



Injection Wells  
The Hidden Risks of Pumping Waste Underground

## On a Wyoming Ranch, Feds Sacrifice Tomorrow's Water to Mine Uranium Today



*Thousands of small black boxes used for uranium mining are scattered across Christensen Ranch in Wyoming. (Abraham Lustgarten/ProPublica)*

by Abraham Lustgarten  
ProPublica, Dec. 26, 2012, 9:54 a.m.

GILLETTE, Wyo. — On a lonely stretch at the edge of the Great Plains, rolling grassland presses up against a crowning escarpment called the Pumpkin Buttes. The land appears bountiful, but it is stingy, straining to produce enough sustenance for the herds of cattle and sheep on its arid prairies.

"It's a tough way to make a living," said John Christensen, whose family has worked this private expanse, called Christensen Ranch, for more than a century.

Christensen has made ends meet by allowing prospectors to tap into minerals and oil and gas beneath his bucolic hills. But from the start, it has been a Faustian bargain.

As dry as this land may be, underground, vast reservoirs hold billions of gallons of water suitable for drinking, according to the U.S. Environmental Protection Agency. Yet every day injection wells pump more than 200,000 gallons of toxic and radioactive waste from uranium mining into Christensen's aquifers.

What is happening in this remote corner of Wyoming affects few people other than Christensen — at least for now.

But a roiling conflict between state and federal regulators over whether to allow more mining at Christensen Ranch — and the damage that comes with it — has pitted the feverish drive for domestic energy against the need to protect water resources for the future. The outcome could have far-reaching implications, setting a precedent for similar battles sparked by the resurgence of uranium mining in Texas, South Dakota, New Mexico and elsewhere.

Twenty-five years ago, the EPA and Wyoming officials agreed that polluting the water beneath Christensen Ranch was an acceptable price for producing energy there.

The Safe Drinking Water Act forbids injecting industrial waste into or above drinking water aquifers, but the EPA issued what are called aquifer exemptions that gave mine operators at the ranch permission to ignore the law. Over the last three decades [1], the agency has issued more than 1,500 such exemptions nationwide, allowing energy and mining companies to pollute portions of at least 100 drinking water aquifers.

When the EPA granted the exemptions for Christensen Ranch, its scientists believed that the reservoirs underlying the property were too deep to hold desirable water, and that even if they did, no one was likely to use it. They also believed the mine operators could contain and remediate pollution in the shallower rock layers where mining takes place.

Over time, shifting science and a changing climate have upended these assumptions, however. An epochal drought across the West has made water more precious and improved technology has made it economically viable to retrieve water from extraordinary depths, filter it and transport it.

"What does deep mean?" asked Mike Wireman, a hydrologist with the EPA who also works with the World Bank on global water supply issues. "There is a view out there that says if it's more than a few thousand feet deep we don't really care ... just go ahead and dump all that waste. There is an opposite view that says no, that is not sustainable water management policy."

Federal regulators also have become less certain that it is possible to clean up contamination from uranium mining. At Christensen Ranch and elsewhere, efforts to cleanse radioactive pollutants from drinking water aquifers near the surface have failed and uranium and its byproducts have sometimes migrated beyond containment zones, records show.

In 2007, when the Christensen Ranch mine operator proposed expanding its operations, bringing more injection wells online and more than tripling the amount of waste it was injecting into underground reservoirs, Wyoming officials eagerly gave their permission, but the EPA found itself at a crossroads.

If the agency did what Wyoming wanted, it could destroy water that someday could be necessary and undermine its ability to protect aquifers in other places. If it rejected the plan, the agency risked political and legal backlash from state officials and the energy industry.

The EPA declined interview requests from ProPublica for this story and did not respond to a lengthy set of questions submitted in writing. After learning that ProPublica contacted several EPA employees directly involved in the debate over Christensen Ranch, the agency instructed staffers not to discuss the matter without agency approval.

For the last five years, as regulators have vacillated over what to do, John Christensen has experienced a similar ambivalence.

His property is speckled with thousands of small, mysterious black boxes. From each dark cube, a mixture of chemicals is pumped into the ground to dissolve the ore and separate out the uranium so that it can be sucked back out and refined for nuclear fuel.

Horses graze behind a gate on a dirt road that winds across this 35,000-acre tract, 50 miles south of Gillette. Nearby, a small metal sign is strung to a cattle guard with chicken wire: "Caution. Radioactive Material."

Christensen still places a tenuous trust in the system that promises to keep his water safe and leave his ranch clean. He relies on the royalty income and believes the national pursuit of energy is important enough to warrant a few compromises.

Yet if he had it to do over again, he's not sure he would lease out the rights to put a uranium mine on Christensen Ranch.

"It's probably worthwhile for this generation," he said. "You just don't know about future generations."

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John Christensen's grandfather, Fred, first allowed uranium exploration on the family's ranch in the 1950s.

Fred Christensen had come to Wyoming from Michigan as a homesteader in 1906, finding work as a ranch hand and settling on a small tract at the base of the northernmost Pumpkin Butte. The Christensens farmed sheep, selling their meat and their wool, and used the proceeds to buy up more land. Through marriage and business, the family amassed some 70,000 acres, coming to rank among the largest private landowners in the United States.

Yet droughts plagued the region, making agriculture difficult. Tapping into Wyoming's resource wealth, the Christensens staked claims on the property, selling mining and drilling rights to companies that helped transform the Powder River Basin into the energy basket of America.

Uranium was discovered underneath Christensen Ranch in 1973. In 1978, after the property had been divided between cousins, Westinghouse Electric launched the first large-scale uranium mine on John Christensen's portion.

Modern mining for the radioactive ore inevitably pollutes water.

To avoid digging big holes in the ground, operators inject a mixture of sodium bicarbonate, hydrogen peroxide and oxygen into the rock to separate out the minerals and bond to the uranium. Then, they vacuum out the uranium-laden fluids to make a fine powder called yellowcake. The process leaves a toxic mix of heavy metals and radioactive ions floating in the groundwater and generates millions of gallons of waste that need to be dumped deeper underground.

The federal Safe Drinking Water Act, implemented in the early 1980s as mining began in earnest on Christensen Ranch, posed a potential hurdle to such ventures because it prohibited disposal of waste in aquifers. But the law allowed regulators to exempt aquifers if they determined that water was too dirty to use, or buried too deep to be worth pumping to the surface, or unlikely to be needed.

In 1982, when Wyoming officials anticipated the need for an aquifer exemption at Christensen Ranch, the state's then-governor, Ed Herschler, wrote to urge EPA officials to streamline their review of such requests and not to delay energy projects or interfere with Wyoming regulators. Steven Durham, the EPA's regional administrator at the time, wrote back to assure the governor the EPA would not second guess state officials, and that he had adjusted the rules so that they "should assure a speedy finalization of any exemptions."

Wyoming environment officials issued the first permit exempting several deep groundwater aquifers on the ranch from environmental protection in 1988. It said the water was of relatively poor quality, and was too deep and too remote to be used for drinking. The permit did not address the possibility that usable aquifers could lie in even deeper rock layers beneath the site.

The EPA confirmed the state's exemptions and issued separate ones allowing the mine operator to contaminate the shallow layer of groundwater closest to the surface, where anyone who needed water — including John Christensen — was likely to go for it first.

Even as they gave their stamp of approval, EPA officials noted that the mine operator's application had not set precise boundaries for the depth or breadth of the exempted area. "The information contained in the submittal does not specifically delineate the area to be designated," the EPA's Denver chief administrator acknowledged in a letter to Wyoming regulators [2] in August 1988.

Still, Christensen, who continued to run stock on his land, saw the pollution as an inconvenience, not a threat. He was assured that the mine operator could steer contaminants toward the center of the exemption zone by manipulating pressure underground. Monitoring wells surrounded the perimeter of the mining site like sentries, checking if pollutants were seeping past the border.

Drilling new water wells beyond the mine's boundary was expensive, but Christensen took comfort from rules obliging the mine operator to restore contaminated water within the exempted area to its original condition once mining was complete.

"That was our best quality water," Christensen said. "I've been given to believe that it is not sacrificed, that they will restore the groundwater quality."

The mining proceeded in fits and starts, stalling in 1982 with a collapse of the uranium market, picking up five years later, stopping again in 1990, and then restarting in 1993. Ownership of the facilities changed hands at least five times.

By 2000, mining activity seemed to be over for good, and restoration efforts geared up under the supervision of the Nuclear Regulatory Commission.

The restoration wouldn't go entirely as planned.

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In July 2004, contaminants were detected in one of the monitoring wells surrounding the mining facility at Christensen Ranch.

This wasn't that unusual, mining and regulatory officials say. Other excursions, as they are called, had occurred over the years. The monitoring wells are an early warning system, detecting benign chemicals long before more dangerous toxins can spread.

"It's sort of like a smoke detector," said Ron Linton, who oversees the licensing for Christensen Ranch for the Nuclear Regulatory Commission. "They will go back in and adjust their flow with their production practices within their ore zone to get those levels down."

But according to documents [3] from the Wyoming Department of Environmental Quality, Cogema — the company then handling the restoration effort — could not fix the problem or identify its cause. The company tested water from the area and examined their injection wells for defects, but told state officials they believed the contaminants had occurred naturally and were not from the mine.

For six years, the contaminants continued to spread, disappearing for short periods as the restoration progressed only to reappear again, records show.

"This really shouldn't happen," said Glenn Mooney, a senior state geologist who oversaw the Christensen Ranch site for Wyoming from the late 1970s until last July.

Mooney observed that the concentration of contaminants at the boundary had leveled, but "showed no hint that they may drop," and warned that some of the chemicals found posed a considerable risk.

"The increase in uranium levels, a level over 70 times above the maximum contaminate limit for uranium, in a well that is located at the edge of the aquifer exemption boundary, is a major concern to WDEQ," he wrote in a 2010 letter [3].

Christensen said he was never told about the excursions beneath his property and that, as far as he knew, several of the minefields had been fully restored. He said he expected to use the shallow aquifer polluted by the mining as a source of drinking water in the future.

Restoration is the most important backstop against the risk that contaminants will spread from the mining site after the mining is finished. Polluted water is pumped from the ground, filtered using reverse osmosis, and then re-injected underground. The worst, most concentrated waste is disposed of in deeper waste wells.

Yet the Nuclear Regulatory Commission approved Cogema's restoration of minefields associated with Christensen Ranch even as the excursion remained unresolved.

The commission deemed nine mining fields [4] there successfully "restored" even though records show that half of the contaminants in the aquifer, including the radioactive byproduct Radium 226, remained above their natural levels.

Studies by the NRC [4], the U.S. Geological Survey [5] and private consultants [6] have found that similar cleanups elsewhere have rarely been fully successful.

The Geological Survey's study of uranium restoration in Texas found that no sites had been completely restored to pre-mining levels, and the majority had elevated uranium when the restoration was finished. The 2008 NRC review concluded that each of 11 sites at three mines certified by the agency as "restored" had at least one important pollutant above baseline levels recorded before mining began. The report concluded that restoring water to baseline levels was "not attainable" for many of the most important contaminants, including uranium.

Some regulators and mining industry executives call attempts to fully restore aquifers at uranium sites idealistic. Such water was often contaminated with uranium before mining began, they contend.

"When you restore it ... you bring each individual ion down to a level that is within the levels that occurred naturally," said Richard Clement, the chief executive of Powertech Uranium, which is currently applying for permits for a new mine in South Dakota. "It depends what you mean by 100 percent successful. Are people saying it is different than what it was? Yes it is. But is it worse? No."

Efforts to restore the groundwater at Christensen Ranch had other consequences. While the water was supposed to be filtered and re-injected, millions of gallons were removed and disposed of permanently as a result of the process, lowering the ranch's water table.

Water wells outside of the mine area that had routinely produced 10 gallons a minute struggled to produce a single quart, Christensen said. The water levels in the aquifer also dropped — in some places by 100 feet.

"They have always claimed that they could restore the groundwater," Christensen said. "The main concern is there isn't much water left when they get it to that quality. It never came back."

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In 2007, as uranium commodities skyrocketed and a new mining boom began, Cogema applied to the Wyoming Department of Environmental Quality and the Nuclear Regulatory Commission for permits to restart and expand its operations at Christensen Ranch.

To do it, the company would need to use two additional deep injection wells, making four total, to dispose of waste produced from ongoing restoration efforts and absorb the byproducts of drying and refining yellowcake. The plan called for more than tripling the amount of waste the company could pump into the Lance aquifer, more than 3,000 feet under Christensen Ranch.

Wyoming had permitted the additional wells years earlier, which it can do under authority delegated to states by the EPA to enact the Safe Drinking Water Act. But Cogema's request required something more — a change to past exemptions — that only the EPA had the power to grant.

Earlier exemptions issued for Christensen Ranch had only indirectly addressed the deep aquifers underlying the Lance.

In November 2010, Wyoming officials asked the EPA to exempt every layer of water below the Lance, regardless of its quality or whether it was being used by the mine, and without additional study. The water quality at those depths was "not reliably known," they wrote. The EPA should apply the exemptions to all of the deep aquifers, they said, "whether or not they meet the definitions of 'underground sources of drinking water.'"

For the EPA, Wyoming's request opened up a morass of legal and environmental concerns.

In the eight years since the agency had approved the last exemption at the ranch, its scientists had grown increasingly convinced that the deep layers of aquifers beneath the property might contain one of the state's largest reserves of good water. One layer, the Madison, is described in a state assessment as "probably the most important high-yield aquifer in Wyoming" and supplies drinking water to the city of Gillette.

Some within the EPA worried that approving Wyoming's request would create a damaging precedent, several EPA employees told ProPublica. It would write off billions of gallons of water in perpetuity, stripping them of legal protections against pollution, even though they were not necessary to the mining process.

Also, arguments that nobody would ever pay to pull water from aquifers below Christensen Ranch seemed more tenuous as scarcity made every drop of clean water more valuable and changing technology made deeper resources economically viable.

"Where do we get that water?" asked Mark Williams, a hydrologist at the University of Colorado at Boulder who has received a National Science Foundation grant to look at energy and water issues. "Right now we want to get it from the near surface because it's cheaper. The question is, is that going to change in the future?"

If the EPA rejected Wyoming's request, it opened itself to other problems, however.

The EPA had granted exemptions allowing the two injection wells already operating at Christensen Ranch based on the notion that the aquifers below them did not qualify as sources of drinking water. If the agency reversed itself on this, it could make the existing mine operations illegal.

"I don't think that you could argue very strongly that it was the intent of the law to routinely use these exemptions to get around complying with the law," Wireman said.

"The law is very clear," he added, referring to the prohibition against allowing injection wells for toxic waste above aquifers. "That was done for a reason."

The process slowed to a crawl as federal officials from Denver to Washington considered the matter.

In December 2010, the EPA sent a letter [7] to Wyoming's chief groundwater supervisor saying the agency saw no justification for granting new exemptions at Christensen Ranch and asked the state to make a stronger scientific argument.

The EPA also informed Wyoming regulators it planned to publish the exemption requests in the Federal Register, a move that would open them up for public comment and push back their potential approval date.

Infuriated, Wyoming officials approved the renewal permit on their own authority on Aug. 7, 2012, and decided the new injection wells did not need EPA permission because they were covered by past exemptions that could not be reversed.

"We were pretty disappointed with the amount of time it was taking to get a determination, and of course the operator was as well," Kevin Frederick, groundwater manager for the Wyoming Department of Environmental Quality, told ProPublica. "The delay... really kind of caused us to rethink what we were asking EPA to consider. We recognized that we were essentially issuing a permit that had already been approved."

Wyoming's top elected official punctuated the state's position on the case by complaining to EPA administrator Lisa Jackson about the agency's interference.

"Wyoming is the number one producer of uranium in the United States. The industry provides the nation with a reliable, secure source of domestic uranium," Gov. Matthew Mead wrote in a stern Aug. 29 letter. The EPA's review was having a "direct impact on operations, planning, investment and jobs. This has resulted in a standstill which has been the situation for far too long."

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The problems and pressures the EPA is facing at Christensen Ranch are not unique.

With uranium mining booming, the agency has received a mounting number of requests for aquifer exemptions in recent years. So far, EPA records show, the agency has issued at least 40 exemptions for uranium mines across the country and is considering several more. Two mines are expanding operations near Christensen Ranch.

In several cases, the EPA has struggled to balance imposing water protections with accommodating the industry's needs.

In South Dakota, where Powertech Uranium is seeking permits for a new mine in the Black Hills, state regulations bar the deep injection wells typically used to dispose of mining waste. The EPA is weighing whether to allow Powertech to use what's called a Class 5 well — a virtually unregulated and unmonitored shallow dumping system normally used for non-toxic waste — instead.

Powertech officials say they will voluntarily meet the EPA's toughest construction standards for injection wells and will treat waste before burying it to alleviate concerns about groundwater.

"It's not going around the process," said Clement, the company's CEO. "It's using the laws the way they were designed to be used."

Environmental groups say the EPA should not be letting mining companies write their own rules.

"It's disturbing that such a requirement would be so easy to get around," said Jeff Parsons, a senior attorney for the Western Mining Action Project, which is representing the Oglala Sioux in a challenge to stop the Powertech mine. "There is a reason that South Dakota prohibited Class 1 wells; it's to protect the aquifers."

Similar disputes are erupting across the country.

In Goliad County, Texas, a proposal for a new uranium mine has triggered a bitter fight between [8] state officials and the EPA.

In 2010, Texas regulators gave a mining company preliminary permission to pollute a shallow aquifer even though 50 homes draw water from wells near the contamination zone.

EPA scientists were concerned by the mining area's proximity to homes and believed the natural flow of water would send contaminants toward the water wells. At first, the agency notified Texas officials it would deny an exemption for the mine unless the state did further monitoring and analysis.

Texas regulators refused [8]. "It appears the EPA may be swayed by the unsubstantiated allegations and fears of uranium mining opponents," Zak Covar, executive director of the Texas Commission on Environmental Quality, wrote in a May 2012 letter to William Honker, acting director of the EPA's local Water Protection Division.

As the case dragged on without a final determination, some within the agency worried that the EPA would go back on its initial decision and capitulate to appease Texas authorities, with whom it has clashed repeatedly.

"This aquifer exemption issue in Goliad County might become a sacrificial lamb that the federal government puts on the altar to try to repair some relations with the state," said a former government official with knowledge of the case.

On Dec. 5, the EPA approved the exemption in Goliad County.

Many disputes over aquifer exemptions focus on water people might need years in the future, but in Goliad County the risk is imminent. People already rely on drinking water drawn from areas close to those that would be polluted.

"This is a health issue as much as a water supply issue," said Art Dohmann, president of the Goliad County Groundwater Conservation District, a local agency that manages water resources.

As of now, it's unclear how the EPA will answer Wyoming's challenge to its authority at Christensen Ranch.

Meanwhile, uranium mining has resumed on the property.

Uranium One, a Canadian-based company with majority Russian ownership that bought the facility from Cogema in 2010, is moving forward with the added injection wells to expand the operation.

For Christensen, it's the same old story. "I'm going to be dead before it's turned back into grazing land," he said of the ranch. "I'm almost 63 years old... so you know, it's gone on my whole life."

1. <http://www.propublica.org/article/poisoning-the-well-how-the-feds-let-industry-pollute-the-nations-underground>
2. <http://www.propublica.org/documents/item/549659-478epaaquiferexemption-1988-letter-approving>
3. <http://www.propublica.org/documents/item/549660-2010-warning-letter-aqex-good-source-ml100840667>
4. <http://www.propublica.org/documents/item/549568-gw-impacts-detailed-report>
5. <http://www.propublica.org/documents/item/549562-usgs-aqex-remediation-of09-1143>
6. <http://www.propublica.org/documents/item/549563-texas-report-on-restoration-good-restoration>
7. <http://www.propublica.org/documents/item/549658-ac-partial-denial-letter-to-wdeq-final>
8. <http://www.propublica.org/documents/item/549557-pir-9994-dkohler>

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