**Waste-water injection well caused 12 earthquakes in Ohio, investigation shows**

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[**View full size**](http://media.cleveland.com/business_impact/photo/gas-drilling-earthquakes-13d11236f4ad535d.jpg)Associated Press fileNorthstar Disposal Services LLC has halted operations at brine well in Youngstown after a series of small earthquakes hit the area.

CLEVELAND, Ohio -- A waste-water injection well induced the series of [**12 earthquakes in Youngstown**](http://www.cleveland.com/business/index.ssf/2012/01/earthquakes_in_youngstown_blam.html) last year, [**an on-going state probe**](http://media.cleveland.com/business_impact/other/UICReport.pdf) has concluded.

And because of that, Ohio regulators on Friday unleashed a round of new permitting rules for injection well drilling that could limit or slow down the number of new injection wells as contractors scramble to comply with tougher rules.

The regulations come on the eve of an expected boom in gas and oil drilling in the state -- a boom that will also produce millions of gallons of naturally occurring salt water and chemically-laced water used to fracture shale containing the gas and oil.

In a 24-page preliminary report of its investigation into the quakes, the [**Ohio Department of Natural Resources**](http://www.ohiodnr.com/) has included a series of new permit requirements that it says go well beyond national standards.

Among the requirements are mandates that injection well developers submit extensive geological mapping and other data before drilling. If such information does not exist or is incomplete, the developer will have to hire experts to do the seismic and other testing.

State-of-the-art pressure and volume monitoring will be required at operating wells, along with an automatic shutoff system if pressures exceed the limits the state has set for each well. And injection well companies will be prohibited from drilling into the ancient bedrock or "basement rock" as what occurred in Youngstown.

Agency spokesman Carlo LoParo said the new rules will limit injection into formations where there is a chance of an unmapped fault line, but he argued the regulations will not slow down or limit construction of additional injection wells. "These regulations set a clear path for safe disposal of brine," LoParo said.

The new rules will prohibit injection well companies from drilling into the ancient bedrock or "basement rock" as occurred in Youngstown. This rock consists of granite, quartz and other impermeable materials and underlies the state at depths between 1,000 feet and 12,000 feet, depending on location.

In the meantime, the [**Northstar 1 injection well**](http://www.cleveland.com/business/index.ssf/2012/01/company_cautions_against_linki.html) nestled between the Mahoning river and Interstate 680 in Youngstown, will remain closed during the continuing investigation, the agency said. And three other wells drilled by the same company, D&L Energy will also remain unused.

D&L blasted ODNR, saying the report is premature.

"Everything done at the Northstar No. 1 well site was done with ODNR knowledge and approval," D&L said in a statement.

The 12 Youngstown quakes, ranging in magnitude from 2.1 to 4.0, all occurred in a cluster less than a mile from the well and about 2,500 feet below the well itself, according to the Ohio Seismic Network, a division of the ODNR.

The quakes began in March 2011, just three months after the well went into operation. The last quake occurred on Dec. 31, a day after the ODNR has ordered - and then watched - the shutdown of the well. State geologists and regulators had inspected the well 35 times from April 26 to Dec. 15, trying to connect the quakes with the injections.

"Geologists believe it is very difficult for all conditions to be met to induce seismic events," the report noted. But "a number of coincidental circumstances appear to make a compelling argument for the recent Youngstown-area seismic events to have been induced."

The ODNR's investigation also noted that D&L Energy appeared to have followed existing regulations and was not exceeding permitted flow and pressure rates as it pushed waste water deep into the well.

D&L said it was surprised that the agency released the report blaming the well for the quakes because there is still a lot scientific investigation going on at the well, research that the company is paying for.

"The agency appears satisfied to base its conclusions on the limited scientific data available from outside sources," the company said in a statement. "D&L prepared, drilled and is now the operating manager of the Northstar No. 1 injection well in full compliance with ODNR permits and supervision."

The ODNR reported that the [**Battelle Memorial Institute**](http://www.battelle.org/) had records of the well, recorded while it was being drilled.

State geologists had referred D&L Energy to Battelle when the company sought information about possible fault lines in the area and the state had incomplete maps.

Battelle was conducting pure geological research in an effort to map the geology of that part of the state, according to the investigation, and ODNR investigators had been initially unaware that Battelle had analyzed its testing records.

Northstar 1 had been drilled 9,184 feet deep, including some 200 feet into the "basement rock."

The Battelle logs show that the ancient bedrock, which is typically not very porous, contained "permeability zones," which investigators believe allowed the highly pressurized waste water to seep into the rock. But the report also notes that investigators are not absolutely sure that the finding of permeable rock is correct and are conducting additional tests.

Further but still incomplete evidence gathered in the investigation suggests that after soaking into the permeable rock the fluids then "intersected an unmapped fault line" in the bedrock that was about ready to fail. The liquid allowed the fault line to fail or break and the huge mass of rock to move.

Within hours of the report's release, a group of Democratic lawmakers criticized the agency's new rules as not going far enough.

Some of the new rules will be incorporated into the ODNR's permitting applications. Others will need law changes.

Led by Rep. Jay Goyal of Mansfield, the coalition is proposing legislation that would give final say of an injection well's location to local authorities rather than the ODNR. Additionally, the lawmakers would require injection well operators to have waste water analyzed to identify chemicals it contains.

Some of the new rules will be incorporated into the ODNR's permitting applications. Others will need law changes. Here is a brief synopsis of some of the proposals.

The state will:

•Require companies seeking a permit to drill an injection well to first review publicly available geological maps identifying fault lines, or cracks, in the bedrock underlying a region.

And if the information is not available or incomplete, the ODNR will require injection well developers to have a seismic survey conducted. That will in most cases require the company to hire a contractor with the expensive equipment and expertise to produce an image of what rock is below the well site and what condition it is in. Seismic testing has not been previously required.

ODNR is also buying four portable seismometers to bolster its own monitoring capabilities.

• Require a company applying for a permit to file documents showing the location of any fault lines "within a specified distance of the propose well location and a plan for how the company will monitor any "seismic events" that occur.

• Require a "complete suite" of geologic logs or records of the dozens of layers of rock into which the well has been drilled. This is what Battelle was doing.

Creating this kind of record takes a number of radiological and magnetic resonance instruments that must be carefully lowered into the bore hole of the well on a wire, said the agency. The instruments will tell the company exactly what kind of rock lines the well, its depth and its permeability and even whether it contains hydrocarbons (gas, oil, coal).

•Require operators to plug any holes drilled into the ancient bedrock before beginning to inject waste into the well. Only 20 of the more than 190 injection wells that have been drilled were drilled into the basement rock, the agency said, typically for testing purposes.

• Require an injection well company to keep complete records of the injection pressure used in the well and to make those records electronically available to the state.

•Require the installation of an automatic shutoff system with the injection equipment. The ODNR will set the pressure it deems safe for each well and if an operator exceeds that pressure, the equipment will shut down.

Finally, the ODNR wants the trucks hauling the brine and waste water from hydraulic fracturing to be equipped with an electronic recording system so that the state can see where the material has come from.

By agreement with the U.S. Environmental Protection Agency, the ODNR has overseen Ohio's brine injection well program since 1983. During those 29 years, the industry has injected nearly 8.5 billion gallons of water into the state-licensed injection well - without contaminating ground water or causing earthquakes, according to the ODNR.

Before 1983, gas and oil producers were allowed to store the waste water in containment ponds, which sometimes leaked, said the agency.

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