



COLORADO

Oil & Gas Conservation
Commission

Department of Natural Resources

1120 Lincoln Street, Suite 801
Denver, CO 80203

December 12, 2018

Ms. Jeri Yarbrough
14512 County Road 6
Fort Lupton, CO 80621

Dear Ms. Yarbrough,

As required in our letter to you dated September 18, 2018 the Colorado Oil and Gas Conservation Commission ("Commission") received no detailed reasons regarding your request for a hearing before the Commission on the NGL Water Solutions DJ, LLC ("NGL") proposal for construction of up to 5 Underground Injection Control Disposal wells in Section 28 of Township 1 North-Range 66 West on what is called the Roy SWD Facility (SWD = Salt Water Disposal). Therefore the Commission considers your request for a hearing closed and will take no further action. The Commission is proceeding with evaluation and possible approval of the injection permits.

The Commission is satisfied that NGL's plans for downhole construction and operation of one or more wells at this location will be protective of surface water, groundwater, and aquifers in the area. In evaluating an application for an injection well the Commission examines a variety of criteria listed at the bottom of this letter. The Commission sets limits on the injection pressure, the daily injection rate, and maximum injected volume over the life of the project. A brief discussion of the limits set by the Commission has been placed at the end of this letter.

For every injection well the Commission consults the Colorado Division of Water Resources in the State Engineers Office. The Division aides our review of the proposed well's potential for affecting groundwater. Depending on the type of injection permit and operation we also consult with the Colorado Department of Public Health and Environment.

The Commission does have some rules that apply to noise and odors but it is Weld County through their Use by Special Review (USR) permit process that has more responsibility regarding lights, dust, truck traffic, roads, and noise and odors.

If you are interested in how the Commission evaluates permit applications two white papers are attached for you. If you have additional questions please feel free to give me a telephone call and we can discuss the matter. The subject is complex, it will be easier to answer any of your questions directly.

P 303.894.2100 F 303.894.2109 www.colorado.gov/cogcc

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Sincerely,



Robert P. (Bob) Koehler
UIC Lead - Geology Advisor

Telephone: 303-894-2100 x5147
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Email: bob.koehler@state.co.us
Website: <http://cogcc.state.co.us>

List of Injection well evaluation criteria

1. Casing design: number of casing strings, depth, wall thickness, alloy, diameter
2. Cement design: amount and type of cement used
3. Where the top of cement is between the casing and wellbore itself with respect to other casing strings, hydrocarbon bearing zones, and aquifers
4. Geology of injection zone (is it an adequate receptor), adjacent sealing layers, known faults
5. Surface and Mineral Owner Notifications
6. Water quality of the injection zone. If Total Dissolved Solid ("TDS") concentration (grossly = "salt") is $\leq 10,000$ mg/L (seawater is about 35,000 mg/L) we apply for an Aquifer Exemption from the EPA. An exemption means the injection zone is not suitable for use as an aquifer.
7. Water quality of the water to be injected, only oil and gas fluids allowed
8. Depth to known aquifers
9. Depth of adjacent water wells as part of groundwater evaluation
10. Injection depth above crystalline basement rocks: we stay away from basement because injecting into basement may result in induced earthquakes.
11. As built construction of adjacent oil and gas wells whether producing, shut-in, or plugged and abandoned for at least ½-mile radius; object is to keep any fluid (oil, water, or gas) confined to the original rock layer it resides in
12. Layout of surface installation; location of well with respect to tanks, pumping station, tank berms and relation of these to each other, size of tanks
13. Other injection wells in the area; injection zones, pressures, daily rates, proximity
14. Producing zones in existing wells being converted from production to injection must be adequately isolated and abandoned
15. Existing or historic seismic activity in the area
16. Potential effects of injection on aquifers and groundwater by the Colorado Division of Water Resources
17. DWR sends a summary to the Colorado Division of Dam Safety
18. Financial bonding for spills and ultimate plugging and abandonment of the well
19. Actual well construction matches the approved plan
20. Any changes in well design during construction must be approved by the commission
21. Actual well is tested to make sure it can withstand the anticipated injection pressure

List of Limits set by Commission

1. Maximum Surface Injection Pressure; objective is to prevent fracturing rock in the injection zone
2. Maximum daily injection rate in barrels per day (1 oil barrel = 42 gallons); also relates to fracturing within the injection zone and induced seismicity
3. Maximum Injection Volume over the life of the project; Federal regulations generally limit the injection zone to no more than ½-mile around the wellbore



ENGINEERING UNIT

SEISMICITY REVIEW FOR CLASS II UNDERGROUND INJECTION CONTROL WELLS

The Underground Injection Control (UIC) program is a federal U.S. Environmental Protection Agency (EPA) regulatory program defined by the **Safe Drinking Water Act of 1974**. The EPA has delegated authority to the Colorado Oil and Gas Conservation Commission (COGCC) to regulate, permit, monitor and enforce on EPA Class II wells engaged in underground injection activities on non-tribal lands within Colorado. Class II underground injection is for disposal or recycling (in enhanced recovery operations) of Oil and Gas Exploration and Production Waste, generally referred to as produced water. Colorado was delegated authority over Class II injection wells in 1989.

Potential for Seismicity

UIC permit review includes a review for seismicity. The seismic review uses United States Geological Survey (USGS) geologic maps and an earthquake database, Colorado Geologic Survey (CGS), public literature, and area-specific knowledge provided by operators to assess seismic potential. If historic seismicity is identified in the vicinity of a proposed Class II UIC well, COGCC requires the operator to characterize the seismic potential with respect to the proximity of injection into basement rocks and known faults. This characterization uses geologic and geophysical data within COGCC's review prior to any permit approval.

The COGCC is engaging with the University of Colorado, Colorado School of Mines, Colorado State University, Mesa State University, Interstate Compact Commission, Ground Water Protection Council and the USGS as well as the EPA to understand induced seismicity.

Maximum Injection Pressure, Rate and Volume

In order to minimize the potential for seismic events related to fluid injection COGCC's policy is to keep injection pressures below the pressure at which rocks fracture in the subsurface. A fracture gradient in pounds per square inch per foot is uniquely calculated for each injection well. To determine fracture gradients in injection zones operators perform a step rate or passive injectivity test. From the resulting fracture gradients, the COGCC designates a maximum surface injection pressure and injection rate determined to minimize the potential for induced seismicity. Values for these parameters are specifically recorded in the injection well's permit to operate.

COGCC also calculates a maximum injection volume, based on injection zone thickness and porosity from geophysical well-log data. By COGCC's policy is to



calculate a gross injection volume over a one-quarter mile radius. The volume may be extended up to one-half mile with additional reviews. This restriction of the total volume of injected fluids is intended to constrain the life of the injection well.

Depth to Basement

The COGCC uses the available USGS and CGS geologic maps, public literature, COGCC well data and geophysical logs, and area-specific understand of basement depth and sealing zones. This allows COGCC to review an individual well for pressure and fluid containment to the injection zone.

Seismicity Monitoring

The COGCC uses the induced seismicity risk management "Traffic Light"¹ protocol as a guide to manage and monitor seismicity at injection wells. The protocol employs a combination of seismic observation methods that includes both qualitative and quantitative criteria to evaluate responses to seismic events. Because the USGS publishes 2.5 magnitude events, Commission staff uses the listed USGS events as a reference to monitor seismic activity.

COGCC by permit conditions requires operators of any new injection well intending to inject over 10,000 barrels of water per day to install seismic monitoring equipment.

Ultimately, COGCC's permit review process incorporates multiple factors as safeguards in the prevention of induced seismicity.

- Review of well construction
- Review of seismic activity in USGS database
- Review of USGS geologic maps
- An understanding of known faults and basement
- Injection volume limit
- Injection pressure less than subsurface fracture pressure
- Daily injection rate
- Required seismic monitoring for commercial wells



Planning - Risk Management Plan: Traffic Lights

- Green** Continue operations – no seismicity felt at surface (MMI I-II)*
– Less than M2.5 within 2.5 Miles
- Amber** Modify operations – seismicity felt at surface (MMI II-III+)*
– Greater than M2.5 & Less than 4.4 within 2.5 Miles
- Red** Suspend operations – seismicity felt at surface with distress and/or damage (MMI V+)*
– Greater than M4.5 within 2.5 Miles

Perceived Shaking	Not Felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme	
Potential Damage	none	none	none	Very Light	Light	Moderate	Moderate Heavy	Heavy	Very Heavy	
Peak Acceleration (%g)	<0.17	0.17 to 1.4	1.4 to 3.9	3.9 to 9.2	9.2 to 18	18 to 34	34 to 65	65 to 124	>124	
Peak Velocity (cm/s)	<0.1	0.1 to 1.1	1.1 to 3.4	3.4 to 8.1	8.1 to 16	13 to 31	31 to 60	60 to 116	>116	
Magnitude	1–2.9	3–3.9	4–4.4	4.5–4.9	5–5.4	5.5–5.9	6–6.4	6.5–6.9	7.0+	
Modified Mercalli	I	II to III	IV	V	VI	VII	VIII	IX	X+	
Traffic Lights *										

Exhibit 1 * Established based upon local conditions, demographics and codes

AXPC / Industry induced seismicity SAE presentation

¹Modified from a talk given by Jeff Bull at the Groundwater Protection Council Meeting January 23, 2013, "Induced Seismicity and the O&G Industry"



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CLASS II UNDERGROUND INJECTION CONTROL WELLS

COGCC permits and regulates Class II Underground Injection Control (“UIC”) wells. Class II wells are used specifically to inject oil and gas exploration and production waste for disposal, and for enhanced oil recovery through injection of water, gas, or other substances.

The COGCC Class II UIC permit process involves the review and approval of:

- Well construction;
- Isolation of ground water aquifers;
- Maximum injection pressure;
- Maximum injection volume;
- Injection zone water quality; and
- Potential for seismicity.

Well Construction and Isolation

Injection wells must utilize a well construction method of cemented surface casing and production casing, which isolates and prevents fluid flow between injection zones and Underground Sources of Drinking Water (“USDWs”). To verify this isolation, the COGCC reviews all relevant information, including:

- Hydrogeologic studies;
- Colorado Division of Water Resources water well information; and
- COGCC’s geophysical well log database.

This information is used in conjunction with specific formation and well construction data submitted by the injection well operator, including resistivity and cement bond geophysical logs, to ensure that:

- The surface casing is set below all fresh water zones used as a water supply; and
- The placement and quality of production casing cement allows for adequate isolation of the injection zone and USDWs, including fresh water zones that are not currently being used as a water supply.

CLASS II UNDERGROUND INJECTION CONTROL WELLS

The geophysical logs are also used to determine the injection zone thickness and porosity, which confirms that the bounding shale zones are thick enough to provide zonal isolation.

Maximum Injection Pressure and Volume

Maximum surface injection pressure is calculated based on a default fracture pressure gradient of 0.6 pounds per square foot ("psi") of depth. The operator may elect to conduct a Step Rate Injection Test to determine whether a higher injection zone fracture gradient exists. From the resulting fracture gradient, the COGCC designates a maximum surface injection pressure at the operator's requested injection rate as a condition of permit approval. The COGCC's policy is to keep injection pressures below the fracture gradient, which is uniquely defined for each injection well, in order to minimize the potential for seismic events related to fluid injection.

The COGCC calculates a maximum injection volume, based on thickness and porosity from the log data. By COGCC policy, the injection volume calculation is restricted to a one-quarter mile radius. This restriction is intended to constrain the total volume of injected fluids during the life of the injection well.

Seismicity Review

The UIC permit review also includes a review for seismicity. This was previously performed by the Colorado Geological Survey ("CGS") but is currently performed by a former CGS staff member now working for the COGCC. The seismic review uses CGS geologic maps, the United States Geological Survey earthquake database, and area-specific knowledge to assess seismic potential. If historical seismicity has been identified in the vicinity of a proposed Class II UIC well, COGCC requires an operator to define the seismicity potential and the proximity to faults through geologic and geophysical data prior to any permit approval.

Water Analysis

Injection permits are only approved if water analyses from the injection zones show an acceptable level of total dissolved solids or an Aquifer Exemption is required. If the total dissolved solids are between 3,000 and 10,000 milligrams per liter, then a request for an Aquifer Exemption is sent to the U.S. Environmental Protection Agency and Colorado Department of Public Health and Environment. An Aquifer Exemption will only be granted if the injection zone: 1) is not currently a source of drinking water, and 2) is unlikely to become one, because it is or may be a hydrocarbon producing interval, is too deep to be economically or technically practical, or currently has more than 10,000 milligrams per liter of total dissolved solids.

CLASS II UNDERGROUND INJECTION CONTROL WELLS

Mechanical Integrity Test

Finally, the well must pass a Mechanical Integrity Test ("MIT") after it has been set up in the final injection configuration. The MIT assures that any leaking fluids from the injection tubing, which conveys fluid from the surface to the injection zone and past the packer, or the packer, which separates the injection zone from the tubing-casing annulus, are contained within the tubing-casing annulus.



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