Technical Analysis

Montalban Oil and Gas Operations Jody Field 34-2

The Montalban Oil and Gas Operations Inc. (MOGO) permit MT52439, Jody Field well 34-2, was initially authorized to inject into the Madison formation under a Montana Board of Oil and Gas Commission (MBOGC) Class II well. With this permitting action, the Class II well will be converted to a Class V well. The modification will allow MOGO to inject fluids associated with oil and natural gas production and municipal fluids from processed renewable feedstocks, such as seed oils, used cooking oil, and tallow. The change from a Class II well to a Class V well was required in order to expand the type of injectate, Class II wells are limited to wastes from oil and gas production.

The well is being permitted as a Class V well because it is constructed above the Devonian Duperow Aquifer, which is considered a USDW in some areas of the basin. However, there is limited data on the Devonian Duperow Aquifer in this area. Well logs drilled into the Duperow Formation approximately 5 to 6 miles east of the AOR indicate that the Sun River Dolomite is separated from the underlying Duperow Formation by approximately 1,300 feet of confining zone (Mississippian Mission Canyon and Lodgepole Limestone and Upper Devonian Three Forks and Potlatch Formations). A water quality sample from the Devonian Duperow Aquifer was observed to have a calculated TDS under 10,000 mg/L (API #25-073-21523). To be conservative, the EPA decided to classify Jody Field 34-2 as a Class V well.

The well injects into the Madison Formation, which is considered a USDW. MBOGC previously submitted an Aquifer Exemption for the Madison Formation for the Jody Field 34-2 well to the EPA. On March 15, 2010, the EPA reviewed and concurred on this aquifer exemption for the Madison Formation in accordance with 40 CFR §§144.7 and 146.4 of the Safe Drinking Water Act.

A workover to acidize and deepen the well was approved by the Montana Board of Oil and Gas Conservation in August 2022 and the workover was conducted in September 2022. Jody Field 34-2 was deepened by 68 feet for a total open hole height of 81 feet across the Madison. No injection has occurred since the well was deepened, except for the injection of clean water used to conduct the step rate test.

The well workover revealed that there was not a confining zone of less permeable layers directly beneath the bottom of the original well depth, as previously assumed in the first aquifer exemption. Since the Madison formation is most likely hydraulically connected and there is not sufficient evidence of less permeable layers within the lower Madison formation, an aquifer exemption and injection zone expansion of the entire Madison Aquifer to a depth of approximately 3,700 feet has been requested for continued injection. The extent of the exempted aquifer is horizontally within a radius of 1/4 mile from the Jody Field 34-2 well.

The aquifer exemption expansion was extended to the approximate bottom of the Madison Formation (approximately 3,700 ft), as there are no confining zones within the Madison to prevent the injectate from travelling below the bottom of the well. Therefore, the entire Madison Formation must be exempted so that the Permittee can comply with the permit and AE.

The parameters below are the values used to calculate the initial maximum cumulative injection volume issued with this Permit. See spreadsheet "Well Calculations.xlsx" for more details.

Aquifer Exemption Radius (miles)	Available Injection Zone Height (ft)	Porosity (%)	Injection Zone Top Depth (ft)	Previously Injected Volume (bbls)	Cumulative Injection Volume Limitation (bbls)
0.25	81	9.7	3,418	503,403	7,156,173

The maximum cumulative injection volume limitation is calculated using the equation below.

$$\boldsymbol{Volume} = (\pi * \boldsymbol{radius}^2 * \boldsymbol{height} * \boldsymbol{porosity}) - \boldsymbol{Previously\ Injected\ Volume}$$

Radius (ft) is the radius of the aquifer exemption.

Height (ft) is the thickness of the open hole as currently constructed.

Porosity (unitless) is the porosity of the injection zone.

Previously Injected Volume (ft^3) accounts for the volume of injectate that has already been injected into the well. Please see additional explanation below.

The Permittee reported a cumulative injected volume of 205,090 bbls for Jody Field 34-2 on December 31, 2022 to MBOGC. Based on past injection through 33 feet of open hole, the radius of injected volume is estimated to have traveled 373 feet horizontally. To ensure that the fluids remain within the proposed exemption area of the Madison Formation, we must assume that the volume was injected uniformly across the entire "height" for the calculation, including the interval that is newly proposed for exemption, for a total of 81 feet. Therefore the previously injected volume must assumed to be 503,403 bbls and the maximum cumulative injection volume is set at 7,156,173 bbls.

To ensure fluids remain within the 0.25-mile radius from the wellbore, the permit establishes a maximum cumulative injection volume limitation of 7,156,173 bbls, which accounts for the previously injected volume of 205,090 bbls into Jody Field 34-2. The volume calculation assumes a porosity of 9.7% for the injection zone, which was derived from a compensated neutron-formation density log from the nearby well Field 1-34, located approximately 0.13 miles southeast of Jody Field 34-2. A compensated neutron-formation density log was run in Field 1-34 well by Schlumberger for the purpose of identifying hydrocarbon bearing zones. The log is a combination of density and neutron porosity logs and provides a good source of porosity data. Since Field 1-34 is located within the 0.25-mile radius of Jody Field 34-2, the results for Field 1-34 can be used to estimate porosity for the injection zone of Jody Field 34-2. The estimated porosity falls within the range found in the literature[1].

Local Stratigraphy

Formation Type	Formation	Top (ft)	Bottom (ft)	Lithology
USDW	Two Medicine	0	484	Fine to medium grained quartzose sandstone that coarsens upward with good porosity in the upper sections of the formation
USDW	Eagle/Virgelle	484	664	Medium grained sandstone and mudstone
Confining Zone	Colorado Shale	664	1,780	Dense, non-calcareous shale with interbedded bentonite
Confining Zone	Blackleaf	1,780	2,028	Very fine-grained sandstone with units of hard, dense, noncalcareous shale and bentonite
Confining Zone	1st Bow Island	2,028	2,534	Very fine grained, very dense quartzose sandstone interbedded with shale, bentonite and siltstone
USDW	Dakota	2,534	2,573	Interbedded units of firm, dense shale and very fine grained bentonitic sandstone
USDW	Kootenai	2,573	3,096	Interbedded units of very fine-grained to fine grained sandstone and firm, dense shale
USDW	Sunburst	3,096	3,203	Interbedded units of very fine-grained to fine grained sandstone and firm, dense shale

[1] The Sun River Dolomite has been studied extensively for its hydrocarbon production potential and was determined to have an average porosity of 8 to 14% and average permeability of 10 to 82 millidarcy with the highest values observed in the Pondera Field (Pasternack 1988).

Confining Zone	Swift	3,203	3,330	Interbedded very fine grained to fine grained quartzose sandstone and firm, dense shale
Confining Zone	Rierdon	3,330	3,404	Firm to hard, dense marlstone
Confining Zone	Sawtooth	3,404	3,418	Firm to hard, dense siltstone interbedded with very find grained quartzose sandstone
USDW (currently partially exempted)	Madison	3,418	3,700	Fine grained dolomite with good vuggy and intergranular porosity
Confining Zone	Mississippian Mission Canyon and Lodgepole Limestone	3,700	4,700	Dense, cherty, hard, tight limestone with crypto to microcrystalline grains (API #25-073-21523).
Confining Zone	Upper Devonian Three Forks and Potlach Formations	4,700	4,900	Dense, tight limestone and shale (approx. 60 ft underlain by interbedded shale and anhydrite; API #25-073-21523)
USDW	Devonian Duperow Aquifer	Approx. 4,900	Approx. 5,600	Dense, tight crypto to microcrystalline dolomite with poor to fair porosity (API #25-073-21523).

USDWs

Formation Name or Stratigraphic Unit	Top (ft)	Base (ft)	TDS (mg/l)	Lithology
Two Medicine	0	484	<3,000 mg/L	Fine to medium grained quartzose sandstone that coarsens upward with good porosity in the upper sections of the formation
Eagle/Virgelle	484	664	<5,000 mg/L	Medium grained sandstone and mudstone
Dakota	2,534	2,573	Ranges depending on location – observed at 7,000 to 12,000 mg/L (Well MT51141-07750)	Interbedded units of firm, dense shale and very fine grained bentonitic sandstone
Kootenai	2,573	3,096		Interbedded units of very fine-grained to fine grained sandstone and firm, dense shale
Sunburst	3,096	3,203		Interbedded units of very fine-grained to fine grained sandstone and firm, dense shale
Mississippian Madison Aquifer	3,418	3,700	5,440 mg/L (API #25-073-21740)	Fine grained dolomite with good vuggy and intergranular porosity
Devonian Duperow Aquifer	Approx. 4,900	Approx. 5,600	9,470 to 13,800 mg/L (API #25-073-21523)	Dense, tight crypto to microcrystalline dolomite with poor to fair porosity

<u>API #25-073-21523, Powers Farm 29-1, TD= 5,800 ft</u>

- 4.8 miles northeast from Jody Field 34-2
- Describes Madison as having good vuggy porosity and good intergranular porosity from the top of the Sun River (3092 feet) to 3125 feet, for a total of 33 feet. At 3125 feet, the geology changes to a micro to very fine

crystalline, dense, tight, hard Dolomite for 5 feet. Then from 3130 feet to 3135 feet, the Dolomite has very finely granular, dense, some fair intergranular porosity.

- Describes Mission Canyon Limestone as crypto to microcrystalline, dense, tight, and hard with poor interfragmental porosity and chalky infill of any porosity (page 54 of Well_API_2507321523.pdf).
- In the PDF on Page 87, there is a report that lists Permeability at depth. The permeability for the Madison formation is relatively high (up to 47.9 md) and stays above 1.0 md. The Permeability drops to 0.1 md at the Mission Canyon Limestone depth and generally remains 0.1 md permeability throughout the formation.
- This geologic log and permeability report show that the Mission Canyon Limestone is an adequate lower confining zone for the injection zone. There is not enough evidence here to classify the lower Madison as a low permeability confining zone.

Injection Zone/Confining Zone

The injection zone is completed within the Sun River Dolomite, the uppermost section of the Mississippian Madison Formation. The proposed UIC area is located on the western edge of the Great Plains, west of the Sweetgrass Arch and east of the Intermountain Seismic Belt. The proposed UIC area is located several miles east of mapped faults in an area with low earthquake risk. No mapped or known faults lie within the AOR.

Formation Name or Stratigraphic Unit	Top (ft)	Base (ft)	Porosity	Proposed Exemption
Madison Formation	3,418	approx. 3,700*	9.7%	Montana Board of Oil and Gas Conservation submitted an Aquifer Exemption for the Madison Formation for the Jody Field 34-2 well to the EPA. On March 15, 2010, the EPA reviewed and concurred on this aquifer exemption for the Madison Formation within a ¼-mile radius from the wellbore between the depths of 3,418 to 3,451 feet, in accordance with 40 CFR §§144.7 and 146.4 of the Safe Drinking Water Act. An aquifer exemption expansion is proposed for the Madison formation from a depth of 3,451 to approximately 3,700* feet.

*Depth is approximate and projected, based on nearby wells (API Numbers 25-073-05439, 25-073-05440 and 25-073-21523).

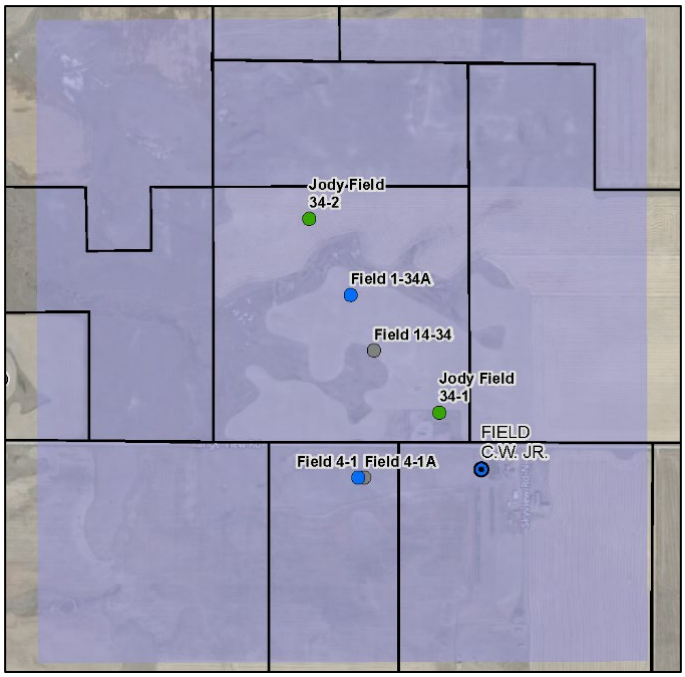
The EPA notes that the current 2010 aquifer exemption for the Jody Field 34-2 well only includes a 13 ft interval of the Madison Group and includes a 20 ft interval of the Sawtooth Formation (between 3,418 feet and 3,438 feet). In Attachment A, Figure 04 of the permit application, the interval between 3,418 feet and 3,438 feet is described as part of the Madison Group. After conducting additional research, the geology between 3,418 feet and 3,438 feet was later determined to be a dense calcareous transitional deposit which is part of the Upper Madison formation and not Sawtooth or a separate USDW.

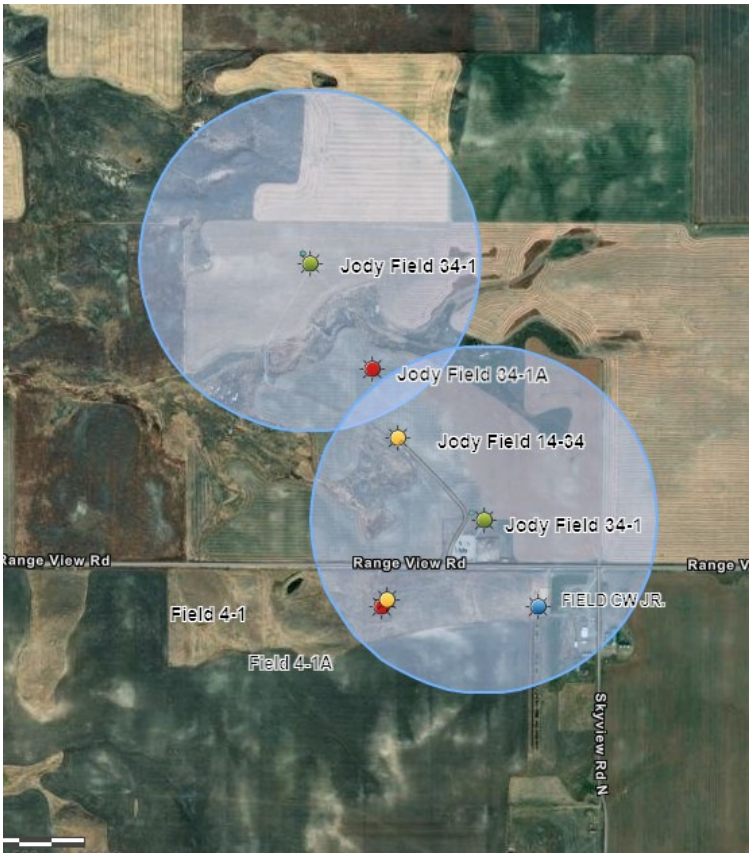
Jody Field 34-2 is completed open hole and the well shoe is set at the base of the Sawtooth formation directly above the Sun River Dolomite. The Sawtooth formation is dense and does not produce in this area or take water. Well logs provided in the UIC application for wells Jody Field 4-1 and Jody Field 4-1A indicate that the bottom of the Sawtooth formation is hard and dense with no oil shows. Research included a review of well logs in the area and review of the USGS Produced Water Database V2.3 across the Sweetgrass Basin in Montana. The USGS Produced Water Database indicates that there are 69 oil and gas wells producing from the Sawtooth Formation within the basin. One of the 69 wells is identified as Jurassic, 9 wells are identified as Devonian and the remaining 59 wells are identified as Mississippian (Madison Group or Lodgepole). The two wells located within Pondera County indicate specifically that the Sawtooth Formation is part of the Madison Sun River Dolomite, further suggesting that this zone between 3,418 feet and 3,438 feet is transitional within the Upper Madison and not a separate USDW.

AOR

The initial permit application was submitted for an area-wide permit. The EPA determined that individual permits for these wells was more appropriate. EPA established the AOR for the Jody Field 34-2 permit based on a delineated radius of 0.25-mile from the well location. The Permittee provided a figure (below) indicating the location of the current injection wells, Jody Field 34-1 and 34-2, and other wells located near the wells and operated by MOGO. These wells were completed in Madison Formation and include; Jody Field 1-34A, Jody Field 14-34, Jody Field 4-1, and Jody Field 4-1A. The only well within the 0.25-mile AOR is Jody Field 1-34A. The Field C.W. JR indicated in the figure is a shallow water well at a depth of 109 feet.

Construction data from AOR wells was reviewed to determine the integrity of the wells and possibility of fluid migration beyond the injection zone due to injection at Jody Field 34-1 and Jody Field 34-2. All wells within the AOR are cemented from the well bottom to above Sawtooth Formation and thus isolate the injection zone. The operator volunteered to monitor the nearby shut-in well (Field 14-34) in the Response to Comments dated December 21, 2021. The Field 14-34 wellbore provides an isolated pathway for pressure and fluid from the injection zone to surface. The surface "shut in" status prevents fluid movement but allows the wellbore to be used as a means of monitoring the injection zone pressures.





The following features were not found, or known to be within, the mapped AOR:

- outcrops of injection and confining formations;
- surface water intake and discharge structures;
- hazardous waste treatment, storage, or disposal facilities;
- mines (surface and subsurface) and quarries; or
- residences, schools, and hospitals.

Fracture/faults/seismicity

There are no known faults or fractures surrounding this well that would compromise the confining zones. Geologic records from wells in the area indicate that the overlying and underlying confining zones are dense, tight, with low porosity and do not exhibit any fracturing (Montana BOGC logs (Wells Jody Field 4-1/API No. 25-073-21824, Jody Field 4-1A/API No. 25-073-21842, Stanwald Sahara No. 1/API No. 25-073-05440, Powers Farm No. 29-1/API No. 25-073-21523, Federal Land Bank of Spokane Well No. 1/API No. 25-073-05439).

Well Construction

Casing Type	Hole Size (in)	Casing Size (in)	Cased Interval (ft)	Cemented Interval (ft)
Production	6.25	4.5	664-3,418	2,430*-3,418
Surface	8.75	7.0	0-664	0-664

*CBL not conducted yet; estimated top of cement.

The well is constructed as:

- 7" LTD 17 lbs/ft surface casing set in an 8-3/4" hole to a depth of 664 feet (below ground level) and cemented with 260 sacks Class G Cement to the surface.
- 4-1/2" J-55, 10.5 lbs/ft long string casing set in an 6-1/4" hole to a depth of 3,418 feet cemented with 125 sacks Class G Cement.
- Open 3-7/8" hole between 3,418 feet to 3,499 feet
- 2-3/8" J-55, 4.7 lbs/ft tubing set at 3,366 feet
- Packer set at 3,373 feet depth

Operation Conditions

No previous SRT was performed on the well, EPA requested an SRT from the permittee. The SRT was completed in April 2023 and the MAIP was calculated utilizing the data submitted (see Jody Field 34-2_SRT Analysis.xlsx).

The table below provides the initial values used to calculate the initial MAIP:

Fracture Gradient	Specific Gravity	SG Fluctuation Factor	Injection Zone Top Depth (ft)	Friction Loss (psi)	Authorized MAIP (psi)
0.634	1.004	0.05	3,418	81	688

Based on current SRT data, the Jody Field 34-2 MAIP will be initially set to 688 psi. This value may change after the specific gravity of the injectate is measured, which is a permit condition prior to authorization to inject. A water quality sample of the wastewater from Montana Renewables feedstock pretreatment unit was taken on May 15, 2023. The TDS in this sample was observed to be 5,080 mg/L. A specific gravity value was calculated from the measured TDS (Collins 1987). Once the Permittee provides a measured specific gravity value of the injectate, the MAIP will be updated.

Monitoring Plan

- The maximum cumulative volume limit since Class V authorization is 7,156,173 bbl. This value represents the volume limitation permissible as a Class V UIC well. Past injection volumes have been accounted for in this calculation.
- The Jody Field 14-34 wellbore provides an isolated pathway for pressure and fluid from the injection zone to surface. The surface "shut in" status prevents fluid movement but allows the wellbore to be used as a means of monitoring the injection zone pressures. Monitor monthly, record min/max/ave monthly, and report quarterly.
- The Permittee must provide a listing of the sources of injected fluids. Copies of all monthly records on injected fluids, and any major changes in characteristics or sources of injected fluid shall be included in the Quarterly Report.

Logging and Testing

- In discussion with ECAD, the MIT SAP tests submitted to MBOGC are not consistent with R8's testing protocol. The operator must conduct an MIT SAP prior to authorization to inject to ensure they meet EPA's test requirement standards (R8 Guidance 39).
- Cement bond log is required prior to receiving authorization to inject.
- Noise log is required prior to receiving authorization to inject.*
- Pressure fall off test must be conducted 10-12 months after injection begins and subsequent tests must be conducted annually thereafter, not to exceed 12 months of the previous test.

* A noise log must be performed to assess the presence of fluid movement between the exposed upper USDWs (Dakota, Kootenai, and Sunburst) and adjacent formations. Based on the calculated top of cement, the existing cement does not appear to prevent movement of fluids between the upper USDWs and the confining layers. The noise log must be conducted between the top of cement behind the 4.5-inch casing and the base of the 7-inch surface casing. If the noise log shows fluid movement, casing perforation and squeeze cementing will be required to isolate the USDWs.

P&A Plan

MOGO submitted an updated P&A plan that was approved by EPA. MOGO submitted a Letter of Credit for the well. Concurrence on the financial assurance was provided, via email by Ben D'Innocenzo on 6/28/2023.

Environmental Justice

The EPA considered its obligations under Executive Order 12898 and concluded that there may be potential EJ communities proximate to the Authorized Permit Area. The primary potential human health or environmental effects to these communities associated with injection well operations would be to local aquifers that are currently being used or may be used in the future as USDWs. EPA's UIC program authority under the Safe Drinking Water Act is designed to protect USDWs through the regulation of underground injection wells. EPA has concluded that the specific conditions of UIC Permit MT52439-12514 will prevent contamination to USDWs, including USDWs which either are or will be used in the future by communities of EJ concern.

Historical Property

EPA considered its obligations under the National Historic Preservation Act and found no impacts related to Historical Property. The National Park Service National Register of Historic Places database was searched for historic properties located in Pondera County. Four locations were found, however none of the locations were in the vicinity of the Jody Field 34-2 well. The Jody Field 34-2 well is already constructed, has been operated for injection, and may require workover activities that will not impact surrounding areas. All roads are in place, and injection fluid will be transported to the site via existing infrastructure. Based on this information, the EPA is proposing to find that no historic properties will be affected as a result of issuing this UIC Permit.

Endangered Species

EPA considered its obligations under Endangered Species Act and utilizing the U.S. Fish & Wildlife Service, Information for Planning and Conservation (IPaC) website (https://ipac.ecosphere.fws.gov), made the following determination.

The federally listed endangered species found in the area of the Facility include:

	Species	**Status**
Mammals	Grizzly Bear (*Ursus arctos horribilis*)	Threatened
	North American Wolverine (*Gulo gulo luscus*)	Proposed Threatened
Insects	Monarch Butterfly (*Danaus plexippus*)	Candidate

(No critical habitats are located in the project area)

The EPA has determined this Permit issuance will have No Effect on any of the species listed by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act within Pondera County. The finding is based upon the following: There is no new construction or facility size increase that would result in ground disturbance or vegetation removal with the reissue of this permit.

In addition to IPAC, the Montana Sage Grouse Habitat Conservation Program database (https://sagegrouse.mt.gov/ProgramMap) was utilized to ensure the Jody Field 34-2 well is not in or close to designated sage grouse habitat. Results from this review "Not In EO Area".

Tribes

EPA considered its obligations under the 1984 EPA Policy for the Administration of Environmental Programs on Indian Reservations. Due to the location of the well, during public notice the Blackfeet Tribe of the Blackfeet Indian Reservation of Montana; Crow Tribe of Montana; and Fort Belknap Indian Community of the Fort Belknap Reservation of Montana will all be notified to ensure awareness of the project and scope.

References

Pasternack, Ira, Nature and Distribution of Mississippian Sun River Dolomite Porosity, West Flank of the Sweetgrass Arch, Northwestern Montana, August 16, 1988

Collins, A., G., 1987, Properties of produced waters, in Bradley, H., B., eds., Petroleum Engineering Handbook: Dallas, SPE, p. 24-15.