

White Paper on Wastewater Disposal

Problem Statement: The Mining and Energy Commission is considering adopting rules that govern disposal of flowback and produced waters from fracturing operations. The Water and Waste Management Committee has already agreed on wording that requires reuse in on-going operations. The rule set recognizes the fact that at the end of useful operations, operators will need to somehow dispose of the wastewater left unused.

The only two disposal methods that the Committee considered were:

- Deep discharge into underground formations in North Carolina per UIC Class II regulations.
- Treatment for some end use such as surface discharge.

The Committee recognizes that the first option is not legally available in North Carolina at this time. But the General Assembly came close to reversing that piece of law in 2013. Consequently, in order to be long lived, our rule set ought to comprehend the possibility of this happening in the future.

Whether legal or not, the Committee is opposed to the deep disposal option. This opinion is documented in the proceedings of the Committee. The only areas potentially suited to said disposal are near the coast. The wastewater would have to be transported great distances over roads to accomplish this. For this and other reasons the Committee is not in favor of this option.

Since this in effect gives oil and gas operators a single option for wastewater disposal, the Committee decided to research the viability of that option. The research included testimony from members of the DENR Stakeholder Group on Oil and Gas Management.

Nature of the Wastewater:

The flowback and produced waters from the Triassic Basin are expected to have relatively low salinity. Based upon existing data and upon geologic considerations, we expect the salinity to be under 5,000 part per million (ppm).

This is compared to up to 350,000 ppm in the Marcellus Shale. This has two implications. On the one hand, reuse ought to require minimal treatment, so that aspect of the rules will not be onerous. On the second hand, even the treatment for discharge or other use ought to have a relatively low cost.

Typical operations are likely to use 3 million gallons of water per well. About a third of that will return to the surface as flowback water. For subsequent wells, the flowback water can be reused, but make-up water will be required to reach the amount needed to conduct hydraulic fracturing. When drilling operations cease, an operator would be left with about 1 million gallons of wastewater. This is the amount for each drilling operation conducted by a single entity. It may be possible to transfer this water to an operation conducted by another entity, as is being permitted in some states. Absent that, each operation would expect to dispose of about a million gallons, or about 24,000 barrels.

Likely Treatment Options:

The total dissolved solids (TDS) for these waters are within the range defined as brackish water. [Commercially available](#) Reverse Osmosis (RO) equipment can treat up to 900,000 gallons per day, well in excess of the volumes we expect operators to treat in North Carolina. [Treatment costs](#) (operating and maintenance costs) are expected to run between \$0.50 and \$1.50 per 1,200 gallons, with the lower numbers for TDS of 2,000 ppm. Twelve hundred gallons equates to about 28 barrels. Capital cost depends on size and capacity of the facility. Since each operation will need to clean about a million gallons of wastewater every few months, the treatment capacity of the plant is probably around 20,000 gallons per day. The capital cost, [according to the U.S. Army Corps of Engineers](#), would be about \$30,000. A 10 year straight line depreciation would ascribe a monthly cost of \$250, which spread over a million gallons is pennies. The Corps' numbers for operating costs are in line with the figures above.

Reverse Osmosis (RO) is a process that pushes fresh water across a membrane by the application of pressure. For brackish water these pressures are low, usually between 200 and 400 psi, so the energy required to produce the pressure is low. For sea water treatment, these pressures are up to 1,200 psi. Yield is defined as

the percentage of the brackish water that results in useful water. The balance is concentrated brine, referred to as concentrate. Disposal of the concentrate is the main issue with RO. Yields with even a single pass RO treatment will be around 80% useful water for these salinities. This means the 1 million gallons treated water would yield 200,000 gallons of concentrate requiring disposal.

Concentrate Disposal Options:

North Carolina currently has in excess of 20 RO water treatment facilities. Most of these are probably a good deal larger than the ones that may be necessary to manage wastewater disposal from hydraulic fracturing operations in North Carolina, however, the data are still being accumulated and will be attached as an appendix to this paper when available. RO water treatment facilities close to the ocean are discharging the concentrated brine into the waters. If not done properly marine life on the sea bottom can be affected. Diffusers are used to ensure proper application as well as for discharge into waterways emptying into the ocean.

Others are discharging into surface waters, and again we are pulling together data on that. Another argument would be that the concentrate produced by the oil and gas industry would simply fall into the jurisdiction of the state and get handled appropriately as a routine DENR task.

An interesting part of the testimony from Southwestern Energy, presented to the Water and Waste Management Committee, was the fact that they own and operate a NPDES permitted Centralized Waste Treatment (CWT) facility. The discharge from this facility goes into verification tanks prior to reuse or disposal. This approach may be needed by operators choosing to process the RO concentrate using an evaporation and salt disposal scheme.

The predominant desalination treatment method used by Southwestern Energy is Mechanical Vapor Recompression (MVR). The output of the MVR treatment process is essentially a combination of distilled water and heavy brine (currently at an 80 to 20 percent ratio respectively). This method is an option for our flowback water but likely not necessary given our low salinities. RO would be

cheaper and more than likely sufficient. If ocean discharge were to be chosen by North Carolina operators, treatment at a permitted CWT would still be required by law as a precursor step.

In other states RO concentrate is handled in one of two ways. One is to sequester it in UIC Class II wells, which is not legal in our state. As far as we are aware the only feasible locations for UIC Class II wells, if underground injection wells were legalized in North Carolina, would be in the Coastal Plain close to the coast. If appropriate host rock is identified, this would be an alternative to ocean discharge. Perhaps the General Assembly should consider a lifting of the ban for the sole purpose of sequestering RO concentrate.

The other commercially available method is to evaporate the water, leaving behind a crystalline residue. This residue is used in some states as road salt in winter months. Alternatively, it could be disposed of in an appropriate landfill. The water produced from this process would essentially be distilled water.

Conclusions

Wastewater from oil and gas operations in the Triassic Basin can be treated at reasonable costs. Commercial systems exist for accomplishing this. Consequently, a rule set that in effect requires multiple reuses, followed by treatment for discharge or another purpose, will not be a deterrent to prospective operators. It will also be the most environmentally responsible option for our state.

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