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# A Report on MDU Resources Group, Inc.'s Safe Management of Hydraulic Fracturing

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## ABOUT THIS REPORT

MDU Resources Group's oil and natural gas production operations are exclusively the responsibility of Fidelity Exploration and Production Company. Fidelity is involved in the acquisition, exploration, development and production of natural gas and oil resources. Fidelity's activities include the acquisition of producing properties and leaseholds with potential development opportunities, exploratory drilling, and the operation and development of natural gas and oil production properties. Fidelity shares revenues and expenses from the development of specified properties in proportion to its ownership interests.

For more information about Fidelity, see the company's website at [www.fidelityepco.com](http://www.fidelityepco.com).

## HISTORY OF HYDRAULIC FRACTURING

The first commercial application of hydraulic fracturing occurred on March 17, 1949, on a well in southwestern Oklahoma. Since that first stimulation treatment, hydraulic fracturing has done more to increase recoverable reserves than any other technique in the energy industry. In addition, it has done so without harmful effects to the environment.

According to the article "[Data Confirm Safety of Well Fracturing](#)" in the July 2010 issue of The American Oil & Gas Reporter (AOGR), more than 2 million hydraulic fracturing treatments have occurred since 1949 with no documented case of aquifer pollution.

The AOGR also reports that as many as 90 percent of all gas wells completed in the United States have been fractured, and the process continues to be applied in new and innovative ways to boost production of American energy resources. Hydraulic fracturing is now responsible for 30 percent of domestic oil and natural gas reserves, and has aided in extracting more than 600 trillion cubic feet of natural gas and 7 billion barrels of oil. According to the National Petroleum Council, 60 to 80 percent of all wells drilled during the next decade will require fracturing to remain viable.

Part of the reason for an increase in use of hydraulic fracturing is simply because all of the "easy" drilling is over. Gone are the days of simply punching a hole in the ground and expecting oil and natural gas to come out unaided much like the opening scene in the 1960s television show "The Beverly Hillbillies." Going forward, new oil and natural gas supplies will be developed from unconventional resources such as the tight shale formations now being exploited, including the Bakken formation in North Dakota, the Marcellus Shale in West Virginia and Pennsylvania, and the Barnett Shale in Texas.

Production of domestic supplies of oil and natural gas keep homes warm in the winter and cool in the summer. Natural gas and oil powers industry and drives the nation's economy. State and county tax receipts on oil and natural gas development support schools and other local activities and are responsible for healthy budgets in the states lucky enough to have abundant energy production. In addition, and maybe more importantly, domestic production of these resources lessens our reliance on foreign fuel imports from unstable and unfriendly countries.

Fidelity Exploration & Production Company has used hydraulic fracturing in most of its production areas for decades. With fracturing, combined with sophisticated horizontal drilling, new supplies of natural gas and oil resources are being safely produced by Fidelity and other energy producers across the country.

In recent years, hydraulic fracturing is entering the public discussion. The discussion presents a number of good questions that deserve a thoughtful and scientifically based response from those responsible for applying this technique.

This report provides company stakeholders with a thorough discussion of the practice of hydraulic fracturing.

MDU Resources and its operating companies believe that we have a responsibility to use natural resources efficiently and minimize the environmental impact of our activities. We accomplish these goals through established operational practices and by leading or participating in a number of programs that help ensure a viable environment. To review the MDU Resources environmental policy and commitment, [click here](#).

## DRILLING AND HYDRAULIC FRACTURING EXPLAINED

To understand the hydraulic fracturing process, it is first beneficial to understand the complete process of drilling a well.

### Preparing to drill

To prepare for drilling, companies like Fidelity will acquire the necessary leases and permits for drilling a well. The process to obtain a drilling permit can take several weeks to several months.

To provide access to the area, a road is constructed and the site is cleared so the rig and related drilling equipment can be placed on the site. Building infrastructure for water and electricity is the next step in the process. At the same time, a large pit will be excavated and then lined with a thick layer of plastic sheeting. This is to prevent contamination of the soil or water table during drilling and to separate the drilling mud and fluids from the native soil and water.

### Drilling

Drilling begins with a hole of a designated depth, which is usually more than 100 feet below the deepest usable groundwater aquifer as defined by the applicable state agency. Upon completion of this initial drilling, surface casing is inserted down the hole. This steel casing is further isolated from the aquifer with cement. After surface casing is set and cemented in place a blowout preventer (BOP) is installed at the top of the surface casing. The BOP contains a series of high-pressure valves that can seal off the well hole if it becomes necessary. If underground pressure forces oil or gas into the wellbore, operators can close the valve remotely or with controls on the wellhead. All further drilling activity in the wellbore is completed inside this structure made up of the steel casing and cement. To understand this better, think of a smaller diameter drinking straw (the drilling stem) inside a larger diameter drinking straw (the surface casing), all of which is surrounded by a layer of cement. Using this standard industry practice, the water table is protected and isolated from all further drilling activity in the wellbore.

### Casing Systems

When the ground water aquifer isolation is completed, the remainder of the wellbore is drilled and another layer of steel casing is run inside the original steel casing creating yet another layer of separation from the aquifer. Called production casing, it runs the entire length of the wellbore and is also partially cemented across all zones of interest. See Figure 1. After the production casing is placed and cemented, the hydraulic fracturing treatment will occur. In some instances, another casing string will be inserted inside the production casing. This is called the "frac string," which provides even more protection and isolation.

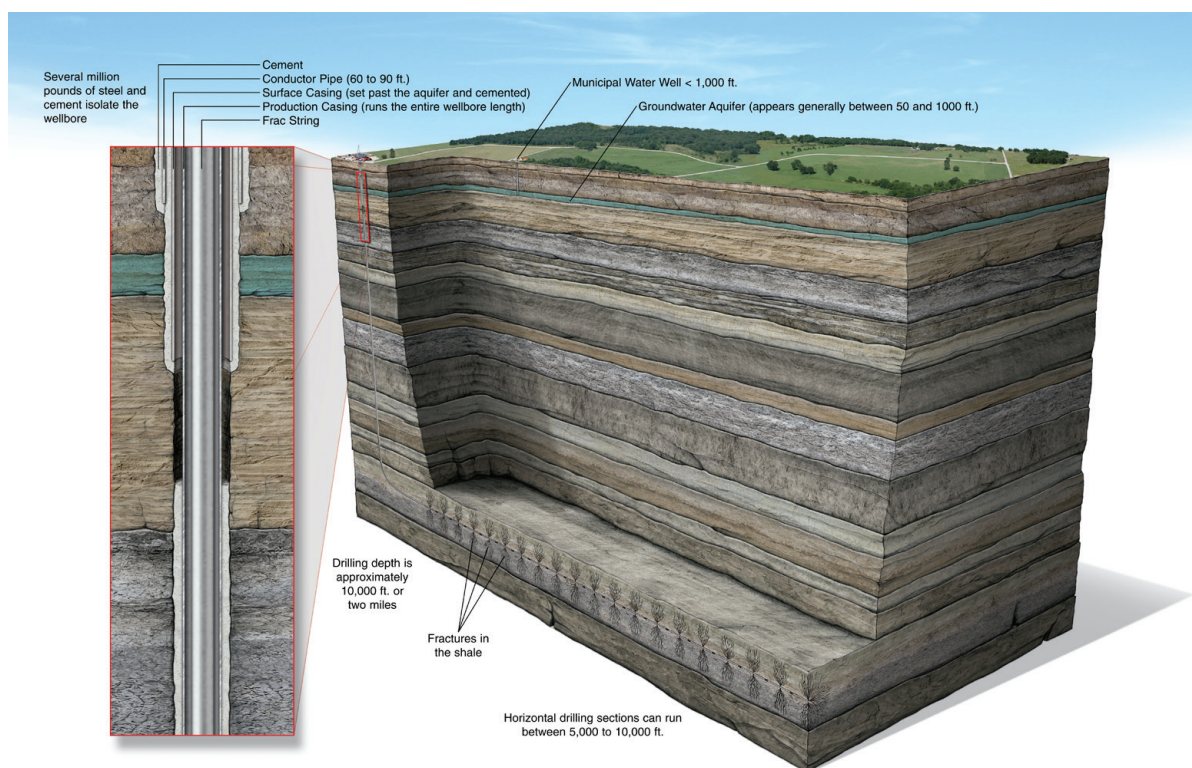


Figure 1: Cement and several layers of steel casing separate the aquifer from drilling activity and fracturing fluids. In addition, the fracturing treatments are separated from the aquifer by thousands of feet.

## Hydraulic Fracturing

Hydraulic fracturing is a sophisticated, highly engineered and controlled procedure that has been used by the oil and natural gas production industry since the 1940s. The process creates fissures, or fractures, in the prospective hydrocarbon bearing formations to allow natural gas and/or oil to flow freely. Before the procedure is conducted, many variables are studied including the underground rock formations and the thickness of the targeted formation. In normal situations, a fracturing operation is only performed once in the life of a well.

The process is quite simple, although it takes a great deal of special equipment and other physical resources. To create the fractures, water, sand and other ingredients are handled in self-contained systems and pumped under high pressure into a geologic formation, which typically is located thousands of feet below the surface. These hydrocarbon-bearing geologic formations do not contain any potable or usable groundwater.

Fidelity, through its contractors, uses different formulations of ingredients throughout its various interests and often will employ different formulations at different well locations within the same operating area. Specific characteristics of the target formation along with the quality of the water used for injection are the primary determining factors for the formula.

Typical ingredients used in the fracturing process are listed in Table 2. The largest components of a typical fluid mixture are water and sand, which typically make up more than 99 percent of the material. The sand serves as the primary agent to “prop” open the fractures to allow the gas and oil to flow up the wellbore. The remaining ingredients (comprising .49 percent of the total mixture) each serve a specific purpose, with the amounts adjusted depending on the kind of formation that needs fracturing and the specifics of the well site. Some energy-producing states require disclosure of these additives.

During the fracturing treatment process, the materials that come back up the wellbore are collected in sealed containers and hauled away to permitted disposal sites.

**Table 2 – Typical ingredients used in the fracturing process**

<b>Ingredient</b>	<b>Purpose</b>	<b>Common Applications</b>
Proppant (sand)	Opens the fissures and keeps them open so gas and oil can move up the well	Play sand and drinking water filtration
Guar gum	Water thickening agent used to suspend the sand	Used in cosmetics, baked goods, ice cream, toothpaste, sauces, and salad dressings as a thickener
Acids	Assists in the process to dissolve minerals and pre-fracture rock	Swimming pool cleaner
Glutaraldehyde	Eliminates bacteria in water	Sterilizes and disinfects medical and dental equipment
Sodium Chloride	Delays breakdown of the gel polymers	Table salt
N, n-Dimethyl formamide	Prevents pipe corrosion	Pharmaceuticals, acrylic fibers and plastics
Borate salts	Maintains fluid viscosity as temperature increases	Laundry detergents, hand soaps and cosmetics
Citric acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Ethylene glycol	Prevents scale deposits in the pipe	Car antifreeze, household cleaners, deicing
Isopropanol	Increase viscosity of fracture fluid	Glass cleaner, antiperspirant, hair color
Sodium or potassium carbonate	Maintains effectiveness of other components	Washing soda, detergents, soap, water softener, glass
Potassium chloride	Creates a brine carrier fluid	Low sodium table salt substitute
Ammonium bisulfate	Removes oxygen from water for pipe corrosion protection	Cosmetics, food and beverage processing, water treatment
Polyacrylamide	Minimizes friction between fluid and pipe	Water treatment, soil conditioner
Petroleum distillates	Slicks water to minimize friction	Make-up remover, laxatives, and candy

*Source: Several oil and natural gas industry trade associations have put together an informative website addressing many of the current issues facing the energy industry. Hydraulic fracturing is among the many issues presented on the site. Called *Energy in Depth*, the website contains a description of a typical solution used in hydraulic fracturing. To see this description and other information about the fracturing process, [click here](#).*

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In addition to the protection offered by the multiple layers of steel casing and cement near the surface, vast separation also occurs between the ground water aquifer and the zone where the fracturing occurs. In North Dakota, where Fidelity produces oil from the Bakken formation, the average depth of the company's wells is approximately 10,000 feet – or almost two miles below the surface. Fresh water formations in the area generally appear at depths ranging between 50 to 1,000 feet. See Figure 1.

When the fracturing treatment is completed, the well is ready to begin producing oil and/or natural gas. At this point, a small diameter tube may be installed inside the production casing to allow the product to flow to the surface.

In total, any freshwater aquifer is now isolated from the flow the wellbore by a layer of cement, the surface casing, the production casing, and the flow line. Think of several straws, each inside one another, surrounded by cement.

#### **For More Information:**

##### **Hydraulic Fracturing Operations-Well Construction and Integrity Guidelines, First Edition/October 2009**

Published by the American Petroleum Institute, this guidance document provides guidance and highlights industry recommended practices for well construction and integrity for wells that will be hydraulically fractured. For a PDF copy of this report, [click here](#).

##### **Water Management Associated with Hydraulic Fracturing, First Edition/June 2010**

Published by the American Petroleum Institute, this document identifies and describes many of the current industry best practices used to minimize environmental and societal impacts associated with the acquisition, use, management, treatment, and disposal of water and other fluids associated with hydraulic fracturing. This document also focuses on areas associated with the water used for purposes of hydraulic fracturing. For a PDF copy of this report, [click here](#).

## **HYDRAULIC FRACTURING: REGULATION**

Currently, hydraulic fracturing operations are regulated by an agency in the state where the drilling and production is occurring. State oil and natural gas regulatory programs have historically placed great emphasis on protecting usable groundwater. State agencies enforce the rules through inspection and rigorous self-reporting requirements.

Natural gas and oil producers not only work with state regulators in implementing hydraulic fracturing, but they also comply with numerous federal requirements. The Occupational Safety and Health Administration, the Environmental Response, Compensation and Liability Act and the Toxic Substances Control Act all contain record keeping and reporting rules followed by energy producers. These regulations ensure all chemicals used in the extraction process are properly handled and stored, and that workers and first responders are made aware of the substances they handle.

The Energy in Depth website lists the [chronology of hydraulic fracturing regulation](#) and the rules put in place to protect underground water supplies. As indicated on the site, federal oversight of groundwater protection began in the 1970s.

Some state regulatory authorities are currently increasing their oversight of hydraulic fracturing. The Wyoming Oil & Gas Conservation Commission final rule covering well stimulation (including hydraulic fracturing) disclosure went into effect on Sept. 1, 2010. The rules require more information about the producer's hydraulic fracturing operations including depth, temperatures, pressure, and fracturing fluid ingredients. In addition to disclosure of the materials used in the fracturing application, the Wyoming rule modification also requires disclosure of the contents of the fluids that come back up the hole after the treatment is completed.

The contractor or producing company may request that the Wyoming Oil & Gas Conservation Commission hold the disclosure in confidence. Proprietary and competitive reasons prompt this position.

Oil and natural gas producers in Wyoming, including Fidelity, have supported the rule modification.

In addition to enhanced state oversight, the federal government has authorized an expansive new study. In its Fiscal Year 2010 budget report, the U.S. House of Representatives Appropriation Conference Committee directed the Environmental Protection Agency to conduct another study on the relationship between hydraulic fracturing and drinking water. EPA conducted outreach meetings on the study in July, August and September 2010. EPA plans to complete the study design in 2010 and expects to initiate the study in January 2011. EPA is proposing to have the initial study results available by late 2012. As part of this study, EPA has asked nine drilling service providers to voluntarily disclose the materials used in their hydraulic fracturing fluids.

Fidelity attended the outreach meeting held in Denver and subsequently submitted comments on the proposed EPA study. Fidelity will continue to work with EPA, industry trade associations and other industry members as the study proceeds. The comments from the outreach meetings are expected to be posted on the EPA website in early 2011. For more information about the 2010-2012 EPA study and to review the submitted comments, [click here](#).

These efforts demonstrate how Fidelity, the energy industry and state regulators are working hard to ensure the integrity and safety of hydraulic fracturing.

In [testimony](#) before the House Energy and Mineral Resources Subcommittee in June 2009, Scott Kell, president of the Ground Water Protection Council (GWPC) and deputy chief of the Ohio Department of Natural Resources Division of Mineral Resources Management, said the most critical issue related to hydraulic fracturing is the protection of water resources. "As such, our goal is to ensure that oil and gas development is managed in a way that does not create unnecessary and unwarranted risks to water. As a state regulatory official, I can assure you that our regulations are focused on this task."

Kell, in his testimony, discussed the effectiveness and success of state regulation as outlined in a GWPC publication entitled "State Oil and Gas Regulations Designed to Protect Water Resources":

"This report evaluates regulations implemented by state oil and gas regulatory agencies as they relate to the protection of water. To prepare this report, the GWPC reviewed the regulations of the twenty-seven states that, when combined, account for more than 99.8% of all the oil and natural gas extracted in the U.S. annually. To prepare this report, each state's regulatory requirements were studied with respect to their water protection capacity. The study evaluated regulated processes such as well drilling, construction, and plugging, above-ground storage tanks, pits and a number of other topics. The report also contains a statistical analysis of state regulations. As a result of our regulatory review and analysis, the GWPC concluded that state oil and gas regulations are adequately designed to directly protect water resources through the application of specific programmatic elements such as permitting, well construction, hydraulic fracturing, waste handling, and well plugging requirements."

To review the complete GWPC publication, [click here](#).

Lynn Helms is the director of North Dakota's Department of Mineral Resources and he also provided testimony to the House Energy and Mineral Resources Subcommittee in June 2009:

"As the head regulator of oil and natural gas development in the state of North Dakota and an officer of the Interstate Oil & Gas Compact Commission representing all oil and natural gas producing state regulators, I can assure you that we have no higher priority than the protection of our states' water resources. It is my firmly held view and that of the IOGCC that the subject of hydraulic fracturing is adequately regulated by the states and needs no further study."

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To assess the capability and integrity of state regulatory programs, an independent review process was put in place in 1999. Incorporated as a non-profit corporation, State Review of Oil and Natural Gas Environmental Regulations (STRONGER) became the independent stakeholder governing body that manages the state regulatory review process. STRONGER was formed to reinvigorate and carry forward the state review process begun cooperatively in 1988 by the EPA and the Interstate Oil and Gas Compact Commission (IOGCC).

Its Board of Directors consists of three state regulators, three environmental/public interest representatives and three industry representatives. The EPA, DOE, and Department of the Interior participate as non-voting Board members. The IOGCC also participates through its State Review Committee, which provides for liaison with the states, provides three state regulators to serve on the Board, and provides state regulators to participate in periodic updates to the Guidelines.

In 2000, and again in 2005, STRONGER updated and expanded the Guidelines to remain current with emerging environmental concerns and regulatory program developments. STRONGER is currently convening a stakeholder group to consider drafting guidelines for state regulation of hydraulic fracturing. For more information about STRONGER, [click here](#).

## HYDRAULIC FRACTURING: RESEARCH AND REVIEWS

Protecting groundwater aquifers from infiltration of the fluids used in the hydraulic fracturing process is essential and underlies the technology used in the cementing and casing systems employed today. Moreover, there is ample evidence that these systems have been working.

Numerous reviews conducted by governmental agencies and respected authorities have unanimously concluded that hydraulic fracturing is safe.

As noted, the Ground Water Protection Council and its education foundation have done extensive work on the subject, particularly as it relates to the adequacy of state regulation of the process. The mission of the GWPC is to provide for and oversee research projects, education and outreach, development and application of technical systems, and pollution prevention efforts relating to underground injection control and ground water protection and other issues related to watershed conservation and protection.

In addition to the reviews completed by the GWPC, both the EPA and the IOGCC have also found the practice to be nonthreatening to the environment or public health.

### **EPA Study: 2004**

The Environmental Protection Agency conducted a review of available science and literature related to hydraulic fracturing practices and their effect on drinking water in 2004. Focusing on very shallow coalbed natural gas wells – which would have the highest potential of harming the water supply – the EPA found several factors that minimize the potential risks associated with hydraulic fracturing. Those factors are:

- Fluid recovery
- Small amount of chemicals contained in fracturing fluids
- Dilution in water
- Absorption by rock formations

In its final report, EPA concluded that additional or further study was not warranted at that time. In making this decision, EPA reviewed more than 200 peer-reviewed publications, other research and public comments. The agency concluded that the injection of hydraulic fracturing fluids into coalbed natural gas wells poses minimal threat to underground sources of drinking water.

In its review of incidents of drinking water well contamination believed to be associated with hydraulic fracturing, EPA found no confirmed cases that are linked to fracturing fluid injection into coalbed natural gas wells or subsequent underground movement of fracturing fluids.

To see the complete report of this June 2004 EPA study, [click here](#).

### **Interstate Oil and Gas Compact Commission**

The Interstate Oil and Gas Compact Commission is a multi-state government agency that works to ensure our nation's oil and natural gas resources are conserved and maximized while protecting health, safety and the environment. The IOGCC is an advocate for environmentally-sound ways to increase the supply of American energy. This is accomplished by providing governors of member states with a clear and unified voice to Congress, while also serving as the authority on issues surrounding these vital resources.

The Commission also assists states in balancing a multitude of interests through sound regulatory practices. The unique structure of the IOGCC offers a highly effective forum for states, industry, Congress and the environmental community to share information and viewpoints to advance our nation's energy future.

Through review and investigation by the member state regulatory agencies, the IOGCC confirmed the GWPC's conclusion that no evidence of contaminated drinking water due to hydraulic fracturing could be found within those member states.

IOGCC resolutions reflect the official position of the commission and in January 2009, IOGCC member states passed Resolution 09.011. Here are the key highlights of the resolution:

- The EPA concluded in a 2004 study that "additional or further study is not warranted" for hydraulic fracturing and "the injection of hydraulic fracturing fluids into coalbed methane wells poses minimal threat to Underground Sources of Drinking Water."
- Hydraulic fracturing is a common operation used in exploration and production for oil and natural gas.
- The states, who regulate production, have comprehensive laws and regulations to ensure operations are safe and to protect drinking water. States have found no verified cases of groundwater contamination associated with hydraulic fracturing. The Safe Water Drinking Act was never intended to grant the federal government authority to regulate oil and gas drilling and production operations such as hydraulic fracturing under the Underground Injection Control Program.
- Hydraulic fracturing plays a major role in the development of virtually all unconventional oil and natural gas resources and federal regulation of the operation as underground injection under SDWA would impose significant administrative costs on the states and increase the cost of drilling wells with no resulting environmental benefit.

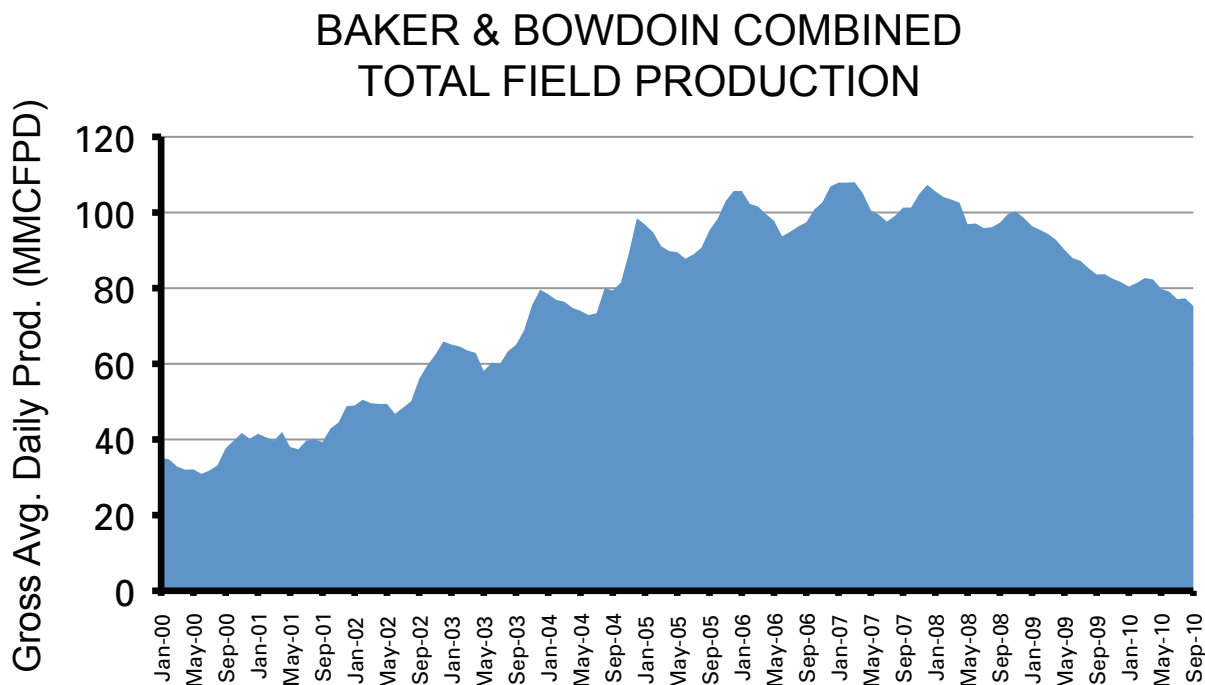
[Click here](#) to read remarks on hydraulic fracturing from 12 state regulatory officials. Several of the states that comprise the IOGCC have created resolutions regarding hydraulic fracturing. [Click here](#) to read these resolutions.

## SHAREHOLDER BENEFITS

The use of hydraulic fracturing has brought many benefits to company stockholders in terms of energy production. A prime example of a shareholder benefit from hydraulic fracturing at Fidelity comes from the company's legacy properties in eastern and north-central Montana. By incorporating the practice to stimulate energy production, the company has taken an old field and given it new life providing significant returns and enhanced shareholder value from increased energy production.

The Baker and Bowdoin Fields in Montana have been producing natural gas since the 1920s. In the mid-1990s, Fidelity implemented a strategy to determine the remaining productive life of these fields. It was immediately obvious that the geology of the gas reservoirs in these fields was going to present a challenge. The Eagle formation at Baker, for example, contained a very high percentage of shale, which means low permeability. One fact became very clear: The reservoir pressure data indicated that while these fields may be old, but they contained a lot more gas to be produced.

Fidelity developed two strategies to actively produce the natural gas reserves. Given the low permeability of the formations, drilling more wells and applying hydraulic fracturing stimulation would enhance gas recovery. And, it worked. See Figure 3 to see the growth of natural gas production from the Baker and Bowdoin natural gas fields. Without using hydraulic fracturing as a production enhancement technique, these production gains would not have been possible.



*Figure 3: Production from these fields, which have been part of the company since the mid-1920s, have come to life in recent years thanks to hydraulic fracturing treatments and more wells drilled.*

In the Bakken formation in western North Dakota, new horizontal drilling technology combined with hydraulic fracturing is a primary reason for the rejuvenation of this field. Originally discovered in the 1950s, initial production was strong but the tight shales proved to be beyond the technology of vertical drilling.

Almost all of Fidelity's oil production in the Bakken formation is due to hydraulic fracturing and horizontal drilling. In total, Fidelity's oil production has climbed 15 percent in the last two years primarily due to the company's activities in the Bakken.

In the Bakken, a typical oil well is drilled to depths of approximately 10,000 feet or nearly two miles. The horizontal leg of the well can extend for another 10,000 feet.

It quickly becomes obvious that hydraulic fracturing has been, and will continue to be, a key production technique for Fidelity Exploration & Production Company and is used extensively in the majority of the company's production areas.

## CONCLUSION

In considering the issues surrounding hydraulic fracturing, Fidelity continually monitors company practices for efficiencies and strives to minimize its environmental footprint. Fidelity's operating philosophy includes compliance with all regulations including, but not limited to, hydraulic fracturing.

Hydraulic fracturing, a successful energy development tool, has been used for several decades without any documented instance of fresh water contamination while significantly increasing domestic production of oil and natural gas under state regulatory oversight.