging underground pipelines and utilities
- it allows drilling in areas with a high ground water table
- it virtually eliminates drilling waste
- rigs use less water per well—it can reduce water consumption by as much as 80%
- it eliminates soil segregation, which reduces wind erosion problems
- it reduces truck traffic associated with transporting drilling wastes by as much as 75%
- it may improve relationship with surface owners
- it greatly reduced waste tracking and need for land farming operations
- drill cuttings may be put to beneficial use, e.g., if not contaminated they may provide a source of finely-ground clay for berm construction around tank batteries or other uses

2. **Redesigning pits can decrease the amount of surface disturbance**. If a pitless drilling system is not used for drilling fluids, another approach may be to use a V-shaped pit instead of the traditional rectangular pit. This type of pit reduces water requirements, as well as the amount of surface disturbance.

   The design is as follows: the open end of the "V" faces the drilling rig and the cross-sectional view resembles a squared-off funnel (about 10 feet deep with the upper 5 feet having slanted walls to a width of about 20 feet). Because the fluid must travel the full length of the pit, this design prevents mud from channeling between the discharge point and the suction point, and reduces the amount of water that must be added to maintain the desired fluid characteristics. In addition, because the V-shaped pit is long and narrow, it is easier to construct and leaves a smaller "footprint" at the site.[336]

   > *A company installed a V-shaped reserve pit and compared the costs with those incurred at similar-sized wells using a traditional pit. The company determined that pit construction time was reduced by about 40 percent, water costs for the well were reduced by about 38 percent, and pit liner costs were reduced by about 43 percent. The total cost savings were about $10,800 per well.*[337]

   It should be noted that whenever earthen pits are used to store wastes, they should be lined with multiple layers of synthetic fabric with leak detection devices between the layers.

3. **Directional drilling help to minimize surface disturbance or avoid disturbance in sensitive or special areas.** Wells do not have to be drilled perfectly vertical. Directional drilling techniques exist that allow wells to be drilled at angles (slant hole wells); allow wellbores to curve sideways (horizontal wells); or to have more than one curve (S-curve or deviated wells).

   The benefits of directional drilling are numerous. Using these techniques, companies can drill a number of wells in different directions from one well pad (multilateral wells), which can decrease overall surface disturbance by reducing the number of well pads required to drain an oil or gas field.

Studies also show that directional drilling has been successful in a variety of geological formations (e.g., shallow reservoirs, deep reservoirs, tight sands, coal beds, tar sands). Furthermore, if horizontal drilling is used in coal beds, there may be no need to hydraulically fracture the beds, resulting in a decreased potential for groundwater pollution.
Perhaps the greatest benefit to the surface owner is the ability to locate well sites away from residences or other areas that surface owners do not want to be disturbed. It is now possible for companies to access oil or gas from beneath a landowner's property by drilling a well that is miles away from that property.[338]

A major benefit to the companies and mineral owners receiving royalties is increased oil and gas production. Oil- and gas-bearing formations tend to be more wide than they are deep, consequently, wells that intersect a producing formation at an angle or horizontally often can drain more of the oil and gas than purely vertical wells. There are numerous studies showing that directionally drilled wells have been able to extract 2-25 times more oil or gas than vertical wells drilled in the same oil or gas field.[339]

FIGURE I-37. A VERTICAL AND HORIZONTAL WELL DRILLED ON ONE PAD. Photo printed with permission of Vermejo Park Ranch.

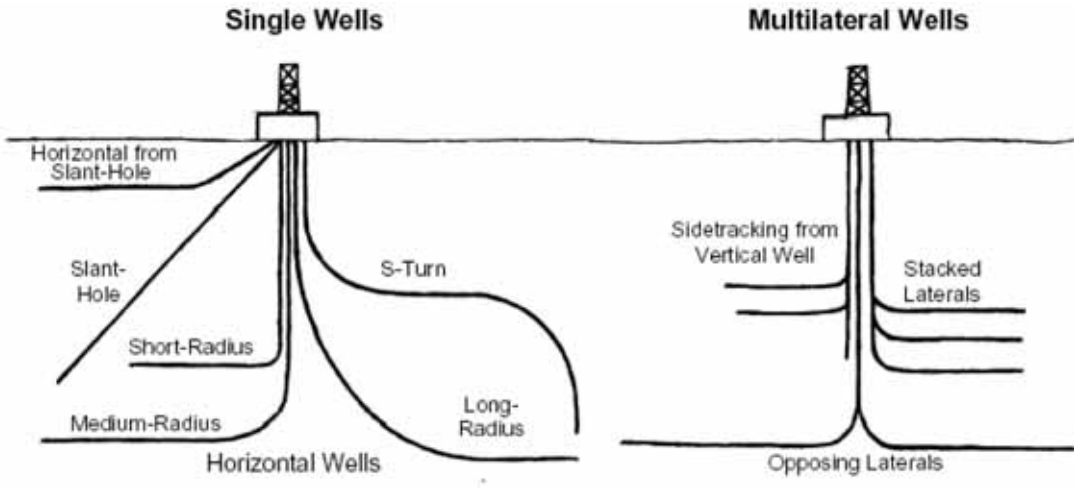


FIGURE I-38. DIRECTIONALLY DRILLED WELLS
Source: Drilling Smarter: Using Directional Drilling to Reduce Oil and Gas Impacts in the Intermountain West.[340]

The drilling of a directional well is more costly than drilling a typical vertical well because it requires specialized equipment; constant attention to the placement of the drill bit; it takes several days longer to drill the wells; and pumping costs may increase because parts may wear out faster. According to the U.S. EPA, however, the increased costs of directional drilling are often more than offset by increased production and the reduced need for drilling multiple wells.[341]

> *In the Dundee Formation of Michigan, as much as 85 % of the known oil remained in the formation after many years of production, but many wells were on the verge of being plugged because daily production had fallen to only five barrels of oil per well. The U.S. Department of Energy co-sponsored a project to drill a horizontal well in the formation. This well produced 100 barrels per day. The program attracted other well developers, and 20 to 30 additional horizontal wells are being drilled in the formation. It is estimated that the application of horizontal drilling to this formation may yield an additional 80 to 100 million barrels of oil.*[342]

4. **Flareless or "green" completions reduce flaring and venting of natural gas.** Before natural gas and coalbed methane wells begin producing gas for sale, the well bore and surrounding reservoir must be "cleaned up" (i.e., any fluids, sand, coal particles, or drill cuttings within the well bore must be removed). The conventional method for doing this is to pump air down the well bore, which lifts the waste fluids and solids out. The solid and liquid waste materials are then dumped into a pit or tank, and any gas that is removed is flared or vented to the atmosphere. In some flareless or green completions, natural gas, rather than air, is pumped down the well bore to clean it out.[343]

   In flareless or green completions the gas that comes to the surface is separated from fluids and solids using a series of heavy-duty separators (sometimes referred to as "flowback units"). The water is discharged to tanks to be reused, the sand is sent to a reserve pit, and the gas is either cycled back through the well bore, or sent to a pipeline to be sold rather than vented or flared. According to the U.S. Environmental Protection Agency (EPA), benefits of this system include: the elimination or reduction in venting or flaring of natural gas; sale of the gas and condensate provides the operator with an immediate revenue stream; there is a reduction in solid waste and water pollution; and the system enables safer operating practices.

   Emissions Reductions: One company, which drilled 63 wells using flareless completions, reported a reduction in natural gas emissions of 7,410 thousand cubic feet per year, which is 70% of the gas that would formerly have been vented to the atmosphere.[344] Another company has been able to reduce flaring by 85-90%.[345]

   Costs and Pay-Back: The capital costs for companies include the use of separators, sand traps and tanks. One company reported these costs as being $180,000. The equipment, however, can be moved from site to site, so if a company were to complete 60 wells per year the annual capital charges would be less than $10,000. Operating costs are less than $1,000 per year. EPA has estimated that "green completions" can pay back their costs in about 1 year.

FIGURE I-39. TYPICAL COMPLETION WITH A FLARE BERM AND WASTE PITS. Photo by Dan Randolph

   An alternative to sending the gas to the pipeline is to send it to a flare tank. Flare tanks

capture and more fully combust the waste gases. The tanks can be carried from site to site. This practice avoids the costs associated with excavating and reclaiming flare pits, and avoids the potential liability associated with cleaning up soils contaminated by flaring.

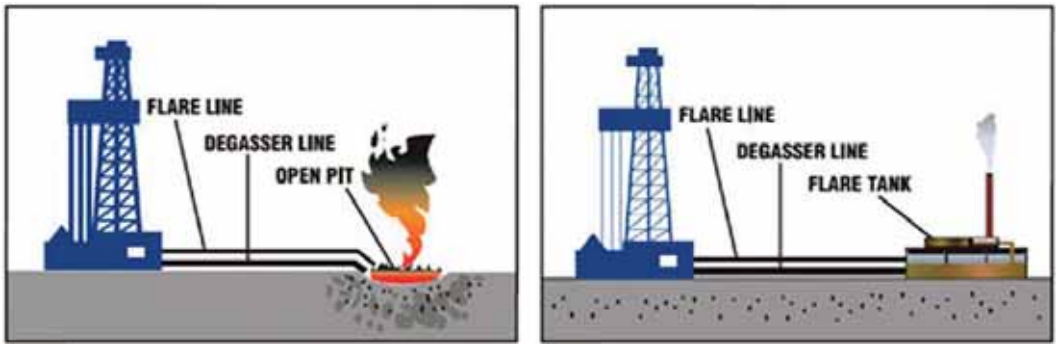


FIGURE I-40. FLARE TANKS REDUCE HAZARDOUS EMISSIONS BY MORE FULLY COMBUSTING WASTE GASES.
Source: Wellco Energy Services, Inc.[346]

5. **Waste minimization during drilling operations.** The state of Texas has produced a document *Waste Minimization in the Oil Field* that provides a general overview of waste minimization techniques for wastes arising from oil and gas operations, including drilling operations.[347] The document also provides case studies of successful waste minimization projects and a bibliography of useful technical references. The document includes dozens of examples of alternative drilling practices, such as:

   - Product substitution. Replacing conventional, toxic products with less toxic, yet effective, substitutes. For example, companies are substituting low toxicity glycols, synthetic hydrocarbons, polymers, and esters for conventional oil-based drilling fluids. The use of these substitutes eliminates the generation of oil-contaminated cuttings and other contamination by the oil-based fluid and decreases concerns related to site clean-up when the well is abandoned. Drilling engineers have published numerous technical papers that describe the successful application of substitute drilling fluids. In many instances, this substitution has resulted in significant cost savings.

     Similarly, companies have designed alternatives to the conventional water- and chemical-based hydraulic fracturing techniques, by substituting carbon dioxide for the more common and more toxic fracing fluids.

   - Process or procedural modifications. For example, in the past few years the drilling industry has improved the technology of slim hole drilling. If feasible, slim hole drilling reduces the volume of wastes (e.g., drilling fluid and the drill cuttings) produced during drilling. The total cost of a slim hole drilling operation may be considerably less than for conventional hole sizes, and smaller casing is required, which may help reduce the total cost of the operation.

   - Reduction in water use. For example, companies can reclaim water from waste drilling fluids by using mechanical or chemical separation techniques such as large bowl centrifuges, hydrocyclones, and/or chemical flocculants. The reclaimed water may then be reused, thus reducing the demand on, and cost of, new water sources. Dewatering of wastes may also result in a reduction of the volume of drilling waste to be managed, thus saving waste management costs, easing site closure concerns and costs, and reducing future potential liability concerns.

   - Preventative maintenance. For example, chemicals and materials should be stored so that they are not in contact with the ground (e.g., stored on wooden pallets), or exposed

to the weather. There should be secondary containment in the case of spills. All drums and containers should be kept closed except when in use. It is very important that all chemical and material containers always be properly labeled so that their contents may be identified at any time. Proper storage and labeling of containers allows quick and easy identification and classification of released chemical or material in the event of a leak or rupture. In some instances, that could save hundreds of dollars in soil sampling and laboratory analysis costs.

- Recycling. For example, the cost of closing a drilling site is increased if waste drilling fluid in a reserve pit must be dewatered and/or stabilized prior to closure. An alternative is to recycle or reuse the waste drilling fluid, e.g., in another drilling project. One company designed a multi-well drilling project where the same drilling fluid was used for drilling each successive well. The result was significant cost savings and greatly reduced waste management concerns. Another cost effective alternative for reuse of waste drilling fluid is in plugging or spudding of other wells.

ALTERNATIVES USED DURING THE PRODUCTION PHASE

1. Minimizing Surface Disturbance

- Well pads are often much larger than they need to be—sometimes exceeding several acres in size. At Ted Turner's Vermejo Park Ranch, however, the well pads are only 0.6 acres. (See Vermejo Park Ranch Coal Bed Methane Project Mineral Extraction Agreement Summary, in Chapter III).
- After the drilling phase if over, the portion of the drilling pad not needed for oil or gas production can be reclaimed. This is known as interim reclamation, and it is required by law in many states. Unfortunately, lack of enforcement by state agencies means that interim reclamation does not occur in many jurisdictions.

FIGURE I-41. MINIMIZING SURFACE DISTURBANCE.
Left to right: Poor Practice: no efforts have been made to reduce surface disturbance at this site. Better Practice: this well site and the road leading to it have been revegetated. The surface owner has 40 additional years of use, and a 40-year head start on reclamation. Photos by Bob Miller.

2. Minimizing Visual Impacts and Noise

- Landscaping can help decrease the visual impacts of wells. For example, soil can be formed into ridges or gentle berms around the well pad, and trees and other vegetation can be planted on the ridges to screen wells so that nearby residents don't see them.
- A low-profile pumping unit can replace the conventional unit, which uses a 30- to 40-foot beam and looks like a giant, bobbing horse's head. The conventional pump is run on a gas- or diesel-powered engine, which is noisy and smelly. Alternatives to this large pump include using a pneumatic pumping device that doesn't require an engine, therefore, produces little or no noise. This pump stands about 10 to 15-feet tall. According to one company, pneumatic pumps will not function correctly if a lot of water is extracted while extracting methane gas.[348] When larger amounts of water are produced, an alterative to the standard beam pump is the progressive cavity pump. These pumps come in different shapes and sizes, and like the pneumatic pump, they can un on electric motors, and therefore, be much quieter than conventional pumps.

FIGURE I-42. PUMPING UNITS
Left to right: Conventional pump "pump jack"; progressive cavity pump; low profile progressive cavity pump.

3. Minimizing Noise

- Noise created by operators constantly driving in and out from the well pad to monitor well production can be mitigated using an automated monitoring system, which allows wells to be monitored remotely, e.g., from the company's office.[349]
- To mitigate noise impacts from engines, a sound barrier made out of four inches of insulation and 18-gauge steel can be used. Sound barriers are placed in an L-shape above the engine, and they extend past the sides of the engine.[350] Some engines can operate at a constant number of revolutions per minute (RPM), which reduces the up-down noise caused by other engines, which speed up and slow down. Mufflers, like those used for automobile engines, can be used to minimize engine noise.[351] To reduce noise in sensitive areas, well-site or field compressors may be enclosed in a sound-insulated building, and equipped with two buried hospital-grade mufflers in series.
- Noise from compressors can be mitigated by treating each significant noise source: gas turbines or engines, compressors, exhaust outlets and air inlets, and cooling and ventilation fans. Abatement may involve changing the blades on fans, which can change the frequency of sound emitted, thereby removing the annoying tones. Engine noise can be muffled using automotive-type mufflers, or by housing the engines in acoustically insulated structures. Also, the entire compressor can be housed in an acoustically insulated building.

FIGURE I-43. SOUND CONTROL
Left to right: Pump jack with sound abatement walls and muffler at lower right. The "barn" houses a compressor station. By treating each noise source, the company achieved its design goal of 40 dB at 300 feet from the station. The barn-like building was designed to fit into the rural countryside; source: ATCO Noise Management. [352]

FIGURE I-44. SOUND CONTROL
Left to right: Sound is directed up; sound is directed away from a house, but is not absorbed; sound is effectively reduced with absorbing panels to 1 decibel above ambient.

4. Minimizing Air Pollution

- If the control valves on a pump's separator unit, which separates the methane and water, are replaced with better valves, methane emissions to the atmosphere can be reduced. This will have positive environmental benefits, as methane is a powerful greenhouse gas that contributes to global warming. By replacing 3,300 controllers on 2,760 wells in Colorado and New Mexico, the Colorado Oil and Gas Conservation Commission expects that methane emissions will be reduced by 12,000 tons per year in the San Juan Basin.[353] According to an engineer with the company BP, replacing valves not only has a positive benefit with greenhouse gases, it also has a positive economic benefit for that company.[354]
- Emissions can be reduced by monitoring and pinpointing fugitive emissions, and then sealing the leaks; using lower heater treater temperatures; connecting storage tanks to flare systems; converting gas-driven chemical pumps to electric-, air- or nitrogen-driven pumps; compressing casing gas and shutting down line pigging. Also, air emission may be decreased by installing: no-bleed or low-bleed pneumatic devices; vapor recovery units; high efficiency flares; closed-loop skimmers on water tanks; and separator pumps and evacuators on pipeline bleeders.[355]
- Wellhead compressors that are powered by natural gas emit NO_X and VOCs (which contribute to ground-level ozone) and carbon monoxide. According to the federal Bureau of Land Management, there are add-on technologies, such as catalytic converters, that can reduce these emissions by as much as 95%.[356]
- Cavitation baffle systems (large storm sewer concrete pipe) can be used to reduce flare height and contain the majority of coal dust during coalbed methane cavitation operations.[357]

- Barrett Resources Corporation has minimized odors generated at natural gas production sites, a common source of complaint by surface owners, by using combustion units designed to destroy vapors released by condensate tanks and glycol dehydrators. These units also reduce emissions of methane (a greenhouse gas), and other hydrocarbons that can affect visibility.

Capture Gas Instead of Flaring It

The federal Department of Energy and the Interstate Oil and Gas Compact Commission are involved in a project to reduce greenhouse gases and NO_x emissions and increase oil production and in California. Gas that would otherwise be flared, and shut-in gas from California's oil-fields will be used to generate electricity. Several types of conventional and new microturbine generators will be tested at selected sites from among California's 21,000 marginal wells.

Petroleum Technology Transfer Council[358]

- Standard glycol dehydrators which are used to remove water from natural gas, typically vent water and hazardous gases directly into the atmosphere. Glycol dehydrators are a major source of benzene emissions within the oil and gas industry.[359] Fatalities from human exposure to high concentrations of benzene have been documented since the early 1900s, and studies have shown correlations between workplace exposure to benzene and the onset of certain forms of leukemia.[360] The issue of air emissions from glycol dehydrators has only been identified in the past few years. Most of the glycol dehydration units are installed in rural environments; they are typically left unattended, and emissions are not regularly monitored.

  In 1995, the Canadian government announced that it would be limiting benzene releases through various measures including controlling emissions of benzene from natural gas dehydrators. A Canadian Working Group composed of industry, government, and public interest groups produced a document, *Best Management Practices for Control of Benzene Emissions from Glycol Dehydrators*,[361] which outlines methods for minimizing benzene emissions in new and existing plants; and provides more information on alternatives to glycol dehydration. These include: methanol or glycol injection; separator packages; line heaters; solid desiccant/molecular sieve plants; membrane technology; and other commercial processes.

  Emissions from glycol dehydrators can be reduced by: optimization of operations; equipment modifications or replacement; and/or, addition of emission control equipment. Emission controls such as condensers, flare stacks, and incinerators for still column vent vapors have been installed by industry at some locations. Research by the U.S. EPA has indicated that operators of glycol dehydrators often maintain a circulation rate that is at least two times higher than is needed to remove enough water from the gas. Therefore, companies can reduce their glycol use by performing simple calculations to determine the minimum circulation rate needed. By doing so, they will lose less methane to the atmosphere; improve the dehydrator unit efficiency; and decrease fuel pump use. EPA has calculated that by doing so, the potential savings for a dehydrator unit can range from $260 to $26,280 per year.[362]

Chapter II

Legal and Regulatory Issues

II

WHO OWNS THE MINERALS BENEATH YOUR LAND?
In some cases the surface and minerals (including oil and gas) are owned by the same person, but often the minerals are owned separately from the surface property.

MINERAL VERSUS SURFACE RIGHTS
Mineral owners have different rights than owners of the surface lands. This section outlines some of the unique rights granted to mineral owners, as well as information on surface owner rights and protections.

REGULATIONS AND SURFACE OWNER PROTECTIONS
This section provides examples of state, county and federal statutes (i.e., laws) and regulations that provide some protection to surface owners, e.g., consultation requirements, compensation for surface damage, reclamation of disturbed lands, and more.

In many regions of the United States landowners are being approached by companies who want to search for oil and gas beneath their land. This can be an extremely stressful, confusing time for landowners. The companies have done this many times before, and understand what their legal rights are. But most landowners are not aware of what they can demand of companies in return.

Too many landowners have signed away certain rights to companies, only later to find out that they didn't have to do so. Or they have agreed to offers, only to find that their neighbors have received a better deal.

What are the first steps a landowner should take?

1. Most importantly, don't panic, and don't rush into any agreements.
2. Educate yourself. Understand your rights, and your options. You may want to consult an attorney.
3. Find allies. You may need support, and be able to learn from others' experiences.
4. Find out who owns the minerals beneath your land. In some cases, the surface and the minerals are owned by the same person, but often the minerals are owned separately from the surface property. Landowners will have different rights and different negotiation strategies depending upon whether the mineral rights belong to them; to federal, state or tribal governments; or to other private parties (e.g., citizens or companies).

This chapter is designed to provide a general introduction to the legal and regulatory issues related to oil and gas development. It is important to have some understanding of government regulations and laws pertaining to oil and gas. These may provide you with important tools for ensuring that oil and gas development will have as minimal an impact as possible on your property and lives. The following pages discuss various legal and regulatory options; and provide some strategies for dealing with oil and gas development whether or not you own the minerals beneath your land.

Bear in mind that the laws and regulations that govern oil and gas development vary from state-to-state. So you will likely need to do some additional research, or contact local organizations,

other landowners or attorneys who may be more familiar with your state's oil and gas laws. And please note that while some recommendations and suggestions are made in the following text, this does not constitute legal advice. Competent legal advice can only be provided when the lawyer has heard all of the factual information pertaining to your particular situation.

The Legal Steps in Oil and Gas Development

In the first chapter, you learned about the technical aspects of oil and gas development. But before any of that can take place, a company must ensure that they have the legal right to develop the oil and gas. The following provides you with an understanding of the legal steps taken by companies to secure those rights.

1. **Mineral ownership is determined.**

   Oil and gas companies usually hire people to research mineral titles, in order to determine who owns the minerals that they want to develop. In some cases, this work involves researching land and mineral deeds that date back to the 1800s.

2. **Mineral owners are contacted by the company.**

   Once mineral ownership is determined, the mineral owners will be approached by the company. The initial contact may be made by a phone call, a letter, or a home visit from an oil or gas company employee or representative (could be a leasing agent or a land man). At this time, the company will explain its desire to explore for and possibly develop the mineral estate for oil and gas. (Unless the surface owner also owns the minerals, he or she will not be contacted at this stage.)

3. **Negotiations begin on the purchase or leasing of mineral rights.**

   The company will attempt to negotiate an agreement to lease or buy the mineral rights. Negotiations may include issues such as: royalties; water use; compensation for damages to property; and other considerations. If successfully negotiated, leases can be used to protect the surface property. The company requires the lease in order to proceed with their development plans, as the lease transfers the right to explore for and develop minerals from the mineral owner to the company. (See Chapter III for Tips on Leasing Your Minerals.)

4. **Company may contact the surface owner (if different from mineral owner).**

   In many cases, when companies are ready to explore, they are legally required to inform surface owners that they have leased the mineral rights and intend to search for and possibly develop the oil and gas under the surface owner's property. Surface Use Agreements (contracts) or less formal agreements may be negotiated with the surface owners at this stage. (See Chapter III Tips on Surface Use Agreements.)

Who Owns the Minerals Beneath Your Land?

It is important for landowners to have an understanding of some key legal terms and concepts related to oil and gas development, such as the difference between surface and subsurface rights.

Oil, gas and minerals, like land, are considered forms of property. The mineral resources that are beneath a tract of land (i.e., the mineral estate or subsurface estate) can be owned, and ownership provides you with the ***mineral rights*** or subsurface rights. ***Surface rights***, on the other hand, refer to ownership of land (i.e., the surface estate) and the right to use the surface, e.g., for dwellings, agriculture, or urban development.

SPLIT OR SEVERED ESTATE PROPERTY

In many states, the owners of the land are not necessarily the owners of the minerals. When the surface and subsurface estates are owned by different parties, they are referred to as split estate or severed estate lands.

When you buy a piece of land, it is not always evident whether or not you own the minerals, because mineral estate owners do not have to inform a new surface owner that the mineral rights have been severed. There are ways of finding out whether or not the minerals and land are split estates. These are discussed later in the chapter.

In many states the owners of the land are not the owners of the minerals.

All western states and most other states allow for the separate ownership of land and mineral resources. Some states have more split estate lands than others. It has been estimated that:

- In Texas, for 90% of the property owned, the surface landowner is not the owner of the land's mineral rights.[363]
- If you're buying land in Colorado, 85% of the time the land purchase will not include the mineral rights beneath that land.[364]
- In Kansas, the landowner usually owns the subsurface rights, too.[365]

In Louisiana, the owner of the land does not "own" the oil and gas, but "has the exclusive right to explore and develop his property for the production of such minerals."[366] Louisiana landowners may convey, reserve, or lease their right to explore and develop their land for production of minerals. This right to explore and develop reverts back to the landowner if no exploration or production occurs within ten years (or within a timeframe prescribed in the lease or contract).[367]

How are Mineral Rights Severed from Surface Rights?

The separation of surface and subsurface rights occurs through: 1) a mineral deed, or 2) mineral reservation.

1. Severance by mineral deed occurs when someone who owns both the surface and mineral rights chooses to sell all or a portion of the mineral rights to another party. Another scenario is when the owner of both the surface and mineral rights sells the land to one party and the minerals to a different party.[368] In either case, the proof of the sale is known as a mineral deed, which is recorded in government land title offices (most often with the county governments).
2. Severance by mineral reservation may occur if a party owning both surface and mineral rights sells the land, but retains (or reserves) all or a portion of the mineral rights. All the mineral owner has to do to preserve title to the subsurface estate is record his or her mineral reservation with the county clerk and recorder's office or other government land title office.[369]

Mineral reservation has been widely practiced by individuals, land-grant railroads, lending institutions, and federal and state governments. For example, one of the largest private mineral owners in Montana is Ag America. That company acquired its minerals through mortgage foreclosures on ranches during the 1930s and 1940s. When the company sold the land, it would reserve half of the minerals.[370] Mineral reservations also often occurred when lands were originally patented (i.e., the federal government sold the land but held on to the mineral rights).

Other Split Estate Considerations

- The mineral estate, like the surface property, can be subdivided. The mineral rights can be split so that there may be numerous parties who own a portion of the minerals beneath your land.
- Mineral rights can be divided by specific mineral commodities. For example, one company can own the mineral rights to coal, while another company owns the oil and gas rights.[371] Consequently, it is important to know which minerals are included in a mineral deed. Some deeds specify that "all minerals" are included. Others use the phrase "oil and gas," which means that only the rights to develop oil and gas are included in that deed. The general rule is that unless specifically defined, the term "mineral" refers to oil, gas, coal, metals and precious or semi-precious stones.[372]
- In some states, there is a third estate that can be severed. In Pennsylvania, a state rich in coal resources, there are three separate estates: the surface estate, the mineral estate and the support estate. If the surface owner also owns the support estate, the mineral owner may mine the coal but must leave enough of it there to support the surface estate, i.e., if the mineral owner mines too much coal, and the surface owner's house falls into the mine, the surface owner's rights have been violated. If, on the other hand, the mineral owner also owns the support estate, the surface owner has no legal right to have his or her property supported by anything.[373]
- Who owns coalbed methane? For the past 50 years, when the mineral rights to the gas and coal beneath a tract of land have been owned by different parties, disagreements have occurred over who owns the coalbed methane.[374] In some states, such as Pennsylvania, Alabama, and Montana, courts have ruled that coalbed methane is part of the coal formation in which it is found.[375] In 1999, however, the U.S. Supreme Court ruled that coal, as defined in the 1909 and 1910 *Coal Lands Acts*, does not include the methane gas found within the formation, and therefore, a coal owner has no right to extract coalbed methane for profit.[376]

- Who owns the groundwater rights? Water quality and quantity issues could become important depending on who owns the rights to the groundwater, there may be an opportunity for landowners to influence the development of oil or gas on their property. In some states, the groundwater belongs to the state (i.e., it's a public resource), and so companies must apply for permits to extract and remove the groundwater that accompanies oil and gas development. In other states, however, the groundwater rights belong to the surface owner.

RECONNECTING THE SURFACE AND MINERAL ESTATES

In some states, mineral rights revert to the surface owner under certain conditions such as death, failure to obtain production, or passage of a specified period of time. It is important to be aware that these types of laws may exist in your state, and they may provide surface owners with the opportunity to take possession of the mineral rights beneath their land. Several states have laws to this effect.

- In Louisiana, if the minerals are not used (e.g., no exploration or production has occurred) within 10 years, the surface owner becomes the owner of the minerals.[377]
- In North Dakota and Ohio, if minerals have lain dormant for 20 years the surface owner can claim them.[378]
- In Michigan, a law that passed in 1998 provides landowners with the opportunity to petition the state to purchase the state-owned minerals beneath their land. They can do this only if there is no pending lease or development. Upon request from surface owners, the state must sell the minerals to them at fair market value, unless the state wants to reserve minerals to prevent damage in environmentally sensitive areas, or there is some other legitimate reason to keep the minerals in state ownership. A deed restriction then will be added to the property that prohibits the minerals from being severed in the future.[379]
- Recent attempts to pass similar laws in Colorado and Montana have failed.

HOW TO DETERMINE OWNERSHIP

If a landowner is unsure of whether or not he or she owns the mineral estate, it is a question that should be answered, especially if the land is owned or leased in a region with oil and gas development.

- If you own the minerals beneath your land, you have considerable opportunity to benefit from and influence the course of oil and gas development.
- If you do not own the minerals beneath your land, that means that other people or entities possess certain rights that may hinder your ability to shape oil and gas development on your property.

There are a number of methods for determining who owns the oil and gas beneath your land.

1. **Read your property deed and research the land title records.**
   If you want to find out who owns the minerals beneath your land the first step is to find the deed to your property. The deed may state that ownership of your property is fee simple absolute. This may mean that you own both the surface property and the underground mineral resources.

   If you can't find your copy of your deed, contact your county government. Surface deeds are almost always recorded in the county government's Recorder of Deeds (or some equivalent) office in the county where the property is located.

   It may be necessary to search the property's historical deeds all the way back to the 1800s. (Be aware that older mineral deeds may not be recorded in any government office.) A phrase in an old deed such as "oil and gas excepted and reserved" means that the surface was sold separately from the oil and gas estate at that time. If you find such a statement in an old deed, the oil and gas is probably not yours to lease or develop.[380]

2. Research mineral deeds, grants and reservations.
Go to the county and federal government offices to find out if there are mineral deeds, grants or reservations related to your property. You will need a legal description of your land (this can be found in your deed or in the title document for your land).

The federal Bureau of Land Management maintains Surface and Mineral Land Status maps, which can be purchased for a nominal fee. These maps are color-coded to show ownership status (i.e., federal, state or private ownership), but the maps do not show private land owner names.

Depending upon where you live, there will be different county officials (e.g., county recorders, register of deeds, county clerk) charged with recording mineral, oil and gas transaction documents such as mineral deeds. To obtain addresses and phone numbers for the appropriate office, contact your county government, or visit the web site: *http://royalty-deeds.com/courthouses/.*

Some county assessor offices track minerals because they are taxed at the county level if they are producing (or they are taxed if non-producing but severed from the surface). You should contact your assessor's office to determine if they track mineral ownership.

3. Have a title search conducted by a land title/abstract or title insurance company.
There are two main types of companies that provide information on property ownership: one that will create an abstract of title, and a second that provides title insurance. In both cases, these companies can research the legal history of property and perform extensive searches of public records including deeds, mortgages, contracts, civil court records, probate court records, federal court records, and tax records. They may be able to assist you, if your own search attempts have not provided you with adequate information.

When you purchased your property, you may have hired a company to provide you with title insurance to prove that you had clear title to the land. In Colorado, title insurance companies are now required by law to inform the title insurance purchaser if the mineral estate has been either leased or severed from the surface estate. The title companies must also inform the purchaser that there is a substantial likelihood that a third party holds some or all interest in oil, gas, other minerals, or geothermal energy in the property; and that such mineral estate may include the right to enter and use the property without the surface owner's permission.[381]

For residents of other states, be aware that title searches may not include information on whether or not you own the minerals. In many states, it is common for title companies to exclude research on mineral rights, mining claims, water rights, and other issues of concern. If you have already done a title search for your property, refer to the exclusion section of the title policy. If mineral rights are mentioned as exclusions, then it is unlikely that this document will provide you with the information you need.

Make sure you find a company that will (and knows how to) include mineral rights in a title search. Not all title companies have personnel trained in examining mineral ownership, so it is important to ask if they are qualified to examine this type of property. The companies should also be willing to "stand behind" their findings. Having a title company insure a mineral title examination may be difficult, however, so find out in advance whether or not the company is willing to provide insurance. Alternatively, you can ask for a mineral guarantee, which will disclose any mineral reservations found in the "chain of title" (i.e., the list of all people/entities who have held title to the property) since the land was first patented. As mentioned above, a mineral reservation indicates that the ownership of the minerals has been severed from ownership of the land. The interpretation of the mineral report, howev-

er, can be complicated. Usually, if you order a mineral guarantee report from a title/abstract company, you will need to take that information to an attorney who can provide you with an opinion based on the findings in the report. If you get mineral title insurance, you do not normally need to get the legal opinion.

Be aware that title searches can be expensive. One Montana titles searcher quoted his hourly fee for producing a mineral report at $126.[382] And there may be attorney fees on top of that.

4. **You may want to consider hiring a landman.**
While landmen typically work for oil and gas companies, determining mineral ownership is a large component of their work, and experienced landmen should have significant expertise in determining mineral ownership. Also, landmen may be more affordable than title companies, but unlike title companies they may not be able to guarantee their findings.

5. **Find out if the minerals have been dormant, and for how long.**
As mentioned above, several states have laws that allow surface owners to claim minerals beneath their lands if those minerals have been dormant for a certain period of time. There may be other states that also have similar laws. Again, you will want to consult an attorney to determine whether the dormant minerals now belong to you, or what steps you need to take to re-claim these rights.

Mineral Versus Surface Rights

If someone owns or leases the mineral rights to oil and gas beneath your land, he or she has the right to enter your property and search for minerals; and, if minerals are discovered, the owner then has the right to remove those minerals.

Depending upon the state that you live in, some or all of the following "rights" may be included in the search for and removal of minerals:

- the right to enter upon the surface for exploration and production of oil and gas
- the right to conduct geophysical exploration and seismic tests on the surface
- the right to mine caliche (dirt, gravel, etc.) for constructing roads, drill pads, etc. from the premises

The Rights

"In Manistee County, the Michigan Department of Environmental Quality (DEQ) has allowed drilling in residential areas of natural gas wells that contain high concentrations of hydrogen sulfide, a poisonous chemical. DEQ officials defend their action on the basis that the rights of mineral and lease holders "must be respected." In effect, they appear to be determining that the drillers' rights are more important than the rights of residents."

— Schneider, Keith.[383]

- the right to construct roads to drill sites (including cutting and removing timber); and to construct, maintain and use roads, bridges, canals and other passageways necessary to transport materials, workers and equipment to and from well sites and associated facilities
- the right to take a reasonable amount of water (fresh or saline, found above or below the surface) for development and production of oil and gas
- the right to dispose of fresh or salt water, which is produced with oil and gas, on premises
- the right to house employees on the premises
- the right to construct or install production and storage facilities, storage tanks, pits, structures, machinery and other appliances
- the right to select drilling sites
- the right to select timing of drilling operations
- the right to install and use pipelines to transport hydrocarbons and waste products to points within or off the leased premises
- the right to enter premises despite the existence of growing crops

It is common to hear of the mineral estate as being "dominant" to the surface estate, because the owner of the mineral estate has the right to access and develop his or her minerals, even if those actions infringe upon the surface owner's property and life. And in many instances, mineral owners do not have to compensate the surface owners for use of their property.

To many people, the dominance of the mineral estate seems unfair. In the United States, the U.S. Constitution guarantees that private property cannot be taken for public purposes without just compensation.[384] For example, if private property is acquired by the U.S. government (e.g., to create a national park), the surface and mineral owners are compensated. Yet private property can be used and damaged by oil and gas development without just compensation for the surface owner - meanwhile, there are huge profits being generated by the oil and gas industry.

SURFACE OWNER RIGHTS AND PROTECTIONS

Surface owners are not without rights. There are rights and protections stemming from legal decisions and government laws and regulations. Also, surface owners have access to the court system if laws and regulations are not enforced, or if negligence on the part of the oil and gas company has damaged their property. In addition, some oil and gas companies will negotiate surface use and/or surface damage agreements with surface owners, including offers for compensation, although they may not be required by law to do so.

Legal Decisions

Over time, the courts in a number of states have recognized that surface owners do have some rights when it comes to mineral development. The following rules related to surface owner protections have become commonly accepted:[385]

1. **Mineral owners may be held responsible for creating a nuisance, depending upon the definition of nuisance in the state where the land is located.**

2. **Mineral owners may be liable for damages if they fail to reasonably accommodate the surface uses.**
   - In *Gerrity Oil and Gas Corp. v. Magness,* the Colorado Supreme Court decided that there is a 'due regard' responsibility, which *"requires mineral rights holders to accommodate surface owners to the fullest extent possible consistent with their right to develop the mineral estate."*[386] The practical application of this ruling is still being worked out.

- In the case of *Getty Oil Company v. Jones*, the Supreme Court of Texas required that Getty Oil bury its oil pumping units in cellars so that Jones, a farmer, could operate his automatic mobile irrigation system unimpeded (the height of the pump prevented full rotation of the irrigation system). This case demonstrates that even though the mineral owner may use the surface to the extent that is reasonably necessary, he or she may not interfere with the surface owner's use of the surface if there are reasonable alternatives available to the mineral owner (e.g., in the case of Getty Oil, the company had the alternative of burying the pumping units).[387]

3. **Mineral owners may be liable for damages to the surface if unreasonable or negligent use occurs, or if the mineral owner violates a contractual obligation.** It is, however, the landowner's responsibility to prove damages in a court of law.

   There have been a variety of court cases that have found unreasonable surface use by an oil and gas operator in a variety of circumstances:[388]

   - Use of an excessive amount of surface. In Texas, an oil and gas operator used six acres more than was reasonably necessary, and had to pay the surface owner for the value of the use of those six acres;[389] in Alaska a mineral lessee was liable for excessive use for clearing a helicopter landing field 50-feet wider, and using 50% more trees, than was reasonably necessary;[390] in Utah, the construction of a road interfered with the landowner's irrigation system and disturbed more than six acres of the surface owner's land. The court held that this was not reasonably necessary, especially since the mineral lessee ignored the surface owner's request to build the access road from a different direction so that damage to the surface owner's property would be minimized.[391]
   - Use of surface for an excessive length of time.[392]
   - Use of fresh water for secondary recovery operations when other solid, liquid or gaseous substances are available that are technically and economically feasible for use; or excessive use of water.
   - Use of obstructing equipment (see *Getty Oil Co. vs. Jones*, above).

FIGURE II-1. LOW PROFILE WELL HEAD
This allows irrigation machinery to operate unimpeded.

Surface Use Agreements

Some states have laws requiring companies to attempt to negotiate surface use or surface damage agreements with the surface owner. These laws are discussed below. In states where such agreements are not required by law, many companies still attempt to negotiate with split estate surface owners on issues such as access and compensation for damages.

These agreements are not reviewed by a government agency. They are contractual agreements between the company and the surface owner.

Negotiations with surface owners may include a discussion of:

- what compensation will be paid, and the timing and method of that compensation;
- the extent or nature of the property interest needed for oil or gas development;
- the quality, location or size of property needed for development;
- management of improvements and personal property during development;
- the date of proposed entry and issues related to use of the property; and
- any other terms and conditions deemed appropriate by either party.

See Chapter III for more information on Surface Use Agreements.

Regulations and Surface Owner Protections

Depending on whether or not minerals are privately owned, or owned by state or federal governments, different regulations apply.

If the minerals are privately owned, e.g., you own the minerals and lease them to a mining company, that company will be subject to state laws, and possibly county or municipal laws. Also, the company will be required to honor any contractual agreements made with you, the mineral owner. The most common of these agreements is a mineral lease. If you own the mineral and the surface rights, the mineral lease can be negotiated to protect your surface. See Chapter III for more information on leasing your minerals.

The oil and gas industry is regulated primarily at the state level. Generally, no matter whether the state, the federal government or a private party owns the minerals, operators must adhere to state laws and regulations governing oil and gas development.[393] Depending upon the state, the laws may be more or less protective of surface rights than federal, county or municipal laws and regulations.

The authority of government agencies to oversee oil and gas development is established in ***statutes***, which are laws established when an act is passed by a state or federal legislature or municipal council. Some state legislatures have passed statutes solely devoted to oil and gas, while others have passed statutes, e.g., environmental or natural resources statutes, which contain small sections that pertain to oil and gas. At the local or municipal level, statutes are usually called "ordinances."

Regulations are rules and administrative codes issued by governmental agencies at all levels (municipal, county, state and federal). Although they are not laws, regulations are adopted under authority granted by statutes, and therefore they have the force of law. Regulations tend to provide much more detail on a particular subject than do their corresponding statutes, and often include penalties for violations.

To find out which statutes and regulations apply to oil and gas in your state, contact the government agencies listed in Chapter V. For a list of federal statutes that apply to oil and gas, see the publication *Preserving Our Public Lands* (to obtain a copy, see Chapter V).

The following sections provide examples of various state, federal and county or municipal statutes and regulations that provide some protections for surface owners.

Before reading about the potential regulatory protections for surface owners, it is important to note that even though there are statutes and regulations on the books, it does not guarantee that these protections will occur. Companies may fail to follow the laws, and their infractions may go unnoticed by the government enforcement agencies. Or governments may turn a blind eye when companies break the law — either for political reasons, or because the agencies do not have the staff to properly enforce the laws. Therefore, it is important for landowners to learn as much as they can about the laws and regulations governing oil and gas in their region. If landowners see that laws are being broken, they can pressure government agencies to enforce the laws.

STATE REGULATIONS

The oil and gas industry is regulated primarily at the state level. Whether the state, the federal government or a private party owns the minerals, generally the mineral operator must adhere to state laws and regulations governing oil and gas development.[394]

Even though there are laws or regulations on the books, it does not guarantee that these protections will occur.

Most states have agencies with the specific mandate to oversee oil and gas development. For example, many states have oil and gas commissions, which are empowered by the state government to regulate the industry. Also, natural resources or environmental quality departments may have the ability to regulate certain aspects of the oil and gas industry, such as discharge of wastes. (A table of state regulatory agencies and contact information can be found in Chapter V.)

The following section provides information on how various states treat some issues that are of concern to surface owners. Selected examples are given of state regulations and requirements. It is not possible to include all regulations for all states in this guide. The purpose of the examples is to provide the reader with an idea of the way in which different states regulate oil and gas development.

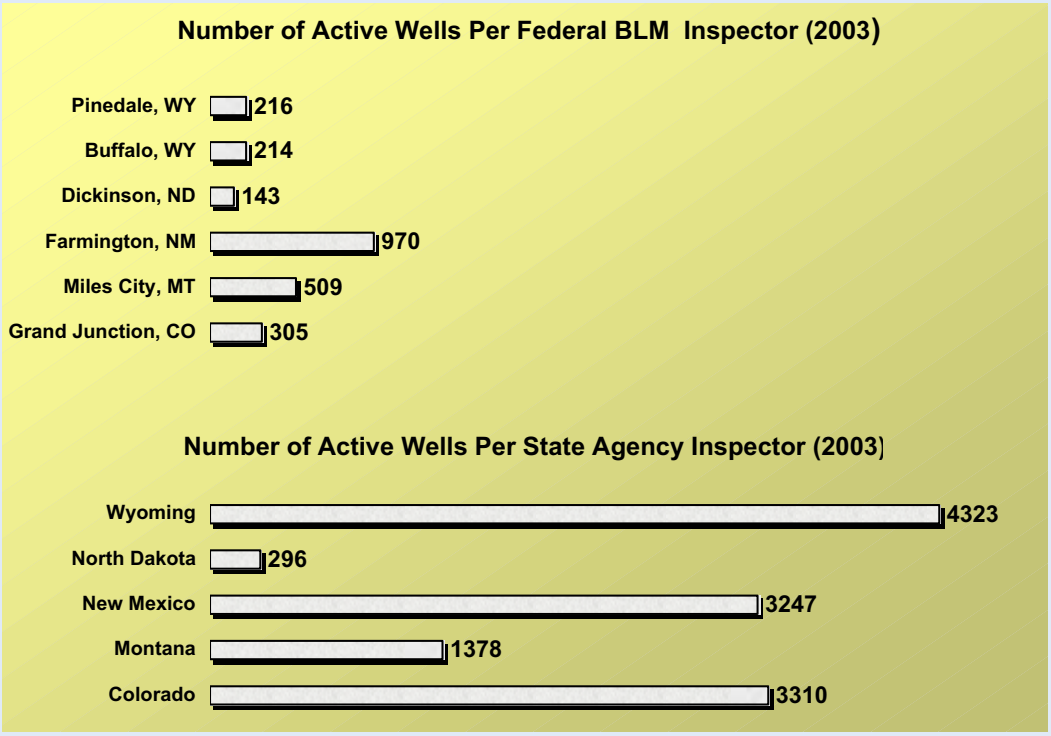
Leasing

The direct notification of individual surface owners typically does not occur when leasing of state or federal minerals occurs. Consequently, surface owners often do not realize that the mineral rights have been leased to a company that may develop oil and gas on their land. Some states do have processes for posting notices about lease sales on state lands. For example, the state agency in Montana will post notices on its web site, in local newspapers and they will send information about leases to a mailing list.[395]

The Interstate Oil and Gas Compact Commission has produced a table that summarizes state oil and gas leasing information, including how the state agencies notify the public about lease sales. This table is available at: http://www.iogcc.state.ok.us/STATELANDLEASINGINFO.htm

Shortage of State and Federal Oil and Gas Inspectors

A 2004 review of inspection and enforcement programs in five western states found that although the number of active oil and gas wells in those states increased by 14% between 2000 and 2004, the number of state oil and gas inspectors generally did not increase. On the federal level, Bureau of Land Management (BLM) field office inspectors conducted 33% fewer inspections in 2003 than they did in 1999. The chart below shows the average number of active wells per state and federal inspectors for the year 2003. From the chart, it is clear that in most jurisdictions inspectors cannot possibly have time to inspect all active wells every year – given the fact that each inspection involves driving to the well site, conducting the inspection, and performing any necessary paperwork and follow-up. Although state agencies have fewer inspectors relative to the number of active wells than the BLM, state inspectors conduct significantly more field inspections than their federal counterparts. State agencies inspect active wells once every 1-3 years, while BLM field office staff inspect active wells every 2-10 years (and inspect active wells for environmental compliance once every 4-5 years).



The above information comes from a report entitled *Law and Order in the Oil and Gas Fields – A Review of Inspection and Enforcement in Five Western States*. It was produced by the Western Organization of Resource Councils in November, 2004.[396]

Exploration

Before a company can enter a surface owner's property for exploration purposes, it may be required to obtain an exploration permit from the state and notify surface owners that exploration is going to take place on their property. Permission, however, is not usually required from the surface owner.

Alaska	A geophysical exploration permit is required to explore on state land. This permit is supposed to provide some controls over activities and minimize negative impacts. Also, exploration may not be conducted on state land until good-faith attempts have been made with surface owners to come to an agreement on a surface damage settlement. If no agreement is achieved within a "reasonable time," exploration may only begin if the company has approval from the government and adequate provisions have been made for full payment of any damages to the surface owner.
Montana	Exploration permits are required; bonds must be posted by the company as a means of ensuring reclamation of exploration sites; and before exploration begins the company must notify the surface owner of the approximate time of the planned activities.
Ohio	No exploration permit is required, as seismic exploration is not regulated by that state. According to the Ohio Department of Natural Resources, the ability of a company to perform seismic exploration rests solely on an agreement between the company and the landowner.
Oklahoma	Companies applying for an exploration permit are required to notify all surface owners of the intention to perform seismic exploration. Notification must occur at least 15 days prior to the initiation of seismic exploration. Additionally, prior to any seismic or stratigraphic test hole drilling companies must post a performance bond in the amount of $50,000.

FIGURE II-2. SELECTED STATES' EXPLORATION REQUIREMENTS[397]

Drilling and Production

Surface Owner Permission and Notification

In most states, surface owner permission to conduct oil and gas operations is not required. Louisiana and West Virginia, however, do require landowner permission before oil and gas development may occur.[398]

Even though permission from the surface owner to develop oil and gas is not required in most states, companies typically do have to notify surface owners about a proposed development or application for a permit to drill.

Once notified of a company's intention to drill, it is important to realize that surface owners generally have a time frame during which they may object to the company's application to drill. Also, if a landowner fails to receive notice during the time frame specified by the government, then the operator has no right to begin drilling operations. In the event that drilling begins without notification, landowners are encouraged to contact the appropriate government agency. If you do not know which agency is responsible for hearing complaints, simply contact any department that deals with oil and gas issues. They should be able to direct you to the appropriate state office.

Consultation and "Good Faith" Negotiations

In some states, there are regulations that require companies to consult with surface owners regarding the location of wells, roads and other items that will affect the surface owner's ability to use his or her property.

In Colorado, for example, an operator is required to make a good-faith consultation with surface owners regarding well locations and access roads. The operator must ask the surface owner if he or she wants to be consulted about the timing of the operations and the location of the well site and access road, as well as final reclamation activities. The operator is required to provide the surface owner with a description or diagram of the proposed drilling location, dimensions of the well site, and if known, the location of associated production or injection facilities, pipelines, roads, and any other areas to be used for oil and gas operations. If there is a surface

Colorado	Companies must notify surface owners before drilling a well. The notice must be mailed or delivered to the surface owner, and posted at the drill site, 30 days in advance of drilling operations (44 days in advance if surface use is irrigated crop land). Operators must also notify surface owners if future operations are planned at an existing well that will cause significant surface disturbances (seven days notice) and before final reclamation of the well site and access roads (30 days notice).
Montana	Before drilling, companies must provide written notice of the intended drilling operations, including a plan of work. This notice must be given within a very specific time frame – no more than 90 days and no fewer than 10 days before activity on the land begins.
Michigan	Within 7 days of submitting a new oil and gas or injection well permit application, companies must send a notice by first class mail to the surface owner(s) of the well site. The notice should include a copy of the first page of the permit application and should identify the expected date when construction of the well site is to begin. If the surface owner is not the mineral owner, the following statement must be included: *"Michigan law provides certain rights to surface owners of lands where the mineral rights have been severed. If you have questions regarding these rights, you may wish to consult an attorney."* Once the permit is received, and before any construction or earth moving activity at the well site, the company must inform (either in writing or verbally) both the surface owner and the appropriate District Geologist of its intended activities: 1) at least five days prior to preparing the well site location; and 2) at least 48 hours prior to commencement of drilling.
Oklahoma	Operators are required to provide surface owners with a written notice (sent by certified mail) of their intent to drill. This notice must contain a designation of the proposed location and the approximate date that the operator proposes to commence drilling. Within five days of the date of delivery or service of the notice of intent to drill, it is the duty of the operator and the surface owner to enter into good faith negotiations to determine the surface damages.
Pennsylvania	In Pennsylvania, companies applying for a permit to drill a well must notify (by certified mail) surface owners, water supply owners and parties with coal interests within 1,000 feet of the proposed well location. Surface owners have 15 days to object to the permit application. Surface owners may be able to file an objection to the proposed location of the drill site with the state's Department of Environmental Protection (based on the assertion that the well location violates section 205 of the Pennsylvania *Oil and Gas Act*). If a surface owner files an objection, however, he or she should be prepared to present facts and reasons as to why the location does not adhere to the *Oil and Gas Act* (e.g., it is too close to your house, etc.).

FIGURE II-3. SELECTED STATES' NOTIFICATION REQUIREMENTS[399]

tenant, however, the operator has no obligation to consult with them unless the surface owner appoints the tenant for consultation.[400]

Similarly, in Illinois, operators must make an offer to discuss access, placements of roads, construction and placement of pits, restoration of fences, use of surface waters, removal of trees and surface water drainage changes caused by drilling operations.[401] Once discussions are conducted, there is nothing that obligates a company to accommodate the surface owner's concerns. There is, however, a provision for surface owner compensation that acts as an incentive for companies to limit the damages done to the surface estate. Otherwise, the company may be taken to court by the surface owner (and if the surface owner's case is successful, the company pays for attorney fees).[402]

In Wyoming, if the negotiations with surface owners are unsuccessful, a company wanting to develop coalbed methane (CBM) may go to state court to try to get "right of access" to the surface owner's property—this could include access to the wells, roads, reservoirs, pumping stations and other facilities. In order for a company to obtain court-ordered access over the surface to develop the CBM, the operator must prove that it made "reasonable and diligent efforts"

to acquire access through good-faith negotiations. At a later time, the court will hold a trial to determine the appropriate damages to be paid to the surface owner. Many of the disputes are settled before the cases go to court.[403]

Conversely, in Montana, there is no requirement for companies who hold valid mineral leases to consult with surface owners about the placement of roads, drill sites, power lines, containment ponds, or other activities that will affect their land.[404]

In states that have a requirement to consult and negotiate "in good faith," it is often unclear what is meant by "good faith." A company's definition may differ significantly from that of the surface owner. In Chapter IV, the landowner story "Company's threat to bond-and-drill is not negotiating in good faith" addresses this issue.

Compensation for Surface Damages

At least nine states have adopted surface damage compensation provisions as part of their state laws.[405] In these statutes, oil and gas companies typically are required to attempt to negotiate damage settlements with surface owners before beginning operations. In most of the states, if the developer and surface owner cannot reach an agreement, the company has the right to proceed with development. The surface owner then has the opportunity to pursue compensation for damages through the court system. One notable exception is in Oklahoma, where no drilling may occur until a surface use agreement is reached or a petition is made to the court to appoint appraisers to assess surface damages. Any operator who willfully and knowingly fails to notify the surface owner prior to entering his or her land, or fails to come to an agreement and does not ask the court for appraisers, shall pay, at the direction of the court, treble damages to the surface owner.[406]

Most surface damage statutes truly give oil and gas operators an incentive to minimize surface damages, since the operators will bear the costs of any damage, not simply "unreasonable" damages (which are often difficult for surface owners to prove). In many of the state statutes listed on the following page, there is a provision for "loss of land value." For surface owners, this is preferable to the federal damage provisions, which only apply to damages to crops and tangible improvements.

In 2005, Surface Owner Protection bills were proposed in four western states: Colorado, Montana, New Mexico and Wyoming. Only Wyoming's bill passed. For more information on Surface Owner Protection bills and legislation, contact OGAP.

Site Reclamation

Site reclamation of abandoned oil and gas wells is required by all states, although there are some differences in regulations. All states have specific requirements for the plugging of wells to protect groundwater, coal, gas, oil, or other natural resources. The definition of acceptable surface reclamation varies from "as near as practical to pre-operation conditions" to detailed requirements for land restoration, including the replacement of site topsoil.

By and large, states do not simply assume that companies are going to plug wells and reclaim well sites. Most states require companies to provide financial assurance (e.g., post a bond) before a well is drilled. This ensures that at the end of the well's life, if companies do not have the financial ability to plug and reclaim well sites, some funds are available to enable the state to do the work.

FIGURE II-4. THIS IS RECLAMATION?
Jonah Natural Gas Field, Wyoming, 2003. Photo by Linda Baker.

Alaska	Before undertaking operations an oil or gas company must provide for full payment to the surface owner for all damages resulting from entering the surface estate. If an agreement can not be made, the company may post a surety bond in an amount determined by the Director of the Department of Natural Resources' Division of Lands. The surface owner may institute legal proceedings to determine damages that the surface owner may suffer.
Illinois	The surface owner is entitled to reasonable compensation from the company for damages to growing crops, trees, shrubs, fences, roads, structures, improvements and livestock caused by the drilling of a new well, as well as subsequent production operations. The surface owner is entitled to reasonable compensation for all negligent acts of an operator that cause measurable damage to the productive capacity of the soil. Award of damages: The compensation required above is paid in any manner mutually agreed upon by the company and the surface owner. Failure to agree upon, or make the compensation required, does not prevent the company from beginning its drilling operation. If an agreement cannot be reached, the surface owner may undertake an action for compensation in the circuit court. If the court finds that the company's offer was not reasonable, the surface owner is entitled to reasonable compensation as well as attorney's fees.
Montana	Mineral developers are required to pay the surface owner a sum of money equal to the damages for loss of agricultural production and income, lost land value, and lost value of improvements caused by drilling operations. The amount of damages may be determined by any formula mutually agreeable between the developer and surface owner, and consideration shall be given to the period of time during which the loss occurs. Payments only cover land directly affected by drilling operations and production.
North Dakota	Companies developing oil and gas must pay a surface owner a sum of money equal to the damages for loss of agricultural production and income, lost land value, lost use of and access to land, and lost value of improvements caused by drilling operations. The companies are also responsible for damages to the domestic livestock or irrigation water supply of any person who owns an interest in real property within one-half mile of drilling operations. The amount of damages may be determined by any formula mutually agreeable between the developer and surface owner. If the surface owner rejects a company's offer, the surface owner can take the company to court. Attorney fees, costs and interest will be awarded to the surface owner if the amount awarded by the court is more than the amount offered by the company.
Oklahoma	Mineral owners must negotiate a written contract with the surface owner for the payment of any damages that may be caused by a drilling operation. This agreement must be negotiated prior to entering the site with heavy equipment. If agreement is not reached or all parties are not contacted, the district court will appoint appraisers to make recommendations to the parties and to the district court concerning the amount of damages. The mineral and surface owners are each allowed to select one appraiser, and the two selected appraisers then select a third appraiser for appointment by the court. The mineral owner and the surface owner share equally in the payment of the appraisers' fees and court costs. No drilling may occur until an agreement is reached or a petition is made to the court to appoint appraisers. The courts may award triple damages where: (1) the mineral owner willfully and knowingly began to drill without giving notice of entry or without the agreement of the surface owner; or (2) the operator willfully and knowingly failed to keep posted the required bond.
Pennsylvania	If gas companies seek to appropriate land for the purposes of natural gas storage, the companies must attempt to reach an agreement with the surface owner about payment for damages to the surface property prior to any appropriation. If no agreement is reached, the company must post a surety bond. If the surface owner does not believe that the bond will cover the cost of the damages, the surface owner may petition the court, who may then appoint three disinterested freeholders of the county to serve as viewers to assess the damages. After the viewers have filed their report with the court, the court will fix reasonable compensation for the service of said viewers. Upon the approval of the bond, the right of the company to store gas and to enter on the property for the purpose of locating, reconditioning, maintaining, plugging or replugging any active or abandoned wells or operating any wells within the storage reservoir boundary or within the reservoir protective area shall be complete.
South Dakota	Mineral developers are required to pay the surface owner a sum of money equal to the damages for loss of agricultural production, lost land value, and lost value of improvements caused by drilling operations. Mineral developers are responsible for all damages to property resulting from the lack of ordinary care by the mineral developer. The amount of damages may be determined by any formula mutually agreeable between the developer and surface owner. To receive compensation under the surface damage statutes, the surface owner must notify the mineral developer of damages within two years after the injury becomes apparent or should have become apparent to a reasonable person.
Tennessee	Oil and gas developers are obligated to pay surface owners for: (1) lost income or expenses incurred as a result of being unable to dedicate land or for drilling operations which prohibit access to the land for a preexisting dedicated use; (2) the market value of crops destroyed, damaged, or prevented from reaching market; (3) damage to water supply; (4) cost of repair of personal property; and (5) the diminution of value after completion of the surface disturbance. To receive compensation under the surface damage statutes, the surface owner must notify the oil and gas developer of the damages within three years after the injury occurs. The person seeking compensation may bring an action in court or can request that compensation be determined by binding arbitration.
Texas	Leases issued for unsold school land must include a provision requiring the compensation for damages from the use of the surface in prospecting for, exploring, developing, or producing the leased minerals.

FIGURE II-5. SELECTED STATES WITH SURFACE DAMAGE COMPENSATION REQUIREMENTS OR LAWS.[407]

Financial Assurance (Bonds)

Typically, if oil and gas operators walk away from their operations (e.g., by declaring bankruptcy), the management of these orphan sites falls to the state or federal governments. Nearly all states require that companies post a bond or another form of financial assurance with the state to cover the costs related to plugging and abandonment of wells. These funds are collected to provide the state with some "insurance," in the event that a company is no longer willing or able to perform the plugging and restoration. The funds are released back to a company if it properly plugs and abandons its well. Proper abandonment typically includes the restoration of surface lands.[408]

State	Financial Assurance Per Well	State-wide Blanket Bond
Alaska	$100,000	$200,000
California	$15,000 (wells < 5,000' deep) $20,000 (wells 5,000 – 10,000') $30,000 (wells > 10,000')	$100,000 (50 or fewer onshore wells) $250,000 (more than 50 onshore wells) $1 million (all onshore and offshore wells)
Colorado	$5,000	$30,000 (less than 100 wells) $100,000 (more than 100 wells)
Illinois	$1,500 (well < 2,000' deep) $3,000 (well = or > 2,000' deep)	$25,000 for up to 25 wells $50,000 for up to 50 wells $100,000 for all wells in state
Kansas	$50 refundable fee (if operator has an acceptable record of compliance) $0.75 per foot drilled (for all the operator's wells)	$5,000 (1-5 wells that are <2,000' deep ; this increases to $20,000 for 25 or more wells at this depth) $10,000 (1-5 wells that are >2,000'; this increases to $30,000 for 25 or more wells)
Kentucky	$500 (wells = or < 500' deep) $5,000 (wells > 4,000' deep)	$10,000
Montana	$1,500 (well < 2,000' deep) $5,000 (2,000' – 3,500' deep) $10,000 (3,501' or deeper)	$50,000
New Mexico	$5,000 - $7,500 (well < 5,000' deep) $7,500 - $10,000 (5,000' – 10,000' deep) $10,000 – $12,500 (well > 10,000' deep)	$50,000
Ohio	$5,000	$15,000
Oklahoma	None.	$25,000 OR financial statement showing operator net worth of at least $50,000
Pennsylvania	$2,500 (this amount may be adjusted every two years; different rules apply for wells drilled prior to 1985)	$25,000 (this amount may be adjusted every two years; different rules apply for wells drilled prior to 1985)
Wyoming	$10,000 (wells < 2,000' deep) $20,000 (wells > 2,000' deep)	$75,000 for all wells < 2.000' deep

FIGURE II-6. VARIATIONS IN FINANCIAL ASSURANCE REQUIREMENTS FOR PLUGGING AND SITE RESTORATION. [409]

Well depth and geographic location are two factors that play into the amount of financial assurance that state agencies require for plugging and restoration of individual wells. The amount varies with well depth in fourteen states (Alabama, Arizona, California, Illinois, Kansas, Kentucky, Michigan, Mississippi, Missouri, Montana, New Mexico, New York, Utah and Wyoming).[410] Geographical differences in financial assurance are evident by comparing bond amounts in Kentucky and Alaska. In Kentucky a single bond for a well 500 feet deep or less is $500, while the minimum per well amount in Alaska is $100,000. This may reflect the higher costs of reclaiming Alaskan well sites.

In most states, companies are allowed to post state-wide or blanket financial assurances with the state government. These blanket bonds are supposed to demonstrate a company's financial capability of plugging and restoring all of its wells in that state. The states vary greatly on the amount of financial assurance required in a blanket bond. The amounts range from as low

as $5,000 in Kansas to as high as $1 million in California.

The cost of plugging and reclaiming a single orphaned well site in the western states can range from $19,000 to $75,000.

A recent study indicates that the costs of plugging and reclaiming a single orphaned well site in the western states can range from $19,000 to $75,000.[411] Based on these numbers, it appears that in most states financial assurance bonds are inadequate to cover the costs of properly plugging and restoring well sites.

A striking example of the inadequacy of bond amounts comes from Wyoming. In 2001, the state of Wyoming and the federal Bureau of Land Management (BLM) were left with an estimated $4 million in liability to plug and reclaim 120 wells abandoned by Emerald Restoration & Production. The government collected $125,000 in bonds from the company, which went toward plugging 56 wells on private land. The state Oil and Gas Commission used $2 million from the state's Conservation Fund to meet plugging costs that the bond did not cover. There are still more than 60 of Emerald's wells on federal and state lands yet to be plugged.[412]

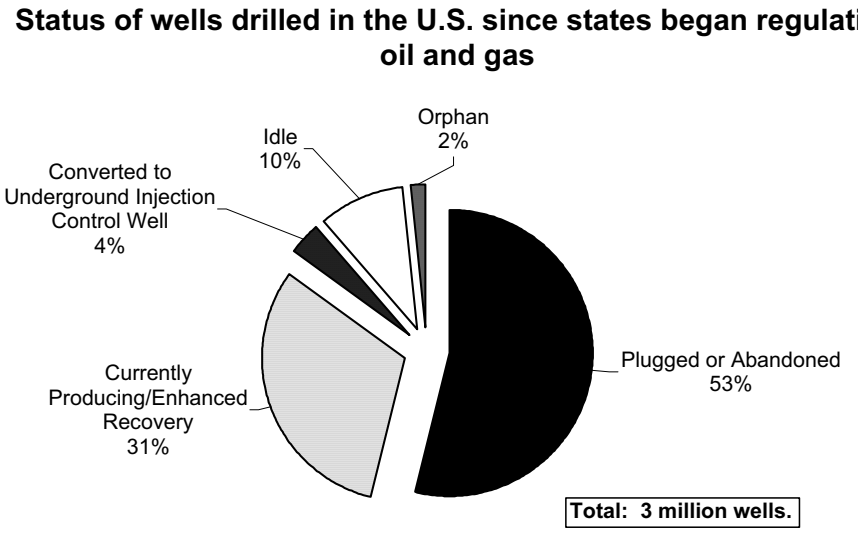


FIGURE II-7. STATUS OF THE THREE MILLION WELLS drilled in the U.S. since states began regulating oil and gas. Source: *Produce or Plug: A Summary of Idle and Orphan Well Statistics and Regulatory Approaches.* [413]

According to industry statistics, approximately 2 % of the three million wells (i.e., 60,000 wells) that have been drilled in the United States are considered orphaned.[414] As already mentioned, it can cost between $19,000 and $75,000 to properly plug and abandon a single orphan well. That means that at the present time $1.1 billion to $4.5 billion of taxpayers' money will have to be spent to properly plug and abandon all of the orphan wells in the U.S.[415]

In some situations it can cost far more than $75,000 to properly plug and abandon a single orphan well. To date, the Colorado Oil and Gas Conservation Commission (COGCC) has spent more than $400,000 trying to plug an orphan gas well in La Plata County, Colorado. Unfortunately, COGCC's efforts have not been successful, and the failure to plug the well has had near tragic consequences.

> *On February 12, 2005, Charles Yoakum turned on his stove. All four walls of his trailer blew apart and the roof blew into the air. An orphan gas well, located about 250 feet from Yoakum's trailer, is the likely source of methane that fueled the –.*[416] *The orphan well has a long history of leaking methane and fouling the groundwater in the Bondad area of La Plata County. In 1994, the Colorado Oil and Gas Conservation Commission (COGCC) spent*

$200,000 trying to plug the well. After the explosion, the COGCC pledged to spend $200,000 more to identify the exact location of the well and of another orphan well in the area, and identify any abandoned pipelines, utility corridors, or other potential conduits for gas migration. [417]

FIGURE II-8. REMAINS OF A TRAILER IN LA PLATA COUNTY, CO. The trailer exploded due to methane that most likely came from an inadequately plugged orphan well. Photo Credit: Yodit Gidey, Durango Herald.

Clearly, if states do not have enough money to put toward plugging all orphan wells, the wells can become environmental problems and present health hazards to nearby residents. (See box entitled "Bankrupt Companies Walk Away from Oil Wells in Texas.") It is important, therefore, for surface owners to: 1) encourage governments to require adequate bonds, and/or 2) include a financial security provisions in Surface Use Agreements. With these measures in place, there will be some assurance that companies —not the surface owners or the public— will bear the cost of adequately plugging and cleaning up well sites.

Bankrupt Companies Walk Away from Oil Wells in Texas

In 1996, the Ginco Operating Company walked away from more than 500 wells in Texas, when the company filed for bankruptcy. At that time, the state held less than four thousand dollars in financial assurance from the company. The maximum the state could have required was a $250,000 blanket bond. By 1999, the agency responsible for the orphan sites, the Texas Railroad Commission (TRC), had spent more than $500,000 plugging and reclaiming some of Ginco's wells, with hundreds more yet to be plugged.

In Texas, as of 2002, the state has 17,000 orphan wells to plug at cost of $4,500 per well.

The state does not collect enough money in bonds to cover the cost of plugging the wells if the companies walk away.

The Ginco case was by no means an isolated one. As of 2002, the state has 17,000 orphan wells to plug, at a cost that the state estimates at $4,500 per well.[418] The reality is that the state does not collect enough money in bonds and other forms of financial security to cover the cost of plugging wells if companies walk away. In 1997 alone, the TRC Oil Field Cleanup Program spent $12.7 million to plug and reclaim wells, and was reimbursed only $82,691 by operators - about 65 cents for every $100 spent, according to state records.[419]

An article in the San Antonio Express newspaper relates the story of a landowner affected by the Ginco bankruptcy.[420] By the time Ginco bought the wells on Milton Brehm's property, most of the oil had been removed. According to Brehm, the wells "just weren't producing that much no more and they didn't take care of them. . . They let them run down."

Before Ginco declared bankruptcy, its workers removed the pump jacks and ripped out hundreds of feet of tubing. Eventually, a slow trickle of oil began flowing out of the well and onto the ground. According to Brehm, the oil "would run into the creeks and that would worry the Railroad Commission." The Texas Railroad Commission, the state agency responsible for the wells, plugged the wells in 1996.

Even though the wells are plugged, Brehm is left with areas in his wheat fields where nothing will grow. These areas are often referred to as "kill zones," and are found around many leaking wells. As well, a tank battery, a number of 55-gallon drums and a large 200-barrel storage tank remain on his property.

"Why is the landowner responsible for all this stuff after they run off and leave it?" Brehm asked.

Note: As of 1999, the TRC has been taking steps toward changing the bonding requirements for the oil and gas industry. A backgrounder on the rationale for the changes that have been made can be found on the Texas Railroad Commission web site. http:/www.rrc.state.tx.us/divisions/og/p5overview.html

Other Protections

Statutes and regulations provide other stipulations that may serve to protect a surface owner's interests. Below are just a few examples of other surface owner protection provisions. Again, to find out what other provisions might be available in your state, consult with individuals, organizations or attorney's who are familiar with your state's laws.

Issue Addressed	How
Protection of water supplies	If an area is designated principally for permanent or recreational residences, regulations prohibit in-ground pits. (Michigan) Any well operator who affects a public or private water supply by pollution or diminution shall restore or replace the affected supply with an alternate source of water adequate in quantity or quality for the purposes served by the supply. Any landowner or water purveyor suffering pollution or diminution of a water supply as a result of the drilling, alteration or operation of an oil or gas well may notify the department and request that an investigation be conducted. It shall be presumed that a well operator is responsible for the pollution of a water supply that is within 1,000 feet of the oil or gas well, where the pollution occurred within six months after the completion of drilling or alteration of such well. (Pennsylvania) Operators shall obtain written approval from the surface owner prior to land application of water-based bentonitic drilling fluids. (Colorado)
Use of alternative technologies or approaches	In Colorado, a surface owner may file an application for a Colorado Oil and Gas Conservation Commission (COGCC) hearing to argue that directional drilling or pitless drilling is necessary to protect public health, safety and welfare, while taking into consideration cost-effectiveness and technical feasibility. Generally, the COGCC has not imposed these requirements on companies because of the Commission's view that there has been no demonstration that the requested method is cost-effective, technically feasible, and necessary to protect the public health, safety and welfare.

FIGURE II-9. PROVISIONS THAT PROVIDE ADDITIONAL PROTECTIONS[421]

Filing Grievances and Complaints

There are a few options for surface owners who believe their surface rights have been ignored. If a specific law has been broken (e.g., a company fails to notify you of their drilling activities, even though there is a law that requires them to do so), the surface owner may file a complaint with the appropriate government agency.

It is not always clear which state agency deals with complaints. A good place to start is with the state's Oil and Gas Commission (if the state has one). Also, consult the list in Chapter V for some of the state agencies involved in oil and gas regulation. If you don't have the right agency or department, a staff person with one of the agencies should be able to direct you to the proper official.

- In Colorado, complaints may be filed with the Colorado Oil and Gas Conservation Commission (COGCC). They have a toll-free complaint line: 1-888-235-1101. If the COGCC enforcement process does not adequately address a surface owner or tenant complaint, an application can be filed for a Commission hearing.
- In the case of Montana, the Board of Oil and Gas and the Department of Environmental Quality are the state agencies responsible for permitting, defining reclamation terms, and enforcement in the case of non-compliance. These agencies should be contacted when companies are not living up to their responsibilities.
- The U.S. Bureau of Land Management and U.S. Environmental Projection Agency are the federal agencies most involved with oil and gas regulations and enforcement for federal minerals.

If a surface owner believes that his or her complaint has not been adequately dealt with by the government agency, or if there has been negligence on the part of the government agency that has led to damage of the surface owner's property (e.g., failure of the agency to enforce laws), the surface owner has the option of filing a lawsuit against the agency and/or company. Or the surface owner can attempt to initiate a dispute resolution process, to settle out of court.

Dispute Resolution

Many states have a procedure in place to allow a hearing of a dispute before a public commission (usually the Oil and Gas Commission). These commissions generally attempt to resolve disputes in meetings that are open to the public. If parties go through the state dispute resolution process and are dissatisfied with the outcome, they may still use the court system to settle a dispute.[422]

COUNTY AND MUNICIPAL REGULATIONS

If a private party or parties own the minerals beneath your land, and your property is within city or county limits, then the oil and gas companies must adhere to both state laws and any county or municipal ordinances or regulations that apply to oil and gas. In many instances, the municipal and county regulations are more stringent than those of the federal or state governments; and quite possibly, they address different aspects of the development than the state and federal regulations. Consequently, it is worth spending the time to contact the county and municipality to obtain copies of these regulations, as they may offer the most protection to landowners.

	State of Colorado	La Plata County, Colorado
Setbacks	A well must be at least 150 feet from homes and property lines. In high density areas (where 36 or more buildings are within a 72-acre area), the wellhead location must be at least 350 feet from any building.	A setback of at least 400 feet shall be required between the well site perimeter and the closest existing residential structure, unless verified written consent is obtained from the affected surface property owner to a waiver of this standard.
Financial Assurance	The financial assurance required by this section shall be in the amount of $2,000 per well for non-irrigated land, or $5,000 per well for irrigated land. In lieu of such individual amounts, operators may submit statewide, blanket financial assurance in the amount of $25,000.	The applicant shall provide one form of the following security to ensure compliance with mitigation requirements set forth in this article and specific conditions of approval for minor and major facilities: $5,000.00 performance bond for each minor or major facility; $50,000.00 countywide blanket bond for all facilities operated by the applicant within the county.

FIGURE II-10. COMPARISON OF COLORADO STATE AND COUNTY REGULATIONS[423]

Under federal and Ohio state laws, permission from surface owners is not required in order to drill an oil or gas well. In the City of Norton, Ohio, however, there is a city ordinance that states that, "No permit may be issued until 51% of the owners of the real estate units within 1,000 feet of the wellhead approve (in writing) the drilling of the oil or gas well."[424]

Other requirements in Norton that favor the surface owner include:

- when permit applications are submitted, the City Council holds a public hearing before granting a drilling authorization; and all property owners and residents within 1,000 feet of the wellhead are notified of the hearing.
- the company has liability insurance of not less than $500,000 for property damage, and not less than $1,000,000 for personal injury before a permit to drill is issued.[425]

- all pumps be operated using explosion proof, electric motors
- all fresh water wells within 1,000 feet of the wellhead are tested by the company

Another example of a protective municipal ordinance comes from the City of Lovington, New Mexico. In December of 2003, the city adopted an ordinance to protect the city's water from contamination due to leaks and spills resulting from oil and gas activities in their water field. According to an article in a Hobbs, New Mexico newspaper, "After becoming frustrated with the [New Mexico] Oil Conservation Division's slow response time to oil spills near the city's water supply, city manager Pat Wise and the commission felt it was necessary to draft its own regulations."[426]

The ordinance contains a number of very stringent requirements for oil and gas companies that want to operate on lands within the city's water field. Examples include:

- The use of closed-loop drilling systems, which prevents on-site storage and disposal of often toxic drilling fluids. Companies in Lovington are required to remove from the site, and properly dispose of, all drill cuttings and fluids. This is much more strict than New Mexico state law, which allows for storage and burial of drilling fluids on-site, in unlined pits. (For more information on closed-loop drilling systems, see Chapter I, Alternatives Used During the Drilling Phase.)
- A ban on the drilling of new disposal wells, and a ban on the conversion of existing wells into disposal wells.
- Leaks or spills must be reported to the city engineer within 15 days.
- The submission of a leakage survey at least once a year. Failure to file the survey with the city engineer within a specific timeframe results in penalties up to $500 per day for every day that the report remains unfiled.
- Before drilling begins, companies must receive a permit from the city.

For more examples of local ordinances, see Chapter III.

Protections for Surface Owners Who Also Own the Minerals

If you own the minerals and lease them to an oil or gas company, that company will be subject to state laws, as well as county and municipal laws (if the land is within county or city limits). Also, the company will be required to honor any contractual agreements made with you, the mineral owner. The most common of these agreements is a mineral lease. If you own the mineral and the surface rights, the mineral lease can be negotiated to protect your surface. See Chapter III for more information on leasing.

FEDERAL REGULATIONS

Many surface owners are unaware that federal minerals have been leased under their land, since there is no requirement to notify surface owners that federal lands have or are going to be leased.

The federal government owns more than 30% of the subsurface of the United States , which is approximately 700 million acres of mineral rights.[427] In 2001, approximately 57 million acres of federally-owned minerals were located beneath privately owned land.[428] The majority of federal split estate lands are located in the western states — in the eastern states only 300,000 acres of land are split between federal ownership of minerals and private ownership of the above-lying lands.[429]

Between 35 and 40 million acres of federal land (onshore) in the U.S. are currently under lease for oil and gas development. When the minerals are federally owned, the federal government retains the right to lease the mineral rights to an oil and gas developer.[430]

If a company leases the oil and gas from the federal government, the company (known as the mineral lessee or operator) usually must adhere to both federal and state laws that govern oil and gas development.[431] The federal Bureau of Land Management is responsible for permitting, bonding, and overseeing the reclamation of federally leased mineral rights.[432]

The following paragraphs provide information on some of the responsibilities of the companies that lease federal minerals where the land above the minerals is privately owned.

FIGURE II-9. THE HD MOUNTAINS, NEAR BAYFIELD, COLORADO
The federal government has leased oil and gas rights in this old-growth roadless area and many other important wilderness and cultural areas across the country.

Exploration

The mineral operator may enter land to explore for oil and gas by filing a notice of intention with the BLM. A copy of this MUST be provided to the surface owner, but surface owner permission is not required prior to entry. The exploration period begins 30 days after the notice of intention is submitted, and lasts for 60 days. During exploration, the "entry" onto the surface owner's land does not allow for use of mechanized equipment, explosives, the construction of roads, drill pads, or the use of toxic and hazardous materials, and may not cause more than "a minimal disturbance of surface resources."[433]

Drilling

Access

Mineral lessees (i.e., oil and gas operators) are supposed to make access arrangements with surface owners prior to entering a surface owner's land for the purpose of surveying and staking; but they do not need approval from the federal government to conduct these operations.[434]

Commenting on Applications for Permits to Drill

Before mineral operators can begin an oil or gas operation, they must submit an application for permit to drill (APD). Upon initiation of the APD process, the authorized officer of BLM must consult with other federal agencies and with other appropriate interested parties. There is a 30-day window of opportunity for surface owners to comment before the BLM takes its next steps:

1. approves the application;
2. returns the application, with an explanation as to why it was not approved; or
3. notifies and explains to the operator why a decision on the application will be delayed.

On-site Visits and Inspections

The BLM is required to conduct an on-site inspection of the proposed drilling operation within 15 days of the submission of either the Notice of Staking or APD. The BLM must invite the sur-

face owner to participate in this on-site visit (along with the mineral lessee), and the BLM is supposed to make an effort to schedule a time that is convenient to all parties.[435] During the on-site visit, the BLM officers will develop surface use and reclamation stipulations, which will be given to the mineral operator to incorporate into their APD. The surface owner may request that specific items be made part of the Surface Use Program (SUP), which is part of the APD.[436] This program contains information such as: descriptions of road and drill pad locations; methods to be used for containment and disposal of waste material; and descriptions of measures that will be taken to reclaim disturbed lands.[437] It is up to the authorized federal official whether or not the surface owner's suggestions are incorporated into the SUP.

Companies can post a state-wide bond of $25,000 for all the company's wells on federal leases within a single state, and a blanket bond of $150,000 for all wells across the country.

Surface Owner Agreements and Bonds

Before entering a surface owner's property to drill a well, a mineral operator is required to enter into good-faith negotiations with the private surface owner to reach an agreement for the protection of surface resources and reclamation of disturbed areas, or compensate the surface owner for loss of crops and damages to tangible improvements.[438] Note that crops only include those used for feeding domestic animals, e.g., grasses, hay and corn, and NOT plants unrelated to stock raising. Also, tangible improvements include those relating to domestic, agricultural and stock raising uses, e.g., barns, fences, ponds or other works to improve water utilization, but NOT nonagricultural improvements.[439]

As proof of these good faith negotiations, the mineral owner is supposed to secure one of the following: a surface owner agreement for access to enter the leased lands; a waiver from the landowner for access to the leased lands; or an agreement regarding compensation to the surface owner for damages for crop losses and tangible improvements.[440]

In reality, the company does not have to negotiate in good faith with the landowner, because if an agreement cannot be reached, the company may simply post a bond to "indemnify the surface owner against the reasonable and foreseeable damages for loss of crops and tangible improvements caused by the proposed operation."[441] The bond must be at least $1,000, which is supposed to cover damages to crops and improvements, as well as any loss of income from using the land. It is highly questionable as to whether this amount will cover the costs necessary to compensate for damages to crops or tangible improvements, especially since drilling a well can disturb anywhere from one to forty acres of land.[442] This bond is sometimes referred to as the 3814 bond, because it is a requirement under BLM department regulations at 43 Code of Federal Regulations 3814. The bond is not intended to cover the costs associated with compliance with lease terms, plugging the well, abandonment, or reclamation. Plugging, abandonment and reclamation are supposed to be covered by a 3104 bond, which is discussed below.

The BLM is required to send surface owners a copy of the 3814 bond proposal submitted by the company. The Northern Plains Resource Council has some suggestions on what to do if you receive a bond notice:[443]

- Carefully review the bond amount. If it is inadequate, challenge it by filing an objection (discussed below)
- Based on calculations that you have made for replacement costs for your crops, your grazing land, your water and any improvements you may have made, develop what you would consider an appropriate bond amount.
- The BLM officer is required to consider these factors, so push hard to make sure they are accounted for in the bond amount.

Surface owners have the opportunity to object to the 3814 bond amount.[444] There is a 30-day period of time during which the landowner may file an objection with the federal office that

issued the bond approval. The protest period begins when the surface owner receives a copy of the bond, which should be sent by certified mail. The bond will not be approved or accepted by the BLM during the protest period. If objections are received during the 30-day period the authorized officer will consider the objections and will determine whether or not the bond amount is sufficient. If it is determined to be sufficient, the surface owner will be sent another certified notice explaining that the objections have been overturned, and that the surface owner can appeal the decision. The surface owner may then file an appeal with the state office that issued the decision. Oil and gas operations may proceed during the appeal process.

Reclamation and Abandonment: the 3104 Bond

Companies are supposed to reclaim the land to pre-development conditions. To provide some insurance that sites will be reclaimed, companies leasing minerals from the federal government must also post a 3104 bond for reclamation and abandonment (in addition to the 3814 bond mentioned above).

The 3104 bond must be provided by the operator prior to the APD approval. The bond is supposed to ensure that the company complies with the federal requirements to plug wells, reclaim the leased area, and restore any of the lands and surfaces affected by the drilling operations.

The minimum bond amount is $10,000 per lease, ***not*** per well. BLM officials have the power to set the bond amount much higher than $10,000, if a case can be made that the reclamation costs will exceed the minimum bond amount. Surface owners should be aware that reclamation of a single well can easily exceed the $10,000 minimum (which is supposed to cover all wells drilled under one federal lease).

- A recent study by the BLM revealed that orphaned wells in the western states will cost an average of $19,000 per well to reclaim, with some sites costing $75,000.[445]
- Another BLM web site reported that, "As the U.S. oil and gas industry continues to decline and as producing oil and gas fields end their production cycle, many small operators face bankruptcy. Although these operators are required to be bonded, the bonds are insufficient to plug and reclaim the well sites."[446]

Another thing to know is that companies can post a ***state-wide*** bond of $25,000, for all of that company's wells on federal leases within a single state, and a ***blanket bond*** of $150,000 for all wells across the country.[447] It is not unusual for companies to own hundreds of wells, and in these situations, if a company were to declare bankruptcy there is no way that the federal government would be holding enough money to pay for the plugging and reclamation of the wells.

Special Situation: If You Lease Land from the Federal Government

If you do not own but are leasing land from the federal government (e.g., for grazing), there is the possibility that oil and gas development may interfere with your use of the land, since most federal lands are open to oil and gas leasing and development. In 2003, the Department of Interior released a report stating that 85% of natural gas on federal lands is accessible and open for oil and gas leasing and development.[448]

As mentioned above, there is no requirement for federal agencies to notify surface owners that federal lands have or are going to be leased. This also applies to those who lease federal lands that lie above federal minerals. Consequently, citizens who lease federal lands may want to stay in close contact with federal agencies to find out if the minerals beneath the land have been leased or have the possibility of being leased.

For one landowner's experience with the leasing of federal minerals, see the story "Rancher Not Informed about Mineral Leasing" in Chapter IV. And for a list of additional resources on oil and gas development on public lands, see Chapter V.

Chapter III

Tips for Landowners

III

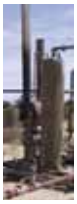
WHAT TO DO WHEN THE LANDMAN COMES CALLING
This section provides surface owners with suggestions on how to respond to the initial visits from oil and gas companies.

SURFACE USE AGREEMENTS
One of the tools available for protecting surface property and surface owner quality of life is the Surface Use Agreement. This section examines the pros and cons of negotiating these agreements, and provides samples of what others have been able to negotiate.

LEASING
The information in this section is geared toward those fortunate enough to own mineral rights. Mineral owners have the option of leasing or not leasing the minerals to oil and gas companies. If they choose to lease, there are some tips contained in this section to help ensure that the lease meets their needs and protects their interests.

OTHER ACTIVITIES LANDOWNERS MAY WANT TO CONSIDER
The final section of this chapter provides additional strategies and tools for surface owners confronted with oil and gas development. Some of these strategies include pushing for reform of oil and gas laws and regulations, taking companies to court, and working with other landowners to pressure companies and governments to carry out responsible oil and gas development.

What to do When the Landman Comes Calling



What is a landman?
A landman is the name given to a man or woman who serves as the company's contact person with the public who may be an employee or contractor with the oil or gas company. Some of the tasks that landmen perform include: researching courthouse records to determine mineral ownership; locating mineral/landowners and negotiating oil and gas leases and other agreements with them; and conducting surface inspections before drilling.[449]

What to do if contacted by a landman

1. When interest develops in your minerals, you may be approached by phone, mail, or in person. The landman or lease broker may determine your interest in leasing by quoting you an offer. You should write the offer down or get it in writing.
2. Do not sign or agree to anything (e.g., a lease or surface use agreement) without understanding the terms of the agreement or getting professional advice. You may want to contact an attorney or organizations that work with landowners. You may want to talk with your neighbors and others who have been in negotiations with oil or gas companies. It may be helpful for you to read through the landowner profiles that are scattered throughout this document. The lessons learned by others may help you to figure out your own strategy for dealing with oil and gas company representatives.

3. Stand your ground. Some landmen may use intimidation tactics or threats to pressure you into signing an agreement. For more information on intimidation tactics, see the story "Threats and Intimidation: This is Negotiation?" and also Peggy Hocutt's story, in Chapter IV.
4. Put together a list of issues important to you before you begin negotiating with the landman. Remember, everything except your name and the legal description of the property is negotiable.
5. At any meeting with a landman, document as much as you can. Take notes, or better yet, tape record your meetings. Or have someone else sit in as a witness.
6. Understand who it is you are dealing with. Research the oil or gas company's track record. Talk with neighbors and other landowners who have had to deal with the same company. Find out, if you can, details of agreements reached between the company and other surface owners (e.g., if they offered to test your neighbor's well water, they should do the same for you).
   - The Colorado Oil and Gas Conservation Commission (COGCC) maintains a database of incidents and complaints. You can look up information on a specific company, e.g., how many violations they have had, and how the company responded to complaints. Also, the database has information on inspections, notices of alleged violations, and spills. It can be found at the COGCC website, under "Database." (http://oil-gas.state.co.us/). There may be similar databases in other states. Contact your state agencies to find out.
7. Consider signing a lease or negotiating a Surface Use Agreement (both are discussed below). If you are going to sign a lease, consider negotiating the Surface Use Agreement either before or at the same time that you negotiate the lease.

Knowing Your Landman

You may want to ask your landman if he or she is a certified landman, and whether or not he or she belongs to any professional landmen associations, the largest one being the American Association of Professional Landmen (AAPL). Many of these associations have codes of ethics that landmen agree to follow. For example, the AAPL Code of Ethics state that:

> *The Land Professional, in his dealings with landowners, industry parties, and others outside the industry, shall conduct himself in a manner consistent with fairness and honesty, such as to maintain the respect of the public.*

If you believe that the land professional has used intimidation tactics, or has lied to you during the negotiations, you should call the landman's association and report the incident. For example, the AAPL has an Ethics Committee to which you may direct complaints. Their address is: American Association of Professional Landmen. Ethics Committee. 4100 Fossil Creek Blvd. Fort Worth, TX 76137. Phone: 817-847-7700.

Surface Use Agreements

Surface Use Agreements (SUA) are sometimes referred to as Surface Damage Agreements (SDA) or Surface Use and Damage Agreements (SUDA). They are all agreements negotiated by the surface owner and a company representative.

They may be negotiated with a company whether or not the surface owner owns the mineral rights. As mentioned in Chapter II, some states require a company to negotiate an agreement with a surface owner who does not also own the mineral rights. Whether or not there is a surface compensation law, many companies will approach landowners with pre-written SUAs that they hope will be signed on the spot.

Before You Negotiate a Surface Use Agreement

1. What are the potential drawbacks of signing an SUA?
    - According to an attorney who works with surface owners, when a surface use agreement is signed a landowner typically gives up his or her right to sue for trespass arising from unreasonable use of the surface. Also, in many cases, the amounts of money paid are so small and the written concessions are so minimal that a landowner might benefit from refusing to sign an SUA, and instead, retain his or right to sue for unreasonable behavior that occurs anytime during the lifetime of the lease. The theory behind this strategy is that the potential threat of suit will keep the oil or gas company on best behavior during the lifetime of the lease, which is a greater benefit than the pittance sometimes offered in "damages," and the minimal written concessions contained in most surface use agreements. Bear in mind, of course, that suing for trespass is an expensive endeavor and may not be feasible even if a landowner retains that right. It is, however, possible that simply filing a trespass suit may lead to improvements on the part of the oil and gas company, in their attempts to avoid the suit or reduce damages.
    - Be aware that if you do negotiate an SUA there may be unintended omissions (on your part) or items that the company will not put into the agreement. Because you have signed the agreement, you may be out of luck if problems arise that are not addressed in the agreement. Or again, you may have to go to court to resolve these issues.

      See Terry Fitzgerald's story for an explanation as to why she and her husband Jim refused to sign a surface use agreement.
2. What are the benefits of signing an SUA?
    - The main benefit of negotiating an SUA is that it provides you with a signed legal document outlining the issues you and the company have agreed upon. And both you and the company know that if the company does not live up to the agreement, you can take them to court; and if you win, they will likely have to pay your attorney fees.
    - You have the opportunity in negotiating SUAs to include issues that are important to you. For example, protection of certain areas of your property; getting the company to agree to upgrade your road or put in fences. If you don't negotiate an SUA, you may never realize many of these sorts of benefits.

If You Negotiate an SUA

- Take some time to review the examples of SUAs below, and suggestions on items to include. But do not feel limited by what you see. If there is something you want in the agreement, try to negotiate with the company to get that included.
- Negotiating SUAs allows you to establish a relationship with the company. Depending on the tone of the negotiations, your relationship may be a positive or negative experience.

This may affect the company's willingness to live up to the letter of the agreements, or to complete negotiations.

- The negotiation process could take up a fair amount of your time. According to one oil and gas industry representative, SUA negotiations can last more than a year, but the average is five months.[450]
- If you do not own your minerals and you are particular about how you'd like to see things done on your land, your attorney's fees could get quite high. For example, a Gillette, Wyoming landowner had $10,000 in attorney fees for negotiating the terms for a 24-inch pipeline (this cost was shared between four landowners). This property owner was particular about how he wanted development to occur on his property. Despite owning some of his minerals, as coalbed methane production got underway the landowner's monthly attorney's fees were $2,000 per month.[451]
- Taking the time to negotiate an SUA is only worth it if the company lives up to the agreement. (See Nancy and Robert Sorensen's story for an example of how a company failed to fulfill the terms of their SUA.) Moreover, oversight of oil and gas development activities and enforcement of SUA terms is extremely time consuming - for many landowners it may be equivalent to a full time job. This time is not compensated under the SUA. It is a loss of income for the landowner because the person overseeing a company's activities cannot do other work during those hours. (This, however, may be equally true for landowners who choose to not sign an SUA. See Terry Fitzgerald's story of her family's 20-plus years of dealing with the oil and gas industry.)
- The Powder River Basin Resource Council has a detailed checklist of items to consider when negotiating surface use and damage agreements.[452]

Powder River Basin Resource Council SUA Checklist

ACTIVITY OF CONCERN

Surveyors
1. When can they go?
2. How will they go?
3. How will they mark?
4. Who will pick up junk?
5. Will they get permission?
6. How much will be paid for access?

Seismic activities
1. Hole
2. Vibrosize
3. 3D
4. Types of damage: (a) Surface – soil compaction; destruction of plant life; junk; time of operations; (b) Water – drainage between formations; damage to existing wells or springs; who will pay?

Junk
1. Oil
2. Mechanical work in field
3. Survey and pin flags
4. Placement of signage
5. Duty to pick up trash

Operations in mud and snow

Water Protection
1. Drilling water
2. Disposal of water: (a) quality of water – heavy metals; salts; temperature; (b) volume of water – slope; (c) soil conditions; (d) protection of water resources (include federal and state laws to be considered)

Soil pollution

Noise pollution

Light pollution

Air pollution

Protection of viewscape

Protection of vegetative resource
1. Growing crops: (a) harvest time; (b) soil erosion; (c) turning expense
2. Grass
3. Fire: (a) vegetation; (b) timber; (c) structures; (d) livestock

Extraordinary loss
1. Livestock
2. Wildlife
3. Human

Cooperation with others as to roads and water storage

Drilling operations
1. Depth
2. Length to time of operations
3. Time of year of operations: (a) Size of pad; (b) Width of easements; (c) Location of drilling operations; (d) Location of road – fences; snow; type of construction; weight to be carried on road; crossing of road; grade and crown; soils (sandy; clays; expansive; compaction; erosion due to wind or water); culverts; gates; cattle guards; deviation from established roads.

Recreational uses
1. Guns bows and crossbows
2. Dogs
3. Drugs
4. Alcohol
5. Recreation vehicles: (a) four wheelers and motorcycles; (b) 4-wheel drives
6. Fishing
7. Hunting
8. Searching for artifacts: (a) paleological; (b) archeological

Reclamation
1. Protection of soil and vegetative resource
2. How graded
3. How long open
4. When seeded
5. What seeded
6. How seeded
7. Wildlife areas: (a) riparian areas; (b) duck islands; (c) fish
8. Noxious Weeds: (a) 21 introduced species - 1 native; (b) how spread; (c) control of

Parking of equipment off road

Access Points (Security and protection of hunting)

Time of operations
1. Time of year
2. Mud and snow
3. Time of day

Cooperation with other companies

Changes in location of roads; electric lines; wells

Dealing with Agencies
1. Federal BLM: (a) on-site inspection; (b) cultural surveys
2. State (e.g., Engineer, Department of Environmental Quality, Oil and Gas Commission, etc.)

Legal Concerns
1. ID of parties; addresses; phone #'s; tax ID
2. Legal descriptions
3. Notices
4. Force Majure: (a) choice of jurisdiction and venue; (b) release of liability and indemnification
5. Statutory law citation

DAMAGES	
Realities of Money 1. When payment is received: (a) before work commences; (b) after work; (c) split payments (some before, some after); (d) annually 2. How much: (a) cover risk; (b) real damages; (c) intangible damages; (d) value to buyer (market value) 3. What form: (a) check; (b) cash; (c) sight draft; (d) time draft 4. Who pays: (a) lessee; (b) contractor; (c) agent 5. Credit worthiness of payor 6. Well Sites: (a) initial damages; (b) annual damages 7. Deep well: (a) initial damages; (b) annual damages 8. Methane well: (a) initial damages; (b) annual damages 9. Strat well: (a) initial damages **Annual damages** **Pipelines** 1. Flowlines: (a) initial damages; (b) annual damages 2. Water Disposal Lines: (a) initial damages; (b) annual damages 3. Large 4" or greater oil lines: (a) initial damages; (b) annual damages 4. Large 4" or greater gas lines: (a) initial damages; (b) annual damages	**Compressor Stations** 1. Initial damages 2. Annual damages **Electrical lines Above the Ground** 1. Initial damages 2. Annual damages **Electrical Lines Below Ground** 1. Initial damages 2. Annual damages **Service access points** **Roads** 1. Permanent shaled: (a) initial damages; (b) annual damages 2. Permanent two track: (a) initial damages; (b) annual damages

Surface Use Agreement Provisions to Consider

Development plan

- Surface owners may want to require from the company an overall development plan showing the location of wells, roads, pipelines, compressors, water disposal/discharge, etc. before development starts, with allowance for changes as development progresses. (See Vermejo Park Mineral Extraction Agreement below for an example of this type of provision)

Water issues

- Address both water quality and quantity issues.
- Establish damage standards as part of the agreement. Spell out in the agreement how much of a change constitutes damage (e.g., if your water well drops below a certain level or water quality declines by a certain amount). Include remedies for what the company will do if damages occur (e.g., the company will pay for the successful drilling of a new drinking water well).
- Be clear from the opening discussion and put into the agreement that if drilling or other development activities damage a water well or the land, the company is required to replace the well and repair or compensate for the damages.
- Water well location (make sure your water wells are registered with the state engineer, so that you have proof of location).
- Require the company to gather baseline water quality and quantity data by a consultant of your choice PRIOR TO any activities on your property. Require the company to conduct periodic monitoring of water quality and quantity, to gauge whether the company's activities are having an effect on your water. Make sure water sampling includes quality and quantity of: domestic well water, surface waters, springs, and groundwater flows. And require the company to provide regular reports of the test results.
- Require that the company disclose the quality and quantity of the water from oil and gas

operations to be discharged or reinjected by the company. Ask for a lab analysis of the water (from an independent lab, if possible), and then be specific about where you want the water to be discharged or piped to avoid damages to your property. Also, retain the right to require the operator to move the point of discharge if it is causing environmental or biological damage (e.g., killing hay meadows, streamside vegetation, fish in the stream).

- Groundwater withdrawal from aquifers is an important issue for landowners who rely on groundwater for livestock and for irrigation. Some gas operators have cooperated with landowners by diverting produced water from CBM wells into stock tanks or other holding areas for their livestock.[453] Depending upon the quality of the produced water, this may be something to add into your SUA.

Land use issues

- Propose development alternatives that make sense in terms of your agricultural or land use operations. For example, don't be afraid to propose alternative routes or pump locations. Don't let them chop up your field with a road or pump that is better located elsewhere.
- You may want to include techniques for preventing/controlling erosion.
- Right-of-way easements. Some companies may try and get you to put this easement in their name. It is in your best interest to do this agreement with your power company, not the oil and gas company.[454]
- When leasing land for certain facilities, e.g., compressors, you will likely lease that land by the acre. You should be specific on the wording of this lease as to what materials are going to be on the acreage involved. If you are not specific, companies may take advantage of it and put as much hardware as they can on the acreage.[455]

Reclamation

- Be specific about reclamation and how it should be done (e.g., you want original land contours restored; and native vegetation planted). Include agreements on reseeding. If you so desire, require that you be authorized to conduct and be paid for carrying out the reclamation.
- Include whether or not you want the option to convert a gas well to a water well.
- You may want to include a clause stating that the company will remain responsible for closure and restoration of containment pits, regardless of whether the landowner uses the produced water they hold; as well as for clean up of any hazardous materials left in the bottom of the pits upon closure.

Rights and responsibilities of the company

- Look carefully at the agreement, and remove any broad language or rights granted to the company. For example, it is common for companies to include the right to place a gas plant on your property.
- Make sure the company is required to pay taxes on improvements (e.g., roads).
- Make sure company removes equipment when activities are completed.
- Include a damage indemnity or bond in the agreement. Most state agencies require companies to post a bond, but often these amounts are not sufficient to ensure that wells will be plugged and abandoned properly.

Benefits granted to the surface owner

- Some landowners have asked to be able to use parts of the well pad for parking vehicles, trailers or equipment.
- Site-specific surface enhancement issues may also be included (e.g., new fences, new gates/cattle guards).

INDEMNIFICATION

Landowners should be sure to request an indemnification clause so that they will not be held responsible for pollution or other long-term liabilities created by the oil or gas company. For more information, see number 33 of the Sample Surface Use Agreement later in the chapter.

Quality of life, health and safety issues

- Often, oil and gas companies spray pesticides to keep weeds down along roadsides. If this is not something you want on your land, be sure to specify this in the agreement.
- Include provisions that protect and preserve aesthetic values (e.g., hide compressors behind hills, reduce and consolidate the number of above-ground power lines, maximize use of buried power lines).
- If noise reduction from pumps and compressor stations is a concern, require the use noise reducing equipment and materials.

General

- Detail what specifically constitutes a breech of the agreement, and give 30 days to cure the breech.

Enforceability of the agreement

This has definitely been a problem for landowners. Even when landowners have had good experiences with oil or gas development on their property, non-compliance with surface use agreements is commonplace. Surface owners have had to resort to legal action when companies have failed to comply with the agreement, even though it contained protective provisions. Some landowners have made suggestions for surface use agreement breach of contract provisions that might make the agreement easier to enforce,[456] including:

- penalty clauses or stipulated damage provisions for violations of the agreement (e.g., $300/day while a pit is leaking);
- operator payment of the landowner's attorney fees if the landowner prevails in a suit to enforce the agreement; and
- escrow account or other financial guarantee to be created by the initial operator, which can be drawn against to correct violations of the agreement that are not cured within a reasonable amount of time.

Industry Perspectives on SUAs

In 2003, interviews were conducted with a number of coalbed methane companies on the topic of what should be included in surface use agreements. Here are some of the findings:[457]

- Some companies said that surface use agreements should address all foreseeable issues up-front, so that both operator and landowner know what to expect as development progresses. These operators also believed there was a benefit to having the same agreement across a number of wells, ensuring that requirements are consistent.
- Some companies resist making commitments on location of wells and supporting infrastructure during the exploratory phase of development, fearing that this could limit the ability to locate additional future wells that may be needed to maximize production in certain areas.
- Some companies prefer to postpone negotiation of a water management agreement until more information is available on the quality and quantity of produced water, especially in an exploratory situation. One company negotiates all things up front, so that it does not spend capital to drill wells only to be "held hostage" by the landowner regarding produced water disposal issues.
- Company representatives described various approaches to the monetary reimbursement component of an agreement. Some had a fixed, non-negotiable price that they offered for each aspect of the development, and if a landowner attempted to discuss a different reimbursement schedule that signaled the end of "good-faith" negotiations from the company's perspective. Others showed more willingness to integrate the damage reimbursement provisions with operational details to address the individual landowners' use of the property. Some companies were willing to consider alternatives to strict damage reimburse-

ment payments. For example, they might be willing to pay a percentage overriding royalty to split estate owners, if it were in lieu of surface damage payments.

- Some companies recognized that the actual implementation of the surface use agreement was a potential area of conflict. Some felt that giving the landowner a single, local point of contact for the agreement would be good. Others did not necessarily provide for this in the agreement, yet said that they believed that landowners prefer companies who have a local office or point of contact. Some company representatives also stated that more authority should be given to local company staff to resolve disputes.

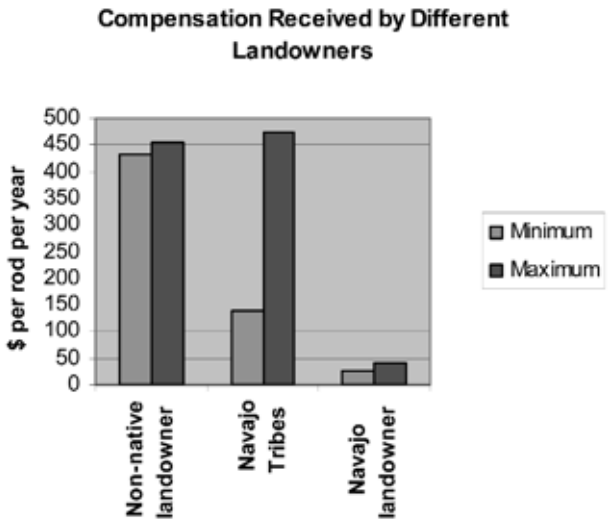
How to Determine Reasonable Compensation

Often, there is no equality in the amount of compensation received from one landowner to the next, or from one region to the next. Also, it is not always easy to find out how much you should be asking for. Often, there are clauses in surface use agreements that prohibit surface owners from disclosing the details of their agreement. This makes it extremely difficult for landowners who are negotiating a surface use agreement to know what is reasonable, or to try to negotiate agreements similar to what their neighbors have negotiated. Still, that should not prevent landowners from talking with other landowners or attorneys, and trying to find out what level of compensation others have been able to receive.

Navajo landowners not receiving the "fair market value" for leased land

Many natural gas pipelines that originate in the San Juan Basin of Colorado and New Mexico cross lands owned by Navajo tribes, individual Navajo landowners, and non-Native landowners. In August of 2003, it was brought to light that some Navajo tribes and individuals in the region were not being compensated for pipeline rights-of-ways at the same rate as private landowners. A report released by a court-appointed investigator revealed that the U.S. Department of the Interior leased Navajo land to oil and gas pipeline companies for as much as 20 time less than the amounts paid to nearby private landowners. "It is doubtful," wrote the investigator, Alan Balaran, whether Navajos "are receiving 'fair market value' for leases encumbering their land. It is certain they are denied the information necessary to make such a determination."[458]

On an annual basis, private landowners who leased their land to oil and gas companies received between $432 and $455 per rod (16.5 feet) of land leased; Navajo Tribes negotiated payments of between $140 and $475 per rod; and individual Navajo landowners only received from $25 to $40 per rod. Using these figures, over the 20-year life of the leases, individual Navajo landowners could receive $11,000 less than their private landowner neighbors. According to a Denver Post article, because the Interior Department did not provide translators for the pipeline right-of-way negotiations, "some of the individual Navajos put their thumbprints on dubious leases they couldn't read and never had explained to them."[459]



The government in Alberta, Canada, has prepared information for surface owners on how to determine adequate compensation payments.[460] Alberta is a major oil and gas producing region, and oil and gas companies that operator there are required to negotiate a "surface lease" with the surface owner (similar to the mineral lease that is negotiated with a mineral owner). In fact, companies are not allowed on a surface owner's property, except to conduct the land survey, until the lease has been negotiated, signed, and the first-year compensation paid. Although prepared for Alberta landowners, the guidelines below may provide landowners in the United States with a starting point for assessing how much to ask for in compensation.

The dollar amounts are in Canadian dollars ($1 Canadian = approximately $0.83 U.S.).

Entry Fee	The entry fee is $500 (approximately $415 U.S.) per acre of land granted to the company, to a maximum of $5,000 when 10 or more acres are used. The minimum entry fee is $250, paid when the area is half an acre or less. • For example, if a company uses 4.25-acres, the entry fee would be: 4.25 acres x $500 = $2,125 *Note: the entry fee for many U.S. states is higher than this amount. For example, in Wyoming the initial payment, which is akin to this entry fee, is closer to $2,000 (US) per acre.
Land Value	The value of the land used by the company is determined by the price expected if the land were sold on the open market by a willing seller to a willing buyer at the time when the lease was prepared. The value is also based on the highest approved use (agricultural, industrial, residential) for the land. • The per acre value for the well site is determined by dividing the value of the titled unit by the number of acres required.
Initial Nuisance, Inconvenience and Noise	This payment is for nuisance during the first year of the lease. • For example, in the first year landowners likely have to spend time dealing with a company's representatives and surveyors, preparing documentation, negotiating with the company and/or seeking advice from government agencies or lawyers. There may also be noise and inconvenience related to construction. The company should pay reasonable compensation to you for nuisance. Keep a record of all time spent, phone calls made and expenses incurred.
Loss of Use of the Land	The company pays an annual compensation for loss of the normal use of the well site area during the well site's life. The amount should approximate the value of the gross annual production reasonably expected from the area. • To calculate the amount, use the greater of yield and price averages from the past five years, or today's street price. For example, assuming canola production at 35 bushels per acre on a well site and access road occupying four acres, the loss would be 4 x 35 = 140 bushels. At $8.50 per bushel, the total annual loss would be $1,190.
Adverse Effect	This payment is related to inconvenience, nuisance and extra costs on the rest of the quarter section where the well site is located. • For instance, farming around the well site may require constantly turning corners, which can cause overlaps, extra strain on machinery, soil compaction, loss of seed and grain, and extra field and labor costs. Other factors related to adverse effect can be noise, dust, odor, additional traffic on the land, and proximity to a residence or farm site.
Other Relevant Factors:	If there are other considerations specific to a landowner's situation, they should be included when negotiating compensation.

FIGURE III-1. ISSUES TO CONSIDER WHEN DETERMINING SURFACE DAMAGE COMPENSATION PAYMENTS.

Reported Compensation Amounts

The following information comes landowners, real estate brokers, attorneys, mineral royalty associations, and community organizations.[461] This information is meant to provide surface owners with an idea of what others have been able to negotiate in various parts of the country. The chart is by no means comprehensive — undoubtedly, some surface owners in these areas receive more or less compensation based on their particular circumstances.

Location	Item	Compensation
Sublette County, WY	Surface damage payment per well	$2,500
Wyoming	Initial payment per well site (1/2 acre) Annual payment Use of existing roads	$1,000 $1,000 $1,000
Wyoming	Initial payment per well Roads and pipelines 4” pipeline – initial payment 4” pipeline – annual payment 8” pipeline – initial payment 8” pipeline – annual payment	$1,000 - $1,500 $5-$10/rod (1 rod = 16.5 feet) $8/rod $4/rod $16/rod $8/rod
Weld County, CO	Surface damage payment per well site (2 acres) 4” pipeline	$4,000 - $5,000 $33/rod
La Plata County, CO	Surface damage payment per well (well site 6/10 acre), plus payments for roads, pipelines and compressor sites 16” inch pipelines	$5,000 - $35,000 $1-$86/rod
Las Animas County, CO	Well site (7/10 acre) Access road	$2,000 - $2,500 $25/rod
Oklahoma	Payment for well pad and access road (appraised value)	$7,500 - $8,600
Kansas	Well site damages 8” pipeline	$5,000 - $10,000 $30-$35/rod

FIGURE III-2. EXAMPLES OF COMPENSATION PAID TO SURFACE OWNERS IN VARIOUS PARTS OF THE U.S.

The following chart (Figure III-3) contains information gathered by the Powder River Basin Resource Council. It shows compensation amounts that some Wyoming landowners were able to negotiate for lands affected by coalbed methane development in the year 2000.[462]

Item	Compensation
Right-of-way easements	$3.00 - $3.50 per rod (1 rod = 16.5 feet; 320 rods = 1 mile)
24-inch diameter pipeline	$13 - $25 per rod
8-, 10- or 12-inch diameter pipelines	$13 - $15 per rod
4- or 6-inch diameter pipelines	$6 - $8 per rod
Small waterlines, e.g., 2-inch diameter	$0.00
Trenches/electrical between well-heads	$0.00
Above-ground power lines and poles	Same as the power company's going rate
Pod Building - meters production, 10 x 12 feet and 8 x 12 feet	$1000/year
Screw compressors – 20 x 40 feet (1 per 8 wells), rented by the acre	$2150/acre for the first year, and then $1200 - $1500/acre for every year thereafter
Large Compressors This example is for a compressor on a 3.67-acre compressor site.	Chain link fence, gravel road to site. Road - $5 per rod per year Compressor - $1300 per acre/year (for five years), with an increase of $500/acre for each additional 5-year renewal period. Reseeding - $325/acre – landowner pays for seed and uses own equipment
Receipt Stations – where production is metered. These stations may include several buildings taking up a 15-foot x 35-foot area.	$1500 per year, paid 5 years in advance. Rental fee is tied to Consumer Price Index, so the initial rental is $7500 after the first 5 years are over. The agreement reflects that $1500 per year is the least the landowner will be paid.
Wells	$500 - $1500 per well for the first year. Every year after that, landowner receives an annual payment of $700 to $1000.

FIGURE III-3. EXAMPLES OF COMPENSATION RECEIVED FOR SURFACE DAMAGE RELATED TO COALBED METHANE DEVELOPMENT.

How much does compensating surface owners affect a company's "bottom line"?
According to the Landowners Association of Wyoming:

> *Surface Owner Accommodation legislation, whether enacted by a ballot initiative or by the legislature, will have no significant impact on revenues generated by Wyoming's oil and gas industry. It may require some additional monies to be spent by the oil and gas industry to compensate the private landowner for losses due to their activities, but those losses are currently being borne by the private landowners—individuals who in no way caused the losses. Currently, Anadarko Production, a top 15 producer, voluntary grants a 1-3% royalty interest in the production to the surface owners on the Union Pacific lands in Wyoming's southern corridor. Clearly, compensating landowners for damages caused by oil and gas activities can go hand-in-hand with being a prudent and successful oil and gas operator.*
>
> *An average well on the Pinedale Anticline in Sublette County costs $2.5 million to drill and complete. Currently companies operating in that area offer $2,500 per well location for a surface damage payment which equates to 1/10th of 1% of the cost of that well going to the affected surface owner. If negotiations ensured by this legislation result in a higher surface damage payment – say even 10 times higher in the extreme case – the surface damage payment would still be less than 1% of the total cost of drilling that well. In this example, the total surface damage payment of $25,000/location would be 3/4 of one day's revenues of a well that is estimated to produce for 20 years. Looking at this another way, the overall IRR (internal rate of return) for this well would be reduced to 25.0% from 25.5% as a result of this higher surface damage payment.*[463]

Examples of Surface Use Agreements

The following are some examples of Surface Use Agreements, which will not only provide you with some guidance on what to ask, but also will help to familiarize you with the language used in these sorts of agreements. The first agreement is a copy of a surface use agreement from Wyoming, which includes clauses that might not be present in the standard agreements that companies ask surface owners to sign. This agreement comes from the Powder River Basin Resource Council web site. This web site also has sample pipeline and right-of-way agreements (see Chapter V for details).

The second agreement is a Mineral Extraction Agreement (MEA) between Ted Turner and El Paso Production Corporation. While not perfect, there are clauses in the Vermejo Park Ranch MEA that are prime examples of how a company can minimize the impact of coalbed methane development on landowners' lives and lands. Ted Turner managed to achieve this agreement without owning the mineral beneath his land. He does, of course, have the financial leverage to negotiate this very landowner-friendly agreement. But this fact should not prevent other landowners from attempting to negotiate similar provisions in their surface use agreements.

FIGURE III-4. CASTLE ROCK, VERMEJO PARK RANCH. Directionally drilled wells access gas beneath this important elk habitat. Photo used with permission from Vermejo Park Ranch.

Sample Agreement

SAMPLE SURFACE USE AND DAMAGE AGREEMENT

This Agreement is made and entered into between _____ _____, of _____, _____, Wyoming _____ ("Owner") and _____, of _____, _____, _____ _____ ("Operator").

IT IS AGREED AS FOLLOWS:

1. **The Land.** Operator holds interests in oil and gas leases covering the following described lands situated in _____County, _____:

   Township , Range , .
   Sections
   _____ County, _____

   and Owner owns the _____, which includes the surface of the above described lands. This Agreement covers Operator's activities on and access across the above described lands only.

2. **Shallow Rights Only.** Notwithstanding any other provision of this Agreement, the rights granted to Operator hereunder shall be limited to operations related to the drilling and producing of wells to the _____ formation. Surface damages for operations related to the drilling and producing of wells to greater depths shall be by a separate agreement to be negotiated by Operator and Owner.

3. **Right-of-Way.** Owner grants Operator, its employees and designated agents, a private right-of-way to enter upon and use the above described lands for the purpose of drilling, completing and producing oil and gas wells on Owner's land. However, access to the above described lands on Owner's portion of the private road known as the "_____" shall be by separate agreement.

4. **Notification and Consultation.** Operator shall notify Owner prior to entry upon Owner's land and shall consult with Owner as to the location of each well, road, pipeline, power line, pod or battery site, gathering system and other facility to be placed on Owner's land. To the maximum extent possible, Operator will use existing roads on Owner's land for its operations, and if construction of a new road is required, Operator will consult with Owner, and following such consultation locate the new road in a manner so as to cause the least interference with Owner's operations on the affected lands. If a pipeline or gathering system is to be installed by Operator, Operator will locate the pipeline and gathering system in a manner so as to cause the least interference with Owner's operations on the affected land. Operator shall notify Owner when each drilling and production operation for any well drilled on the above-described land has been completed and when Operator is permanently or temporarily absent from the surface.

5. **Termination of Rights.** The rights granted by Owner to Operator shall terminate when the Oil and Gas Lease terminates, Operator ceases its operations on the land, upon Operator's notification to Owner of Operator's intention to cease operations, or if Owner so elects, upon a breach of this Agreement by Operator, whichever shall occur first. Upon termination of this Agreement, Operator will execute and deliver to Owner a good and sufficient recordable release and surrender of all of Operator's rights under this Agreement, and will promptly remove all equipment and property used or placed by Operator on Owner's land unless otherwise agreed by Owner in writing.

6. **Nonexclusive Rights.** The rights granted by Owner to Operator are nonexclusive, and Owner reserves the right to use all access roads and all surface and subsurface uses of the land affect-

ed by this Agreement and the right to grant successive easements thereon or across on such terms and conditions as Owner deems necessary or advisable.

7. Payments. As compensation for surface damages, Operator will pay to Owner the following:

a. Stratigraphic Test. $_____ per stratigraphic test (well drilled only to obtain geologic information which is not completed for production) on Owner's land. This amount shall be paid by Operator to Owner before entering upon the premises to drill.

b. Well Locations. $_____ for each well location. This amount shall be paid by Operator to Owner before entering upon the premises to drill the well. Operator shall also pay to Owner an annual rental of $_____ per year for each well site location. This annual payment shall be made on the anniversary date of the commencement of drilling of each well in each and every year until the well has been plugged and abandoned and the location of any roads and pipelines constructed in connection therewith have been reclaimed as provided herein.

c. Roads. Operator shall pay to Owner an initial access fee of $_____ per rod for use of existing roads on Owner's land, and the rate of $_____ per rod for new roads constructed by Operator or existing roads improved by Operator on Owner's land. Operator shall pay to Owner an annual access rental at the rate of $_____ per rod for use of roads on Owner's land. The annual payment shall commence one year from the anniversary date set out in Paragraph 7.b. above for the well or wells served by such road, and shall be made on the anniversary date in each and every year thereafter until the road is reclaimed and restored by operator as provided herein. Operator shall provide Owner with a plat showing the location and length of all roads promptly after their first use, construction or improvement.

d. Pipelines.

i) For each gas gathering system pipeline and each water pipeline less than 8 inches in diameter installed by Operator, Operator shall pay to Owner the sum of $_____ per rod for each such pipeline unless pipelines are located in the same ditch, in which case a single payment shall be made. A take up of any such pipeline shall be at the rate of $_____ per rod. For pipelines 8 inches in diameter or larger installed by Operator, Operator shall pay to Owner the sum of $_____ per rod for each such pipeline. A take up of any such pipeline shall be at the rate of $_____ per rod. Payments for pipelines shall be made by Operator to Owner within fifteen (15) days after installation or take up of the pipeline. There shall be no annual rental payment.

ii) The pipelines referred to in this paragraph are only those gathering system pipelines used in connection with wells drilled on Owner's land or as allowed pursuant to Paragraph 8 below. Surface damages for high pressure (greater than 970 psi) gas transmission pipelines serving lands other than those owned by Owner shall be by separate agreement.

iii) Operator shall be responsible for backfilling, repacking, reseeding and re-contouring the surface so as not to interfere with Owner's operations. Operator shall provide Owner with a plat showing the length and location of all pipelines and gathering systems promptly after their installation. All pipelines and gathering systems located by Operator on the premises shall be buried to the depth of at least three (3) feet below the surface. Owner reserves the right to occupy, use and cultivate the lands affected by such pipelines, and to grant such rights to others, so long as such use does not interfere with Operator's operations. If Operator fails to use any pipeline for a period in excess of 24 consecutive months, the pipeline shall be deemed abandoned and Operator shall promptly take all actions necessary or desirable to clean up, mitigate the effects of use, and render the pipeline environmentally safe and fit for abandonment in place. All such clean up and mitigation shall be performed in compliance with all federal, state and local laws and regulations.

Sample Agreement

e. Gathering, Metering and Compression Sites. For each central gathering facility or "battery site" Operator shall pay to Owner an initial fee of $_____. This amount shall be paid by Operator to Owner before entering upon the premises to construct the battery site. Operator shall also pay to Owner an annual rental of $_____ per year for each battery site location.

f. Power Lines.
   i) Operator will consult with Owner and with the independent power company supplying power to Operator with respect to the location of overhead power lines prior to construction. Overhead power lines will be constructed so as to cause the least possible interference with Owner's visual landscape and Owner's existing and future ranching operations, and, to the maximum extent possible, overhead power lines will be constructed along fence lines or property lines. Construction shall not begin unless Owner has consented to the location of such power lines.
   ii) All power lines constructed by Operator downstream of the independent power company's meters shall be buried and all power line trenches shall be fully reclaimed and reseeded to the satisfaction of Owner. For buried power lines, Operator shall pay Owner a one-time payment of $_____ per rod unless such power line is installed in the same ditch and at the same time as the pipelines described herein, in which case there will be no duplication of payment.

g. Increase or Decrease in Payments. On the fifth anniversary of this Surface and Damage Agreement, and every five years thereafter, surface damage payments provided for in this paragraph shall be increased or decreased (but never below the amounts stated herein) by a percentage equal to the increase or decrease in the Consumer Price Index as published by the United States Department of Commerce for the preceding five year period.

8. **Limitation on Rights.** Owner's land may not be used in connection with operations on other lands owned by Owner which are not described herein or on other premises not owned or leased by Owner without Owner's written consent.

9. **Locations.** All well site locations shall be limited to approximately one (1) acre of land while drilling and no more than one-half (½) acre for permanent facilities. No wells shall be drilled within 1,000 feet of any residence, house or barn on the property without the prior written consent of Owner. No housing or dwelling unit shall be constructed or placed on Owner's land by Operator.

10. **Operations.** Operator shall at all times keep the well sites and the road rights-of-way safe and in good order, free of noxious weeds, litter and debris, and shall suppress dust and spray for noxious weeds upon reasonable demand therefore by Owner. All cattleguards and fences installed by Operator shall be kept clean and in good repair. Operator shall not permit the release or discharge of any toxic or hazardous chemicals or wastes on Owner's land. Operator shall remove only the minimum amount of vegetation necessary for the construction of roads and facilities. Topsoil shall be conserved during excavation and reused as cover on disturbed areas to facilitate regrowth of vegetation. No construction or routine maintenance activities will be performed during periods when the soil is too wet to adequately support construction equipment. If such equipment creates ruts in excess of two inches deep, the soil shall be deemed too wet to adequately support construction equipment. All culverts shall be at least 18 inches in diameter. All surface facilities not subject to safety requirements shall be painted to blend with the natural color of the landscape. Only truck mounted drilling rigs will be allowed to drill on the property, and no seismic operations shall be permitted without Owner's written consent.

11. **Consolidation of Facilities.** Whenever possible, Operator will consolidate its facilities for as many wells as practical. Incoming power will be located at centralized points to minimize to the maximum extent possible the construction of above ground power lines. Battery sites will serve as many wells as possible. The consolidated facilities may not be used for operations connected with lands not owned by Owner or with lands owned or leased by Owner which are not described herein.

12. **Dry Hole.** If Operator does not discover oil and gas in paying quantities at a well site and determines the well to be a "dry hole" or upon cessation of production, Operator will give Owner thirty (30) days written notice of the opportunity to take over any abandoned well and convert the well to a water well. If Owner elects in writing to take over the abandoned well and convert the well to a water well, then the Owner will assume all liability and costs associated with the well thereafter, and both parties shall execute any and all documents necessary to provide that the water in the well shall become the property and responsibility of the Owner. If Owner does not elect to take over the well and convert it to a water well, then Operator shall fill and level the location, re-contour the location, distribute the top soil, make the location ready for reseeding and reseed the area, and plug and abandon the well as required by applicable law and regulations. All cleanup and restoration requirements shall be completed, if weather permits, by Operator within six (6) months after termination of drilling or production activities at the well site.
13. **New Roads.** Any new roads constructed by or for Operator shall be limited to twenty (20) feet in width for the actually traveled roadbed, together with a reasonable width, not to exceed fifteen (15) feet from the edge of the actually traveled roadbed for fills, shoulders and crosses. No permanent roads will be constructed unless absolutely necessary and Owner consents to the construction and location of the road. Operator shall annually maintain existing and newly constructed roads used by Operator to the satisfaction of Owner, which maintenance may include shaling, ditching, graveling, blading, installing and cleaning culverts, suppressing dust and spraying for noxious weeds.
14. **Fences.** Operator shall construct stock-tight fences around any dangerous area, including any pits where Operator drills wells. Operator shall rehabilitate and restore all disturbed areas caused by Operator's operations within six (6) months after termination of drilling or production activities at the well site and right-of-way, unless inclement weather prevents such rehabilitation and restoration within that time period.
15. **Cattleguards.** Operator shall construct cattleguards with wings at all fence crossings designated by Owner. Installation of the cattleguards shall be at the sole cost and expense of Operator. Cattleguards shall not be less than 16 feet wide by 8 feet across and shall be set on concrete sills not less than 24 inches high by 16 inches wide. Fence braces shall be installed on each side of the cattleguards. Fence braces shall be constructed of like quality material and installed in like style and form as the fence braces currently constructed on Owner's lands. Cattleguards shall be constructed approximately 6 inches above the existing grade of the road so that water does not run into the cattleguard. Operator shall be responsible for maintenance of all cattleguards used by Operator, together with wings and attached braces. All cattleguards currently in existence on roads used by Operator which are not aligned with existing fence lines shall be reconstructed by Operator so as to be in line with the fence.
16. **Improvements.** No fences, cattleguards or other improvements on Owner's property shall be cut or damaged by Operator without the prior written consent of Owner and the payment of additional damages or the institution of other safeguards to protect the rights and property of the Owner. Upon final termination of Operator's rights under this Agreement, Operator shall return all roads and other rights-of-way or sites as near as practical to the condition which they were in prior to the execution of this Agreement, unless otherwise agreed by Owner. Unless otherwise agreed by Owner, all disturbed areas caused by Operator's activities will be reseeded. Cattleguards shall be removed and fences restored as near as practical to the original condition unless otherwise agreed by Owner, in which case all cattleguards installed by Operator shall become the property of Owner. All cattleguards and fences installed by Operator shall be kept clean and in good repair.
17. **Fencing of Access Roads.** Operator will not fence any access roads without the prior consent of Owner.
18. **Purchase of Shale and Water.** To the extent that Operator's activities require the use of shale, gravel, or water, where reasonable and practicable Operator shall purchase shale, grav-

Sample Agreement

el, or water from Owner at the rates prevailing in the area. Operator recognizes Owner's concern about importation of noxious weeds onto Owner's land and, therefore, agrees wherever possible to purchase shale, gravel, or water from Owner.

19. **First Preference for Work.** Operator shall give first preference to Owner in awarding contracts for any work required to be performed on Owner's land pursuant to the terms of this Agreement, including but not limited to earthmoving, grading or plowing roads, spraying noxious weeds, or reseeding, provided that Owner has the equipment necessary to accomplish the work, is capable of adequately performing the work and is willing to perform the work at rates prevailing in the area.

20. **Payments.** The payments herein provided are acknowledged by Owner as sufficient and in full satisfaction for damages to Owner caused or created by the reasonable and customary entry, rights-of-way and operation and use of the roads and well sites, but do not include damage to livestock, buildings or improvements, or injuries to persons or to any damage or destruction caused to Owner's wells or water supply on the property. Operator shall be liable for damages if, as a result of its operations hereunder, any water on or under the premises which had been potable is affected to the extent that it is rendered nonpotable for humans, cattle or other ranch animals on Owner's premises, or any such water supply, well or reservoir be destroyed or its output diminished. Operator shall be liable for any downstream damage caused to other lands or the operations of other landowners. This Agreement does not relieve Operator from liability due to Operator's negligence or due to spills or discharges of any hydrocarbon or toxic or hazardous chemicals or wastes, or from leaks or breaks in Operator's pipelines. Damage to livestock and damage to crops shall be paid for by Operator at current market value. Any fires caused by Operator's personnel, agents, or assigns shall be paid for by paying the cost of replacement pasture, the costs of trailing or trucking cattle to replacement pasture plus replacement and/or repair costs for all personal property destroyed or damaged. The cost of replacement pasture will be determined by the amount generally accepted in the area for like kind pasture.

21. **Restoration.** Unless Owner otherwise agrees in writing, upon termination of any of Operator's operations on Owner's land, Operator shall fully restore and level the surface of the land affected by such terminated operations as near as possible to the contours which existed prior to such operations. Operator shall use water bars and such other measures as appropriate to prevent erosion and nonsource pollution. Operator shall fully restore all private roads and drainage and irrigation ditches disturbed by Operator's operations as near as possible to the condition which existed prior to such operations. All surface restoration shall be accomplished to the satisfaction of Owner.

22. **Reseeding.** All reseeding shall be done with suitable grasses selected by Owner and during a planting period selected by Owner. Reseeding shall be done at the rate of twelve (12) pounds of seed per acre for range land, and an amount to be determined by Owner for irrigated ground. In the absence of direction from Owner, no reseeding (except for borrow pits) will be required on any existing access roads. It shall be the duty of Operator to insure that a growing ground cover is established upon the disturbed soils and Operator shall reseed as necessary to accomplish that duty. It shall further be the duty of Operator to inspect and control all noxious weeds as may become established within areas used or disturbed by Operator. Operator shall inspect disturbed areas at such times as Owner shall reasonably request in order to determine the growth of ground cover and/or noxious weeds, and Operator shall reseed ground cover and control noxious weeds from time to time to the extent necessary to accomplish its obligations hereunder. Operator recognizes that this shall be a continuing obligation and Operator shall reseed ground cover and/or control noxious weeds until areas disturbed by Operator are returned to as good condition as existed prior to construction.

23. **No Warranty.** Owner makes no warranty of title or otherwise in entering into this Agreement.

24. **Nondisturbance.** Operator and its employees and authorized agents shall not disturb, use or travel upon any of the land of Owner not subject to this Agreement.

25. **Firearms and Explosives.** None of Operator's employees or authorized agents or any other person under the direction or control of Operator shall be permitted to carry firearms or any weapon while crossing Owner's property, and such persons shall not hunt or fish on Owner's property and shall not trespass on Owner's property for the purposes of hunting or fishing or recreational uses. No dogs will be permitted on Owner's property at any time. No explosives shall be used on Owner's property. Operator will notify all of its contractors, agents and employees that no dogs, firearms, weapons, hunting, fishing or recreational activities will be allowed on Owner's property.

26. **Surface Owner's Water.** Operator shall not disturb, interfere with, fill, or block any creek, reservoir, spring, or other source of water on Owner's land. Before conducting any drilling operations, Operator, at its sole cost and expense, will measure or cause to be measured the static water level and productive capacity of all water wells and springs located on Owner's land within one mile of Operator's wells, and will test the water wells for the presence of methane. Operator shall also provide Owner a chemical analysis of all wells and springs within one mile of Operator's wells, which analysis shall measure, at a minimum, the following:

pH	Hydroxide
Hardness (ppm and grains/gallon)	Chloride
Conductivity (mmhos/cm)	Sulfur as SO4
Sodium Absorption Ratio	Salt Concentration (TDS)
Adjusted Sodium Absorption Ratio	Boron
Cation/Anion Ratio	Nitrate
PPM of Calcium, Magnesium, Potassium, Sodium, Iron	Nitrite
Total Alkalinity (CaCO3)	Ammonia Nitrogen
Carbonate	Phosphorus
Bicarbonate	Methane

Owner shall be notified prior to such testing and measuring and Owner or its agents or representatives shall have the right to be present during such testing and measuring. The results of these tests and measurements will be immediately provided to Owner. Operator shall establish a continuing water well monitoring program to identify changes in the capacity of any water wells located on Owner's land and in the methane content of the wells, and Operator shall immediately provide that monitoring data to Owner.

27. **Loss or Impairment of Water Wells or Springs.** In the event that any water well or spring located on Owner's land is lost or materially diminished in productivity, or the quality of water produced by such well or spring is reduced so that the water is unusable by livestock or humans (as the case may be), as a result of production of oil, gas, or water by Operator, Operator shall, at its expense, immediately repair or replace any water well or spring which is lost or diminished in productivity with a new water well or spring at least equal in productivity and quality of water to the lost or diminished well or spring, using a water well drilling contractor acceptable to Owner.

28. **Produced Water.** Surface discharge of produced water will be allowed on Owner's land only with Owner's prior written consent, and only after Owner has approved, in writing, Operator's written water management plan for each discharge point located on Owner's land. In any event, such discharge will be permitted only if it does not degrade or adversely affect the quality of water in reservoirs and water courses on Owner's land or otherwise damage Owner's land. If Owner does not consent to surface discharge of produced water, Operator shall be responsible for piping water off Owner's land and making appropriate arrangements for discharge with adjacent landowners. All water produced and discharged from Operator's wells shall be produced and discharged in accordance with all applicable rules and regulations of any governmental authority. Whenever possible, and if Owner so consents, the produced water shall be discharged directly into an existing drainage system or reservoir, if allowed by appli-

Sample Agreement

cable laws and regulations, and if the discharge will not degrade or adversely affect the quality of water in the drainage system or reservoir, so that the Owner may make beneficial use of the water. Produced water shall be discharged in a way so as to cause the least amount of surface disturbance and damage to Owner's land.

29. **Reservoirs.** If Owner consents to the discharge of produced water but does not wish Operator to discharge any of its produced water into Owner's existing reservoirs, Operator shall be solely responsible for finding a suitable water discharge location acceptable to Owner, building the necessary catchment structures (including pipelines, dikes, dams, and outlet piping) and maintaining the same at its sole cost, risk and expense. Similarly, if Operator requests and is granted permission to use any of Owner's reservoirs, should any such reservoirs require modification, upgrading and/or improvement to be able to hold Operator's produced water, any such modification, upgrading or improvement shall be done at Operator's sole cost, risk and expense. Owner shall not be responsible for payment of any cost associated with Operator's development activities which shall include, but not be limited to water discharge, catchment of produced water or maintenance of any related facilities.
30. **Water Well Mitigation Agreement.** Operator is aware that its operations may impact domestic and/or agricultural water wells in the vicinity of coal bed methane producing wells. In order that the parties hereto may avoid potential future conflict regarding loss of use or degradation of existing water wells by Owner, Owner and Operator hereby adopt the terms and conditions of the Water Well Mitigation Agreement attached hereto as Exhibit "A," to the extent that the terms of Exhibit "A" are not inconsistent with the terms of this Agreement.
31. **Enforcement Costs.** If Operator defaults under this Agreement, Operator shall pay all costs and expenses, including a reasonable attorney's fee, incurred by Owner in enforcing this Agreement.
32. **Time.** Time is of the essence in this Agreement.
33. **Indemnification.** To the maximum extent permitted by law, Operator will indemnify, defend and hold Owner, and if applicable, Owner's officers, directors, employees, agents, successors and assigns harmless from any and all claims, liabilities, demands, suits, losses, damages and costs (including, without limitation, any attorney fees) which may arise out of or be related to Operator's activities on Owner's property (including, without limitation, any claims that Operator's operations hereunder are either illegal, unauthorized, or constitute an improper interference with any parties' rights, or have damaged the lands or operations of adjacent landowners, and including any claims based on the alleged concurrent negligence of Owner).
34. **Compliance with Law.** Operator shall conduct operations and activities in accordance with existing local, state and federal laws, rules and regulations.
35. **Release.** To the maximum extent permitted by law, Operator releases and waives and discharges Owner, and, if applicable, Owner's officers, directors, employees, agents, successors and assigns from any and all liabilities for personal injury, death, property damage or otherwise arising out of Operator's operations under this Agreement or use of Owner's property.
36. **Notice.** Notice may be given to either party to this Agreement by depositing the same in the United States mail postage prepaid, duly addressed to the other party at the address set out below the party's signature on this Agreement. Such notice shall be deemed delivered when deposited in the United States mail.
37. **Designated Contact Person.** Operator and Owner will each from time to time designate an individual, with appropriate twenty-four hour telephone and fax numbers, who is to be the primary contact person for discussions and decisions concerning matters related to this Agreement.
38. **Recording.** This Agreement may not be recorded without the written consent of Owner.
39. **Construction of Agreement.** This Agreement shall be construed under the laws of the State of Wyoming.
40. **Nonassignability.** This Agreement shall not be assigned by Operator to any other entity either

in whole or in part, unless Owner consents in writing to such assignment.

41. Binding Effect. This Agreement is binding upon the successors and assigns of the parties.

DATED this _____ day of _____, _____.

OWNER

_____

By: _____

Title: _____

Address:_____, _____

OPERATOR

_____

By: _____

Title: _____

Address:_____, _____

Agreement Summary

VERMEJO PARK RANCH COALBED METHANE PROJECT
MINERAL EXTRACTION AGREEMENT SUMMARY

The mission statement for all of the Turner Properties, including Vermejo Park, is "to manage Turner lands in an economically sustainable and ecologically sensitive manner while promoting the conservation of native species." Restoring the ecological integrity of Vermejo Park, and then managing that restoration in a sustainable manner, requires planning in very long time-frames, and placing maximum income generation secondary to sustainability.

The Vermejo Park Ranch (VPR) Mineral Extraction Agreement (MEA) governing mineral resource development is a voluntary agreement negotiated and signed by the surface estate (Vermejo Park Ranch) and mineral estate owner, El Paso Production Corp. (Producer).

The MEA was created to allow for the development of Coal Bed Methane (CBM) in the most environmentally responsible manner, while minimizing the short and long-term effects. This agreement is unique in the industry and provides the guidelines, checks and balances, and requirements for CBM development. VPR has established and staffed an Environmental Department, which is responsible for managing the CBM project and assuring compliance with the MEA. Key components of the MEA are as follows:

Covenant of Nondisturbance: Areas of special sensitivity (Sensitive Areas) have been established on the ranch where the producer shall in no event have the right to use or occupy. Sensitive areas at VPR constitute almost 30% of the ranch property.

Total Well Cap: The total number of wells that can be producing at any one time is limited to a set number. In addition, the total number of wells that can be drilled through the life of the project is set.

Well Spacing: All well sites locations are limited to one for every quarter section (160 acre spacing). In addition, well site (0.6 acre) and other facility locations (2-4 acres), roads (20 ft.), pipeline corridors (10-30 ft.) are limited in terms of size of disturbed ground.

Mandatory Groundwater Reinjection: All produced groundwater must be reinjected for disposal purposes unless otherwise approved by VPR. The Producer may use some higher quality produced water (where approved by VPR) for field operations including drilling, reclamation and dust suppression.

Annual General Plan of Development: Prior to Aug 15th of each year the Producer is required to meet with VPR to review and discuss all proposed or contemplated plans for work at VPR in the following Calendar year. Prior to October 1st of each year the Producer submits to VPR an Annual General Plan of Development for the following year. This Plan must have sufficient detail to allow VPR to reasonably evaluate the effect of the proposed activities on the Ranch and assess the Producers compliance with the MEA. VPR has 45 days after it receives a Development Plan to provide the Producer with comments and to request in writing that reasonable changes be made to proposed plan.

Reclamation Bonding: The MEA mandates that at the conclusion of the project all infrastructure, wells, compressors etc., must be removed from the property. In addition, the MEA requires that a reclamation bond be in place related to the Producer's reclamation responsibilities at the end of the project. This includes the full abandonment and reclamation of all well pads, roads and other project related facilities and disturbances. This bond is reviewed and increased on an annual basis as the project grows.

Annual Reclamation Requirements: As soon as practicable, but no later than September 1st of each calendar year, the producer reclaims and restores all new well site locations and other facilities installed that year, to as close to their original state as possible. Reclamation includes grading, top soil replacement and hydro seeding with a native (certified weed free) seed mixture. The Producer is also responsible for noxious weed control in the project area.

VPR Construction Review and Formal Approval Process: VPR Env. Dept. representatives working with El Paso representatives jointly site all proposed future project facilities including well pads, roads, pipeline corridors etc. VPR has final say of the location of all project components, and formally approves all facility locations prior to construction. VPR attempts to locate facilities to minimize visibility, reduce environmental impact, support future growth and expansion, and facilitate and optimize final reclamation efforts.

Viewshed Mitigation Requirement: VPR may request viewshed mitigation to conceal Oil and Gas Facilities in close proximity to ranch infrastructure.

Notice Requirements and Information Submission: Producer must notify VPR of the staking of any oil and gas facility one week prior to staking and a survey must be submitted to VPR 45 days prior to commencement of site preparation. In addition, the Producer submits to VPR a copy of all well logs, as-built diagrams in GPS/GIS electronic format for all roads, electric transmission lines, pipelines and facilities within 30 days of construction completion. VPR also receives daily gas and water production, monthly vehicle tracking reports, and other hydrogeologic data related to the water resources underlying the property. The Producer also supplies VPR prior to Oct 1st of each year, its health and safety and training plans and Producers Emergency Preparedness and Response Plan (EPRP).

Joint Groundwater Monitoring Program: VPR and Producer are jointly conducting a hydrogeologic monitoring program on the ranch properties. This 10-year program is unprecedented in the industry and is focused on monitoring the effects of coal seam dewatering in conjunction with CBM development. If the monitoring program establishes that a portion of the Hydrocarbon Operations is having any material adverse effect on any stream, spring, well or other surface or groundwater resources in or under the ranch land, then upon the request of VPR, Producer shall take all reasonable steps necessary to mitigate the adverse effect as mandated under the MEA.

Water Rights: VPR is the record owner of any and all water rights associated with produced water, and in the event any governmental entity should deem Producer the record owner of any such water rights, Producer shall execute a quitclaim deed or other instrument sufficient to transfer and convey title to any such water rights to Owner.

Vehicle and Personnel Limits: The maximum number of vehicles and workers on the ranch at any one time is limited. These limits fluctuate according to the time of year to accommodate VPR's fishing and hunting programs. Current limits during the summer are 170 vehicles and 300 people. The MEA also mandates a ranch speed limit of 25 m.p.h.

Noise Restrictions: If requested the Producer shall install housing around equipment located within ½ mile of any Sensitive Area boundary. In addition the Producer is required to install and operate noise abatement equipment at all facility locations where economically feasible. A noise threshold of 65 dB at 200 feet from any Oil and Gas Facility must be met.

Secured Access: Access to ranch property by project personnel is monitored 24/7 by security personnel located at 3 access points.

Accident/Spill Response and Notification Plan: All accidents or spills of any type are immediately reported to VPR's Env. Dept.

Restrictions and Limitations on Producers Activities: In general, all drilling and construction activities in given year must be completed by August 31st of each year to accommodate VPR's fall hunting program. In addition, the Producer can only be on the ranch during specific hours of the day. Some additional fall construction activity is allowed but is only in an area of the ranch specified by VPR.

Development Time Line: A timeline is established related to when the development phase of the project must be completed, i.e., installation of all producing wells.

Breach of Contract Damage Clause: A formalized mechanism is contained in the MEA where by VPR can notify the Producer of a breach of contract related to a specific MEA requirement. If the Producer does not comply or cure the infraction in a set time period, then monetary penalties may be assessed.

Leasing

A mineral lease is a contractual agreement between the owner of a mineral estate (known as the ***lessor***), and another party such as an oil and gas company (the ***lessee***). The lease gives an oil or gas company or individual the right to explore for and develop the oil and gas deposits that underlie an area described in the lease. This right exists whether you own both the mineral rights and surface rights or simply the mineral rights. When the lease terminates, all rights to the minerals revert back to the mineral owner.

When you (the lessor) sign a lease you essentially become a partner with that company (the lessee). When a company holds a lease to your mineral property, you cannot lease those mineral rights to another company until the lease term with the first company expires.

As with any partnership, open communication, constant dialogue and true understanding is necessary to maintain a successful relationship. A lease may be something that you may have to live with for many years - perhaps the rest of your life. Consequently, it is in your best interest to maintain a business-like relationship.

- Get everything in writing, and keep the lease in a safe, but easily accessible place. In the event the lease is lost, you should be able to obtain a copy of the lease from the county recorder's office.
- Ask neighbors, government agency staff or other mineral owners and landowners about the company, your potential business partner. It is important to know who you are dealing with before entering into a lease.

Before Leasing Your Minerals

- Ideally, do not lease your minerals until you have negotiated your surface damage agreement. This will give you leverage in negotiating your lease.
- Review the lease carefully and ask questions about those portions not understood. Be sure the forms are readable (i.e., the writing is legible), and that they use language that you understand.
- Consider purchasing a basic book on oil an dgas lease terms, such as *Oil and Gas Law in a Nutshell* by John Lowe.
- Read pre-printed lease forms very carefully. Often, companies create these standard leasing agreements to protect their interests. The mineral owner will almost always want to negotiate adjustments to the standard lease to make it more fair and applicable to his or her situation.

- Within the mineral lease you can stipulate anything beyond the standard leasing provisions that you want with regards to protection of surface property and issues related to quality of life. The company may try to negotiate with you to remove some of your requested stipulations. Once signed, however, the mineral lease is a binding contract.
- Include a clause that says that companies cannot deduct expenses related to gathering, treating and compressing (GTC) gas. If this clause is included, mineral owners may receive thousands of dollars more in royalty payments than if companies are allowed to deduct the GTC costs. See box "Royalty owners may receive millions" for more information.
- Ask for references from the company. These may be landowners who have property where the companies has operating wells. Call the references and ask questions such as:
  - Is the company easy to talk with? Do representatives quickly respond to problems?
  - Are delay rentals or royalties paid regularly and on time?
  - Were you consulted on access road, well site and facility locations?
  - Was site reclamation/restoration done in a timely manner?
  - Have you had any problems with the company, its subcontractors or its workers?

Royalty Owners May Receive Millions

OCTOBER 8, 2003
By Dale Rodebaugh, Durango Herald

A 6th Judicial District Court judge has ruled that BP can't deduct the cost of bringing natural gas to marketable condition from the royalties it pays some 4,000 lessors in La Plata and Archuleta counties.

An attorney for the royalty owners [Bob Miller] estimated the ruling could mean hundreds of millions of dollars owed to lessors.

Miller said BP is shortchanging royalty owners 60 cents per 1,000 cubic feet of gas. "Total damages will reach tens of millions of dollars, and may well reach hundreds of millions," Miller said.

The most important ruling of the four issued on Monday was the finding that the cost of the gathering, treating and compressing [GTC] of the gas is an integral part of bringing it to marketable condition, and those costs cannot be passed on to the royalty owners.

Since 1991, BP has deducted from royalty payments what are known as GTC expenses. "We saw half our royalty checks disappear," said Richard Parry, the lamb rancher who initiated the lawsuit against Amoco in 1994. Parry and his wife, Linda, had received royalties from the firm since the late 1980s. Amoco was subsequently bought by BP. Parry declined to discuss personal particulars. But as for the court victory, he said: "We're real happy. We won big time."

According to Miller, 95 percent of the BP leases in the current case prohibit the deduction of GTC costs or are silent on the matter. Five percent of the leases expressly say that GTC expenses can be deducted.

Note: the above are excerpts from the original story, which can be found at: http://www.durangoherald.com[464]

Lease Provisions to Consider

These are just a few examples of provisions to include in a lease. For those mineral owners wanting more guidance on leasing their minerals to oil and gas companies, please see Chapter V (Other Landowner and Mineral Owner Resources) for a list of references.

A lease agreement contains a number of stipulations, including but not limited to:

- Legal description of the area, and number of acres involved
- An effective date of the lease agreement, and the anniversary date for the lease. This is important because lease rental payments must be paid on or before this date in order to keep the lease in force.
- A statement of the primary term of the lease. This may be any period of time, but it is commonly between 1 and 10 years. If you want a well to be drilled soon, make sure the term is short. Companies may tell you that they will drill quickly, but only a short term lease will ensure that action. Watch out for standard lease provisions that renew the lease or hold it in force without your permission. If these are present, you may ask for them to be removed. Also, recognize that once production is established, oil and gas leases will normally continue for the life of the production.
- Lease Rentals. These rentals are paid to maintain the lease during the primary term. The rental charges vary from lease to lease. Talk with other landowners to find out what is typical for your region. Typically, the first year's lease rental and any bonus should be paid when the lease is negotiated.
- Signing bonus. It is common for a bonus is paid upon signing the lease. In competitive production areas these bonuses can be significant.
- A royalty clause. Royalty is a major consideration for a mineral owner, especially if the lease is highly productive. Look closely at the royalty provision, and understand how it is calculated. The royalty is the share of the oil and gas production that is reserved to the mineral rights owner. It is usually indicated as a fraction or percentage of the proceeds received from the oil or gas that is produced. It is common to have a royalty between 1/8 (12.5%) and 1/4 (25%). Royalty may be received in-kind, which means that the lessor may take physical possession of the oil or gas. Usually, however, the oil or gas is sold to a refinery and the lessor receives payment for his or her share.
- Payment of Royalties. Often, it is stipulated that payment must be received within 30 days of production, and each 30 days thereafter. Payment of royalties directly to the landowner by the gas purchasing company is desirable, so that there is no delay while the oil or gas company does its accounting.
- Shut-in Royalty. If a landowner wants a well to produce gas for his home/farm operation, it should be understood that it will be an interruptible supply because of the nature of the gas production and distribution system. Consequently, the landowner may want to write a lease that provides high enough shut-in royalty to provide for alternative fuels. Landowners may be interested in adding a provision to have the option of taking over a well if it is not in production for 12 consecutive months, or prior to the removal of equipment from the well. If a landowner takes over a well, however, he or she also takes on the responsibility for plugging the well. The landowner should contact the state agencies to find out what their plugging obligations will be, and whether or not the well can be converted to a water well.

- Requiring landowner approval before a lease can be sold to another company. This prevents the lease from being sold to an undesirable company. Sometimes companies will transfer leases without telling the landowner. In a few states there are laws requiring that landowners be notified within 30 days of a lease transfer. If your state has such a law, you can include a provision that automatically cancels the lease if the company fails to notify you of such a transfer.
- Landowner approval in writing of well, tank, access road and pipeline sites. It should be stipulated that written landowner approval must be granted before any construction or drilling occurs. A plat map attached to a lease may be desirable where special land features (orchards, springs, etc.) should be protected. The maximum width of a combined access road and pipeline easement should be established in the lease (e.g., often it is 40 feet during drilling operations and 20 feet after a well is completed). The size of the well drilling site should also be specified.
- Payment of damages for property and crops destroyed by the operations. Many leases contain an indemnification provision, which makes the operator liable for any and all damage and liability resulting from their oil and gas operations. This provision should include wording that makes the company liable for damage to growing crops, trees, fences, buildings, tile lines and drainage ditches, springs, water wells for homes and livestock, other items of significance to the landowner, and all damages to the surface of the lessor's property. A landowner should not accept a lease that only provides payment for growing crops. Such a lease will not entitle the landowner to any other damages, no matter how serious they may be. The landowner may want to include provisions allowing him or her to harvest timber in the area of a proposed well site prior to the company bringing in drilling equipment; and requiring that well heads be fenced in, landscaped, and have sound barriers erected.
- Pipeline Restrictions. Many leases authorize installation of pipelines or transmission lines that may be required. A provision authorizing ONLY pipelines that serve the wells on the landowner's property is desirable. Additional pipeline easements should be negotiated separately.
- Burying pipelines at a specified depth. Since pipelines may or may not be buried according to state regulations, the landowner may want to ask the company to bury the line at a depth that he or she desires (e.g., below tillage depth). The company laying the pipeline should be required to file a map of line location with the landowner.
- Depth of minerals. The mineral owner can specify the depth of the mineral being leased. There are other minerals that may be located at other depths, and those may be leased separately.
- Implied Covenants. In virtually all states, significant mineral owner protections are implied by law in oil and gas leases (for example, requirement of prudent operations, protection against drainage, exploration and development, and marketing of oil or gas). The lease should not limit the covenants normally implied in oil and gas leases.

Other Activities Landowners May Want to Consider

Organize

Organized opposition can play an important role in determining whether oil and gas permits are issued, how closely government agencies oversee the project during its operating life, and what sort of surface owner protections the laws and regulations offer.

Surface landowners can band together, and also work with other interested groups to exert pressure on state legislatures, government agencies, and the oil and gas industry.

- In La Plata County, a number of groups of residents have banded together to negotiate better deals for natural gas pipeline easements crossing their properties. In one case, approximately 30 residents worked together and paid the legal fees needed to negotiate the deal with the company. As a result of their negotiations, the landowers were offered about $86 per rod (16.5 feet) of property used. Residents who were not part of the group were offered anywhere from $1 to $20 per rod.[465]
- The story Bellflower Well (Chapter IV) provides an example of how landowners worked with a county government to pressure a company to implement better mitigation strategies.
- In Michigan, a state-wide coalition of 30 local government and public interest organizations have formed the Michigan Energy Reform Coalition (MERC) seeking to strengthen oversight of oil and gas development, reduce environmental damage from drilling, and increase the authority of landowners and affected communities. MERC, while recognizing that oil and gas development is an important part of the state's economy, has taken the position that:[466]
  1. Local governments and communities are entitled to be full participants in the planning and oversight of oil and gas development.
  2. Townships should have the clear legal right to enact ordinances to regulate oil and gas processing facilities, truck traffic, and the hours of operation.
  3. An impact fee should be levied on oil and gas production that returns a portion of the revenues back to the counties where the development occurs.

  See the story *A Firsthand Account: Support for Bill Comes From Experience*, for more information on MERC and one of the townships involved in that coalition (Chapter IV).

There are numerous national, regional and local groups who are dedicated to improving oil and gas regulations, protecting public and private lands, air and water, and supporting surface owners in their efforts to get the industry to minimize the damages that are done to private property. Some of these groups are listed in Chapter V.

Organizing efforts can target industry, federal and state governments, county or municipal governments, and the public at large. Organizing strategies may include working with other surface owners to pressure a company to improve its practices; using local, regional and national media to highlight your issue; using litigation to force improvements; participating in public review processes; attending public meetings; launching letter writing campaigns to support or oppose bills; writing letters directly to government agencies and legislators; appearing before government commissions or committees; holding mass protests and rallies; and educating the public about your issues using media, door-to-door canvassing, or holding public meetings and events.

Push for Reform of Oil and Gas Regulations

There are different ways to attempt to change the way governments regulate the oil and gas industry. Legal battles have been waged to try to get governments to enact regulations that are more protective of the environment and human health. And citizens have put pressure on government officials through organizing efforts and being vocal about their concerns. Below are some examples of regulatory changes that have resulted from the efforts of surface owners and others.

Litigation Has Led to Changes in State and Federal Government Regulations.
In 1989, a family living in the Black Warrior Basin of Alabama experienced contamination of their water well. Long, oily strings and a strong sulfur smell emanated from their tap water. The family believed the contamination resulted from the hydraulic fracturing occurring at nearby coalbed methane operations.[467] At that time, however, there were no regulations governing hydraulic fracturing. The family enlisted the help of the Legal Environmental Assistance Foundation (LEAF). In hopes that improvements to regulations could be made, LEAF petitioned the federal Environmental Protection Agency (EPA), asking the agency to assume responsibility for Alabama's underground injection control (UIC) program. EPA had delegated this responsibility to the State of Alabama. In 1995, when EPA refused to take responsibility, LEAF took them to court. After years of court battles, the 11th Circuit Court decided that in order for the state to maintain the ability to regulate UIC, the state must regulate hydraulic fracturing.[468] In 1999, Alabama adopted hydraulic fracturing regulations. Some positive aspects of the regulations include that:

- fracturing fluids cannot exceed applicable primary drinking water regulations or otherwise adversely affect the health of persons
- fracturing is prohibited from ground surface to 299 feet below ground surface (bgs)
- for fracturing performed between 300 feet and 749 feet bgs, the company must monitor fresh-water wells within ¼ mile of the well to be fractured, submit a fracturing program to the state, and perform a cement bond log analysis.

  (See Peggy Hocutt's story in Chapter IV, to learn more about the potential effects of hydraulic fracturing.)

Citizen Pressure Has Influenced State Regulations.
If you want to help protect yourself and others from industry practices that affect surface owners' property, water quality, air quality, health and safety; or if you want to protest unfair leasing practices used by industry, one way is to let your voice be heard. Public officials and legislators need to hear from people who have been mistreated by industry representatives, or who have had their quality of life and livelihood affected by the oil and gas industry. If you believe that the laws and regulations need to be reformed, then contact your state legislators, the state Governor, and the directors of the various state agencies that regulate oil and gas.

- In a "smashing breakthrough for citizen advocacy," Michigan citizens were able to get five new oil- and gas-related bills passed in 1999. The positive changes included: protections for state-owned lands; increased funding for state oil and gas oversight; allowing some private landowners to buy back mineral rights from the state; and making health and safety a priority when considering new well permits.[469]
- In eastern Colorado, the drilling of more than 3,000 new wells in the early 1990s caused a protest among farmers so fierce that the Colorado Oil and Gas Conservation Commission established new policies for notifying landowners about drilling before it occurs.[470]

FIGURE III-5. LANDOWNER'S BUTTON FROM ALASKA

Citizens Have Affected Local Regulations and Permitting Processes.
Many landowners have found support from their municipal and county governments. Local governments often have a longer term vision for the health of the community. So if there is enough public concern about a project, they may be more willing to champion the interests of local residents. Below are some examples of how changes to local regulations have worked to benefit surface owners.

- **Water concerns prompt La Plata County Commissioners to attach conditions to permits**
  More and more people are finding that their groundwater wells are being affected by the drilling of nearby gas wells. In response to citizen concerns related to this issue, the County Commissioners in La Plata County, Colorado, attached a water-well testing condition to a controversial gas well permit in a county subdivision. "I'm very nervous about making any concessions about anything having to do with water," Commissioner Bob Lieb said. "If we ruin the water up there we ruin it forever."

  Largely due to public concerns, Commissioners voted unanimously to attach a set of conditions on the well application that were unparalleled in the county. The conditions included: 1) monitoring domestic water wells within ½-mile of the gas well before and after drilling. If contamination is found, the company must fix the problem; 2) build a 6-foot earthen berm and plant trees on the berm to screen the well from sight; 3) after the well is drilled, all work at the well will be limited to between 8 a.m. and 6 p.m.; 4) six months after the well begins producing gas, the company must replace the traditional I-beam pump, which looks like a bobbing horse's head, with a smaller, quieter pump, and switch from diesel motors to electric motors.[471]

  The company complained that the tests were an unfair time burden on the company. Commissioner Fred Klatt said it was hard to imagine the well tests being a burden on Huber, considering that the projected profit from that one gas well was $6.5 million.[472]

- **Gallatin County Commission issues a moratorium on CBM exploration and development**
  In Montana, at the urging of local conservation groups including Park and Gallatin Citizens' Alliance and Greater Yellowstone Coalition, as well as Bridger Canyon Property Owners Association and hundreds of citizens, the Gallatin County Commission adopted a temporary moratorium in July 2002 on exploration and development of all oil and gas. An emergency interim zoning district was also and created in the coal deposit area of Bozeman Pass. The regulations were passed specifically to address a proposal by J.M. Huber Corporation for coalbed methane and natural gas exploration. Earlier, J.M. Huber was denied a permit by the local planning and zoning commission to explore for coalbed methane in an existing zoning district. While the permit denial was unexpected, Huber's subsequent lawsuits against Gallatin County were not. The precedent-setting decision paved the way for Huber to sue the county in both state and federal courts for a "takings" of its private property, among other claims. The outcome of these cases may determine the extent to which local governments can regulate energy development. As of January 2004, the cases remain in the courts.[473]

- **Filer Township adopts a landmark health protection ordinance**
  In 1999, Filer Township in Manistee County, Michigan adopted a landmark health protection ordinance to ensure the safety of residents living and working near oil and gas facilities that are associated with poisonous hydrogen sulfide (H_2S).[474] The rigorous ordinance was developed after three years of repeated refusals by the Michigan Department of Environmental Quality to address the problem. The ordinance built on the tough H_2S exposure standards previously adopted by the township, and requires energy companies to: 1) Conduct a health risk analysis of proposed new pipelines, processing plants, and compression stations. If an

analysis indicates that a project would exceed the exposure limits in the event of an accident, the township would deny the required land use permit. 2) Implement an effective emergency warning system. 3) Inform the township about hazardous materials used on the site.

- **Colorado communities gain some ability to regulate oil and gas**

  In Colorado, courts have ruled that local governments, as well as the state government, have the ability to regulate oil and gas companies. The Colorado Appeals Court decided in 2002 to uphold a trial court ruling in a case between the town of Frederick and the oil and gas operator North American Resources Co. (NARCO). The town had passed an ordinance requiring gas and oil companies to obtain a special use permit to drill in town, and pay an application fee of $1,000; as well as requiring certain setbacks, and noise and visual impact mitigation, among other things. NARCO went ahead and drilled a well without getting a permit from the town. The town initiated a court action, and the trial court stopped the operation of the well and ordered the company to either remove the well or get the required permit from the town. The case went to the Colorado Appeals Court. The Appeals Court ruled that Colorado communities, including counties, can regulate oil and gas wells, as long as the regulations do not conflict with state laws.[475] The court acknowledged that town's ordinances may delay drilling, but upheld the regulatory scheme as a whole because the ordinances did not allow the town to prevent drilling entirely or to impose arbitrary conditions that would materially impede or destroy the state's interest in oil and gas development.[476]

  Examples of conflicts between town ordinance and state laws:

  - the regulations of setback requirements, noise abatement, visual impact of oil and gas operations, and the authority of the town to assess additional penalties for violation of state rules.

  Examples of acceptable community ordinance provisions:

  - requiring companies to obtain a special use permit. The court said that this did not conflict with the state's objectives even though it could result in a delay in drilling.
  - requiring an inspection fee and a $1,000 application fee, because there was no state rule on the amount a local government could charge for these fees.
  - requiring building permits for above-ground structures, access roads, and emergency response and fire protection plans and costs, again because there was no state rule that created an operational conflict with the town's rule.

The state of Colorado fails in its bid to limit local regulation of oil and gas

In 2002, the state agency that oversees oil and gas development, the Colorado Oil and Gas Conservation Commission (COGCC), amended a rule saying that state drilling permits would take precedence over any county permit or land-use approval process. This amendment was challenged in court by La Plata, Archuleta, Las Animas, Routt and San Miguel counties.

In September, 2003, the Colorado Court of Appeals ruled 2-1 that the COGCC overstepped its authority with the amendment, which the court said pre-empted county land-use rights; and the amendment was declared invalid. The two appeals court judges who ruled in favor of the counties wrote that counties "have a legally protected interest in enacting and enforcing their land-use regulations governing the surface effects of oil and gas operations."

Colorado Court of Appeals, September 25, 2003.[477]

- **Residents of Matunuska Susitna Borough in Alaska press for, and get, progressive local regulations on mineral leasing and development.**

  In 2003 Evergreen Resources purchased coalbed methane leases in the Matanuska Susitna (Mat-Su) Borough area of Alaska. Property owners were alarmed to find that State law allowed for permitting of these leases with no public notice. Citizens in the region took it upon themselves to became more and more educated on CBM development, inviting OGAP to Alaska to deliver landowner workshops. Eventually, public outcry against the leasing practices of the state led the Alaska Department of Natural Resources to hold a series of public meetings for the purpose of developing operating standards for the leases.

  After more than a year of controversy surrounding the CBM leases, Pioneer Natural

Resources announced that the Mat-Su leases acquired through its merger with Evergreen Resources would be relinquished to the State. Despite the return of the leases, the Mat-Su Borough Assembly took steps to prevent a situation of this magnitude happening in the future. Members of the Borough Assembly traveled to the lower 48 to visit areas with CBM development and talk with local governments about oil and gas regulations. In the fall of 2004, the Borough Assembly passed a CBM ordinance with several progressive provisions, for example, requiring ground and surface water monitoring plans, and allowing a surface owners to deny access until a surface use agreement is signed. The Mat-Su ordinance is available on-line at: http://www.matsugov.us/Assembly/documents/04-175AMor.pdf

Industry Will Try to Push Back

Citizens and local governments must anticipate that industry may object to any additional regulations that impose a perceived burden on the way that they do business. There have been many cases where citizens have made some strides in surface owner and environmental protection, only to have the industry use their clout to have the protections removed.

- **Exploratory wells allowed in a sensitive watershed, despite community opposition.**
  In 2002, in Delta County, Colorado, local citizens groups such as the Grand Mesa Citizens Alliance, worked hard to organize old-time farmers, ranchers, fruit growers and others to convince county commissioners to reject well applications that threatened the water supply in their county. County commissioners denied four of five applications by Gunnison Energy to drill exploratory coalbed methane gas wells. One Delta County Commissioner said that the wells were denied because they were in the middle of the county's watershed. The one well that was approved was located in a remote end of the county where domestic water supplies would not be threatened. The decision went against an earlier decision by the state Oil and Gas Commission, which approved the exploratory drilling.[478] The county also imposed a moratorium on drilling, pending further study of impacts on the water supply, largely due to the efforts of the Western Slope Environmental Resource Council.[479] Legal actions were initiated by Gunnison against the county, and Delta county against the Colorado Oil and Gas Conservation Commission. In 2003, a Denver District court ruled that the county did not have jurisdiction to deny the permits on the basis of water quality or quantity concerns, and Gunnison was issued its permits.

- **Oil and gas industry tries to remove ability of local governments to regulate oil and gas in Kentucky."**
  In early 2003, the oil and gas industry drafted a bill to remove virtually all ability for Kentucky counties to adopt any ordinances related to oil and gas development. At the time, the law gave counties broad powers to protect public health, safety and the environment, as long as the county's regulations did not conflict with state laws.

  The issue that prompted the bill was that Letcher County, Kentucky was considering passing an ordinance regulating the placement of "gathering lines" used to gather gas and oil from wells, due to abuse of landowners' rights. Rather than suggesting that the state implement a program to address the issue of gathering lines (e.g., make the industry accountable to surface landowners for the damage caused when gathering lines are located), the oil and gas industry simply proposed a bill to remove local government authority over all aspects of the industry.

  In February, 2003, the Kentucky Legislature passed the bill, despite citizens' attempts to stop it.[480] Continued citizen action helped to force some amendments to the bill, and in March, 2003, the Senate passed an amended bill that allows local communities to adopt ordinances that regulate oil and gas exploration, production, development, gathering and transmission, if they do so through community planning and zoning processes. The Senate

amendment also requires the state Department of Mines and Minerals to develop regulations on gathering lines within six months of when the new law takes effect, and to develop regulations on other aspects of the industry.

Meanwhile, Letcher County is continuing to move forward with its ordinance to protect public health, safety and property from damage due to the siting of gathering lines.[481]

File Lawsuits

Both citizens and companies have the opportunity to use the legal system if they believe their rights have been infringed upon. The following are some lessons learned from various legal battles involving landowners and oil and gas companies.

Landowners and Strategic Lawsuits Against Public Participation (SLAPP Suits)

In 1998, landowners and others belonging to a group called SoCURE (Southern Colorado Citizens United for Responsibility to the Environment) became concerned about their water. These residents of Las Animas County were concerned that the produced water from coalbed methane operations might contaminate their drinking water.[482]

The group commissioned studies of the water; and they complained to county, state and federal officials. Prompted by the citizens' concerns, in the spring of 1998 the state conducted its first inspection of the wells since they were originally permitted in 1995. The state found that several wells did not have permits, and other wells were discharging water into unlined ponds without permits. Also, the company's own data showed that some of the produced water contained concentrations of chemicals, such as benzene, at levels that exceeded federal standards for drinking water.

It is not uncommon for companies being challenged by citizens to sue them for slander.

In May, SoCURE gave the company, Evergreen, sixty days' notice that it intended to file suit under the federal *Clean Water Act*. In their notification letter, the group's members enclosed more than a dozen photographs of Evergreen's discharge sites and containment ponds. In July, SoCURE filed the suit. These sorts of citizen lawsuits are allowed under the enforcement provisions of the *Clean Water Act*. The Act gives citizens the right to file a suit demanding that government agencies enforce the Act's regulations and take action against polluters.

Within days, members of SoCURE were sued by Evergreen for trespass and slander. The company claimed that SoCURE members trespassed on company property to take pictures of the gas wells and waste ponds; and that they slandered the company by saying that Evergreen was operating without required permits and by questioning whether health was being threatened by the thousands of gallons of wastewater being generated on a daily basis.

It is not uncommon for companies being challenged by citizens to sue them for slander. These sorts of lawsuits are often known as SLAPP suits, which stands for *Strategic Lawsuits Against Public Participation.* Every year thousands of people are hit with SLAPP suits for such activities as writing a letter to a newspaper, reporting misconduct by public officials, speaking at public meetings, and filing complaints with officials over violations of health and safety laws.[483]

According to the California Anti-SLAPP Project, while most SLAPPs are legally meritless, they effectively achieve their principal purpose: to chill public debate on specific issues. Defending a SLAPP requires substantial money, time, and legal resources and thus diverts the defendant's

attention away from the public issue. Equally important, however, a SLAPP also sends a message to others: you, too, can be sued if you speak up.

It appears that this is exactly what happened in Las Animas County. As part of the lawsuit, the company asked the judge to require SoCURE to provide the company with the names of its members. This was seen as a deliberate attempt to frighten people out of supporting the group. And it worked. According to one SoCURE member, people in the area became so worried about being named in a SLAPP suit that they would only support SoCURE through anonymous contributions.

How to Protect Yourself From SLAPP suits

According to the California Anti-SLAPP Project, there are things that you can do to protect yourself from SLAPP suits:[484]

1. Know your legal rights. Some states have "anti-SLAPP" laws that present a mechanism that allows a judge to dismiss a SLAPP against you at the very outset of the suit. If the judge rules that the suit must be dismissed, the SLAPP filer is required to pay the cost of your defense, including any attorneys' fees.

2. Check out your insurance policy. If you are a homeowner and have homeowner's insurance, see if you have personal injury liability coverage. Some policies protect homeowners from personal injury lawsuits based on such things as defamation, malicious prosecution, abuse of process, etc. Consult your insurance company or an attorney to see if you may be covered. If your present policy does not cover you, ask about a rider which would extend coverage to potential SLAPP claims.

3. Speak the truth. Whether you are writing your government representative or speaking on an issue of public importance, always make sure your statements are factually correct. If your statements are accurate, there will be no factual disputes later on. You may want to keep copies of all background materials and note sources of facts and figures quoted so that you can show where you obtained the information.

   Understand that there are differences between statements of fact and statements of opinion. In some states you may be legitimately sued for false statements of fact, but not for statements of opinion. Be careful. You will not be protected for stating, "In my opinion, Senator Squelch is a liar and a thief," unless, of course, your statement is entirely true. If your words contain an assertion of fact that is capable of being proven true or false — i.e., that Squelch is or is not a liar and a thief — you can be sued if it is shown that your statement is false, even though you tried to qualify the statement as "opinion."

4. Seek legal advice. If you are planning to write to a government official or speak out on a public issue, and you are unsure if your statements could subject you to a lawsuit, contact a lawyer who can assist you. Contact the California Anit-SLAPP Project (information in Chapter V) or check out their web site for a listing of organizations that are knowledgeable about SLAPP suits, and attorneys that can provide advice (sometimes at no charge) to citizens.

   For more information on SLAPP suits, see the references in Chapter V.

Landowners are Winning Some Important Legal Battles

Recently, there have been landowners who have had successes in the courts. These cases set precedents for landowners across the country. Some notable cases include:

- **Wyoming Landowner Victory: Court Holds Paxton Resources Accountable for Damages.** This story illustrates how landowners may have to go to court to have the provisions of surface use agreements enforced.[485]

  A big victory for landowners everywhere was handed down in particular to Dan and Mary Brannaman of Brannaman Ranch in the Powder River Basin of Wyoming. A jury ordered the Michigan-based Paxton Resources, LLC. to pay the Brannamans more than $800,000 for causing extensive damage to their ranch.

  The Brannaman's filed suit in February of 2002 against Paxton Resources, claiming the company neglected its agreement to properly reseed damaged areas, spray for noxious weeds, and build fences to keep livestock from danger. The Brannamans also claimed that the company did not follow through on agreements not to build roads through specific areas or cut fences without consulting them.

  After a five-day civil trial that ended on February 7th, 2003, a 12-person jury ruled that Paxton breached its surface and damage use agreement with the ranch and ordered the company to pay $810,887.

  The Brannamans own their land, but not its mineral reserves and they entered into a surface and damage agreement with Paxton in 1999. The Brannamans testified that after Paxton repeatedly assured them that their property would be treated with respect, the coalbed methane crews turned their roads into mud bogs, left trash on the ground, drove across rangeland, mixed topsoil with salt-ridden soil and did nothing as hillsides eroded. According to a February 9th article in the Billings Gazette, Paxton anticipates appealing the court decision. For more details see Powder River Basin Resource Council's web site, *www.powderriverbasin.org.*

- **Landowners locked out a company, are taken to court—and win!** In Aztec, New Mexico, ranchers tired of having cattle killed by oil and gas industry trucks locked their gates. The following story is excerpted from a newsletter article published by the San Juan Citizens Alliance.[486]

  Last November 14th [2002], three New Mexico ranching families, all members of the San Juan Citizens Alliance, restricted access across their private land by padlocking gates. Ranchers Linn and Tweeti Blancett, Don and Jane Schreiber and Chris Velasquez stood in front of locked gates, restricting access across their private land by gas industry giants such as Burlington Resources, Phillips-Conoco and El Paso Natural Gas.

  The ranchers handed out access agreements to astounded energy industry managers, which allowed operators one key per company for the locked gates. Several San Juan Citizens Alliance members from Colorado were there to support their New Mexico neighbors.

  Most companies refused to sign the access agreements and demanded more than one key. El Paso immediately filed for a Temporary Restraining Order in State District Court against the Blancetts to prevent them from locking the gate. At a court hearing the next week a compromise was reached when El Paso agreed to put an electronic key system on the gate.

  The ranchers were restricting access across their land to limit damages to grass, water

sources, roads and to their livestock. Industry operations have a severe impact on landowners; cattle die from drinking water with high concentrations of hydrocarbons or ethylene glycol and grazing permit numbers shrink because bare well pads reduce the grass available. Gas industry activities directly reduce the livestock producers' income, which threatens the viability of their ranching businesses.

(For more on this story see *Why I Fight: The Coming Gas Explosion*, by Tweeti Blancett in Chapter IV.)

Chapter IV
Landowner Stories

IV

As has been emphasized throughout this guide, one of the best ways to learn about the potential effects that oil and gas development may have on landowners' lives is to hear or read about their stories. Landowners new to oil and gas development are encouraged to talk with neighbors or community members who have had interactions with oil and gas companies, and to consult with organizations who advocate for surface owner rights. Chapter V contains a listing of some of these organizations.

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1. CBM DESTROYS RETIREMENT DREAM
Ron Moss tells his story of how methane in his water well, noise associated with gas compressors, and air pollution from nearby coalbed methane (CBM) development destroyed his family's hopes of having a dream home in Wyoming.

2. COALBED METHANE WATER WREAKS HAVOC DOWNSTREAM
In this story, Ed Swartz outlines how CBM produced water disposal has affected cattle grazing pastures, and created concern about the longterm groundwater supply in his county.

3. EXCERPTS FROM A LETTER TO SENATOR BINGAMAN
In this letter, Peggy Hocutt documents how a spate of illnesses occurred after CBM hydraulic fracturing operation affected the water wells in her neighborhood; and why she was evicted from her home.

4. COUNTY OFFICIALS SAY RESIDENTS IGNORED
This newspaper article outlines the frustration felt by Colorado surface owners when states hold hearings related to oil and gas development (e.g., to determine drilling windows and spacing).

5. THE LONG ROAD: LESSONS LEARNED FROM MORE THAN TWO DECADES OF DEALING WITH THE OIL AND GAS INDUSTRY
In this story, Terry Fitzgerald shares some of the lessons that she has learned regarding oil and gas development, including: mineral rights and forced pooling; deciding whether or not to sign a surface use agreement; and the types of conflicts that may arise.

6. THREATS AND INTIMIDATION: THIS IS CALLED "NEGOTIATION?" FORCE POOLING AN AFFRONT
This article documents how force pooling of mineral leases occurs in Michigan, and what this means for mineral owners.

7. STATE COULD FORCE PROPERTY OWNERS TO ALLOW DRILLING
As in other states, Michigan allows force pooling. This story documents one mineral owner's experiences in trying to better understand the oil and gas leasing process, and force pooling laws.

8. RANCHER NOT INFORMED ABOUT MINERAL LEASING
This is Jeanie Alderson's story about how the federal government can lease federal minerals without informing the surface owner, and that surface owners have no input into the leasing process or decisions that will greatly affect their lives and livelihoods.

9. REACHING AN AGREEMENT: LUCK OF THE DRAW
Pete Dube managed to achieve a Surface Use Agreement with a company, yet, as this story illustrates, even with signed agreements companies may not always act quickly to remedy problems.

10. ONE RANCH FAMILY'S STRUGGLE WITH COALBED METHANE
This story outlines how Nancy and Robert Sorensen were unsuccessful at negotiating a satisfactory Surface Use Agreement, and how the company ended up violating numerous provisions of the agreement that was eventually signed.

11. BUSINESS OWNER STRUGGLES WITH COALBED METHANE
Phil Hoy's story provides a lesson on understanding the potential ramifications of signing agreements, e.g., how certain clauses may allow companies to get out of having to pay for damages to a surface owner's property.

12. WHY I FIGHT: THE COMING GAS EXPLOSION
Tweeti Blancett tells how landowners can stand up to the industry, and win, despite seemingly insurmountable odds.

13. BELLFLOWER WELL
Curt Swanson and his subdivision neighbors pushed to get a gas company to mitigate some of the effects from their wells, and Curt relates how the county and local community organizations proved to be invaluable allies in this struggle.

14. A FIRSTHAND ACCOUNT: SUPPORT FOR BILL COMES FROM EXPERIENCE
This letter outlines how one township in Michigan developed its own ordinances, and the importance of forming alliances in order to pressure the industry and government to carry our reasonable industrial development.

15. HYDRAULIC FRACTURING IN THE GAS FIELDS
Laura Amos is an affected landowner from Silt, Colorado. Her family's water well was contaminated after a gas well was hydraulic fractured near her home in 2001.

16. COMPANY'S THREAT TO BOND AND DRILL IS NOT NEGOTIATING IN GOOD FAITH.
This letter, written in support of a Surface Owner Protection Bill in Colorado, provides insight into the imbalance in power between surface owners and oil and gas companies.

17. WYOMING LANDOWNERS FACE CONDEMNATION OR LOSS OF HOMEOWNERS' INSURANCE.
This story documents a potential lose-lose situation for split estate landowners facing seismic development. If they refuse seismic exploration, their property can be condemned. But if they allow the seismic tests, they may lose their homeowners' insurance.

1. CBM DESTROYS RETIREMENT DREAM

By Ron Moss

Let me share with you my first impression of Gillette when I got off the airplane in Gillette 14 years ago. I came here for a job interview for a position at the Northern Wyoming Community College, Gillette Campus operated by Sheridan College. It was a beautiful day. I felt so good about being here I was hoping that after the interview they would offer me the college position. Before I boarded the plane the next day to go back to Wisconsin I was offered the job. Needless to say, I was thrilled.

During that short visit back in 1987 I experienced my first contact with methane. Campbell County was evacuating Rawhide Village due to a severe methane problem. At that time a total community was uprooted and forced to move. I knew right then that after I returned to Gillette with my family, I would buy a house and property as far away as possible from Rawhide Village. I ended up buying a house and 20 acres in a rural subdivision 10 miles west of Gillette. We bought the house and property with the idea that this is where we would live after I retired. After working for the college for 12 years I retired and have been so for two years.

During the first ten years living in our home we were very happy. Even though we only have 20 acres of sagebrush, we felt very blessed living with nature and the peaceful, quiet surroundings. Then it started. They began drilling for methane east of me.

My first thought was what was going to happen to my water well when they removed all the water from underground. I and others met with three producers and each one assured us that nothing would happen to our well water. We in the subdivision have our own individual wells. Right now I still have water; however, although I had good water for over 10 years I started to get methane in my water after they started drilling. Coincidence? I think not.

I thought in my mind about the methane that closed down Rawhide Village. The methane got so bad in my well that the hose I used for filling the horse tank with water would blow out of the tank unless I held on to it. And I can tell you one thing: You never wanted to flush the toilet while you were sitting on it! Humor helps but when the State of Wyoming told my wife not to light a match near the source of water, humor quickly left. I talked to the methane producer and was told they would be happy to monitor my well; however I would just have to prove they were the cause of the problems. Let me ask you, how can someone living on Social Security and a small Wyoming retirement benefit afford to challenge the producer? I definitely could not. Although the methane in the water has now subsided considerably (not ended but subsided,) I feel our retirement home has been down graded.

"Noise that was so loud my dog was frightened to go outside... sounded like a jet plane circling."

Now comes the second phase. The dreadful noise generated by a nearby large compressor station. Noise that was so loud that our dog was too frightened to go outside to do his business without a lot of coaxing. Noise that sounds like a jet plane circling over your house for 24 hours a day. Noise that is constant. Noise that drives people to the breaking point.

My neighbor called the sheriff, state officials and even the governor and was told nothing could be done about the noise. Like I said, the noise drives people to the breaking point, and my neighbor fired 17 rifle shots toward the station. Unfortunately he received a lot of grief for his actions; however he got the company's attention.

And after many telephone calls and after numerous letters by various neighbors (and eight months later) the company owning the compressor station finally made some modifications to the compressor station to help alleviate some of the noise. However the noise is still a problem for a number of the neighbors. The company also planted 40 small trees around the station to

create a sound barrier. I am already retired and at my old age do you really think 40 trees are going to help me?

One methane producer using the compressor station said the noise wasn't so bad. Of course he doesn't live anywhere near it. The going phrase right now is that we all need to be good neighbors. In order to be a good neighbor I am being asked to accept the current noise level for the good of the industry and what the industry is doing for the State of Wyoming. All I can say is that my retirement home has taken one more step down for the worse.

Now I want to share with you one final event that has shattered our dream of living in our retirement home. A dream that began 14 years ago, when my wife and I moved to Gillette. We are finally licked. Last year my wife suffered severe asthma attacks on four different occasions. Even with medication and the use of a Breathalyzer she nearly had to go to the hospital emergency ward to get help to breathe. Why is this happening now and not before CBM development? It's because during the height of CBM development when you looked over the valleys surrounding our home and Gillette, you didn't see the clean air that once existed. I don't have time to go into details about the problem, but I can tell you I was so thankful for the recent moisture and wind to help clean the surrounding air we breathe. I cannot and will not allow my wife to suffer like she did last summer. My retirement home in the rural subdivision is now useless to me.

I can now relate to all those families that had to evacuate their homes in 1987 due to methane. However where they didn't have a solution to their problem, my problem with water, noise and air pollution could have been alleviated with advanced planning by industry in cooperation with the State of Wyoming. Guidelines would have been established to allow them to drill and ship in a responsible manner this valuable resource that exists in the Powder River Basin. I feel it isn't too late to establish these basic guidelines for the well being of ALL the citizens of Wyoming. We as citizens all have the right to enjoy the good life this great state has to offer. Right now that isn't the case for me. Thank you for allowing me to share with you my experience with methane while living in a rural subdivision.

Reprinted with permission from the Powder River Basin Resource Council's (PRBRC) Coalbed Methane Monitor, Winter 2002/2003. See Chapter V for information on PRBRC.

2. COALBED METHANE WATER WREAKS HAVOC DOWNSTREAM

By Ed Swartz

I own a ranch in Campbell County, Wyoming. The really good feature of our ranch is Wildcat Creek, which meanders about eight miles through the ranch. It flows only during snowmelt or violent storms, and it is typically dry nine or more months of the year. I have water rights on alluvial meadows, which provide winter hay supplies and a lot of our winter grazing.

In early October 1999, coalbed methane discharge water started flowing across my ranch from a neighbor's property. This water ran all winter and finally stopped in late April 2000. When this water evaporated in the spring and summer of 2000, I noticed that all the vegetation and grasses which I usually graze in the winter were dead. This usually dry streambed's soil could not stand water for such a long period of time. Alkali was drawn from the clay soils, and salts and sodium were dropped out of the water. This caused the vegetation to die and left white salt and alkali deposits on the surface.

The next flood will wash these deposits out on my hay meadows and probably kill my alfalfa and grass hay. These same meadows have been irrigated in every flood since about 1901 and there

has never been a loss of vegetation or as much salt and alkali deposits as I got with just seven months of what the agencies say is drinkable coalbed methane water.

Other coalbed methane companies, probably knowing what damage the water could cause, started building reservoirs in the drainages above my water rights to store the water. An employee of the Wyoming State Engineer's office (which is in charge of water rights) told me that there were at least 30 new, unpermitted reservoirs above my water rights.

When I started raising hell about interference with my water rights, the State Engineer allowed the coalbed methane companies to permit these reservoirs as permanent livestock reservoirs instead of industrial coalbed methane water storage reservoirs, which could be removed once development is complete.

One day's coalbed methane water would supply my ranch's water needs for 127 years-in dry years with no reservoir water. Can we afford to lose this much groundwater? What damages will be caused to the soils and vegetation from this much water?

It's way past time for action. I and other ranchers have too much to lose.

Reprinted with permission from the Western Organization of Resource Councils' (WORC's) fact sheet *Coalbed Methane Development: Landowner Profiles.* (See Chapter V for information on WORC)

3. EXCERPTS FROM A LETTER TO SENATOR BINGAMAN

WHY THE OIL AND GAS INDUSTRY SHOULD NOT BE EXEMPTED FROM THE SAFE DRINKING WATER ACT.

By Peggy Hocutt

Dear Senator Bingaman,

The oil and gas industry is not telling the truth about well contamination resulting from coalbed methane development. Just because the industry does not document cases, is no reason to believe they don't exist. The main reason that most of the general public is not aware of well contamination due to coalbed methane development, is because most people don't have the slightest idea of what a methane gas well is, or an underground aquifer, or the important part it plays in a water well, especially when a methane gas well is fractured.

I would like nothing better than to be able to tell you my story in person, but since that is not likely to happen, I would like to tell you some of the events that happened to me, my family, and some of my neighbors due to coalbed methane development.

I cannot tell you my story without giving you some family history, and without telling you about the awesome power USX Corporation unleashed on my family when we stood up against well contamination.

My husband worked for Tennessee Coal & Iron/USSteel/USX Corp., for thirty six years, taking his retirement when the Fairfield Works closed in 1983. His father worked there for forty-two years, retiring in 1971. Our river house, was built in 1952, with family money and labor, on a waterfront lot, leased from Tennessee Coal & Iron/US Steel/now USX Corporation, and located in a remote area of western Jefferson County, Alabama, on the Black Warrior River. It was built as a vacation house, but became our permanent home. The years we spent there were wonderful until the late eighties when the area was re-zoned from agricultural lands to heavy industry.

Our problems started when The State Oil & Gas Board, Tuscaloosa, Alabama, issued Permit #5946-C., to USX-Amoco Oil Production, in September, 1988.

The water used in fracturing this gas well was drawn from an abandoned strip mining lake, which had been used for a landfill for years. Everything from old roofing, trash, creosote lumber, raw household garbage, industrial wastes, junk cars, tires, batteries, paint and oil cans, herbicide and pesticide containers, and dead animals, was dumped in the lake. During the fracture of this particular gas well, I saw trucks there many times filling their tanks and delivering the water to the methane gas well site I am going to tell you about.

This gas well was hydraulically fractured with radioactive sand proppant, and tagged with radioactive material. The Board's approval was primarily based on the absence of water wells in the immediate area, but our house and our water well were located at 720 Big Bend Trail, Adger, Alabama 35006, which was well within the immediate area. This well was fractured in the fall and winter of 1988-1989. The men who worked in the test laboratory at the drilling site, wore special clothing, and their laboratory bore a radioactive logo.

"I, and my family, were the innocent victims of drinking and bathing in water, contaminated with toxic chemicals and radioactive materials."

Early spring, 1989. When the gas well was operable, the run-off was piped directly from the site to a point and then left to run uncontrolled down a hillside gully, through a culvert, and down a ravine where it then emptied into the slough behind our boathouse. The run-off was the color of Coca Cola, foamy, with oily streaks in it, and smelled like oil and rotten eggs. It killed all plant life and water creatures in its path. I never again saw another salamander, bull frog, or lily pad around our boathouse. I didn't know anything about methane gas wells at that time, but I realized if the run-off killed plant life and water creatures, it certainly posed a potential danger to the health of humans.

I called ADEM, (Alabama Department of Environmental Management), and asked for someone to come and take water samples. No one came. I called ADEM again, but nobody came and my calls were never answered. The run-off continued night and day.

May, 1989. I called a local television station and asked for someone to come and see this operation. A reporter came, (with CNN now), and did an environmental report on the river, but I saw nothing about this particular gas well. ADEM finally came, took water samples several times, at our house, as well as other places. I called for, but never got any results of the testing.

June 1989. Something prompted a hydrologist from the State Oil and Gas Board, to pay us a visit. He told me that USX-Amoco, had agreed to shut the operation down until a better way to take care of the run-off could be determined. He also advised me not to swim in our slough.

I thought this would resolve our problem. I was wrong, because something was obviously happening to our drinking water well too. We had 65′ of water in a 110′ well that had always been wonderful, but within a short time, it turned the same Coca Cola rusty brown, with long slimy tags of gunk that floated in a pitcher, when I filled one. It ruined everything it touched. We had to buy our drinking water and send our clothes to the laundry. Every shower bath left us feeling like we were covered in an oil slick.

By 1989, I was experiencing episodes of severe stomach cramps, vomiting, diarrhea, fevers and unexplained rashes which sent me to the emergency room and to the hospital several times. I was finally diagnosed with diverticulosis. I also experienced sudden and unusual, urinary infections. My urologist was baffled. He told me that something had traumatized my bladder, just what, he did not know.

My neighbor had the same experience with her water well. She said it smelled so much like petroleum, she was afraid it was going to explode. She called and officials from the Oil and Gas

Board came. They accused her of pouring crude oil in her drinking water well. A reporter interviewed her and made a photograph of her holding a jar of her water. She mentions a neighbor who is having the same problems. I am that neighbor.

The equipment at the gas well sat idle from July 1989, until the pre-dawn hours one morning in March, 1991, when I awoke to the sound of voices, and heavy equipment, motors and the clanking of chains and metal against metal, coming from the gas well site. The next morning, when I looked in that direction, all of the equipment was gone....including a 500 gallon tank of diesel fuel, used to run a generator. Shortly afterward, I turned my dishwasher, and faucets on, and got huge globs of black, jellied grease, bearing the strong odor of petroleum. I no longer wondered, but knew at once, that my suspicions were correct, and that the underground aquifer, which supplied our drinking water well was affected by the fracture of the gas well and that I, and my family, were the innocent victims of drinking and bathing in water, contaminated with toxic chemicals and radioactive materials, plus the filthy, bacteria filled water, drawn from the strip mining lake. A nagging fear about our health, was forever imprinted in my mind. It will never go away.

Something else happened at the gas well site too. Special efforts were immediately taken to bulldoze the whole area, cover it with a thick layer of soil, and plant grass, then huge piles of rocks and dirt were bulldozed to block the entrance of the road leading to the gas well site, and grass was planted there as well. The USX-Amoco, sign disappeared too.

April 1991. I had a mammogram with good results, but was still having severe attacks of diverticulosis. February, 1992. I had breast cancer, a radical mastectomy, and five years of treatment.

March, 1992. My neighbor, who had complained about her well, had breast cancer, and a radical mastectomy. She also had a cancer surgically removed from her nose. Later on, she had a cancerous nodule removed from her breast scar tissue, and took thirty-three radiation treatments. Later on, about 1995, she was hospitalized and in isolation for several weeks before a doctor from CDC, diagnosed her with a very rare Herpes Pneumonia, (Shingles in her lungs). Last year, she expressed to me again, her firm belief, and her fear, was that her cancers, and the Herpes Pneumonia, were caused by drinking her well water, which was contaminated by the fracture of the methane gas well, but that her fear of USX, retaliating against her family, like it did ours, was so great, it kept her from trying to do anything about it legally.

My brother and my sister-in-law lived across the street from us and also shared our water well. In May, 1992. My sister-in law, had several skin cancers surgically removed. Since then, she has had numerous cancers surgically removed from different areas of her head and body. In August, 1992. My brother was diagnosed with prostate cancer. He had surgery. He later had a cancer removed from his ear.

November, 1992. Another neighbor on my street, had colon cancer. He took a year of therapy. All of us lived well within the immediate area of the USX-Amoco gas well, where the Board said no water wells existed. Since then, there has been five more cases of cancer, with three deaths in the same small area. The neighbors were reluctant then, and they still are, to speak out about contamination and pollution period, because the land they live on is leased from USX Corporation, and some of them either still work, or they are retired from it, and they are afraid of retaliation, and rightly so.

September, 1994. We received a mandatory notice from USX Corporation. "Yes," I want to live on USX Lands, or "No," I do not want to live on USX Lands. Our lease did not expire until December 31, 1994, but in October, 1994, we received a new "License Agreement." The new document was eighteen pages and forty-nine paragraphs of legal jargon, which mainly stated that if we did sign it, we would drop all lawsuits, and we would have no recourse in the event that we, or any member of our family, was injured, or died, due to any operations being carried

out by USX Corporation, or it's Agents, on USX Lands, and that we would have no recourse as far as pollution or contamination on USX Lands was concerned, and that we would offer no resistance should USX corporation, with or without reason, inspect our premises at any time, day or night, and that our License Agreement, could be terminated, without reason at any time, and that USX Corporation, had the right to confiscate our personal possessions and sell them.

We refused to sign this third world document, and when we didn't, USX, entered a summary judgment against us and the judge agreed that we didn't have the right to live on USX Lands, if we didn't sign the new agreement, so we were given thirty days to move forty-four years of family possessions. We were not allowed to sell our home. We wanted to give our home to a worthy family. We were not allowed to. USX Corporation wanted us and our home, removed from the area period, and intended to use us as an example to show the mighty power it held. We could not move our home, because it was immovable, and if we could have, the financial burden would have been too great. We lost our forty-four year investment. USX also demanded, if we did move our house, that the land be put back into the condition it was when we first leased it in 1952. That task would have been impossible. The new License Agreement was created by USX Corporation lawyers, to use against us and the rest of the people living there, and anyone who might live on it's lands in the future....people are not too prone to buy a house there now.

You are probably wondering why we didn't move away. We couldn't. That was our home, a part of our life, and we were nearly sixty-five years old and had hoped to be able to spend our retirement years there. We could not just walk away (or thought we couldn't), and leave our investment. Our home was very comfortable, it was the environment around it that was horrible.

November, 1996. After our eviction, our house was torn down a board at a time, until nothing remained except the skeleton. It stood for several weeks as a reminder to the other people living there to keep quiet or suffer the same fate. We were publicly ridiculed by a USX Corporation Land Agent, who said we were "deadbeats," and "slackers," who just didn't pay our bills, and that was the real reason we were evicted.

I still have episodes of diverticulosis and other health problems. Recently, I was diagnosed with Herpes Zoster (Shingles), in my face, neck and sinus tract. I lost hearing in one ear and lost my sense of smell and taste. I live in a state of anxiety over my health and that of my husband, because I firmly believe that my health problems and the cancers on both his cheeks, are the results of drinking bathing and shaving, in water contaminated by this coalbed methane gas well. My husband recently had those two cancers surgically removed from his face, and is facing another one.

I believe that a company or corporation should have the right to operate, and workers should have jobs, but at the same time, they should not be left to police themselves, and they should have a very strict duty to protect the health and welfare of the general public.

On account of coalbed methane development, it's loose permits, lax regulations, and a giant, ruthless corporation, my home is gone. My good health is gone, our life's savings is gone. The gas well is gone, covered up, and planted over with grass, and we never had our day in court to tell about it.

Senator Bingaman, you have only read parts of what happened at my house when I still lived there. I ask you please, not to sponsor the Bill to exempt the oil and gas industry from The Safe Drinking Water Act.

Sincerely,

Peggy Hocutt
Alabama

4. COUNTY OFFICIALS SAY RESIDENTS IGNORED

By Josh Hoppe, Durango Herald, May 26, 1999

La Plata County residents are being ignored by the state commission that oversees oil and gas development, two county commissioners told the director of the Colorado Department of Natural Resources on Tuesday.

Controversies between the county and the Colorado Oil and Gas Conservation Commission have left residents in four subdivisions feeling powerless, County Commissioner Bob Lieb told Greg Walcher, director of the Department of Natural Resources, which oversees the COGCC.

“The thing that bothers me most is you have a whole group of people who feel powerless,” Lieb said. “You’ve got to be a good neighbor, and some of these gas proposals they have now are not being good neighbors.”

Commissioner Josh Joswick said that the COGCC has not been accessible to residents wishing to express concerns about gas well development because the commission usually meets in Denver. During at least one public hearing, residents were barred from speaking because they did not meet certain criteria that qualified them as “affected parties,” he said.

While the COGCC has a field representative in Durango, Walcher hoped the commission would meet in or visit Durango more often.

“I believe that with any board or commission that decides anything that affects people, they ought to do it there,” he said

Lieb said that when the COGCC allowed downspacing, which permitted one well on 160 acres of land instead of one well on 360 acres, landowners were unexpectedly faced with having a well close to their homes.

On these 160-acre plots, the COGCC designated drilling windows where drilling must be completed. Drilling windows are based primarily on geological data and do not take into consideration where people live.

Lieb suggested that downspacing be made a political process so local representatives would have an opportunity to vote on any similar move in the future.

Once the drilling windows were determined, the maps were overlaid with surface uses and found to be located near residential properties. Even when property owners said that drilling wells in their neighborhood would not be feasible, the commission approved the drilling windows, said Nancy Lauro, the county’s manager of planning services.

Approval of drilling windows despite residents’ opposition demonstrates that something is wrong with the commission and its approval process, Lieb said.

The state has a responsibility to develop oil and gas resources, but the resources must be developed responsibly, Walcher said. Local development regulations are important, but residents cannot expect to have no wells in sight, he said.

Walcher said there needs to be stricter mineral rights disclosure laws so that residents know if a company may extract natural resources from beneath their land. Under current regulations,

title insurance companies only need to inform land buyers that there may be a mineral rights owner, but specific owners do not have to be provided.

"If you know if (J.M. Huber Corp.) or Amoco does in fact own the mineral rights, it might affect whether you buy (land) or not," he said.

Joswick told Walcher that while the COGCC regulates drilling windows and well permits, local governments should have some say in what happens on the ground surface.

"What you're talking about with the COGCC is how they extract the resource and how and where they impact the surface; the surface owner has rights," he said. "When it hits the surface, what we've asserted all along is we have some control over that."

Joswick also expressed frustration with the COGCC's reluctance to discuss gas well locations because the commission says the county is premature in wanting to deal with the issue.

"I don't look at that as being irresponsible because we want to work with a problem we see coming down the line," he said. "We need to start working with this before there's a rig out there drilling."

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5. THE LONG ROAD

LESSONS LEARNED FROM MORE THAN TWO DECADES OF DEALING WITH THE OIL AND GAS INDUSTRY

By Terry Fitzgerald

When the "landman" comes-a-callin' landowners embark on an unsolicited, long and contentious experience. Such issues as private property rights, the meaning of privacy, and just compensation swirl around us. We ask and debate continually questions such as:

- Why was my property chosen to be a sacrifice area?
- Why is it that the public agencies of my county, state and national government see me at best as a nuisance and at worst, an enemy?
- How does a very small group have the right to change entirely our environment (sounds, water, sight, air)?
- Why do I feel so alone in these negotiations with a multinational industry?

Jim and I own 375 acres southeast of Durango, Colorado. We purchased the property with the understanding that we would own a 1/8th interest in the mineral estate. There was no development in our area at the time. In the 1980s we began to be visited by several different "land men" who consumed a tremendous amount of our time but gave us a very good education in gas drilling and the various rules and regulations surrounding it. They also made us aware of drilling activities on public lands and private lands in pockets of the county. By 1991, there was a well on our land and a well on an adjacent neighbor's land that pulled gas from under our place.

We never signed either a mineral lease or a surface agreement, and from these active omissions we learned the following points:

First, why we did not sign a surface agreement.
We had been very public about the emerging problems from the time we learned of the activity in our county. We attended meetings of angry landowners, and county hearings. There were workshops sponsored by the Oil and Gas Conservation Commission (OGCC) as a response of the state agency to look accountable. By the time the landmen approached us we were afraid to sign an agreement because the contract backed the surface owner into a set of rules; and when the state promulgated new rules, the old contract held.

There seemed very little reason for signing an agreement after the well was drilled. Both from experience and information from others we learned that the companies will not honor any agreements after drilling is completed. Most of us cannot afford to follow the legal roads to enforce the contracts.

On the issue of well pads.
In the state of Colorado the surface owner has a right to use the well pad as long as the activities of the gas producers' activities are not curtailed. People have frequently used the pads for storage of horse and camping trailers, sheep herder wagons, RVs, extra vehicles, water tanks, etc. Also, in Colorado, interim reclamation should be started no later than 3 months after a well is drilled. Much of the pad can be put back into vegetation or crops. The land owner is responsible for requesting their reclamation.

When negotiating with a company about a well pad, never believe their description of how many people and how many trips will be made to the area. Our wells have been operating for about 12 years. At this point there are small chunks of time when the well traffic is a little less, followed by large periods of time with a great flurry of activity.

Mineral rights and force pooling.
We own 1/8th of the mineral rights under our property, and have never leased them. Since the well has never been "paid out" we still do not know the results of this decision. Our decision not to lease was based on a right-of-way dispute. At the time, there was little financial incentive to do otherwise. Through conferences given by the state agency, through discussions with the company, through advice from lawyers, and finally through a careful reading of the state regulations, we understood that we would be "force pooled" if no mineral agreement was signed. The word was used as a threat by the companies, and whispered as if it were a death sentence by the state agency personnel. There appeared, however, no question that if you did not sign a lease you would be force pooled by the company. As production began on the wells of our interest, we contacted the state and told them that no agreement had been reached. The agency gave us false information that would have allowed the company to steal our gas. We asked for clarification from the board of directors of the state agency and ended up force pooling BP-Amoco. Recently, it has come to light that many companies never force pooled small mineral owners, and the state has sanctioned this theft. The state takes no responsibility to protect mineral interests, does not insist on a full reservoir leasing before drilling permits are issued, and the state will not assist mineral owners in the recovery of their payments after the well begins producing.

Conflicts.
If you live near the well conflicts are almost inevitable. We have divided the conflicts into three categories:

1. Workers and crew bosses forget that they are working around others. They seem to get a mind-set where the edge of the pad is the end of the world. If the work boss forgot to install a port-a-potty, well, the worker does the obvious. If the company needs to do some welding, never mind the fire ban. If there are closed gates when you enter, it can't hurt if you leave them open.

- We have felt that these issues usually are best solved by frequent, direct contact with the workers, and calls to the company.

2. Sloppy company procedures. These result in erosion problems, road and dust, fencing and waste pit issues, and the never ending noise (we feel that human beings who can hear are now an endangered species).
   - We have found that dealing with the company is at best a very short-term solution, and usually resolves nothing. Any political entity (county, city, state) will insist that you begin with the company. We have found a simultaneous approach to be more effective. If a well is "blowing off," a frantic call to the company is necessary; a call to the county should follow immediately. Whenever possible, a letter or email is far superior so that documentation exists.

3. Neighbors. It has become customary for the company representatives to foment suspicion among neighbors. Carrying stories about trash, driving habits, infidelities, etc., from one house to another has become common practice. This suspicion can be escalated by secrecy around payments for land use, "better deals" on fencing, gates, culverts, etc.
   - When leasing or surface occupancy begins in an area, neighbors need to guard against these tactics immediately. Hurt feelings are hard to cure.

Over the years we have tasted success in measures to improve our situation. Election times are often successfully used to draw politicians' attention to our problems. The noise problem is still unsolved, but things have improved. No longer are wells "blown-off" to reduce the internal pressure so that work can be done. Now the pressure is released very slowly, and there is no sound. Sound barriers have become routine. Mechanical problems with pumpjacks will be repaired (so long as you report them). Water quality is monitored.

Speaking out really does pay off. The sages of yesteryear who cautioned "Be nice to the company or they will get you" have been proven wrong.

In anticipation of a new well construction, and in the discussion of compensation, remember that you are entering a time (probably a lifetime) of monitoring, reporting and investigating activities around the well to protect your own health and well being, and that of your neighbors. It is no small task - don't sell yourself short.

6. THREATS AND INTIMIDATION: THIS IS CALLED "NEGOTIATION"?

FORCE POOLING AN AFFRONT

By Hans Voss, Michigan Land Use Institute, Great Lakes Bulletin News Service, Spring 1997

About a dozen property owners actually are force pooled each year. But the state's authority to force holdouts to lease strongly affects oil and gas policy across Michigan.

Leasing agents frequently mention force pooling during negotiations with property owners who have questions or reservations, as a tool to pressure them into signing a company's contract. In addition to threats of forced pooling, property owners report that common tactics include constant badgering, misinformation, and inflated estimates of royalties.

The Michigan Energy Reform Coalition often hears stories like these:

- Property owners in Manistee County's Filer Township were pressured into authorizing a natural gas well in their neighborhood. The well contains dangerous levels of poisonous hydrogen sulfide, but residents were not told of the health risks.

Here is part of a description of one couple's conversation with a leasing agent: "When my husband asked what would happen if we did not sign the lease, I remember Mr. – indicating that we would be taken to court and that there would be a lot of money involved and that we would have our mineral rights force pooled to form a drilling unit and in the end we would gain nothing and lose in court. So with the perceived threat of a lawsuit we felt we had no choice and signed the lease."

- A couple in northern Manistee County was told by a leasing agent that all the neighbors had already signed. The agent went on to say that if the couple didn't sign the lease he was presenting, the company would just draw the gas from under their land without paying any royalties. The couple then invited several of their neighbors over for coffee, and found out that most of them also were taking a wait-and-see approach, and had not leased.
- An Antrim County couple was coerced into leasing with promises for royalties of up to $10 per acre per month. Actual royalties turned out to be about 50 cents an acre.

Under current Michigan law, landowners who do not wish to lease their mineral rights for oil and gas development can be forced by the state not only to accept a lease, but also to pay penalties.

The law is called "compulsory pooling." It was developed as part of the original Oil and Gas Act of 1939 to promote development by ensuring that mineral owners who want to lease have "...the opportunity to receive his or her just and equitable share of the oil and gas." In the 1930s other oil producing states across the country adopted similar laws. Legislators of this post-Depression industrial era viewed leaving the oil and gas in the ground as "waste," and enacted laws like compulsory pooling to make sure the resources were developed.

Today, state regulators are required by law to prevent waste of the environment, but the overriding pro-development intent of the 1939 act still drives Michigan's oil and gas program.

Compulsory pooling, also called forced pooling, typically is used when a small minority of landowners, usually no more than 5% of a unit, refuses to lease their minerals. However, the law does not specify an appropriate percentage, or even that the pooled interests should be a minority. It merely requires that the decisions of the Department of Environmental Quality [DEQ] are "just and reasonable."

Once a petition to compulsory pool is submitted by an oil company, the "holdouts" are given 15 days in which to respond. If a landowner or group of landowners protests, a formal DEQ administrative hearing is scheduled in Lansing. The hearings are formal, courtroom-like proceedings. To work through the rigid guidelines, most holdouts need to hire attorneys.

The DEQ, which reportedly receives about a dozen oil company petitions for compulsory pooling a year, rarely denies them. It is unclear if the state has ever denied a company's attempt to force pool.

Once a "holdout" is compulsory pooled, he or she is given two options:

1. Pay to the company the proportionate share of the cost of drilling, completing, and equipping the well, whether it is a producer or a dry hole;

2. Await the outcome of the drilling of the well, and if it is a producer, pay to the company the proportionate share of the cost of drilling, completing, and equipping the well, plus an additional percent determined by the DEQ's Supervisor of Wells.

   Both options make the holdout a full working party in the well. The landowner receives a 1/8 royalty, but unlike the voluntary lessors, the holdout must pay a portion of the drilling

and operating costs. In Option 1 the costs are paid up front, and in Option 2 the landowner pays only if the well proves successful. In Option 2, however, there is an additional charge of usually 200% of the proportionate costs of drilling the well. When the unleased mineral owners do not choose one of the options, the DEQ automatically assigns the terms of Option 2.

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7. STATE COULD FORCE PROPERTY OWNERS TO ALLOW DRILLING

Great Lakes Bulletin, Spring 1997

Late in the autumn of 1994, Sue Falco, a greenhouse owner and longtime Antrim County resident, was busy shutting down her business for the season when she received an unexpected visit from an oil company leasing agent. He outlined the company's plans to drill for Antrim Shale natural gas in the area, and said that Sue would be well-rewarded if she signed over her mineral rights to the company.

But Sue Falco is not the kind of woman who signs anything on the spot. She told the agent, who was working for the Traverse City-based Oilfield Investments Ltd. (O.I.L.), that she wanted some time to think it through.

Sue then learned as much as she could about oil and gas leasing, while fending off numerous pleas from leasing agents, and braving two formal hearings in Lansing. Now she is desperately defending what she always thought was a given: Her right to not sign a lease.

Sue is not the only holdout in her Jordan Township neighborhood. Thirteen other landowners have refused to lease, and four others had leased but refused the company's plan for dividing up the royalties. They all are named in a petition that O.I.L. filed with the Department of Environmental Quality, to force them into accepting the company's terms.

And it looks like the DEQ is going to allow it. Michigan law allows companies to "compulsory pool," or force, unwilling mineral owners to join drilling units. The rationale is that holdouts should not be able to prevent neighbors from developing their oil and gas resources. The law typically is used when a small minority of landowners—representing less than 5% or so of a unit's acreage—refuse to lease, or when the owners can not be located.

What is astonishing about O.I.L.'s action in Sue Falco's neighborhood is the scale. The company, which secured authorization from the owners of just 1,517 acres, is trying to force pool 1,283 more acres to form a drilling unit. Even though this would force an unprecedented 45% of landowners into a drilling unit, current law allows such an action.

A DEQ administrative hearing was held in Lansing last fall. The state has not yet made a final decision on the matter. Hal Fitch, the DEQ's Assistant Supervisor of Wells and the decision maker on compulsory pooling issues, defends the forced pooling process as an "important mechanism" to prevent "waste" of oil and gas.

"It certainly does not take away anyone's property rights" Mr. Fitch said. Instead, he said that the reverse is true, and that the law is necessary to protect the rights of those who want to lease. " (If the DEQ did not force pool) we would be in effect taking those rights without compensation," said Mr. Fitch.

One of the main factors of the state's decision will be based on whether O.I.L. made a reasonable effort to obtain signed leases. The company's petition to the DEQ shows that in some

cases the agents called and visited landowners, but in other cases they did nothing more than send a lease by certified mail.

Sue Falco says that O.I.L. did not really negotiate with her. She had consulted with a lawyer, and wanted her lease to be more explicit. She asked for contract language that assured her there would be no roads or pipelines on the property. She wanted a slightly higher royalty rate.And she wanted to specify which geological layers she was leasing. The company agents, however, insisted that they could not change the "standard" lease format.

"I was willing to work with them, but the point is that you just can't work with them," she said. Sue also questions the whole premise of state-controlled negotiations for private property. "Would it be right for a logger to come and log my land for a price that isn't fair to me?" she asked. "No way. You should have the right to deny them."

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8. RANCHER NOT INFORMED ABOUT MINERAL LEASING

By Jeanie Alderson

My father and two sisters own Bones Brothers Ranch, a cow/calf ranching operation in southeastern Montana. Like many ranches in this part of Montana, ours has been built over the last 110 years. We own and pay taxes on 8,435 acres, and lease grazing land on the Custer National Forest. While we own some of the minerals below our land, other family members and the federal government own the rest. Many of the federal minerals are under land that is very close to our homes.

I knew that the federal government owned minerals below our ranch; however, I knew nothing about the process of federal mineral leasing. In December 2000, I called a Bureau of Land Management (BLM) official in Miles City to find out if the minerals under our ranch had been leased for coalbed methane development. From the information I eventually received from this BLM official, I learned that five companies and individuals had leased the federal minerals below our land. Although the BLM does not distinguish between regular oil and gas leases and coalbed methane leases, all indications point to these minerals being leased for coalbed methane development.

BLM never informed me they were leasing minerals under our ranch. BLM never asked for input regarding lease stipulations. I was never told about the leasing process, nor did I receive any information about the relationship between surface owners and mineral owners in regard to the development of federal minerals.

Had we been able to be involved in the leasing process we could have provided helpful information about our ranching operation, and how leasing decisions will affect our ranch. We have an intimate knowledge of the landscape and could have provided information about wildlife habitat, native plants, unstable slopes, watersheds and so forth. We could have provided information about where not to allow drilling, and where it might be acceptable. This information could have guided the leasing in a more reasonable and, ultimately more effective, manner.

In the present situation, we had no input into a process that will ultimately affect our land, water, business and lives forever. It seems like common sense that landowners should have more say in what happens on their property, but the simple truth is that oil and gas rights take precedence over surface rights.

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9. REACHING AN AGREEMENT: LUCK OF THE DRAW

By Pete Dube

My wife and I own an outfitting business in Buffalo, Wyoming, and about six years ago we bought 5,000 acres in Campbell County as a place to run cows and winter the horses we use for outfitting. The bulk of the minerals under our land are owned by the Federal Bureau of Land Management (BLM).

My experience with coalbed methane was a two-year nightmare of negotiations. CMS, one of the biggest coalbed methane "players" in the Powder River Basin, approached us with a proposal to develop the southwest corner of our land. The company asked us to sign a surface use agreement that was one and one-half pages long. I came back with a more detailed agreement that would have required the company to prepare a water discharge plan prior to drilling, only use existing two track roads, bury all electrical lines, and monitor our two water wells. It took me more than two years to reach an agreement with the company, and I spent at least $5,000 in lawyer's fees.

Then I discovered methane gas seeping up the side of my stock well. I was forced to dismantle the well cover to relieve the pressure of the venting gas, and the pipes to my stock tank froze. Finally CMS responded by fencing off the well and posting the enclosure with danger signs.

My well problems coincided exactly with coalbed methane drilling by CMS on a neighbor's property, but the company initially refused to take responsibility. They were trying to tell me it was just a coincidence, and that my well had been improperly drilled. What irks me is you have to be the one to prove the company caused the problem. The company finally installed a new pump, and solved the problem.

It's kind of the luck of the draw whether or not you can reach a good surface use agreement with a company. If you get a rancher friendly company, you might get along alright; if you get one that's not, you're in for a fight. If an agreement is not reached all the company has to do is post a bond to cover capping the gas wells and they can come on your property.

If I had the mineral rights there would be no development on this land. I don't blame my neighbors for wanting to make some money on this. That's their business. But for me, this is not about money. This is the only ranch I've got. I was out riding and looked down at what's happening to the country, and I thought this must be how the Indians felt when they saw the covered wagons coming.

There goes the neighborhood.

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"I came back with a more detailed agreement that would have required the company to prepare a water discharge plan prior to drilling, only use existing two track roads, bury all electrical lines, and monitor our two water wells."

10. ONE RANCH FAMILY'S STRUGGLE WITH COALBED METHANE

By Nancy and Robert Sorensen

We have lived for the last 29 years on a cattle ranch in the Powder River Basin in northern Wyoming, and my husband's family has pioneer roots reaching back over 100 years. This semi-arid environment only allows so much disturbance before the land is stressed to the point that a living cannot be made. My husband's family listened to the land and has persevered for four generations.

Our ranch is typical of many in the West in that the mineral and surface rights to the same parcel of land are often held by different parties (known as a "split estate"). We share mineral ownership 50-50 with Shriners Hospitals for Children under 2,500 acres of our ranch, and the federal Bureau of Land Management and State of Wyoming own the minerals under 200 and 160 acres of our ranch, respectively.

In October 1999, we were approached by a coalbed methane company to drill on a state-owned section of land that we lease. After consultation with the State Lands Office we attempted to reach a surface use agreement with the company that was in line with our philosophy of sustainability. After a long negotiation, an agreement was sent to the company management that we understood they had approved. The company rejected the agreement, and the State Lands Office allowed development operations to begin. A substantially weaker agreement was later offered to us by the company which the state urged us to sign. We did.

Being denied a reasonable agreement was only the first defeat. Next, we tried to get the company to live up to the agreement that it had authored.

Prior to commencing operations the company was supposed to provide us with a map. We finally received one six months after commencement of operations. There were to be no overhead power lines, but the company went ahead and constructed them anyway. The company also failed to discuss water management plans with us prior to beginning operations as it had agreed.

Over time the company has violated at least eight provisions contained in its agreement.

The problem as we see it is the overwhelming advantage of the mineral owner against the surface owner. We need regulations that give surface owners a more equitable bargaining position for surface damages.

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11. BUSINESS OWNER STRUGGLES WITH COALBED METHANE

By Phil Hoy

I moved to Gillette, Wyoming in 1972, where I have a welding shop and a 56-space mobile home park six miles north of town. I am in the middle of both coal mining and coalbed methane development.

When I lost my drinking water well to the dewatering of a coal seam, I didn't know what had happened. I was forced to drill a new well at my own expense. I was advised to pursue the Eagle Butte coal mine for remediation, because federal law stipulates that coal companies replace affected or depleted water wells on adjacent properties. As it turned out, an investigation by the

Wyoming Department of Environmental Quality (DEQ) revealed that my water well was depleted by a combination of coal mining and coalbed methane development. The coal and coalbed methane companies agreed to pay for the cost of the water well and its feeder lines.

Afterwards, I agreed to sign a release of liability for loss of the water well with both companies. This created a huge problem because the wording also released the coalbed methane company from future liability for property damages which have occurred and are continuing to occur on my property.

Between 1997 and 2000, Barrett Resources discharged 163 million gallons of coalbed methane water, much of which traveled down gradient to my property. The shallow alluvial sands on my property were flooded by these discharges and an unlined instream impoundment reservoir, rendering my leach field unusable. In 1999, I had to install a sewage treatment plant.

I have been in regular contact with government officials in order to resolve these problems. For example, when I objected to the issuance of a coalbed methane water discharge permit by the Wyoming DEQ, I was told by state officials that the discharges did not violate state law and they had no authority to prevent damages to my property. When I wrote to the State Engineer's Office about the permitting of the impoundment reservoir, they not only neglected my concerns but did not require the company to use simple, common sense measures to protect my property. It's not right for state officials to issue permits when they know that other people's property will be damaged.

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12. WHY I FIGHT: THE COMING GAS EXPLOSION IN THE WEST

By Tweeti Blancett

Here's what I once believed: that if the President knew about the damage done to our land by the energy industry, the damage would cease.

I once believed that if you could show that industry can extract gas without damaging land right near us -- as it does on the Southern Ute Indian Reservation, and on Ted Turner's Vermejo Ranch -- that those examples would be followed by every company.

Believing that, I went to Washington, D.C., in August 2002, and met with Kathleen Clarke, who runs the Bureau of Land Management; I met with Rebecca Watson, a Montanan high in the Department of Interior; I met with V.A. Stephens, who is with the Council on Environmental Quality; and I met with the New Mexico congressional staffs. I told them all that gas drilling could be done right but that it was being done wrong. I begged them to enforce existing regulations.

I came home to the small town of Aztec, N.M., and waited for change. I'm still waiting. I suppose not everyone can waltz into Washington and get that kind of entree. But I ran George Bush's 2000 campaign in my part of New Mexico. I ran Sen. Pete Domenici's campaign in my county in 1996. Our family has been on the land here for six generations and going on three centuries. We graze cattle on 17 square-miles of Bureau of Land Management, state and our private land.

We once ran 600 cows on those 35,000 acres. Today, we can barely keep 100 cows. Grass and

shrubs are now roads, drill pads or scars left by pipeline paths. We have trouble keeping our few cows alive because they get run over by trucks servicing wells each day, or they get poisoned when they lap up the sweet anti-freeze leaking out of unfenced compressor engines.

I have not taken this quietly. I have been on a mission for 16 years. In the beginning, I wanted to save the 400-acre farm and the adjacent piece of wild land in northwest New Mexico that I care most about. That's not much out of 35,000 acres. My family thought I was nuts. My son was a senior in high school, and resisted my attempts to enlist him. My husband said I was wasting my time.

They knew I was going against an industry that sharpened its teeth chewing on little people. They thought industry had the upper hand, legally speaking. But I believed industry had the upper hand because it threatened and intimidated. I once met Rosa Parks. I thought: If that little lady could sit, alone, in the front of a bus filled with hostile passengers, then I could act to protect where I live.

Gradually, I came to see why everyone else thought I was nuts. All of San Juan County in southern New Mexico has been leased for 50 years to gas companies. Our fathers and grandfathers signed these "perpetual" leases long ago, when the gas companies were owned and run by neighbors. The rest of the land is federally managed.

The industry claims its right to underground minerals trumps our rights to the surface. We don't deny their rights. We just say that we also have rights. Unfortunately for us and our cows and the wildlife, we are on top of unimaginable wealth, in the form of coalbed methane. Each year, our small, rural and fairly poor county produces $2.4 billion, and most of that money flows right out of here.

My 400 acres sit at the heart of this wealth. Nevertheless, several of us last fall locked the gates to our private land. We have not denied access to those who have leases. But we now control the access. We were tired of being told by the companies that "someone else" had killed the cow, or the deer, or drove across freshly reseeded land. Now we know who is on our land, and when.

It's perfectly logical and legal to control access to private land, except in gas country. So the companies pulled us into court. This, it turned out, was not a bad thing. We found out that industry doesn't have the rights its says it has. And when we go to court, we don't go alone. We bring our rancher friends. We bring our environmental friends -- friends we never dreamed of having. We bring pictures of the surface damage -- pictures that are so bad other states use them to show what happens when you trust industry and the BLM to "do the right thing."

We've been in more newspapers than I can count. We've been in People magazine. We've been on Tom Brokaw's TV news program. This natural gas boom has become a Western plague. In conservative Wyoming, home to Vice President Dick Cheney, the reaction against coalbed methane helped elected a Democratic governor.

But this isn't a partisan issue. We had as much trouble under Clinton as we do under Bush. This is a campaign-contribution problem. They give more than we can.

At times it seems hopeless. Then I hear from people facing similar situations in Colorado, in Montana, in Wyoming, in Utah. Many are like us -- conservative, Republican, pro-free enterprise

people. Others are environmentalists, or just care about land and animals.

Shortly, there will be a huge natural gas explosion, but it won't be pipelines or gas wells that blow. The explosion will come from the average Westerner, who is tired of being used by the oil and gas industry, with the help of state and federal officials.

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13. BELLFLOWER WELL

By Curt Swanson

Introduction:
My wife, Anne, and I moved to Colorado in 1997 to build our retirement home on property we had purchased in the Bellflower Ranch subdivision northwest of Bayfield. This subdivision consists of lots between 10 and 25 acres.

Like so many other newcomers, we knew nothing about gas wells or the impact they could have on residents. In looking around we could see pumpjacks operating in open fields, but never thought that they could put these things in subdivisions.

My story here is about the process our community went through in dealing with the drilling company. We learned a lot about how gas companies operate and how to more effectively deal with them. I would like to share with you some of the mitigation wins we managed to obtain and how we achieved them.

The key to any success we had was EDUCATION. That is, educating ourselves on what can and cannot be done and some of the options the drilling companies have that can make gas wells more bearable to our community. We also learned that in the industry there are good guys and bad guys. We managed to draw one of the bad guys.

History:
In March of 2000 the drilling company met with several neighbors to discuss mitigation of the proposed well. We presented a list of what we wanted, and the Company verbally agreed to most of our requests.

Two days after our meeting, we received a letter from the drilling company that they had already submitted a drilling application the previous week. None of our critical mitigation requests had been incorporated in the application. This was our first clue as to how this company operates when it comes to dealing with landowners.

Subsequent to the application, there were several hearings with the La Plata County Commissioners resulting in an agreement with the Company on the mitigation items required to obtain a County permit. Included in this agreement was a low-profile pumping unit and the use of electricity in place of gas to run any equipment after six months of operation. We all walked away from the meetings feeling we had a satisfactory agreement and could co-exist with the gas well.

Two years later we were still waiting for the Company to replace the large, gas-driven pumpjack they had installed. Instead of doing what they promised, they petitioned the County to waive the requirement for a low-profile, electric-driven pumping unit. The County refused. The Company's response was to file a suit in court and to appeal to the COGCC to force the County to abandon their requirement for a low-profile pumping unit. A comprise was finally reached between the

County and the drilling company to install electric-driven equipment in return for not enforcing the low-profile pump unit.

What we learned:

1. We won the County's support because we came prepared:
   - We obtained 70 signatures on a petition.
   - 50 people showed up for the hearing.
   - We researched what other companies were doing.
   - We had data to support the feasibility of both the low-profile pumpjack and electric-driven equipment.
   - We were able to counter the drilling company's arguments.

2. You cannot believe all that a drilling company tells you. You need to research on your own what is feasible for the company to do. Make sure you have any agreements in writing and signed by the company.

3. Some drilling companies are more honest and community-minded than others.

4. The gas industry and the COGCC will blindly support any drilling company action that is within State regulations when it comes to issues of visual or noise mitigation. For example, we found that the allowable noise level of 50 decibels is similar to running a diesel pickup truck 20 feet away from an open window, unacceptable to most residents.

5. Our only line of political defense is the County and our legislators. This is why we feel it is important that county governments be empowered to regulate noise and visual impacts of gas wells.

6. There are organizations in the county that can provide information and help for mitigation issues (Oil and Gas Accountability Project and the San Juan Citizens Alliance are two of them).

7. The gas companies and the equipment manufacturers we visited were more than happy to give us information and to show us what they had done in the way of site mitigation.

   Some of the things that can be done to mitigate sound are:
   - Electric-driven pumping motors (this is the ideal solution). Some gas companies will maintain that 3-phase electricity is required to install electric-driven equipment. In fact, there are electric motors available that will drive up to 60HP using single-phase electricity. Also, single-phase can be converted to 3-phase by use of a converter (approximate cost $2,000).
   - Properly engineered and installed sound panels (e.g., no openings in the panels). For example, we visited a site where a compressor was completely enclosed so that the noise was virtually eliminated outside the enclosure. This enclosure was engineered by C&J Welding in Bloomfield.
   - Hospital grade mufflers on gas-operated engines.
   - Properly maintained equipment.

   Some of the things that can be done to minimize visual impact are:
   using a low- profile pumping unit, landscaping and minimizing the size of the drilling pad (many companies are using pads of less than 1 acre).

8. Above all, you need to be persistent. It took us almost three years to get half of what we wanted, and we are still pressing for a low-profile pumping unit and replacement of dead

"We found that the allowable noise level of 50 decibels is similar to running a diesel pickup truck 20 feet away from an open window, unacceptable to most residents."

vegetation. Fortunately, a new company took over operation of our well and we have improved hopes of reaching our goals.

The San Juan Citizens Alliance has a folder on the people we contacted and some of their brochures. I also would be happy to share any information I have. You can contact me at (970) 884-2163.

14. A FIRSTHAND ACCOUNT: SUPPORT FOR BILL COMES FROM EXPERIENCE

A LETTER FROM PLEASANTON TOWNSHIP

By Gerard Grabowski , Michigan Land Use Institute, Great Lakes Bulletin News Service, December 1997

One of the main reasons our township has been instrumental in Michigan Energy Reform Coalition (MERC) is because the issues surrounding oil and gas development are too big to confront alone. MERC shares our goal – to create a cooperative partnership with the oil and gas industry that will insure reasonable industrial development in our neighborhoods.

The following article by Mr. Grabowski, a member of the Pleasanton Township Board, is excerpted from a statement he made at a public meeting in Manistee County on proposed oil and gas legislation.

In 1994, Pleasanton Township adopted an Industrial Facilities ordinance affecting the oil and gas industry. The ordinance requires companies to obtain special use permits for processing plants, and to minimize the noise from their compressors. It also requires companies to provide their development plans to neighboring residents and township officials.

I am happy to report that we have gotten full compliance from the oil and gas companies that have undertaken Antrim natural gas projects in Pleasanton. They have told the township that they want to work with us, and pledged that being a good neighbor is very important to them.

These companies are complying with our ordinance because it is reasonable, similar to the minimal requirements imposed on other industries, and in no way prohibits them from doing business here. We welcome this cooperation, and are pleased that we have a working relationship with the industry.

It hasn't always been this way. One company that now has a project up and running in our township was absolutely furious that we were going to require anything at all from them.

This company had plans for over 40 wells and three compressor stations. They sent letters to leaseholders, warning that the Industrial Facilities ordinance was going to make doing business impossible in Pleasanton Township, and that local officials were robbing them of their private property rights. The letters further warned that we had a hidden agenda, which was to stop oil and gas development altogether.

Well, the reality of course is much different, and residents packed our township hall to implore us to make sure our ordinance was obeyed fully. They overwhelmingly supported the defense of our ordinance against attacks from the Geological Survey Division, (the state agency that promotes as well as regulates the development), and the oil and gas industry.

Now – Pleasanton could never have gotten this far without establishing a network of other Michigan townships, communities, and organizations that are dealing with oil and gas devel-

opment in their backyards. This is why we are one of the founding members of the Michigan Energy Reform Coalition. MERC has provided our township with a statewide view of things, and has given us the access to information and expertise vital to making intelligent decisions.

One of the main reasons our township has been instrumental in MERC is because the issues surrounding oil and gas development are too big to confront alone. MERC shares our goal – to create a cooperative partnership with the oil and gas industry that will insure reasonable industrial development in our neighborhoods.

It comes as no surprise that some members of the oil and gas industry are loudly complaining that the proposed legislation will put them out of business, and that MERC's hidden agenda is to stop oil and gas development. We have heard these ridiculous accusations before. And we have learned our lesson, which is to let reality take its course, to stick to the truth, to be patient, and with time, our reasonable demands will be met.

The days of letting the oil and gas companies and the GSD behave like dictators are over. The days of companies ignoring the people who live and work amongst their projects are over!

The bills currently under consideration by the Legislature are for minimum changes that are long overdue. They are just the start of a process of insuring that townships, counties, and citizens have a say in the health, safety, and quality of life in their communities. We hope our legislators see that these bills become law.

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15. LAURA AMOS: HYDRAULIC FRACTURING

FAMILY'S WATER WELL WAS CONTAMINATED AFTER HYDRAULIC FRACTURING NEAR THEIR HOME.

By Laura Amos

My husband Larry, our daughter Lauren and I live south of Silt in the heart of what we call Encana's Industrial Wasteland. We were among the first in our area to have natural gas drilling on our property. We are among the unfortunate who do not own the mineral rights under our property. The "Good Faith Negotiations" required by the Colorado Oil and Gas Conservation Commission addressed none of our concerns. Encana sent to our home a nice old gentleman who sat at our kitchen table and told us more or less, "I feel for you, but you own the surface, we own the minerals, and we're coming in to drill. Here's the Surface Use Agreement, you can sign it, but you don't have to. If you sign it you get a check for $3000. If you don't sign you get no financial reimbursement for any damages that may occur." We hesitated to sign for a couple of weeks until we learned that what he was telling us was accurate—the law provided us no protection, no mediation, and no real power to negotiate. It also now appears that others who do not own the mineral rights under their land were also bullied.

In May 2001 while fracturing four wells on our neighbors' property (less than 1000' from our house on what's known as the G33 pad), the gas well operator 'blew up' our water well. Fracturing created or opened a hydrogeological connection between our water well and the gas well, sending the cap of our water well flying and blowing our water into the air like a geyser at Yellowstone.

Immediately our water turned gray, had a horrible smell, and bubbled like 7-Up. Water production dropped drastically from 15 gallons per minute to nothing or near nothing. Tests of our water showed 14 milligrams (mg) per liter of methane. That's almost as much methane that water will hold at our elevation. But the Colorado Oil and Gas Conservation Commission (COGCC) claimed that the methane was "transient" in nature. We were assured that methane is safe, that in fact our bodies produce it naturally, and that there are no known health effects. We were warned, however, to make sure there were no closets or pockets in our home where the gas could build up and explode. They tested the water in our well a couple more times that summer, ending in August 2001.

In the spring of 2003 I became very ill. I spent months in doctors' offices and hospitals. I was eventually diagnosed with Primary Hyper Aldosteronism, a very rare condition of a tumor in my adrenal gland. None of my doctors had any idea of how I could have acquired such a rare disease. The tumor and my adrenal gland had to be removed. As a result, I am concerned that my immune system is now compromised, as well as the other endocrine related systems that are linked with the adrenal glands.

For more than two years my husband and I felt more or less abandoned by the COGCC. We resolved nothing. In January 2004 I had had enough and decided to become better informed and make others aware of my predicament. I started my 1st letter-writing campaign. The gas commission came back, tested again, and again found 14 mg of methane per liter in our water. They determined that it was Williams Fork Formation gas, a Notice of Alleged Violation was issued to Encana, but no fine was administered by the COGCC.

In August 2004 I came across a memo written to the US Forest Service and BLM Regional offices in Delta County, describing the health hazard posed by a chemical used in fluids that are injected underground to enhance the release of methane. Dr. Theo Colborn of Paonia, Colorado submitted the memo in response to decisions that were being made in Delta County by the government officials to allow gas exploration and development on the Grand Mesa. Colborn is the President of the Endocrine Disruption Exchange, Inc (TEDX) and for over 10 years directed the World Wildlife Fund's Wildlife and Contaminants Program. She has been honored worldwide for her focus on the effects of synthetic chemicals on human and wildlife health. The focus of Colborn's memo was on a chemical called 2BE, used in fracturing fluids.

The following information was taken from Colborn's report: "2BE is a highly soluble, colorless liquid with a very faint, ether like odor." She wrote that at the concentration to be used in Delta county 2BE might not be detectable through odor or taste. "2-BE has a low volatility, vaporizes slowly when mixed with water and remains well dissolved throughout the water column." "It mobilizes in soil and can easily leach into groundwater." "It could remain entrapped underground for years." She noted it is readily absorbed by the skin and can easily be inhaled as it off-gasses in the home. Colborn cited the Agency for Toxic Substances and Disease Registry Profile that listed the following effects of 2-BE: kidney damage, kidney failure, toxicity to the spleen, the bones in the spinal column and bone marrow, liver cancer, anemia, female fertility reduction, embryo mortality, and the biggie that got my attention…elevated numbers of combined malignant and non-malignant tumors of the adrenal gland.

Of course that sent up a huge red flag! I have had no peace of mind ever since. Remember that from August 2001 until January 2004 no testing was done on our water. Our daughter was only 6 months old when fracturing blew up our water well. I bathed her in that water every day. I also continued breast-feeding her for 18 more months until she was 2 years old – during the time the tumor was developing in my adrenal gland. If there was a chemical in my body causing my tumor, she was exposed to it as well. She was in contact with the chemical through every possible exposure pathway.

After reading Colborn's memo, I tried to find out if Encana used 2BE in fracturing. Encana's spokesman, Walt Lowrey, assured several of our neighbors, and my husband and me that 2BE was NOT used. In addition, Lowrey told many reporters in western Colorado, Denver and the Associated Press that 2BE was not used on the pad, or anywhere in this area.

However, on January 31, 2005, I learned that the industry had not been telling the truth to all of us. In June 2001, five weeks after the operator and the COGCC knew that there was a connection between the gas well and my water well, they proceeded to fracture wells on the G33 pad again. It was reportedly an experimental fracture, a new idea to fracture into the Wasatch formation, the same formation that our water comes from. They fractured 2000 feet below the surface, and they DID use 2BE. Encana is now delivering us alternative water for use in our home, but we are concerned that our well water may never be safe again.

I am ONE MAD MOTHER who intends to continue to challenge the system that allows average citizens to be ignored and trampled on, without consideration for their health, their children's health, and life-long investments. I am ONE MAD MOTHER who believes it is the role of government to protect the average citizen. I believe that I should have the support and concern of the COGCC, but that is far from the case. Instead, it is obvious that the COGCC is continuing to be more concerned with corporate interests. In fact, Brian Macke, director of the COGCC recently told a CBS News Bureau Chief in Washington D.C. that I am crazy, and that my exposure to 2BE may have come from Windex!

Surface owners need some protection and some power in dealing with huge corporations who care only about profit. I am not the only person who believes her health has been compromised because of gas development in Garfield County. There are many others out there who feel that they have been violated. Giving surface owners some legal rights to protect themselves and their property is critical in order to prevent more situations like mine.

16. COMPANY'S THREAT TO BOND AND DRILL IS NOT *NEGOTIATING IN GOOD FAITH.*

THE FOLLOWING LETTER WAS WRITTEN TO ASK COLORADO LEGISLATORS TO SUPPORT A BILL THAT WOULD PROVIDE PROTECTIONS FOR SURFACE OWNERS.

By Bruce Thomson

I'm writing in hope that my story of working with BP Amoco will help persuade you to support the Curry Surface Owners Compensation Bill.

My background is as a CPA, small business owner, and sometimes real estate developer. Along with my wife, I own 157 acres about 15 miles east of Durango that we plan to develop. The land has been conceptually approved by La Plata County for 10 residential lots.

In 2000, we received notice from BP Amoco of their intention to drill another gas well on our land (there was one on the property when we bought it). I specifically asked to work directly with whomever was authorized to make final decisions regarding well placement, pad size, noise mitigation, compensation, etc. I was told that Ralph Chamberlain of Timberline Land Corporation was the man for me to work with. After many hours of work and numerous walks on the land, Ralph and I agreed to a pad location and size with specific protection for about a dozen very nice, large Ponderosas.

Then I got a call from BP Amoco, from the man for whom Ralph was working. This company representative said that what Ralph and I had agreed to had no standing and that BP Amoco and I

would have to begin all over again on working through well placement, pad size, etc. In my mind, this was an egregious breach of good faith. If I had been working with a building contractor in an arm's length transaction, I would have severed the relationship immediately and refused to do business with them.

But as I was reminded by BP Amoco in every phone conversation, letter, and meeting at that time, I had no choice but to do business with them and if I didn't cooperate, they didn't need to do business with me and they would simply 'bond and drill'. 'Bond and drill' became the gun to my head that made me realize that I could only ask for or resist very little and then I'd better shut up.

As it turned out, BP Amoco drilled the well in approximately the location that Ralph and I had agreed to, but with a much bigger pad size so that we lost those dozen or so Ponderosas closest to the gas well that we had hoped to protect. I can't tell you specifically what compensation or promises of mitigation my wife and I got from BP in our Surface Use Agreement because I am legally bound to confidentiality by the agreement itself, but I can tell you that the money doesn't come close to compensating us for the damage to the surface and the promises of mitigation are pretty much non-existent.

I was opposed to the agreement confidentiality provision because I would like to be able to share the experience I had with BP Amoco with other landowners facing the same situation and perhaps help them, but again BP Amoco held the gun to my head and I was forced to leave the confidentiality provision in the agreement. My relations with BP Amoco were and continue to be very cordial, but there's always the implicit understanding that the game is rigged in their favor and I'd better cooperate or else.

I am a businessman and I believe in the free market. I believe that BP Amoco has the right to profit from their mineral rights, but I also believe that I have the right to enjoy and profit from my surface rights. By drilling a gas well on my land without adequately compensating me for surface destruction or protecting against noise or other pollution related to the gas well, I have been denied a portion of my surface rights.

The 10 lots that I will develop on my land will now all have a reduced value because of the proximity of the gas wells and it will be my family and not BP who suffers that financial loss.

I ask you to please support the Curry Surface Owners Compensation Bill to help level the playing field between gas well operators and land owners.

Don't let gas well operators continue to exploit their mineral rights at the expense of land owners' surface rights.

Thank you,

Bruce M. Thomson

17. WYOMING LANDOWNERS FACE CONDEMNATION OR LOSS OF HOMEOWNERS' INSURANCE

By Dan and Barbara Renner

Under the current laws of the State of Wyoming, Landowners who own their surface but not the minerals lying underneath (commonly referred to as split estate) face a desperate decision: Either agree to allow a seismic company to place explosives on your property and detonate them, or be condemned under eminent domain.

But wait, there's more...Should the landowner agree to allow the explosive seismic testing to take place in order to avoid condemnation, they may lose their homeowners' insurance. So, what do you do? You call the Governor, right?

In June 2004 the residents of Clark, WY, a small community on the outskirts of Yellowstone Park, received notification of a pending 3-D seismic testing project in a 47 square mile area that encompassed much of the Clark community. Quantum Geophysical, Inc., based in Houston, TX, was contracted to perform the 3-D seismic testing and proposed 3,420 seismic shotholes in and around Clark. This proposed activity is unusual in that Clark is a residential community encompassing approximately 350 private landowners and this activity will take place in their front yards!

In addition to the seismic testing, Windsor Wyoming, LLC, an oil and gas developer based in Oklahoma City, has applied to the BLM and the State of Wyoming for permits to install approximately 20 miles of pipeline across public and private lands, as well as the Clarks Fork River, and construct a gas separation plant in Clark. Again, this exploration and development activity, will take place in the front yards of Clark's residents. Such activity is not unknown in the area — Windsor has taken over the operation of an abandoned well site that sits just one-quarter mile of 5 homes. But residents in the area had not realized until recently that all of this activity, particularly explosive seismic testing, places them jeopardy when it came to homeowners' insurance.

Much of the private land in the Clark area overlies minerals owned and leased by the federal government. Under Wyoming law, the mineral owner (or the mineral lessee) holds a superior position to that of the surface owner. Surface owners in Wyoming are required by law to allow open access to their lands by the oil and gas industry for the purposes of exploration and development. Attempts to block or inhibit that access will result in condemnation procedures against the surface owner.

In January 2005 Quantum Geophysical began to contact, via telephone and mail, residents in the Clark area regarding the not yet permitted seismic testing they had been hired to conduct. One of the residents, Dan Renner, questioned Quantum,s representative (Bruce Fulker) regarding the possibility of unexploded ordnance remaining on his property following the testing and who is liable should that ordnance explode at a later date. He also requested information regarding the type of explosive to be used, how often misfires occur and how long it would take any unexploded ordnance to deteriorate. The representative could not readily answer the questions, but assured Mr. Renner he would obtain the answers.

The events that have taken place subsequent to Quantum,s phone call have made it abundantly clear that Mr. Renner and other surface owners in his situation are caught in an untenable position: If they allow seismic testing to place and permit explosives on their property, they risk losing their homeowner's insurance; If they oppose the testing in order to maintain adequate insurance coverage, they risk condemnation by the seismic testing company via the eminent domain laws in the State of Wyoming. A full explanation of the events follows:

Mr. Fulker replied, in writing, to Mr. Renner that the explosive his company would be using is Seis-

gel, that approximately 1% of the charges would misfire and that the sleep time for Seis-gel is two years (after which it would begin to deteriorate until it eventually became completely inert). Mr. Fulker did not address the liability issues.

However, Mr. Renner had begun to conduct some research on his own. He phoned his insurance company, advised them of the proposed explosives and seismic exploratory operations and asked about his liability coverage. He was promptly advised that should such activity take place on his property, his homeowner,s insurance would either be cancelled or would not be renewed on the next renewal date.

Mr. Renner's next call was to the Wyoming Insurance Commissioner's office. He posed the same questions and was told that the commissioner's office would have to investigate the matter and would get back to him in about a week. Approximately an hour later, Mr. Renner received a call from the Insurance Commissioner's office advising that they could not be of any assistance to him. He was referred to Eric Nelson, an attorney with the Wyoming Oil and Gas Conservation Commission (WOGCC).

A message was left for Mr. Nelson which resulted in a phone call from Mr. Don Likwartz, State Oil and Gas Supervisor with the WOGCC. Mr. Renner was advised that the issue of homeowner,s liability coverage during and after seismic testing had never come up before and questioned Mr. Renner as to why he had contacted his insurance company. Mr. Likwartz said he did not have any answers at that moment but would look into the matter. The last contact from Mr. Likwartz was approximately a week later. He advised that the WOGCC still didn't have any answers.

Mr. Renner contacted a local insurance agency and asked that they attempt to find an insurer who would be willing to cover him under the seismic testing circumstances. The insurance agent responded about a week later advising Mr. Renner that he had contacted four companies (that would insure ranch property of his type) and was told that "with the possibility of undetonated explosives on his property, they would not be willing to write a policy which would include liability."

Further research led Mr. Renner to Mr. Bob Hartwig, Senior Vice President & Chief Economist with the Insurance Information Institute (NY). Mr. Hartwig stated that he knew of no underwriter who would write a policy for liability insurance under the proposed circumstances. He further advised that if a landowner signed the seismic agreement to allow testing involving explosives to take place without notifying his insurance provider, he had significantly changed the conditions of his coverage; his insurance provider could potentially deny any claim based on that change in conditions. On the other hand, if the homeowner notified his insurance carrier of the seismic activities, he would most likely be cancelled, or at the very least, not renewed on the next renewal date. Mr. Hartwig went on to say, however, that the issue could certainly be resolved, although not quickly. He offered a series of solutions, including legislative changes that would be required, which are attached. Mr. Renner forwarded Mr. Hartwig's email response to Ryan Lance, Office of the Governor, State Planning Office, Cheyenne, WY.

Governor Freudenthal's office, through Mr. Lance, has been supportive to the surface owners in Clark who find themselves faced with a no-win situation and has tried to come up with a quick and adequate solution for all involved. The WOGCC, on the other hand, has taken the approach of "they will sign on the dotted line, or they will be condemned." The BLM has maintained that the issue of insurability on private lands does not fall under their purview and that the issue of insurability on public lands "should not be problem."

The Governor's office issued a final statement to the residents of Clark during a community meeting on February 16: The issue is a private party issue that has to be resolved between the two parties. His office offered to assist in finding a solution, but advised that the surface owner and Quantum would have to resolve the issue on their own. "We can't have the heavy hand of the State

involved in a private property issue," said Mr. Lance. (Billings Gazette, February 22, 2005)

The problem with that solution is that it isn't a "private party" issue. If the parties fail to come to an agreement it becomes a State issue with the seismic company using State eminent domain laws to condemn private property and permit seismic testing to go forward. At that point the landowner is right back where he started with the risk of becoming uninsurable.

Furthermore, the issue is much more far-reaching than an agreement between a landowner and a seismic company in Clark, Wyoming. It affects similarly situated landowner's throughout the State and possibly throughout the U.S. It affects lenders who hold the mortgages on such property and have insurance requirements that must be met by the borrower. It affects the ability of insurers to write insurance in Wyoming and other states where explosive seismic activity is involved.

One has to ask has this administration become so unconscionable when it comes to oil and gas development that they would not only allow, but support development in subdivisions, next to schools, alongside churches, and in people's front yards? Better yet, has the quest for development become so outrageous that the State would allow people's land to be condemned if they do not agree to allow seismic activity in order to maintain their homeowners insurance?

Chapter V
Sources of Information

RESOURCES ON THE OIL AND GAS DEVELOPMENT PROCESS

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Natural Gas—from wellhead to burner tip. http://www.naturalgas.org

Pembina Institute
This Canadian institute is an independent, not-for-profit environmental policy research and education organization. Pembina Institute has developed a series of primers on Environment and Energy in the North. While these primers are geared for northern environments, they also contain a lot of excellent general information on the oil and gas development process.
http://www.pembina.org/publications_item.asp?id=168

Centre for Energy
A Canadian energy industry web site that has some basic overviews of the development process for conventional and nonconventional oil and gas sources. http://www.centreforenergy.com/generator2.asp?xml=/silos/ong/UNGOverview01XML.asp&Template=1,1,1

Resources on Oil and Gas Development on Public Lands
See the publication *Preserving our Public Lands* for more information on the federal laws that apply to oil and gas development on public lands. This publication provides citizens with some strategies for protecting public lands from the harmful effects of oil and gas development. To obtain a copy of this publication, contact: the Wyoming Outdoor Council; the Oil and Gas Accountability Project; or download a copy from the Western Resource Advocates web site: http://www.westernresourceadvocates.org/media/pdf/preserv_public_lands_FINAL.PDF

Information on the federal leasing process can be found at the BLM Colorado web site.
http://www.co.blm.gov/oilandgas/leasinstruct.htm

Regulations that govern the BLM's oil and gas leasing program may be found in Title 43, Groups 3000 and 3100 of the Code of Federal Regulations (a publication available in BLM State Offices, law libraries and most public libraries).

Morton, P., Weller, C., Thomson, J., Haefele, M. and Culver, N. 2002.
Coalbed methane and public wildlands: how much and at what cost?
http://www.wilderness.org/Library/Documents/upload/ Drilling-in-the-Rocky-Mountains-How-Much-and-at-What-Cost.pdf

Resources on Impacts to Livestock

Marr-Laing, T. and Severson-Baker, C. 1999. *Beyond "Eco-terrorism": The Deeper Issues Affecting Alberta's Oilpatch.* Pembina Institute for Appropriate Development. Drayton Valley, Alberta. pp. 13-15. This report describes a number of studies that have shown links between oil and gas operations and health effects on livestock.
http://www.pembina.org/pdf/publications/oilpatch.pdf

Resources on Air Emissions

The *Health Effects Notebook for Hazardous Air Pollutants* is an excellent resource for information on specific air pollutants. It can be found on the U.S. EPA's web site.
http://www.epa.gov/ttn/atw/hapindex.html

An excellent report on the impact of hydrogen sulfide emissions from gas wells and related facilities on surface owners is: Schindler, D. 2001. Survey of Accidental and Intentional Hydrogen Sulfide Releases Causing Evacuations and/or Injuries in Manistee and Mason Counties from 1980 to 2001. http://www.mecprotects.org/oilaccidents.pdf

Resources on Oil and Gas Noise

Breul and Kjaer. 2000. *Environmental Noise Handbook.*
http://www.macavsat.org/pdf_files/misc_reports/bk.pdf

Berglund, B., Lindvall, T. and Schwela, D. 1999. *Guidelines for Community Noise*. World Health Organization. http://www.who.int/docstore/peh/noise/Commnoise2.htm

Leventhall, G. 2003. *A Review of Published Research on Low Frequency Noise and its Effects.* Prepared for Department for Environmental Foods and Rural Affairs. (United Kingdom). http://www.defra.gov.uk/environmental/noise/lowfrequency/index.htm

Danish Environmental Protection Agency. 2002. *Danish Guidelines On Environmental Low Frequency Noise, Infrasound And Vibration.*
http://www.mst.dk/transportuk/02030000.htm#vibration

Resources on Oil and Gas Processing, Refining, Pipelines and Liquefied Natural Gas

NaturalGas.org
For more details on the steps involved in processing natural gas, read "Processing Natural Gas" at the NaturalGas.org web site.
http://www.naturalgas.org/naturalgas/processing_ng.asp

Pipeline Safety Trust
The Pipeline Safety Trust promotes fuel transportation safety. This web site has an extensive library with information on pipeline accidents, pipeline policies and regulations, and more.
http://pstrust.org/

Federal Energy Regulatory Commission.
Landowner Guide: An interstate natural gas facility on my land - what do I need to know?
http://www.ferc.gov/about/doing/6513gpo.pdf

Oil spill information research links.
This site provides a listing of government, industry, academic and nonprofit organizational web sites, with descriptions of the information offered on the various sites.
http://www.racerocks.com/pearson/ensy/oils/esoilspl.htm

Liquefied Natural Gas (LNG) Watch
The "LNGwatch" web site has been created by a coalition of citizens and organizations concerned with the health issues associated with LNG. The site contains links to various resources and information on LNG. http://lngwatch.com/

Energy Justice Network
The network works locally (Pennsylvania), nationally, and internationally, focusing primarily on liquefied natural gas issues. The network has also work on combined cycle natural gas power plants and other "dirty energy" issues. Contact Mike Ewall (215-743-4884, catalyst@action-pa.org) or visit their web site. http://www.energyjustice.net

RESOURCES ON "BEST" OR ALTERNATIVE TECHNOLOGIES AND PRACTICES

The authors of this publication do not claim that any specific technologies or practices in the following resources are the "best". The resources are included as potential sources of information on alternative practices in the oil and gas industry. Surface owners will have to decide for themselves what technologies and practices fit best with their needs.

Alaska Department of Environmental Conservation
A pollution prevention opportunities guide for the oil field service industry, from the Alaska Department of Environmental Conservation Pollution Prevention Office.
http://es.epa.gov/program/regional/trade/p2-oppt.html

A Canadian Working Group composed of industry, government, and public interest groups produced *Best Management Practices for Control of Benzene Emissions from Glycol Dehydrators*, which outlines methods for minimizing benzene emissions in new and existing plants; and provides more information on alternatives to glycol dehydration. The document is available on the Small Explorers and Producers Association of Canada (SEPAC) web site
http://www.sepac.ca/Downloads/bmp.pdf

Bureau of Land Management.
The BLM has a program dedicated to techniques used to reduce the visual impacts from surface disturbing projects. Information on this program can be found at
http://www.blm.gov/nstc/VRM/destech.html

Colorado Oil and Gas Conservation Commission
The commission's Outstanding Oil and Gas Operation Awards may give landowners a sense of what some companies have done to set them apart from the rest of the industry.
http://www.dnr.state.co.us/cdnr_news/oil-gas/2001810132249.html

Groundwater Protection Council
For example, they held a Produced Water Conference on Oct 15-17, 2002 in Colorado Springs, CO. Proceedings from this conference can be found at
http://www.gwpc.org/Meetings/PW2002/Post-Meeting-Report.htm

New Mexico Energy, Minerals and Natural Resources Department
In 2000, the Oil Conservation Division of the department released a two volume handbook on Pollution Prevention - Best Management Practices for the Oil and Gas Industry.
http://www.emnrd.state.nm.us/ocd/

Petroleum Technology Transfer Center (PTTC)
Case Studies on various technologies (some of these are highly technical) http://www.pttc.org/case_studies/case_studies.htm, and PTTC Technology Connections: State-of-the-Art Technology Summary http://www.pttc.org/tech_sum/statev8no1.htm

Railroad Commission of Texas
This state regulatory body has waste minimization information for various oil and gas related operations; a guidance document Minimization in the Oil Field Manual; and case histories of waste minimization projects.
http://www.rrc.state.tx.us/divisions/og/key-programs/ogkwast.html

Southwest Pollution Prevention Center, Gas and Oil Hub
This site provides a great deal of information on oil and gas pollution prevention alternatives for all stages of oil and gas development (drilling, well completion, oil and gas processing, oil and gas storage, pipelines, well servicing, oil recovery, transportation and more). Also, the site provides lists of wastes associated with various stages of oil and gas operations
http://p2.utep.edu/hubs/toc.cfm?hub=11&subsec=7&nav=7

U.S. Environmental Protection Agency
Oil and Gas Industry Sector Notebook describes pollution prevention opportunities
http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/oil.html

EPA's Natural Gas STAR Program is a source of information on waste minimization techniques in natural gas treating and processing operations. The program is designed to promote environmental protection through cost-effective measures without regulation, by encouraging natural gas companies to adopt "best management practices" that can reduce methane emissions. More information on the Natural Gas Star Program can be obtain by contacting: U.S. EPA Natural Gas Star Program, U.S. EPA, 401 M Street, SW Washington, DC 20460.
http://134.67.55.16:777/dc/methane/home.nsf/pages/gasstar

The Illinois office of the EPA produced the document *Best Management Practices for Oil Exploration and Extraction.*
http://www.epa.state.il.us/p2/fact-sheets/bmp-oil-exploration.html

Western Governor's Association
The WGA is developing a handbook of best management practices for coalbed methane development. Some of the topics likely to be addressed in their handbook include practices related to planning, landowner relations, land use, water, infrastructure, and fish and wildlife habitat. The handbook should be available in 2004. http://www.westgov.org/

Drilling Waste Management Information System
This is an online resource created by the Argonne National Laboratory and industry. It contains technical and regulatory information on standard and better practices for managing drilling wastes. http://web.ead.anl.gov/dwm/

COALBED METHANE RESOURCES

High Country News
This newspaper produced a special report called *Coalbed Methane Boom*. It can be found on their web site. http://www.hcn.org

ALL Consulting
ALL Consulting has prepared some in-depth material on CBM, including some information on

best practices and mitigation strategies. http://www.all-llc.com/CBM/

Wyoming CBM Clearinghouse
This web site is a clearinghouse of information about coalbed methane (CBM) in and around the state of Wyoming. The CBM Clearinghouse is a joint project of the University of Wyoming and the U.S. Bureau of Land Management. http://www.cbmclearinghouse.info/

East of Huajatolla Citizens Alliance
This group has produced numerous information sheets for citizens dealing with CBM development (including issues such as health and welfare, produced water, impacts on wildlife and livestock, well spacing, and many others). http://ehcitizens.org/cbmgas/index.htm

Montana Department of Environmental Quality
See their information on CBM Environmental and Economic Issues, which contains papers on agriculture, irrigation, water quality, air quality, biological issues, geology and soils, social and economic impacts, and other issues, including a study on *Potential Costs and Benefits to Montanans from CBM Development*. http://www.deq.state.mt.us/CoalBedMethane/index.asp

RESOURCES ON SLAPP SUITS

California Anti-SLAPP Project (CASP)
CASP is dedicated to helping protect and further the rights of Californians to participate in government and civic affairs and to speak freely about public issues. CASP maintains a resource and information center about California SLAPPs. CASP also provides legal assistance and representation to individuals and organizations to defend against SLAPPs.
Phone: 510-486-9123
http://www.casp.net

First Amendment Project (FAP)
FAP is a nonprofit public interest law firm active in two main areas of First Amendment law: anti-SLAPP and open government. FAP provides legal representation to individuals and organizations to defend against SLAPPs.
Phone: 510-208-7744
http://www.thefirstamendment.org

Political Litigation Project, University of Denver School of Law
The Political Litigation Project is run by University of Denver Professors George Pring and Penelope Canan, the leading authorities on SLAPPs. They have a wealth of knowledge about SLAPPs all over the United States, and beyond.
Phone: 303-871-2049

SLAPP Resource Center
http://www.slapps.org

NONPROFIT ORGANIZATIONAL RESOURCES FOR SURFACE OWNERS

For landowners facing gas well development, a number of resources are available. Information on various issues including how to negotiate with an oil and gas company and developing a surface use agreement can be accessed by contacting the nonprofit organizations and/or visiting the websites of the groups listed below. (As well as the groups listed in the Coalbed Methane Resources section.

East of Huajatolla Citizens Alliance in Colorado
This organization has useful information sheets on coalbed methane, and many of these fact sheets are useful for those dealing with conventional oil and gas extraction (e.g., topics such as Surface Use Agreements, Pooling, Force Pooling, Spacing, Citizens Rights and Responsibilities, and many others).
Phone: 719-941-4740 http://www.ehcitizens.org/cbmgas

Northern Plains Resource Council
This Montanta organization has produced a number of publications for surface owners, including *Coal Bed Methane - A guide to protecting your property*, and *Your Lands, Your Rights.*
Phone: 406-248-1154
http://www.northernplains.org

Oil and Gas Accountability Project
This Colorado/New Mexico group has produced this guide, along with various other materials that are helpful for surface owners.
Phone: 970-259-3353
http://www.ogap.org

Powder River Basin Resource Council
Located in Wyoming, this group has a section on their web site "Help for Surface Owners," which includes example legal documents, surface damage agreement checklist and a lot of other great information.
Phone: 307-358-5002 or 307-672-5809
http://www.powderriverbasin.org/helpforsurface_owners.htm

Western Organization of Resource Councils
A Montana-based group with a number of reports and fact sheets that may be useful to landowners (See also CBM resources above). These include: *How to Negotiate; How to Deal With Intimidation* and *Protecting Surface Owners and Promoting Responsible Coal Bed Methane Development*
Phone: 406-252-9672
http://www.worc.org

Michigan Land Use Institute
This organization has a great deal of information on surface owner issues with oil and gas. They also have a *Leasing Packet for Michigan Property Owners*, which includes educational information, tips on negotiating a lease, and model language for a lease addendum. According to the Institute, this packet has helped numerous property owners receive higher royalty rates, and establish protections for their surface land and groundwater. The leasing packet is free to Institute members, and is $15 for non-members.
Phone: 231-882-4723
http://www.mlui.org

GOVERNMENT-PRODUCED LANDOWNER GUIDES AND RESOURCES

A Landowner's Guide to Oil and Gas in Alabama, by Strudwick Marvin Rogers, J.D., and Lisa Lee Mancini. 26 p. 1991. $4.50. Order from Alabama Oil and Gas Board.
http://www.ogb.state.al.us/

Landowners Guide on Oil and Gas Leasing. Ohio Department of Natural Resources. Free Brochure. http://www.ohiodnr.com/mineral/oil/o6.htm

Answers to Typical Questions from the Public and Information for Surface Owners. Colorado Oil and Gas Conservation Commission. http://oil-gas.state.co.us/General.html

Landowners and Oil and Gas Leases in Pennsylvania. Department of Environmental Protection. Fact Sheet. http://www.dep.state.pa.us/dep/deputate/minres/oilgas/fs2834.htm

A Landowner's Guide to Oil and Gas Leasing. New York State Department of Environmental Conservation, Division of Mineral Resources. Brochure. http://www.dec.state.ny.us/website/dmn/Lndownrguide.htm

OTHER LANDOWNER AND MINERAL OWNER RESOURCES

David, Rick D. April 2000. *Conflicts Between Surface Owners and Mineral Lessees.* Internal Paper, Cotton, Bledsoe, Tighe & Dawson, P.C., Attorneys at Law (Midland, Texas). http://www.cbtd.com/news/conflicts.pdf

National Association of Royalty Owners (NARO) is geared toward mineral owners. They have free brochures, and paid publications on mineral deeds, leasing, *How to Survive Force Pooling*, and other topics. http://www.naro-us.org/index.shtml

PETEX Publications. *Land and Leasing*. This manual is for landowners, landmen, lawyers, and investors as well as all oil company employees. It takes a layperson's approach to the legal aspects of land-ownership, transfer, and leasing, privately owned land; state and federal lands; preparations for drilling, producing, and selling; agreements to explore and develop leased properties; and pooling, unitization, and release. It uses examples from Alaska, California, Louisiana, and Canada, Kansas, Michigan, New Mexico, North Dakota, Oklahoma, Texas, and Wyoming. 1984, 287 pp. $21. http://www.utexas.edu/cee/petex/pubs/reference.html

Purdue University Agricultural Economics Department. *Negotiating Oil and Gas Leases on Indiana Farmland.* http://www.agcom.purdue.edu/AgCom/Pubs/EC/EC-564.html

Real Estate Center at Texas A&M University has information for mineral owners and surface owners. Topics include: Negotiating Leases; Scrutinzing Royalty Payments; Recovery of Surface Damages and Remediation Costs; Subdivision Drill Sites, and more. http://recenter.tamu.edu/pubs/catoilg.html

Straube, Michele and Holland, Melinda. March, 2003. *A Conflict Assessment of Split Estate Issues and a Model Agreement Approach to Resolving Conflicts Over Coalbed Methane Development in the Powder River Basin.* Prepared For: U.S. Institute for Environmental Conflict Resolution. http://www.ecr.gov/pdf/CAR.pdf

NONPROFIT ORGANIZATIONS WORKING ON OIL, NATURAL GAS AND CBM ISSUES

NATIONAL AND REGIONAL ORGANIZATIONS

Oil and Gas Accountability Project
OGAP works with citizens and communities from the U.S. and Canada. Visit OGAP's web site for information on: general oil and gas issues; public health and toxics; alternative technologies and practices; federal and state regulatory reform; model local regulations; and surface owner protections.

Durango, Colorado Office
Phone: 970-259-3583
Email: gwen@ogap.org;
bruce@ogap.org;
lisa@ogap.org;
carolyn@ogap.org

Bozeman, Montana Office:
Phone: 505-776-3276
Email: jennifergoldman@ogap.org
http://www.ogap.org

Natural Resources Defense Council
Headquarters: New York
Phone: (212) 727-2700
Email: nrdcinfo@nrdc.org
http://www.nrdc.org

The Wilderness Society
Head office: Washington, DC
Phone: 1-800-THE-WILD
http://www.wilderness.org

Western Organization of Resource Councils
WORC is a regional network of seven grassroots community groups from Montana, North Dakota, South Dakota, Idaho, Oregon, Montana, and Colorado. WORC also has an office in Washington, DC.
Phone: 406-252-9672
Email: billings@worc.org; dc@worc.org
http://www.worc.org

STATE-BASED ORGANIZATIONS

Alaska

Alaska Center for the Environment, Anchorage
Phone: 907-574-3647
Email: cliff@akcenter.org http://www.akcenter.org

Cook Inlet Keeper, Homer
Phone: 907-235-4068
Email: bob@inletkeeper.org
http://www.inletkeeper.org

Denali Citizens Council, Denali Park
Phone: 907-683-2593
Email: leslie@denalicitizens.org
http://www.denalicitizens.org

Friends of Mat-Su (Alaska), Palmer
Phone: 907-746-0130
Email: cbm@pobox.mtaonline.net
http://www.foms.net

Northern Alaska Environmental Center, Fairbanks
Phone: 907-452-5021Email: info@northern.org
http://www.northern.org/artman/publish/coalBed.shtml

Colorado

Grand Valley Citizens Alliance, Parachute
Phone: 970-285-6276

San Juan Citizens Alliance, Durango (works in San Juan Basin)
Phone: 970-259-3583
Email: dan@sanjuancitizens.org; mpearson@frontier.net
http://www.sanjuancitizens.org

Southern Colorado CURE, Weston
Phone: 719-846-6863
Email: pbieber@sensonics.org

Western Colorado Congress, Grand Junction
Phone: 970-256-7650
Email: info@wccongress.org
http://www.wcccongress.org

Western Slope Environmental Resource Council, Paonia
Phone: 970-527-5307
Email: wserc@wserc.org
http://www.wserc.org

Kentucky

Kentucky Resources Council, Frankfort
Phone: 502-875-2428
Email: fitzkrc@aol.com
http://www.kyrc.org

Montana

Greater Yellowstone Coalition, Bozeman
Phone: 406-586-1593
Email: mfrost@greateryellowstone.org
http://www.greateryellowstone.org

Native Action, Lame Deer
Phone: 406-477-6390
Email: gsmall@rangeweb.net

Northern Plains Resource Council, Billings
Phone: 406-248-1154
Email: teresa@northernplains.org;
http://www.northernplains.org

Surface Owners of the Wolf Mountain Area, Billings
Phone: 406-259-9295
Email: sowmacrow2002@hotmail.com

New Mexico

San Juan Citizens Alliance, San Juan Basin
Aztec, New Mexico
Phone: 505-360-8994
Email: cynthia@sanjuancitizens.org
http://www.sanjuancitizens.org

Coalition for Otero Mesa
Phone: 505-843-8696
Email: steve@nmwild.org; nathan@nmwild.org
http://www.oteromesa.org

Coalition for Valle Vidal
Phone: 505-758-3874
Email: jodonnell@vallevidal.org
http://www.vallevidal.org

North Dakota

Dakota Resource Council, Dickinson
Phone: 701-483-2851Email: drc@dickinson.ctctel.com
http://www.drcinfo.com

Pennsylvania

Allegheny Defense ProjectClarion
Phone: 814-223-4996
Email: info@alleghenydefense.org
http://www.alleghenydefense.org

Utah

Southern Utah Wilderness Alliance
Salt Lake City
Phone: 801-486-3161
Email: heidi@suwa.org; sean@suwa.org
http://www.suwa.orgWest

Virginia

Legal Aid of West Virginia, Charleston
Contact: David McMahon
Email: wvdavid@wvdavid.net

Wyoming

Biodiversity Conservation Alliance, Laramie
Phone: 307-742-7978
Email: erik@voiceforthewild.org
http://www.biodiversityassociates.org

Clark Resource Council, Clark (front range of Beartooth Mountains)
Email: dthomas@nemontel.net
http://www.clarkresourcecouncil.org

Powder River Basin Resource Council, Sheridan
Phone: 307-672-5809
Email: jillm@powderriverbasin.org; gillian@powderriverbasin.org
http://www.powderriverbasin.org

Wyoming Outdoor Council, Lander
Phone: 307-332-7031
http://www.wyomingoutdoorcouncil.org

STATE REGULATORY AGENCIES

State Oil and Gas Regulatory Agencies		Contact Information
Alabama	State Oil and Gas Board	http://www.ogb.state.al.us Ph: 205-349-2852
Alaska	Oil and Gas Conservation Commission	http://www.state.ak.us/local/akpages/ADMIN/ogc/homeogc.htm Ph: 907-279-1433
	Department of Natural Resources, Division of Oil and Gas	http://www.dog.dnr.state.ak.us/oil/ Ph: 907-269-8800
Arizona	Oil and Gas Conservation Commission	http://www.azgs.state.az.us/OGCC.htm Ph: 520-770-3500
Arkansas	Oil and Gas Commission	http://www.aogc.state.ar.us/ Ph: 501-862-4965
California	Department of Conservation, Division of Oil, Gas and Geothermal Resources	http://www.consrv.ca.gov/DOG/ Ph: 916-445-9686
Colorado	Colorado Oil and Gas Conservation Commission	http://oil-gas.state.co.us/ Ph: 303-894-2100
Florida	Department of Environmental Protection, Geological Survey	http://www.dep.state.fl.us/geology/ Ph: 850-488-4191
Georgia	Natural Resources/Environmental Protection	http://www.dnr.state.ga.us/dnr/environ/ Ph: 404-751-6612
Idaho	Department of Lands, Bureau of Surface and Mineral Resources, Oil and Gas Conservation Commission	http://www2.state.id.us/lands/Bureau/Surface_and_Mineral_Resources/Surface_Minerals_Resource_Mngmnt_Bur.htm Ph: 208-334-0200
Illinois	Illinois Department of Natural Resources, Division of Oil and Gas	http://dnr.state.il.us/mines/dog/welcome.htm Ph: 217-782-7756
Indiana	Indiana Department of Natural Resources, Division of Oil and Gas	http://www.state.in.us/dnroil/ Ph: 317-232-4055
Kansas	Kansas Corporation Commission, Conservation Division	http://www.kcc.state.ks.us/conservation/conservation.htm Ph: 315-337-6200
Kentucky	Department of Mines and Minerals, Division of Oil and Gas	http://dmm.ppr.ky.gov/OilAndGas.htm Ph: 502-573-0147
Louisiana	Department of Natural Resources, Office of Conservation	ttp://www.dnr.state.la.us/cons/conserv.ssih Ph: 225-342-5570
Michigan	Department of Environmental Quality, Geological and Land Management Division	http://www.michigan.gov/deq/0,1607,7-135-3311_4111--,00.html Ph: 517-373-7917
Mississippi	Oil and Gas Board	http://www.ogb.state.ms.us Ph: 601-354-7142
Missouri	Department of Natural Resources, Geological Survey and Resource Assessment Division	http://www.dnr.mo.gov/geology/geosrv/oil.htm Ph: 573-368-2100
Montana	Department of Natural Resources and Conservation, Montana Board of Oil and Gas Conservation	http://bogc.dnrc.state.mt.us/ Ph: 406-656-0040
Nebraska	Oil and Gas Conservation Commission	http://www.nogcc.ne.gov Ph: 308-254-6919
Nevada	Commission on Mineral Resources; Division of Minerals, Oil, Gas and Geothermal	http://minerals.state.nv.us/programs/ogg.htm Ph: 775-684-7040

New Mexico	Energy, Minerals and Natural Resources Department, Oil Conservation Commission	http://www.emnrd.state.nm.us/ocd Ph: 505-476-3440
New York	Department of Environmental Conservation, Division of Mineral Resources	http://www.dec.state.ny.us/website/dmn Ph: 518-402-8076
North Dakota	Industrial Commission, Oil and Gas Division	http://www.oilgas.nd.gov/ Ph: 701-328-8020
Ohio	Ohio Department of Natural Resources	http://www.ohiodnr.com/mineral/oil Ph: 614-265-6633
Oklahoma	Corporation Commission, Oil and Gas Conservation Division	http://www.occ.state.ok.us/Divisions/OG/Og.htm Ph: 405-521-2211
Oregon	Department of Geology and Mineral Industries; Oil, Gas and Geothermal Regulatory and Reclamation Program	http://www.oregongeology.com/oil/oilhome.htm Ph: 503-731-4100
Pennsylvania	Department of Environmental Protection, Bureau of Oil and Gas Management	http://www.dep.state.pa.us/dep/deputate/minres/oilgas/oilgas.htm Ph: 717-772-2199
South Dakota	Department of Environment and Natural Resources, Minerals and Mining Program	http://www.state.sd.us/denr/des/mining/oil&gas/o&ghome.htm Ph: 605-394-2229
Tennessee	Department of Environment and Conservation, State Oil and Gas Board	http://www.state.tn.us/environment/boards/oilandgas.php Ph: 615-532-1500
Texas	Railroad Commission, Crude Oil and Natural Gas	http://www.rrc.state.tx.us/divisions/og/og.html Ph: 512-463-6977
Utah	Division of Oil, Gas and Mining	http://www.ogm.utah.gov/oilgas/ Ph: 801-538-5277
Virginia	Department of Mines, Minerals and Energy, Division of Gas and Oil	http://www.mme.state.va.us/Dgo/default.htm Ph: 276-676-5423
Washington	The Department of Natural Resources, Division of Geology and Earth Resources, Energy (Oil and Gas) Regulation	http://www.dnr.wa.gov/geology/energy.htm Ph: 360-902-1450
West Virginia	Department of Environmental Protection, Office of Oil and Gas	http://www.dep.state.wv.us/item.cfm?ssid=23 Ph: 304-558-6075
Wyoming	Wyoming Oil and Gas Conservation Commission	http://wogcc.state.wy.us/ Ph: 307-777-7434

Glossary of Oil and Gas Terms

glossary

A

abandoned well
A well no longer in use, whether dry or no longer productive, and the previous operator has intentionally relinquished its interest in the well.

abstract (of title)
A chronological history of the ownership or events affecting a particular piece of property; prepared by an abstract or title company.

acidizing
A procedure in which acid (often hydrochloric acid) is pumped into a reservoir to dissolve calcite in order to increase oil or gas production.

air emissions
Waste gases, vapors and small particles released into air.

anniversary date (of lease)
The date, usually one year from the effective date of a lease, by which rentals must be paid to maintain the lease in effect in the absence of drilling or production.

aromatics
Hydrocarbons that are characterized by unsaturated ring structures of carbon atoms. Commercial petroleum aromatics are benzene, toluene, and xylene.

associated gas
Natural gas that overlies or contacts oil in a reservoir.

B

basin
A large natural depression on the earth's surface in which sediments, typically waterborne, accumulate.

battery
Storage facility receiving production from a well or wells. Includes equipment for separating the fluid into oil, gas and water for measurement, as well as containers for holding the separated fluids, e.g., tanks.

Bcf
The abbreviation for billion cubic feet of gas.

beam pumping unit
A machine designed specifically for sucker rod pumping. An engine or motor (prime mover) is mounted on the unit to power a rotating crank. The crank moves a horizontal member (walking beam) up and down to produce reciprocating motion. This reciprocating motion operates the pump.

benzene
An aromatic hydrocarbon present to a minor degree in most crude oils. Used in manufacturing detergents, synthetic fibers, and petrochemicals, as a solvent, and as a component of high-octane gasoline. Is a known carcinogen.

bit
The cutting or boring element used in drilling oil and gas wells.

BLM
Abbreviation for the Bureau of Land Management, a federal department.

blowout
An uncontrolled flow of gas, oil, or other well fluids or materials from a well.

blowout preventer
One or more valves installed at the wellhead to prevent the escape of pressure and substances during drilling or completion operations.

bond
A financial guarantee supplied by the oil or gas company to ensure the reclamation of the lands disturbed by oil and gas development. If required reclamation is not completed, the state or federal agencies or surface owner can use the money supplied by the bond to complete the necessary work.

bonus
The cash amount paid by a lessee (e.g., an oil or gas company) to the owner of the leasing rights, usually upon execution of an oil and gas lease. May take other forms than cash. Some lessors, for tax reasons, may request partial payment over a number of years.

borehole
The hole created in the earth when a well is drilled or bored.

brine
Water that has a quantity of salt, especially sodium chloride, dissolved in it; salt water.

C

carbon dioxide
A colorless, odorless, gaseous compound of carbon and oxygen; it is a product of incomplete combustion.

carcinogenic
Causes cancer.

casing
Steel pipe that is placed in the borehole and cemented in to prevent the hole from collapsing; and to prevent movement of drilling fluids from the borehole into the formation, or fluids from one formation to another. Casing operations occur periodically throughout the drilling process starting with the surface casing and ending with production string which takes place during well completion.

cementing
The application of a liquid slurry of cement and water to various points inside or outside the casing in order to support the casing and prevent fluid migration between permeable zones.

chain of title
Recorded transfers (links) in title of property from patent to present.

christmas tree
The system of control valves, pressure gauges and related equipment that is located on top of The well at ground level to controls the flow of oil and/or produced from the well. It is used when reservoir pressure is sufficient to cause reservoir fluids to rise to the surface.

complete a well
To finish work on a well and bring it to productive status.

compressor
A device that raises the pressure of a compressible substance such as vapor or gas, and creates a pressure differential to move the vapor or gas.

compulsory pooling
Also known as forced pooling, it is the right, granted by a state regulatory body, for a company to include adjacent tracts in its drilling unit, even if the company owning the lease on that tract does not want to be included or the individual mineral owner of the tract does not want to lease. Certain payments are due the mineral owners of compulsory pooled tracts.

condensate
The liquid resulting when a vapor is subjected to cooling or application of pressure. Also, liquid hydrocarbons condensed from gas and oil wells.

covenant
A promise to do something. Under a lease there are two types of covenants: (a) stipulated, i.e., set out in the lease, (b) implied, i.e., interpreted by and the courts to be present in the lease whether written out or not. Implied covenants may include fully developing the property, diligence in marketing of the production, etc.

crude oil
Unrefined liquid petroleum.

cuttings
The fragments of rock cut from the formation by the drill bit and brought to the surface in the drilling mud. Used by geologists to obtain information about the formations.

D

damages
Compensation paid by an operator to the surface owner for actual and potential damage to the surface and crops in the drilling and operation of a well.

deed
A written document transferring ownership of a piece of property. A mineral deed conveys only an interest in the minerals.

dehydration
The process of removing moisture.

delay rentals
The payment made to the lessor (e.g., oil or gas company) for the privilege of continuing the lease without drilling on it. This payment is usually made annually if drilling does not take place.

development well
A well drilled within the proved area of an oil or gas reservoir to the depth of a geological formation known to be productive.

directional drilling
Drilling at an angle from the vertical. Controlled directional drilling makes it possible to reach subsurface areas laterally distant from the point where the drill bit enters the earth.

disposal well
Well used for disposal of produced water into an underground formation.

downhole
Pertaining to the wellbore, as opposed to activities and equipment associated with the surface.

drill bit
The cutting or boring element used in drilling oil and gas wells. The bit consists of the cutting elements and the circulating element. The circulating element allows the passage of drilling fluid and uses the hydraulic force of the fluid to improve drilling rates.

drill cutting analysis
Also known as drill core analysis, it is the analysis of cuttings or core samples to determine characteristics such as porosity, permeability and probable productivity of the formation.

drilling fluid
Specially formulated liquid circulated through the wellbore during rotary drilling operations. Used to bring cuttings from the wellbore to the surface; to lubricate and cool the drill bit, string, line, and walls of the well; and provides weight to counteract downhole formation pressure. Also known as drilling mud.

drilling mud
See drilling fluid.

drilling unit
The maximum area from which one well can efficiently and effectively extract the oil or gas. Drilling unit size is determined by a state agency.

drilling window
The section of a drilling unit where drilling must take place.

dry gas
Natural gas that does not have a significant content of liquid hydrocarbons or water vapor.

dry hole
A drilled well that does not produce oil or gas in commercial quantities.

E

easement
A temporary right given to a non-owner of the land for a specific purpose; i.e., an easement to lay a pipeline from a well, cross the land with a road, etc.

EPA
Abbreviation for the Environmental Protection Agency, a federal department.

egress
The act of getting out or leaving.

estates in land
The various types of land ownership, e.g., fee simple or split estate.

enhancement (of production)
The use of various processes to increase the displacement of oil from the reservoir, e.g., gas injection, flooding and waterflooding. Also known as secondary recovery.

exploration phase
The phase of operations that covers the search for oil or gas by carrying out detailed geological and geophysical surveys, and, if appropriate, exploratory drilling.

exploratory well
A well that is drilled for the purpose of securing geological or geophysical information to determine the viability of developing oil, gas, geothermal, or other mineral resources. It includes what is commonly referred to in the industry as "slim hole tests," "core hole tests," or "seismic holes".

erosion
The process by which materials, such as rock or soil, are worn away or removed (as by wind or water).

F

fee simple estate
This form of estate is not qualified by any other interest and, upon the owner's death, passes unconditionally to the heirs.

field
An area of oil and gas production with at least one common reservoir for the entire area. There may be two or more reservoirs in a field that are separated vertically by intervening impermeable geologic layers, or laterally by local geologic barriers, or by both.

flaring
burning of hydrocarbon gases for commercial or technical reasons.

flooding
Forcing oil from a reservoir into a well by injecting water or chemicals under pressure into the reservoir formation. See waterflooding.

flow line
The surface pipe through which oil or gas travels from a well to processing equipment or to storage.

flowing well
A well that produces oil or gas by its own reservoir pressure rather than by use of artificial means such as pumps.

forced pooling
See compulsory pooling.

formation
A layer of rock with distinct features such as texture or mineral composition. The thickness of a geological formation can range from a few feet to several hundred feet.

formation fluid
A fluid, such as gas, oil, or water, that exists in a subsurface or geological formation.

fracing fluid
A fluid such as water, oil or acid, used in the hydraulic fracturing process. Under extremely high hydraulic pressure these fluids are pumped downward through production tubing. The pressure causes cracks to open in the formation, and the fluid penetrates the formation through the cracks. The fluid also carries substances called proppants that hold open the formation cracks after hydraulic pressure dissipates. Also known as frac, fracturing or hydraulic fracturing fluid.

fracturing
A method of stimulating oil or gas production by opening new flow channels in the formation surrounding a production well. It involves pumping of crude oil, diesel, water, or chemical into a reservoir with such force that the reservoir rock is broken and results in greater flow of oil or gas from the reservoir. Also known as hydraulic fracturing or fracing.

G

gas well
A well that primarily produces gas. Legal definitions vary among the states.

gas field
A field containing natural gas but no oil.

gas injection
A secondary recovery method whereby dry natural gas or carbon dioxide is injected into an oil reservoir to increase pressure around the injection well and thus increase flow and oil production from nearby wells.

gas processing
Separation of oil and gas, and removal of impurities and from natural gas.

gathering line
A pipeline that transports oil or gas from a central point of production to a gas transmission line or mainline.

gel
A semisolid, jellylike substance.

geologist
A scientist who gathers and interprets data pertaining to the formations of the earth's crust.

grant
To give title or ownership by deed or other instrument to another.

greenhouse gases
Gases (e.g., water vapor, carbon dioxide, methane, nitrous oxide, CFCs, and ozone) that alter thermal properties of atmosphere.

H

heavy oil
Hydrocarbons composed of long chains of hydrogen and carbon atoms

horizontal drilling
A drilling technique where a well is drilled vertically to a certain depth and then drilled at a right angle so that the borehole penetrates a productive formation in a manner parallel to the formation.

hydraulic fracturing
An operation in which a specially blended liquid is pumped down a well and into a formation under pressure high enough to cause the formation to crack open, forming passages through which oil or gas can flow into the wellbore. See also fracturing.

hydrocarbons
Organic compounds composed of hydrogen and carbon. Their densities, boiling points, and freezing points increase as their molecular weights increase. The smallest molecules of hydrocarbons are gaseous; the largest are solids. Petroleum is a mixture of many different hydrocarbons.

hydrogen sulfide
Chemical formula H2S, also known as sour gas. It is a flammable, colorless gas that is often associated with oil and gas development. Hydrogen sulfide is toxic and smells like rotten eggs at low concentrations. It is heavier than air, and may accumulate in low-lying areas.

I

impermeable
preventing the passage of fluid. A formation may be porous yet impermeable if there is an absence of connecting passages between the voids within it.

independent producer
An energy company, usually in the exploration and production segment of the industry and generally, with no marketing, transportation or refining operations. A non-integrated producing company in the oil industry.

ingress
The act of entering.

injection water
Water that is introduced into a reservoir to help drive hydrocarbons to a producing well. May also refer to produced water that is introduced into a formation other than the one from which it was extracted.

injection well
A well through which fluids are injected into an subsurface formation to increase reservoir pressure and to displace oil (e.g., during oil enhancement or waterflooding operations). Also called an input well.

L

landman
An employee of an oil and gas company or an agent for the company who negotiates oil and gas leases with mineral owners, cures title defects, and negotiates with other companies on agreements concerning the lease. Landmen may become certified by passing an exam given by the American Association of Professional Landmen.

lease
A legal instrument that could be a contract, profit-share agreement, joint venture or other agreement between a mineral owner (lessor) and another party (lessee) that grants exclusive right to the lessee to explore for, drill, produce and remove oil or gas from a piece of land.

legal description
An adequate description of land which enables a surveyor to locate a tract of land. Two systems of land surveys exist in the United States: (1) the metes and bounds system describes the boundaries of parcel of land; and (2) the rectangular survey system describes land parcels using equal-sized townships, sections and fractions thereof. A legal description is essential in deeds, land contracts, mortgages, wills and leases.

lessee
The person or party who receives the lease, sometimes called the tenant.

lessor
The person or party giving the lease, sometimes called grantor or landlord.

liquified natural gas (LNG)
Natural gas that is cooled to about -260°F at normal pressure, resulting in the condensation of the gas into liquid form. LNG takes up about 1/600th of the volume of gaseous natural gas, which decreases the cost of transporting the natural gas. But LNG is costly to produce, and thus, only accounts for 1 % of the natural gas used in the United States.

log
A systematic recording of data, such as a driller's log, mud log, electrical well log, or radioactivity log. Many different logs are run down wells to discern various characteristics of downhole formation.

M

Mcf
Abbreviation for one thousand cubic feet.

MMcf
Abbreviation for one million cubic feet.

methane
A gaseous hydrocarbon (at normal temperature and pressure) consisting of one carbon atom and four hydrogen atoms. Chemical formula CH4.

mineral
A naturally occurring homogeneous substance that is obtained from the ground for human use (e.g., stone, coal, salt, sulfur, sand, petroleum, water, natural gas).

mineral estate
The ownership of minerals lying below the surface of land, and considered to be "real property." The mineral ownership may or may not be tied to surface ownership.If the surface ownership and the mineral ownership are different, the minerals are said to be "severed."

monitoring
The periodic observation and orderly collection of data to evaluate the effects of oil and gas development.

mud
The liquid circulated through the wellbore during rotary drilling and workover operations. Also known as drilling fluid.

mud pit
Originally, an open pit dug in the ground to hold drilling fluid or waste materials discarded after the treatment of drilling mud. For some drilling operations, mud pits are used for suction to the mud pumps, settling of mud sediments, and storage of reserve mud. Steel tanks are much more commonly used for these purposes now, but they are still usually referred to as pits.

mud tank
A series of open tanks, usually made of steel, through which the drilling mud is cycled to allow sand and sediments to settle out.

N

natural gas
A highly compressible, highly expansible mixture of hydrocarbon and small quantities of non-hydrocarbons, with a low specific gravity, and occurring naturally in a gaseous form. Found in porous formations beneath the earth's surface, often in association with petroleum. The principal constituent is methane.

natural gas processing plant
A facility designed to recover natural gas liquids from the stream of natural gas which may or may not have been processed through field facilities; and to control the quality of the natural gas to be marketed.

Natural Gas Liquids (NGL)
Hydrocarbon liquids extracted from natural gas.

NO_X
Nitrogen oxides, which are gases containing nitrogen and varying number of oxygen atoms. Some sources of these gases include motor vehicle exhaust, burning of diesel fuel, coal, and flaring of methane. The brown haze sometimes seen over cities is mainly nitrogen oxides. These gases are also partly responsible for the generation of ozone. Exposure to high levels of nitrogen dioxide can interfere with the ability of blood to carry oxygen, leading to dizziness and shortness of breath. Prolonged exposure can lead to respiratory failure.

O

oil
A simple or complex liquid mixture of hydrocarbons that can be refined to yield gasoline, kerosene, diesel fuel, and various other products.

oil field
The surface area overlying an oil reservoir or reservoirs. The term usually includes not only the surface area, but also the reservoir, the wells, and the production equipment.

open hole
Any well in which casing has not been set, or an open or cased hole in which no drill pipe or tubing is suspended.

open-hole completion
A method of preparing a well for production whereby no production casing or liner is installed opposite the producing formation. Reservoir fluids flow unrestricted into the open wellbore.

operator
A person or company that operates a well or lease. Generally, the oil or gas company that engages the drilling, service, and workover contractors.

offshore drilling
Techniques used in the search for petroleum deposits beneath the oceans. The drilling is conducted from large, fixed platforms of special design that can withstand all but the most violent of storms.

onshore drilling
Techniques used in the search for oil and gas deposits beneath the surface of the land.

ozone
A gas containing three oxygen atoms in each molecule, chemical formula O_3. Ozone forms in atmosphere when nitrogen oxides and organic gases emitted by automobiles and industrial sources are exposed to sunlight.

P

PAH
Abbreviation for polynuclear aromatic hydrocarbon; also called polycyclic aromatic hydrocarbons. PAHs are hydrocarbon compounds with multiple benzene rings. Typically, they are components of asphalts, crude oil, coal, coal tar pitch, fuels, and greases. Also, PAHs are formed during the incomplete burning of coal, oil, and gas. Studies of people show that individuals exposed by breathing or skin contact for long periods to mixtures that contain PAHs and other compounds can also develop cancer. EPA has determined that the PAHs benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene are probable human carcinogens.

paraffin
A saturated aliphatic hydrocarbon having the formula CnH_2n+2 (for example, methane, CH_4; ethane, C_2H_6). Heavier paraffin hydrocarbons (for example, $C_{18}H_{38}$) form a waxlike substance that is called paraffin. These heavier paraffins often accumulate on the walls of tubing and other production equipment, restricting or stopping the flow of the desirable lighter paraffins.

perforation
A hole made in the wellbore casing, cement, and into the formation, thus allowing oil or gas to flow into the wellbore.

permeability
Ability of rock to transmit fluids through pore spaces.

petroleum
A substance occurring naturally in the earth in solid, liquid, or gaseous state and composed mainly of mixtures of chemical compounds of carbon and hydrogen. Petroleum may contain nonmetallic elements such as sulfur, oxygen, and nitrogen. In some cases, petroleum refers only to oil. When used more generally, however, it is the name for hydrocarbons, including crude oil and natural gas and their projects.

pit
Hole dug out in the ground surface for temporary storage of fluids during drilling operations.

plug
Any object or device that blocks a hole or passageway, such as a cement plug in a borehole, which seals off formations to stop open communication of formation fluids within a well.

particulate matter
A collective name for fine solid or liquid particles added to the atmosphere. Particulate matter includes dust, smoke, soot, pollen and soil particles.

pollution
Contamination of surface or subsurface air, waters or land.

pooling
Pooling is the combining of small or irregular tracts into a unit large enough to meet state spacing regulations for drilling permits. Not to be confused with unitization (below). See also compulsory and voluntary pooling.

porosity
The percentage of rock volume that can be occupied by oil, gas or water.

primary recovery
Also known as primary production. Primary recovery is the first stage of hydrocarbon production, and natural reservoir pressure is often used to recover oil. When natural pressure is not sufficiently capable of forcing oil to the surface, artificial lift equipment, e.g., a pump, is used. Primary production accounts for less than 25 % of the original oil in place. To recover a portion of the remaining oil, secondary recovery methods are used.

primary term
The period of time during which a lease may be kept alive by a lessee (even though there is no production in paying quantities) by virtue of drilling operations on the leased lands or the timely payment of rentals.

processing plant
A plant where liquefiable hydrocarbons are removed.

producer
Any party owning, controlling, managing, or leasing any gas well and/or any party who produces in any manner natural gas by taking it from the earth or waters.

produced water
Liquids produced during the drilling and production operations. Produced water usually is composed of groundwater and by-products of the drilling operations, e.g., mud, drilling lubricants, and oil. The volume of coalbed methane produced water is orders of magnitude greater than water associated with conventional oil and gas production.

production
The phase of the petroleum industry that deals with bringing the well fluids to the surface and separating them and storing, gauging, and otherwise preparing the product for delivery. Also, may refer to the amount of oil or gas produced in a given period.

proppants
Sand grains, aluminum pellets, walnut shells, or similar materials that are carried by fracing fluid during hydraulic fracturing. When the pressure is released at the surface, the fracturing fluid returns to the well but leaves behind the propping agents to hold open the formation cracks.

proved reserves
The estimated quantities of oil or natural gas that geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions.

pump
A device that increases the pressure on a fluid or raises it to a higher level. Various types of pumps include the bottom hole pump, centrifugal pump, hydraulic pump, jet pump, mud pump, reciprocating pump, rotary pump, sucker rod pump, and submersible pump.

pump jack
A surface unit similar to a pumping unit but having no individual power plant. Usually, several pump jacks are operated by pull rods or cables from one central power source.

R

reclamation
The restoration of lands disturbed by oil and gas activity to some specified end, e.g., productive use. Activities usually include recontouring and reseeding the land.

record title
The ownership of an interest which is determinable from the county records in which the property is located. Record title may be different than actual ownership where there are assignments or letter agreements unrecorded. Under federal leases, the official chain of title is kept by the government. Each time lease ownership changes, the changes must be made with the government and an instrument also filed in the county records to update both.

recording
The act of placing an instrument in the county or parish records. The recording is required to put all concerned of notice that a transaction has occurred. If a document is not recorded, it may be invalid and voided.

regulation
A rule or order, which is issued by an agency of the executive branch of government, that has the force of law. Regulations must be authorized by a statute and generally provide more details on a particular subject than does the authorizing statute.

refinery
An industrial operation that manufactures finished petroleum products from crude oil, unfinished oils, natural gas liquids, other hydrocarbons, and oxygenates.

reinjection
The introduction of produced water into the same formation from which it was extracted, as opposed to injection, which is the introduction of produced water into a different formation.

reservation
Action by the federal government reclassifying a tract of land to a specified purpose, e.g., wildlife preservation; or action to hold back or reserve a portion of rights, e.g., a mineral owner (or "grantor") may reserve a royalty interest in the minerals. For example, an oil company may receive"...all the right, title and interest in the above described property, save and except 1/16 royalty interest herein reserved to Grantor...".

reserve pit
It is usually an excavated, earthen-walled pit. It may be lined with plastic or other materials to prevent soil contamination. It may be used to store water, drilling fluid, or drill cuttings and wash water during drilling operations, or as a waste pit for spent drilling fluid. If used to store drilling fluids, additives are mixed with the mud in the pit, and the fluid is temporarily stored there before being pumped back into the well.

reserve tank
A special mud tank that holds mud that is not being actively circulated. A reserve tank usually contains a different type of mud from that which the pump is currently circulating. For example, it may store heavy mud for emergency well-control operations.

reserves
The unproduced but recoverable oil or gas in a formation.

reservoir
The underground formation where oil and gas have accumulated. It consists of porous, permeable or fractured rock, which holds the oil or gas, and a cap rock that prevents its escape. Most reservoir rocks are limestones, dolomites, sandstones, or a combination of these.

rig
The derrick or mast, drawworks, and associated surface equipment of a drilling or workover unit.

rotary drilling
A drilling method in which a hole is drilled by a rotating bit to which a downward force is applied. The bit is fastened to and rotated by the drill stem, which also provides a passageway through which the drilling fluid is circulated. Additional joints of drill pipe are added as drilling progresses.

rotary rig
A machine, used for drilling wells, that employs a rotating tube attached to a bit for boring holes through rock.

royalty
An interest in an oil and gas lease that gives the owner of the interest the right to receive a portion of the production from the leased acreage (or a share of the proceeds of the sale of production). Normally, royalty interests are free of all costs of production (drilling or operating the wells), except production taxes.

royalty payment
The cash or kind paid to the owner of mineral rights.

S

salinity
A measure of the concentration of dissolved salts. Water is defined as saline if it contains 3 to 5% salt by volume, and highly saline water is referred to as brine. The ocean is naturally saline at approximately 3.5% salt. Salinity is an important ecological factor, as it influences the types of organisms that live in a body of water, or the kinds of plants that will grow either in a water body, or on land fed by saline water.

sandstone
A sedimentary rock composed of individual mineral grains of rock fragments between 0.06 and 2 millimeters (0.002 and 0.079 inches) in diameter and cemented together by silica, calcite, iron oxide, and so forth.

scale
Is essentially a mineral deposit (for example, calcium carbonate) that forms when minerals separate out of water. The minerals harden and can adhere and build up inside of pipes, heaters, and other equipment.

secondary recovery
Enhances the recovery of liquid hydrocarbons by repressurizing the reservoir and reestablishing or supporting the natural water drive. See also waterflooding and enhancement of production.

seismic tests
Measurements of seismic-waves in an effort to detect boundaries between different kinds of rocks; this detection assists in mapping of geologic structures.

setback
The minimum allowable horizontal distance from a given reference point (e.g., a drilling rig) to the vertical wall or other element of a principal building or structure (e.g., a house).

severed mineral interest
An interest, which is held by someone other than the surface owner, in the minerals in, on, and under a given tract of land.

shale
A fine-grained sedimentary rock composed mostly of consolidated clay or mud. Shale is the most frequently occurring sedimentary rock.

shale shaker
A vibrating screen used to remove cuttings from the circulating fluid in rotary drilling operations. Also called a shaker.

shut in
To close the valves on a well so that it stops producing; or to close in a well in which a kick has occurred.

shut-in well
A well that is capable of producing but is not being produced. Reasons for wells being shut in may be lack of a pipeline, lack of a market, etc.

sour gas
Natural gas containing significant quantities of sulfur and/or carbon dioxide, making it impractical to use without purifying, because of its corrosive effect on piping and equipment and its danger to human life.

sour crude
Crude oil contaminated by sulphur compounds, typically hydrogen sulfide. Sour crude has sulphur content above 1%.

spacing
The distance between wells allowed by the regulatory body. The spacing is based on what is deemed to be the amount of acreage that can be efficiently and economically drainedby a well.

split estate
When the surface and subsurface estates are owned by different parties. See also severed mineral interest.

spud in
The operation of drilling the first part of a new well.

statute
A law established when an act is passed by a state or federal legislature.

storage tank
Tank for storing an accumulation of oil prior to its transfer to a pipeline company or other purchaser.

sweet gas
Natural gas that contains little or no sulfur or sulfur components, and therefore no processing is necessary for their removal, and the gas may be used directly as a non-corrosive domestic heating fuel.

T

tank battery
A collection of tanks used for oil storage prior to delivery to a refinery.

tank farm
An installation used by gathering and trunk pipeline companies, crude oil producers, and terminal operators (except refineries) to store crude oil.

three dimensional (3-D) seismic
An advanced method for collecting, processing seismic data to yield a three-dimensional picture of the subsurface.

tight formation gas
Gas produced from a sedimentary layer of rock cemented together in a manner that greatly hinders the flow of any gas through the rock.

tight sand
A sand or sandstone formation with low permeability.

title opinion
A statement of opinion by an attorney, often in the form of a letter, as to the state of the title to land, minerals, royalty, or working interests.

tract
Any specific area of land.

trap
A geological structure in which hydrocarbons build up to from an oil or gas field.

U

Underground Injection Control (UIC)
A program required in each state by a provision of the federal Safe Drinking Water Act (SDWA) for the regulation of injection wells. An applicant must demonstrate that the well has no reasonable chance of adversely affecting the quality of an underground source of drinking water before a permit is issued.

unit
The area covered by a unitization agreement.

unitization
This occurs when companies pool their individual interests in return for an interest in an overall unit, which could be all or some portion of a producing reservoir. The unit is then operated by a single company on behalf of group. As contrasted to "pooling," unitization involves a group of wells in an area, rather than the pooling of leases to create an enough of an area to constitute a drilling unit for one well. It commonly occurs under secondary recovery operations, when a number of producers in a field recognize the need to have a field-wide strategy to increase overall production in the field.

USGS
Abbreviation for United States Geological Survey.

V

viscosity
The resistance that a fluid has to natural flow. Oil's viscosity is usually greater than an oil and gas mixture.

VOC
Abbreviation for volatile organic compound. VOCs are compounds that have a high vapor pressure and low water solubility. VOCs include benzene, toluene, ethylbenzene and xylene; trichloroethylene; fuel oxygenates, such as methyl tert-butyl ether (MTBE); and VOCs are often components of petroleum fuels, hydraulic fluids and paint thinners. VOCs are common groundwater contaminants.

voluntary pooling
pooling of leased mineral tracts willingly undertaken by all the parties involved, both working interest owners and royalty owners.

valve
A device used to control the rate of flow in a line to open or shut off a line completely, or to serve as an automatic or semiautomatic safety device.

venting
release of gases to atmosphere.

W

waterflooding
Injecting water into one well, thereby causing oil not recovered by primary production to migrate to an adjacent well.

water quality
The chemical, physical and biological characteristics of water with respect to its suitability for a particular use.

water well
A well drilled to obtain a fresh water supply.

well
The hole made by the drilling bit for the purpose of finding or producing crude oil or natural gas or providing services related to the production of crude oil or natural gas. Wells are classified as oil wells, gas wells, dry holes, stratigraphic or core tests, or service wells. A wells may also be referred to as a borehole, hole, or wellbore.

well log
A record of geological formation penetrated during drilling, including technical details of the operation.

well completion
The activities and methods of preparing a well for the production of oil and gas or for other purposes, such as injection; the method by which one or more flow paths for hydrocarbons are established between the reservoir and the surface.

well logging
The use of radioactive, electric, mechanical, and sonic tools to identify formation and other downhole properties of the well bore.

wellbore
The borehole or hole drilled by the bit. A wellbore may have casing in it or it may be open (uncased); or part of it may be cased, and part of it may be open. Also called a borehole, hole or well.

wildcat well
A well drilled in an area where no oil or gas production exists. A well drilled for the purpose of discovering a new field or reservoir, as opposed to a development well, which is drilled in an area known to be productive.

workover
One or more of a variety of remedial operations used to try to increase production of a well.

wet gas
Natural gas having significant amounts of heavier hydrocarbons.

Z

zone
A layer of rock which has distinct characteristics that differ from nearby rock.

Endnotes

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