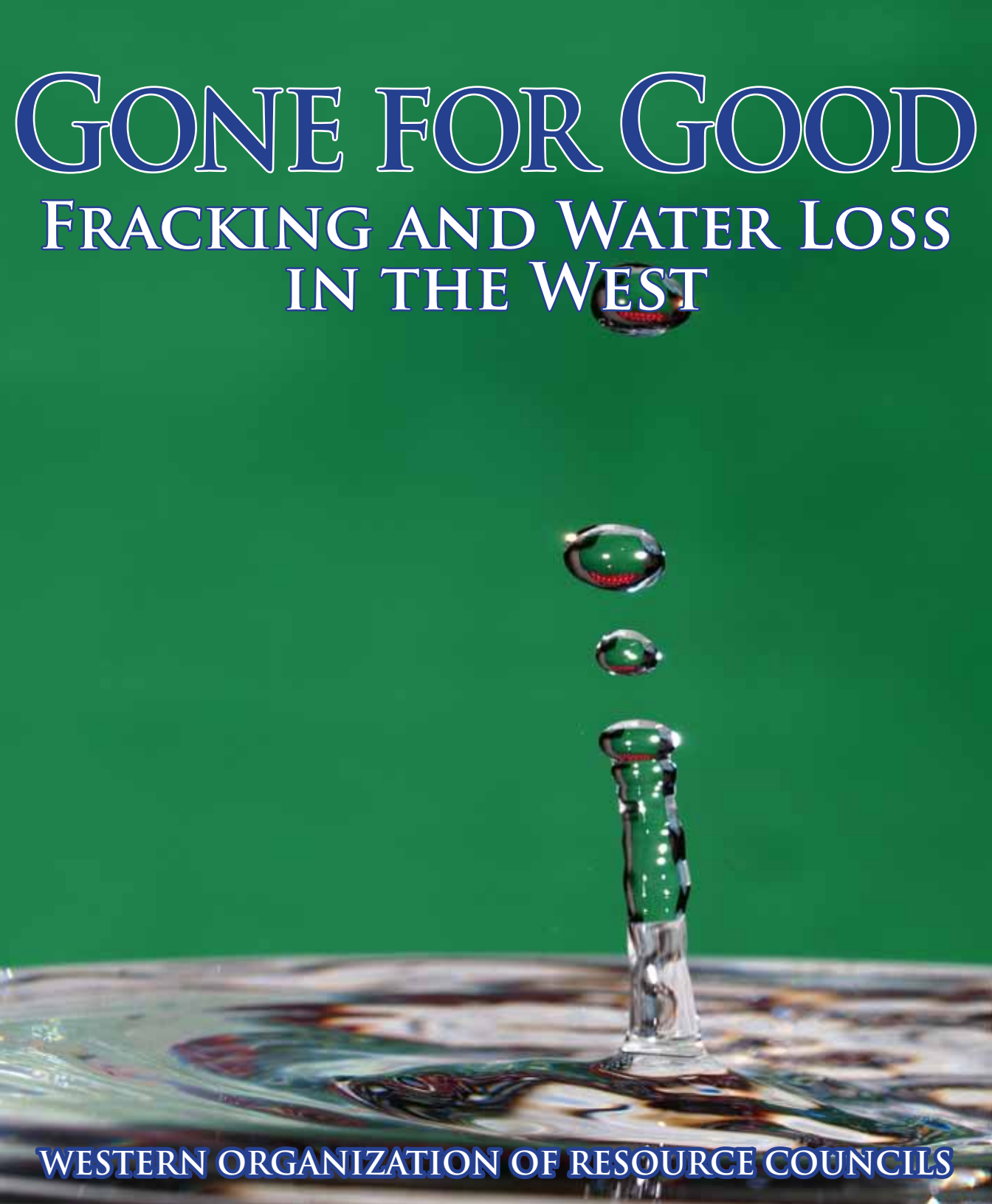
Gone for Good

Fracking and Water Loss in the West



Western Organization of Resource Councils

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Gone for Good

Fracking and Water Loss in the West

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This report is a publication of the Western Organization of Resource Councils (WORC). WORC is a regional network of grassroots community organizations that include 10,000 members and 35 local chapters. WORC's member organizations are: Dakota Resource Council (North Dakota); Dakota Rural Action (South Dakota); Northern Plains Resource Council (Montana); Oregon Rural Action; Powder River Basin Resource Council (Wyoming); and Western Colorado Congress. WORC's mission is to advance the vision of a democratic, sustainable, and just society through community action. WORC is committed to building sustainable environmental and economic communities that balance economic growth with the health of people and stewardship of their land, air, and water.

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All views and opinions expressed in this report are those of WORC and do not necessarily reflect the views of WORC's funders. Any errors are the responsibility of WORC.

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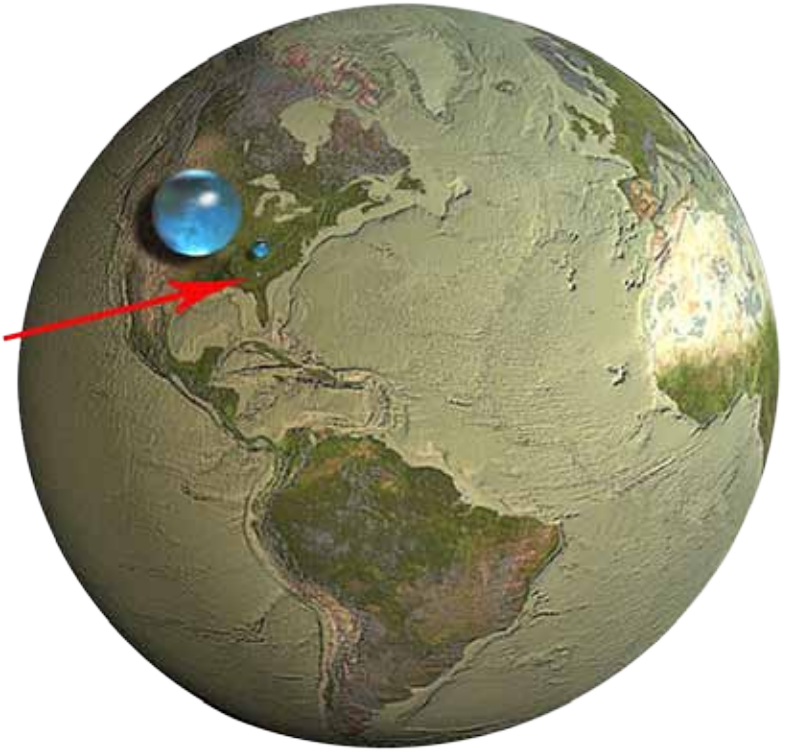

The three blue spheres represent relative amounts of Earth's water in comparison to the size of the Earth.

The largest sphere includes all the water in the oceans, ice caps, lakes, and rivers, as well as groundwater and atmospheric water.

The medium blue sphere (over Kentucky) represents the world's liquid fresh water (groundwater, lakes, swamp water, and rivers) of which 99 percent is groundwater.

Highlighted with the arrow, the smallest sphere bubble represents fresh water in all the lakes and rivers on the planet, and most of the water people and life of earth need every day comes from these surface-water sources.

Credit: Howard Perlman, USGS; globe illustration by Jack Cook, Woods Hole Oceanographic Institution (©); Adam Nieman. Data source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources (Oxford University Press, New York). http://ga.water.usgs.gov/edu/2010/gallery/global-water-volume.html

Introduction

Hydraulic fracturing (or "fracking") in combination with horizontal drilling has been a key vehicle for the recent upsurge in oil and gas production in the United States. This well stimulation technique is used for both oil and gas production. Much of the public concern about fracking nationally has focused on the threat of water contamination from the chemicals used. Especially in the arid West, however, fracking poses an additional and even more serious threat: water consumption and availability. By volume, water is by far the largest constituent of fracking fluid. After water has been laden with other substances and pressed into the service of hydraulic fracturing, it is typically injected into deep wells.

> "Available surface water supplies have not increased in 20 years, and groundwater tables and supplies are dropping at an alarming rate."
>
> — "Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Sources," Environmental Protection Agency

The oil and gas industry often refers to the possibility of treating and reusing fracking water without citing specific examples where oil and gas operators are actually doing so. According to the industry-run FracFocus website, "some operators in the Marcellus Shale and at least one operator (Devon Energy) in the Barnett Shale" are reusing fracking water. Devon Energy claims it has recycled "more than 500 million gallons of water since 2005" in the Barnett Shale. This equates to the amount of water used at just 125 to 250 shale oil wells, according to U.S Environmental Protection Agency estimates.[1] With few exceptions, the rest of the water used for fracking is gone for good from the hydrological cycle.

The purpose of this report is to outline the status of water consumption for fracking in four states: Colorado; Montana; North Dakota; and Wyoming. The report also outlines and evaluates current regulatory frameworks for fracking water usage in each of those states. Regulating the water use connected with fracking has to this point, like all water use regulation, been a state rather than a federal responsibility.

There has been federal research on water availability. A project led by the National Oceanic and Atmospheric Administration, together with the U.S. Department of Agriculture and the University of Nebraska, tracks drought conditions throughout the United States. It finds that the entire states of Colorado and Wyoming currently suffer from drought conditions, and large sections of those states are characterized by extreme or exceptional drought, with major crop or pasture losses and water emergencies. Nearly half of Montana and about two-thirds of North Dakota are also experiencing drought.[2]

The U.S. Environmental Protection Agency's "Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Sources," is primarily concerned with the water quality. It scarcely touches on questions about availability of water. On the other hand, a 2006 draft version of a Department of Energy report, authorized by the 2005 Energy Policy Act but never finished, raises red flags about the quantity issue. It notes that "available surface water supplies have not increased in 20 years, and groundwater tables and supplies are dropping at an alarming rate."[3]

IT SEEMS CLEAR THAT WATER USE FOR FRACKING IS REACHING A CRISIS POINT IN THE REGION.

State policies will, in large measure, determine whether water remains available in the West for farming, ranching, industry and domestic consumption after the current oil and gas boom subsides. What are the states doing now? And what can and should they do to ensure that they don't run out of water?

The four contiguous states in this study were selected for several reasons. First, each has long experience with oil and gas extraction. Second, in recent years, each state has seen significant new oil and gas exploration in which fracking has played a prominent role. Third, each state is semi-arid and has numerous constituencies, including agriculture, competing for scarce water resources. Finally, each state has a WORC member group with an active constituency concerned about oil and gas issues: the Dakota Resource Council (North Dakota); the Northern Plains Resource Council (Montana); the Powder River Basin Resource Council (Wyoming); and the Western Colorado Congress.

The oil and gas industry is significantly affecting water resources in the West. As a result, WORC foresees the need for additional reports to supplement this one, and would welcome similar studies in states outside the WORC region. Pending legislation in some states could modify state regulatory frameworks related to fracking water. In addition, the scope of the current report is limited to the use of water for fracking. Further analysis of the connection between fracking and water use is necessary, especially protocols for the management and disposal of wastewater. Finally, the practice of fracking may open up fields of exploration in previously untapped areas of the West, including three other states where WORC is active: Idaho, Oregon, and South Dakota.

From the research undertaken to compile this report, it seems clear that water use for fracking is reaching a crisis point in the region. There is mounting evidence that the current level of water use for oil and gas production simply cannot be sustained, and that projected increases in use may lead to a crisis. Something has to give.

Oil, Gas, Fracking and Water

Fracking has a nearly unquenchable thirst for water. The U.S. Environmental Protection Agency (EPA) estimated in February, 2011 that 50,000 to 350,000 gallons of water were needed to frack the average coalbed methane (CBM) well across the country (although not all CBM wells are fracked.) That's a lot of water. But for horizontal wells drilled into shale formations, EPA said, water needs were much greater—from two to four million gallons of water per well. In some cases, demands go as high as 13 million gallons per well. EPA also estimated that about 35,000 wells are fracked annually in the United States, requiring between 70 and 140 billion gallons of water for fracking.[4]

EPA's lack of precision is striking. The twofold spread in the agency's estimate of water usage for fracking underscores the fact that reliable cumulative records of this usage are not available. If our federal government does not know how much water is being used for fracking, how can it determine the consequences of the practice? How can the Department of the Interior fully determine whether lease sales of federally-owned minerals are prudent? How can the EPA fully evaluate the impact of fracking on clean and adequate drinking water supplies? Closer to home, if our state governments do not know how much water is being used for fracking, how can they incorporate consideration of water use into their oil and gas permitting actions? How can they determine whether or not the price they are paying for oil and gas production includes a hidden cost: long-term water shortages? Among the states

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surveyed here, there is no indication that the amount of water available for fracking, or the potential impact of that use on the availability of water for other uses, plays any role whatsoever in the routine permitting of oil and gas wells.

On the other hand, a study by the Pacific Institute, based on interviews with representatives of government, academia, industry and public interest groups, indicated that the volume of water use was one of the top three concerns of all of those interviewed about fracking.[5]

To prevent draining groundwater, North Dakota decided to take water from Lake Sakakawea for fracking. After a dispute about water rights between the Army Corps of Engineers and the state, the Corps issued free temporary permits in 2012 to take water from the lake for fracking.

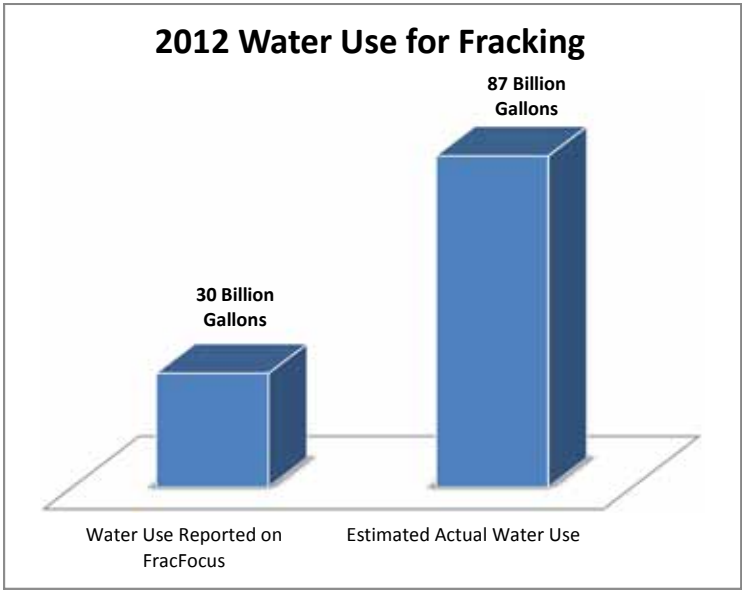
FracFocus

Just two months after the above-cited EPA document appeared, the industry-operated website, *www.fracfocus.org*, began publishing industry-reported well-by-well statistics on the amount and nature of fluids used in fracking operations across the United States. Several states (including Colorado, Montana and North Dakota) have adopted policy to require that drillers post fracking data on FracFocus. This practice, however, does not directly equate to better public understanding of water use in fracking. The industry, not the states, provides the information to FracFocus. This information is usually not available directly on the websites of state governments. Moreover, the FracFocus website simply reiterates well-by-well reports without any evidence of independent verification or analysis. In addition, the website is not useful for the purpose of obtaining aggregate information, since it offers only well-by-well statistics, in a format that requires opening a separate PDF file for every single well. Data is thus available one well at a time.

The non-profit organization SkyTruth has done the public a service by aggregating information from the FracFocus website. This begs an important question: Why don't states require drillers to report to SkyTruth instead of FracFocus, at least if public access to data is their goal?[6] State agencies should have an interest in aggregating water use data in a useful format. By handing off their responsibility for monitoring fracking water use to the oil and gas industry via FracFocus, states appear to be content simply to lend credibility to unverified data.

A look at these cumulative statistics from FracFocus, as aggregated by SkyTruth, raises serious questions about their completeness. According to FracFocus, the total reported amount of water used nationwide for fracking in 2012 was a little less than 30 billion gallons. At that rate, reported use would fall between just 21 and 43 percent of EPA's 2010 estimate of 70-140 billion gallons of water per year. Yet in 2012, oil and gas companies drilled 43,669 wells in the United States, according to an industry publication, or more than 20% above EPA's 2010 projection of 35,000 per year. If only 35,000 of the new wells drilled

in 2012 were fracked, the average amount of water used for fracking and reported on FracFocus is less than one million gallons per well, or less than half of EPA's low-end estimate. In North Dakota, the State Water Commission recently reported 2012 use of water from fracking depots at 5.4 billion gallons. FracFocus, by contrast, reports 3.16 billion.[7]



If only 35,000 of the new wells drilled in 2012 were fracked, the average amount of water used for fracking and reported on FracFocus would have been less than one million gallons per well, or less than half of EPA's low-end estimate. Based on EPA estimate of 2 million gallons of water per 43,669 wells drilled in 2012.

These statistics strongly suggest that states may not be getting accurate and useful data from FracFocus. Lack of useful data can only increase the risk of failing to anticipate, plan for and prevent critical water shortages. States would be advised to undertake independent review of the FracFocus data reported. This is especially true in the arid West, which is prone to drought that could be made worse by climate change, and where the water wars have already begun. A recent *New York Times* article, for example, describes how the current drought in New Mexico is pitting various water users against each other. The article lists as competitors farm irrigators and other industries, including an oil refinery. Notably, however, it does not mention that 518 million gallons of New Mexico water was used in 2012 for fracking, according to FracFocus.[8]

North Dakota: Overwhelmed

The rapid expansion of oil extraction from the Bakken formation in North Dakota has catapulted the state from ninth to second in oil production nationally since 2006. The Bakken is a shale formation that underlies parts of North Dakota, Montana and Saskatchewan. The formation was first identified in 1953, but technical advances in directional drilling and fracking led the oil industry to begin exploiting it by 2008. As a result, oil production in the state climbed dramatically from 45 million barrels in 2007 to more than 241 million barrels in 2012. The number of producing oil wells in the state at year's end was 8,224, with 183 rigs operating. Over 70% of the state's 2012 production came from Bakken wells in Mountrail, McKenzie, Williams and Dunn Counties. The number of drilling permits issued in North Dakota in 2011 was 1,927. It rose to 2,463 in 2012. By contrast, only 419 drilling permits were issued in 2006.[9]

Estimates of total recoverable reserves vary considerably. For example, the U.S. Geological Survey estimate is between 3 and 4.3 billion barrels in North Dakota and Montana combined, whereas Continental Resources, Inc. (which is currently drilling in the Bakken) estimates 24.3 billion barrels in North Dakota's Bakken alone.[10] FracFocus lists North Dakota as sixth nationally in use of water for fracking—behind Texas, Pennsylvania, Oklahoma, Arkansas and Colorado.

Permits for oil and gas drilling, as well as the enforcement of regulations, lie in the hands of North Dakota's Department of Mineral Resources. The department is under the supervision of the North Dakota Industrial Commission, which is made up of three statewide elected officers—the Governor, Attorney General, and Agriculture Commissioner.

North Dakota ranks sixth nationally in the amount of water used in fracking, behind Texas, Pennsylvania, Oklahoma, Arkansas, and Colorado.

Oil production in North Dakota climbed dramatically from 45 million barrels in 2007 to more than 241 million barrels in 2012.

Initially, most fracking water in North Dakota came from aquifers. Under North Dakota law, both aquifers and surface water are waters of the state. Anyone with an interest in a piece of land (including, for example, surface occupancy, ownership, a mineral lease, or ownership of minerals) has a right to apply for a permit to use the water beneath it. Many applications for water "depots" to service fracking companies have come forward. Bitter opposition has sometimes ensued, especially when the applicants were not the landowners. The power to issue permits rests with the state Water Commission. It is made up of two elected officials—the Governor (who chairs it) and the Commissioner of Agriculture—and seven appointed members.

The Killdeer Aquifer, in Dunn County, was one of the aquifers targeted for withdrawals by the oil and gas industry. It was also the first aquifer identified for study by the Water Commission. At a town meeting in Killdeer, June 18, 2009, the Commission presented its study, which concluded that the aquifer would not recover from the depletion if all pending permit applications were granted. The Commission agreed to only 280 acre-feet out of the 1,000 acre-feet proposed for withdrawal by several parties.[11] Subsequently, state action to approve water permits for fracking slowed considerably, and many permits were issued for withdrawal amounts smaller than requested. A Water Commission employee said late last year that determinations on water permit applications were typically requiring close to two years and documentation equivalent to a master's thesis. In 2009, the Commission had turned down permit applications for withdrawals from the Fox Hills Hell's Canyon aquifer for fracking in McKenzie County, on the basis that it would amount to "groundwater mining" and endanger current users.[12]

Robert Shaver, Director of the Water Appropriations Division of the Commission, told the *Bismarck Tribune* in 2010 that he expected 1,800 new oil wells in 2011 and a demand of 7.2 billion gallons (or 22,100 acre-feet of water), and that "our groundwater supply will not be able to meet that need."[13]

Shaver's strategy for prevention of drawdown of North Dakota groundwater was to gain access to water for fracking from Lake Sakakawea, the body of water formed when the Garrison Dam on the Missouri River was built about 60 years ago. The state and federal governments differed over whether North Dakota

had the right to allocate water from the lake, and whether the U.S. Army Corps of Engineers had the right to charge for allocations. North Dakota officials claimed the state was promised the use of lake water for municipal, industrial and agricultural uses when the Garrison Dam was built in the 1950s. (During the debate, some water from the lake was already being used for fracking through sales by municipalities and rural water systems that held allocations.) The Corps agreed in May 2012 to issue temporary free permits for fracking water pending clarification of national policy on permit fees.[14]

Recent developments indicate that North Dakota may need not only protection *of* groundwater, but *from* it. Western North Dakota geology contains uranium and other radioactive metals in low concentrations. Ironically, North Dakota's efforts to improve the handling of produced water have resulted in concentration of those metals. Historically, disposal of water and other materials produced in oil drilling in North Dakota has been through a combination of reserve pits and deep well injection. Solid and some liquids wastes produced by or associated with drilling were often deposited in "reserve pits" near the drilling sites, and produced water was re-injected into the earth below drinking water sources.

After 47 reserve pits overflowed during the spring thaw of 2011, the state Department of Mineral Resources initiated new rules that essentially eliminated reserve pits at the sites of fracked wells. As a result, more wastes from fracking operations have been disposed of in solid waste landfills. These wastes include "filter socks" used to strain fracking water when it is injected into disposal wells. These filter socks trap and aggregate heavy metal particles. For this reason, landfills have begun rejecting filters and other wastes that exceed the federal radioactivity standard of five Picocuries per gram. One waste industry executive estimated in January, 2013, that only 20 percent of this waste was being handled legally.[15] Edmund Baker, acting director of the Three Affilated Tribes Environmental Division, issued a public notice on March 1, 2013, that the illegally dumped filters were being discarded in fields, dumpsters and roadsides.[16]

Meanwhile, state oversight of fracking water withdrawals from ground and surface water has come under official scrutiny. The state legislature in 2011 passed an amendment to state budget legislation by Representative

Robert J. Skarphol (R-Tioga) calling for electronic monitoring of fracking water sales. Current oversight relies primarily on self-reporting. The impetus for the amendment appears to have been sales of fracking water that exceeded amounts authorized by the Water Commission and which were made public.[17] Governor Jack Dalrymple exercised his line-item veto authority to nullify the amendment. A subsequent performance audit of the Commission's oversight of fracking water permitting and withdrawals under the auspices of the State Auditor, completed January 13, 2013, called for implementation of electronic monitoring, and the hiring of a new water resource manager position to increase field inspections and process monthly water use reports.[18] In the 2013 legislative session, Rep. George Keiser (R-Bismarck) introduced a bill to impose a new excise tax of 11.5% on purchasers of groundwater extracted for fracking. The House defeated the bill, 57-38.[19]

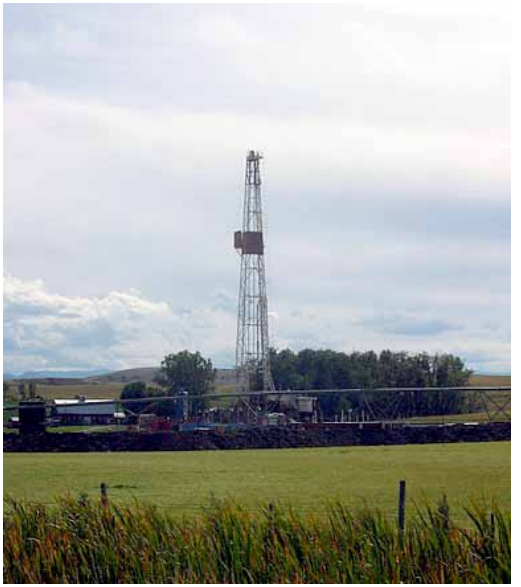
Montana: The Thin Edge of the Bakken

Montana shares the Bakken Formation with North Dakota. The Bakken underlies five entire counties in Montana and portions of five others. Montana oil production statistics have not skyrocketed like North Dakota's. In fact, according to the Montana Oil and Gas Commission, state oil production declined from 34.9 million barrels to 24.1 million from 2007 to 2011—about 10% of North Dakota production—before increasing to approximately 26.4 million barrels in 2012. Well completions in 2011 amounted to 100.

Roughly half of the state's oil production in 2011 came from one county, Richland, which borders McKenzie and Williams Counties in North Dakota. Nearly 90% of Montana's oil is produced in the northeastern counties where the Bakken lies.[20] Most of the fracking in Montana also occurs in this region. Analysts generally point out that the middle layer of the Bakken formation is the target for drilling in North Dakota because of its thickness. But the same layer is much thinner in Montana. Those who remain enthusiastic about increased Bakken production in Montana tend to show interest primarily in the upper layer, which geologists say becomes thicker in Montana.[21]

The Montana Board of Oil and Gas Conservation issues drilling permits, enforces oil and gas standards, and issues injection well permits. The Board is made up of seven gubernatorial appointees. Of these, three must be experienced in the oil and gas business, by law, and two must be landowners. One of the landowners must have mineral in addition to surface rights, and the other must hold only surface rights. In addition, one of the Board members must be a lawyer. Although it is attached to the state Department of Natural Resources and Conservation (DNRC), the Board has independent authority.

Extracting water for fracking in Montana in most cases requires a water right, which must be conferred by permit from the Water Resources Division of the state DNRC. State law requires the establishment of water rights for all "beneficial uses" of water. One of these beneficial uses is oil and gas well development. An existing right may not be used for oil and gas development, however, unless it is already designated for industrial use or extraction for oil well development. Water right holders may gain approval from the DNRC for changes in the use of their rights, but the process usually takes six months. During the process, possible adverse effects on other water rights must be considered. A municipality holding water rights may market water to the oil industry under its designated "municipal" purpose, so long as the point of sale is within the municipal boundaries or at the historical place of use. Municipalities, however, do not have independent authority to increase the amount of water associated with their water rights.



Parties may also apply for new water rights to service the oil industry, but not to the detriment of existing rights. Montana has closed some basins to new permits "due to over-appropriation." DNRC also clarifies that some areas still open to new permitting have restrictions.[22] The agency's website says that 13 fracking water permit applications are currently pending in Roosevelt and Richland Counties for a total of 11,681.2 acre-feet (or about 1.8 billion gallons), with over 70% of the requested volume slated to come from surface water.[23] The agency website does not report the total amount of water actually used for fracking. FracFocus lists a total of just under 255 million gallons of water used for fracking in Montana in 2012, but that total may be incomplete. Agency staff indicated it takes six to nine months to evaluate and act on new applications. Evaluation addresses both the protection of existing rights and the sustainability of the water source.

Despite this seemingly rigorous process, water rights are only effective if there is enforcement to protect those rights. During the summer of 2012, DNRC discovered 13 illegal oil and gas water depots operating without the correct permit. No fines were issued. DNRC staff said they believed some fracking water from North Dakota sources may also have been used in Montana. They noted that Montana law does not currently allow out-of-state delivery of water withdrawn under any existing Montana permits, but regulatory oversight seems loose enough to have allowed it.

Rather than take steps to improve oversight, DNRC promoted legislation in the 2013 Montana legislature to allow holders of water rights to lease those rights temporarily for other uses (House Bill 37, sponsored by Rep. Bill McChesney, (D-Miles City). DNRC has already identified 13 existing water rights in Dawson and Richland Counties that have the capacity for use as sources of fracking water. The water rights leasing bill handily passed the state House of Representatives and is expected to become law. The Northern Plains Resource Council succeeded in adding language that placed a six-year sunset on the bill, but remains concerned that the bill will incentivize the use of any excess flow of water that would normally go downstream to other users.[24] Multiple agencies in Montana are responsible for different aspects of water law, and no single agency is addressing the cumulative water use by the oil and gas industry in Montana and its implications for state policy.

Multiple agencies in Montana are responsible for different aspects of water law, and no single agency is addressing the cumulative water use by the oil and gas industry in Montana and its implications for state policy.

A draft, uncompleted report by the Department of Energy raised concern about water quantity in 2006, noting, "available surface water supplies have not increased in 20 years, and ground water tables and supplies are dropping at an alarming rate."

Wyoming: Shrinking Aquifers

Oil and gas production takes place in many parts of Wyoming. Twenty-one of its 23 counties had oil and gas production in 2012. Production for the year amounted to about 57 million barrels of oil and over two trillion cubic feet of gas (two billion mcf).[25]

Nonetheless, both oil and natural gas production have been declining in Wyoming. Oil production was more than 136 million barrels in 1978 and had gradually trended down since then, until it increased modestly in 2012. Gas production rose steadily for many years and had reached its current level by about 2008; natural gas production declined slightly in 2012. Its monthly total of a little over 145 million mcf in January 2013 was the lowest since May, 2003.

The rise and fall of gas production in the state reflects the fortunes of CBM exploration and production, and the effect of declining prices on production from tight sands formation in the Jonah Field and the Pinedale Anticline. CBM wells are located in the Powder River Basin in the northern part of the state. The wells are unique because they are so shallow. The aquifers that run through them are normally used for drinking water or to water livestock. Although they are not fracked, they still result in significant groundwater loss due to the tremendous quantity of produced water discharged in order to produce methane from CBM wells.

Through November 23, 2009 drillers had completed 10,508 federal CBM wells and another 16,436 non-federal wells in Wyoming, according to the Wyoming Oil and Gas Conservation Commission (WOGCC). But the handwriting was already on the wall. Only 220 CBM permit applications were filed in September 2009, compared to 980 just three years earlier. By 2012 there were an estimated 11,800 idle CBM wells in Wyoming. Drillers took the opportunity to blame federal government policies, such as protection of sage grouse, for choking off the boom.[26] One more likely reason for this is that the volume of gas from the most

productive wells was in decline—the field had begun to play out. Another major factor was certainly the natural gas market crash that started in the summer of 2008, when the natural gas wellhead price was close to $11 per mcf. By October the average price was down to $5.64 per mcf, and by March 2009 it stood at $3.38. It has yet to recover.[27] The CBM boom in Wyoming not only ended up in an economic bust, it left the state with significantly less groundwater quantity and diminished water quality.

Outside the Powder River Basin, natural gas drilling has also affected Wyoming's water. Water quality problems from fracking, especially related to human health issues, have captured the lion's share of national interest. EPA is currently conducting a study of the Pavillion area and issued a 2011 report that said fracking could have contaminated groundwater there. EPA announced in December 2012 that it was continuing its study, but was still unable to "draw conclusions about the potential impacts of hydraulic fracturing on drinking water resources, which will be made in the final study." EPA's target date for its draft report is late in 2014.[28] Meanwhile, Encana Oil and Gas, the Canadian company that owns, developed and is producing the Pavillion/Muddy Ridge gas field, has proposed pumping wastewater produced from some 280 wells in its Moneta Divide project into the large Madison geological formation, which contains an aquifer used for drinking water in much of Wyoming.[29]

EPA's fracking report is not studying water quantity issues, but they do loom large in the state. A recent staff-written opinion piece in the *Casper Star Tribune*, entitled "Water Is the Next Great Wyoming Energy Resource," noted that water is like oil and gas in that "if we waste it, ruin it or use it at an unjustifiable rate, it's going to be awfully hard to get back."[30] In the same vein, *Wyoming Energy News* identified water as an "impediment" to new exploration "from industry and environmental standpoints" because of drought and water scarcity.

New oil drilling has commenced in the Niobrara and other targeted shale formations, including the Shannon, Parkman and Turner. More than 20,000 new natural gas wells have been proposed in the State as well, including the Continental Divide-Creston Project which, with nearly 9,000 wells proposed over 1.1 million acres in Wyoming's fragile Red Desert, is one of the largest natural gas proposals on the planet.

The more profitable this drilling proves to be, of course, the more water demands will increase. To date most groundwater losses in Wyoming have occurred through water produced CBM wells. Drilling in deep shale formations like the Niobrara and in the Powder River Basin entails extensive deep horizontal drilling and hydraulic fracturing.[31] This type of drilling, also used in the Bakken formation, requires 2 - 4 million gallons per well, according to EPA estimates. Most of this water in Wyoming for deep horizontal drilling is expected to come from groundwater.

The problem with new shale drilling is that Wyoming's groundwater is already compromised in terms of quantity, according to a recent report by the Powder River Basin Resource Council (PRBRC).[32] The report notes that the Wyoming State Engineer determined in 1992 that the use of groundwater for CBM production was a "beneficial use" under Wyoming law. (WOGCC is responsible for considering drilling permit applications, while the office of the State Engineer grants water permits.)

This determination led to virtually unlimited use and the loss of significant groundwater, especially in the Powder River Basin. By 2006, the Wyoming Geological Survey issued a report based on data from monitoring wells, which found that the Fort Union aquifer had dropped as much as 625 feet since 1997 due to extraction and disposal of groundwater for CBM production. This aquifer provides drinking water to Gillette, a city of about 30,000. At its estimated recharge rate, the Fort Union aquifer would take 50,000 years to replenish—provided all withdrawals stopped in 2006.[33] (They didn't.)

PRBRC's study made seven recommendations for protecting Wyoming groundwater in light of the water already wasted by CBM drilling and discharges, the threats from fracking in tight sands formations, and the looming threat posed by a potential boom in deep horizontal drilling. Three of the recommendations directly address prevention of further aquifer drawdown. One is a comprehensive groundwater inventory program to be conducted by the State Engineer with assistance from the University of Wyoming and the state Geological Survey. The second is that the State Engineer should designate additional Groundwater Control Areas in counties where increased demands on water are expected. The designation enables the State Engineer to issue immediate temporary orders to

limit groundwater extraction in those areas. PRBRC's final recommendation is a program of interagency assistance to develop programs to recycle flowback and production water for drilling and hydraulic fracturing.[34]

Wyoming does not ask companies to use FracFocus to report fracking fluid contents or volume, but rather requires reporting of this information directly to the WOGCC. Nevertheless, many companies do post fracking information to the FracFocus website. The total water use reported to FracFocus in 2012 was just over 407 million gallons. Staff at WOGCC, however, would not speculate on the accuracy of the FracFocus listing. The agency indicated that it has not had available the staff hours necessary to aggregate the information that has been submitted to it.

AT ITS ESTIMATED RECHARGE RATE, THE FORT UNION AQUIFER WOULD TAKE 50,000 YEARS TO REPLENISH

Colorado: Competition for Water

Colorado has experienced boom times for both oil and natural gas production in the past decade, with major effects on both sides of the state. Gas production in Colorado has risen steadily since 1999, increasing from about 200 million mcf to 1.7 billion mcf in 2012,[35] with the sharpest rise occurring last year. About half of the production comes from the Piceance Basin, which sprawls over a large portion of Colorado's Western Slope, including the Roan Plateau, which is still in part protected but much desired by the oil and gas industry. The Basin also takes in the Grand Valley and Parachute, where a massive underground spill from a natural gas processing plant, in late winter 2012-2013, leaked at least 6,000 gallons of benzene and contaminated 176,000 gallons of groundwater.[36]

The Colorado Oil and Gas Conservation Commission has authority to issue oil and gas drilling permits in Colorado, and is responsible for regulatory oversight. The Colorado Division of Water Resources, also known as the Office of the State Engineer, administers the state's priority-based water rights system, issues water well permits, and monitors stream flow and water use.

Oil production in Colorado in 2012 reached 48 million barrels, the highest since 1961. The primary reason was exploitation of the Wattenberg field of the Niobrara shale. The field is in the northeast part of the state and has been extensively drilled near densely-populated areas of the Front Range, including Greeley and Longmont. The field accounts for about three-fourths of the state's oil production.

Hydraulic fracturing is used extensively in both of these fields. According to FracFocus, Colorado's use of water for fracking in 2012 amounted to just over 3.25 billion gallons. The Colorado Oil & Gas Association (COGA), a private

industry group, estimated 2012 water use at 6.5 billion gallons. Nevertheless, COGA downplays the industry's water use by stating that water use for oil and gas extraction amounts to only 0.13 percent of total state water use—a "drop in the bucket."[37] It conveniently ignores the fact that the large majority of other water users return used water to the hydrological cycle, but water that goes into injection wells is gone for good.

It seems likely that the industry's assertive defense of its water use is at least in part a response to a report published in 2009 by Western Resource Advocates (WRA), "Water on the Rocks."[38] The report's conclusions emphasize the need to know how much water is required, and where the water will come from, before Colorado commits to commercial oil shale leasing.* The report lays out a scenario characterized by a number of conflicts over water use likely to emerge during an oil shale boom.

THE LARGE MAJORITY OF OTHER WATER USERS RETURN USED WATER TO THE HYDROLOGICAL CYCLE, BUT WATER THAT GOES INTO INJECTION WELLS IS GONE FOR GOOD.

The report estimates that oil and gas companies have sufficient water rights to divert and store enough water annually to meet the domestic needs of up to 10 million people. Use of that much water for oil and gas development would disadvantage irrigated agriculture, exclude other new development projects, and could lead to water shortages in Denver and other Front Range communities that rely on water diverted from the Western Slope. Simultaneously, the report says, global warming is expected to reduce precipitation and increase evaporation in the Rockies, leading to conditions similar to the Dust Bowl era.

Some elements of this scenario are already playing out, even without any oil shale production. A *New York Times* article last fall reported a Colorado water auction where farmers and ranchers were finding themselves "outbid by water haulers who supply hydraulic fracturing wells." Earlier last year, the city of Aurora

*Oil shale *is a type of rock that, when heated, yields kerogen, a liquid hydrocarbon that can be further refined into gasoline and other fuels. It is not to be confused with* shale oil*, which is conventional oil that can be released from the shale formations in which it is found by horizontal drilling and fracking.*

leased 2.4 billion gallons of effluent water to Anadarko Petroleum over a five-year period. Although it was not drinking water, but rather effluent, opponents pointed out that the water would normally have benefited communities downstream on the South Platte River. The city of Greeley is on a pace to provide 586 million gallons of water to energy companies this year—more than FracFocus says is used for fracking in all of New Mexico.[39]

Meanwhile, WRA has increased its estimate of the amount of water that could be demanded annually by fracking, based on new information from the state and industry.[40] WRA notes that the state itself has projected water needs for fracking in 2015 at 18,700 acre-feet.[41] By adding the water needed for drilling itself, WRA estimates full 2015 water demand at 22,100 acre-feet, just over 7.2 billion gallons, and more than is listed on FracFocus for Colorado, Montana, Wyoming and North Dakota combined in 2012. However, WRA notes, a fact sheet issued by Chesapeake Energy about its drilling in the Niobrara formation estimates 12.3 acre-feet of water per well to frack and nearly an additional acre-foot to drill.[42] Multiply that by the 2,992 wells drilled in Colorado in 2011, and the result is 39,500 acre-feet of water, or nearly 12.8 billion gallons per year—twice the amount FracFocus lists in 2012 for the biggest user of frack water, Pennsylvania.

Covering much of Colorado's Western Slope, the Piceance Basin yields about half of the natural gas production in the state.

Summary of Findings

Fracking has become standard operating procedure for almost all new oil and gas wells in the region, as in most of the country. There is nothing to indicate that the industry will ever again rely extensively on conventional methods of extraction, at least in the United States.

Oil and gas recovery has thus become a water user at levels that few would have anticipated just a decade ago. It is no longer possible to think responsibly about oil and gas extraction without also thinking about its implications for both water quality and water quantity.

The authority to protect water supplies is currently at the state level. Congress exempted fracking, other than fracking with diesel, from the Safe Drinking Water Act in 2004. Federal agencies have not yet identified a means of regulatory leverage adequate to address looming conflicts over water quantity. In this regard, it is telling that the U.S. Department of Energy has not yet completed a report authorized by Congress in 2005 on oil and gas drilling and water quantity. At this point, it appears to be up to the states, through whatever codified water quantity protections and permitting processes they have and are willing to use, to design methods to curtail water loss related to fracking.

State agencies have continued to emphasize permitting over regulation, however, and often joined the industry in an effort to downplay environmental issues related to oil and gas extraction.

State agencies have continued to emphasize permitting new wells over regulation, of the oil and gas industry however, and have often joined the industry in an effort to downplay the impacts of oil and gas extraction.

A related problem is the rise of FracFocus, an industry website that now serves as a de facto arm of government for the many states that have delegated to it the official duty of tracking fracking chemicals and water use. This maneuver, no doubt, seems attractive to state governments because it saves them money. Indeed, a public employee in Wyoming, the one state in the region surveyed in this report that does not use FracFocus, said that the state does not have adequate staff to aggregate or analyze the fracking water and chemical information submitted by drilling companies. Discrepancies noted in Colorado and North Dakota between FracFocus numbers on water use and those of other entities cast doubt on the reliability of FracFocus' accounting.[43]

Recommendations

It is vital that communities do not forfeit the water resources essential to their future prosperity for the one-time extraction of oil and gas. This is true everywhere, but especially in the arid West. Water is one of the pillars upon which the hope of prosperity rests in this region, since it is integral to agriculture, local manufacturing and other business, as well as daily living.

i. Study

States should commit themselves to thorough, impartial study of the water resources available, and of how much fracking can be conducted without endangering those resources. The U.S. Government Accountability Office remarked in 2012 on the lack of "data on the quantity and quality of existing water supplies," noting that "effective decisions about withdrawing water from existing supplies for energy production cannot be made without first understanding how much water is actually available and the quality of these supplies."[44]

So far, the cart is far ahead of the horse. It is imperative that studies commence immediately. These studies should take into account not only current conditions, but also the way the climate is changing, and the extent to which drought induced by global warming may affect the amount of water available in coming years.

ii. Plan

States should conduct independent planning for energy needs in general. This planning should take into account the health and environmental impacts of fossil fuel production and the benefits (including reduced water use) of a transition to a sustainable renewable energy economy.

iii. Monitor and Control

States should closely monitor and control all the impacts of fracking, especially impacts on the quantity of available water. States should base their regulation of the oil and gas industry's water use on the basis of overall current and future needs, rather than on the more narrow interests of a single private

industry. States should levy oil and gas taxes that will bring in public revenue sufficient for regulatory operations. States should not farm out public functions, such as monitoring the contents and amounts of fracking fluid used, to private entities linked with the regulated industry.

iv. Recycle

States should require reuse or recycling of water used for fracking. The oil and gas industry brags that it can be done. The public interest would be served if states make the oil and gas industry walk the talk, and require that it be done.

Notes

1 See www.dvn.com. See also www.fracfocus.org.

2 www.drought.unl.edu/dm/monitor.html.

3 "Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water," U.S. Department of Energy, 2006, p. 12. This report pre-dates the shale oil and gas booms, including the Marcellus shale gas boom in the northeastern United States and the Bakken shale oil boom in North Dakota. The report includes a figure from a 2003 Government Accountability Office study that identified North Dakota as one of seven states not likely to face water shortages over the next decade, but the demands of fracking on water sources were clearly not envisioned.

4 "Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources," February 7, 2011, p. 19.

5 See also "Hydraulic Fracturing and Water Resources," Pacific Institute, June 2012, p. 15, www.pacinst.org/reports/full_report.pdf.

6 See www.skytruth.org.

7 Oil and Gas Journal, www.ogj.com. Also see "North Dakota oil field is thirsty: 5.4B gallons of water used in 2012," Amy Dalrymple, Forum News Service, March 17, 2013. Asked for log numbers from 2012, the Oil and Gas Division of the North Dakota Department of Mineral Resources agreed to provide a fracking water log from June 2012. It totaled 353 million gallons. If that was an average month, the DMR's accounting would put fracking water use in North Dakota at 4.2 billion gallons.

8 "New Mexico Farmers Seek 'Priority Call' as Drought Persists," Felicity Barringer, New York Times, March 26, 2013.

9 Statistics from the North Dakota Department of Mineral Resources website, www.dmr.nd.gov.

10 See "Drill, Baby, Drill: Can Unconventional Fuels Usher in a New Era of Energy Abundance?" by J. David Hughes, www.postcarbon.org. Citing steep production decreases at Bakken wells after 24 months, Hughes sees peak production in 2016 followed by a steep decline to less than 100,000 barrels per day from the Bakken in 2015.

11 Dakota Counsel, Vol. 32., No. 4, June 2009.

12 Kimberly Fischer, North Dakota Water Resource Investigation, No. 54, p. 58, North Dakota State Water Commission, 2013, www.swc.state.nd.us.

13 "Gov. Hoeven tells EPA that N.D. can handle fracturing," Rebecca Beitsch, Bismarck Tribune, May 16, 2010. At least two different versions of Shaver's power point on the inability of ground water sources to meet fracking needs in North Dakota are on line. See www.roughneck.com and www.mgwa.org.

14 "Lake Sakakawea, North Dakota Water from Missouri River Can Be Used for Drilling, Feds Say," James MacPherson, Associated Press, May 9, 2012. In December, the Army Corps of Engineers reportedly proposed a fee of $21.60 per acre-foot for Sakakawea water used for industrial purposes.

See "Corps opens faucet from Lake Sakakawea to oil patch," Lauren Donovan, Bismarck Tribune, December 13, 2012.

15 "Radioactive oil patch waste on the loose in N.D.," Lauren Donovan, Bismarck Tribune, January 13, 2013.

16 "Tribe warns that children might play with illegally dumped filter socks," Lauren Donovan, Bismarck Tribune, March 5, 2013.

17 See "Dunn County at odds over water permit," January 5, 2010, and "Dunn County man who sold water to oil industry could be charged," February 13, 2010, both by Lauren Donovan, Bismarck Tribune. She reported that William Pavlenko, New Hradec, sold 23 million gallons (or 67 acre-feet) of fracking water over and above his permitted amount in 2009. His revenue from the illegal sales was reported to be $230,000. The Water Commission took no criminal action.

18 "Performance Audit of the Water Appropriations Division of the North Dakota Office of the State Engineer," KPMG International.

19 HB1398. See "Water Wars," Dale Wetzel, Great Plains Examiner, March 4, 2013.

20 Statistics from Montana Oil and Gas Commission, www.bogc.dnrc.mt.gov.

21 "The Montana Bakken Oil Play: 'Great News for a Great Play,'" Keith Schaefer, Oil and Gas Investments Bulletin, December 18, 2012.

22 "Water Use Options for Oil Well Development," Montana Department of Natural Resources & Conservation, published April 19, 2012, www.dnrc.mt.gov.

23 Montana Department of Natural Resources, Water Resources Division, Appropriations Program, www.dnrc.mt.gov.

24 See www.leg.mt.gov.

25 See www.wogcc.state.wy.us.

26 Dustin Bleffeizer, "Wyoming betting on coal-bed methane comeback despite industry bankruptcies," May 2012, www.wyofile.com.

27 U.S. Energy Information Administration, www.eia.gov.

28 "EPA Releases Update on Ongoing Hydraulic Fracturing Study," press release, December 21, 2012.

29 "Encana aims to dispose of wastewater in Madison aquifer," Casper Star-Tribune, by Adam Voge, February 25, 2013.

30 Adam Voge, March 3, 2013.

31 April 2, 2013, www.wyomingenergynews.com. Some have touted the Niobrara, which underlies parts of Wyoming, Colorado, Kansas and Nebraska, as "the next Bakken," but Wyoming Energy News recently noted that in Colorado, "after a strong start…output has been less than predicted."

32 "Unconventional Oil & Gas Development Requires State Action to Protect Wyoming's Groundwater," January 2013, p. 5.

33 Keith E. Clarey, Nicholas W. Gribb, Richard J. Hayes and Fred J. McLaughlin, "1993-2006 Coalbed Natural Gas Regional Groundwater Monitoring Report: Powder River Basin, Wyoming," Wyoming State Geological Survey Report, Open File Report 2010-02, updated September 2010 at p. 31, cited by PRBRC in its report.

34 Pp. 12-17. PRBRC's other three recommendations to the state are 1) to project anticipated volumes of flowback and produced water from future drilling and develop a comprehensive tracking program; 2) to charge a statewide task force with investigation of the condition of disposal wells; and 3) to develop a new program to establish a funded well-plugging program.

35 Production statistics from the Colorado Oil and Gas Conservation Commission, www.cogcc.stat.co.us.

36 "Benzene is detected in grounds near creek," Dennis Webb, Grand Junction Daily Sentinel.

37 "Colorado Water Supply and Hydraulic Fracturing: The Basics," first paragraph of a brief factsheet, www.coga.org,/index.php//Colorado_Water_Supply_and Hydraulic_Fracturing#sthash.iNI5AoFW.dpbs. See also "Water Use Fast Facts in Translation" and "Water Sources and Demand for the Hydraulic Fracturing of Oil and Gas Wells in Colorado from 2010 through 2015," prepared jointly by COGA, the Colorado Water Conservation Board and the Colorado Division of Water Resources. This final document projected the need for 5.25 billion gallons of water for fracking in Colorado in 2012.

38 www.westernresourceadvocates.org

39 "For Farms in the west, Oil Wells Are Thirsty Rivals," Jack Healy, September 5, 2012.

40 www.westernresourceadvocates.org

41 Colorado Division of Water Resources, Colorado Water Conservation Board, and Colorado Oil and Gas Conservation Commission, 2012. "Water Sources and Demand for Hydraulic Fracturing of Oil and Gas Wells in Colorado from 2010 through 2015." www.cogcc.state.co.us.

42 Colorado Oil and Gas Conservation Commission. January 23, 2012 Staff Report. www.cogcc.state.co.us.

43 A study by Harvard University has come to similar conclusions according to a report by Mike Soraghan, Environment & Energy Daily, April 23, 2012. The study, "Legal Fractures in Chemical Disclosure Laws: Why the Voluntary Chemical Disclosure Registry FracFocus Fails as a Regulatory Compliance Tool," by Kate Konschinik with Margaret Holden and Alexa Shasteen, can be seen at www.eenews.net/assets/2013/04/23/document_ew_01.pdf.

44 "Energy-Water Nexus: Coordinated Federal Approach Needed to Better Manage Energy and Water Tradeoffs," United States Government Accountability Office Report to the Ranking Member, Committee on Science, Space, and Technology, House of Representatives, p. 15.

Gone for Good: Fracking and Water Loss in the West outlines the status of water consumption for fracking in four states: Colorado; Montana; North Dakota; and Wyoming. The report also outlines and evaluates current regulatory frameworks for fracking water usage in each of those states.