

# Additional Information

## Mack Energy Glacier SWD-2617

- E-mail documenting lack of data for FSP analysis, historical well plugging details and unavailability of Devonian water sample
- Induced Seismicity Report without FSP analysis

**From:** [Harris, Anthony, EMNRD](#)  
**To:** [Reed Davis](#)  
**Cc:** [Oliver Seekins](#); [Tom Tomastik](#); [Goetze, Phillip, EMNRD](#); [Gebremichael, Million, EMNRD](#); [Sandoval, Stacy, EMNRD](#)  
**Subject:** RE: [EXTERNAL] FW: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.  
**Date:** Tuesday, September 24, 2024 2:58:00 PM  
**Attachments:** [image001.jpg](#)  
[image002.jpg](#)  
[image003.jpg](#)  
[image004.jpg](#)  
[image005.png](#)

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Good Afternoon Reed

Please see my response below in RED

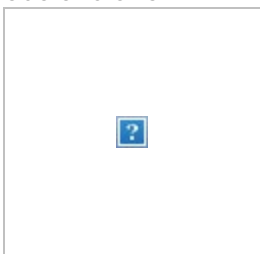
Regards

Tony Harris

Petroleum Specialist

[Anthony.harris@emnrd.nm.gov](mailto:Anthony.harris@emnrd.nm.gov)

505 549 8131.



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**From:** Reed Davis <[rdavis@all-llc.com](mailto:rdavis@all-llc.com)>  
**Sent:** Wednesday, September 18, 2024 10:36 AM  
**To:** Harris, Anthony, EMNRD <[Anthony.Harris@emnrd.nm.gov](mailto:Anthony.Harris@emnrd.nm.gov)>  
**Cc:** [Oliver Seekins](mailto:oliver.seekins@all-llc.com) <[oliver.seekins@all-llc.com](mailto:oliver.seekins@all-llc.com)>; [Tom Tomastik](mailto:tomtomastik@all-llc.com) <[ttomastik@all-llc.com](mailto:ttomastik@all-llc.com)>; [Goetze, Phillip, EMNRD](mailto:phillip.goetze@emnrd.nm.gov) <[phillip.goetze@emnrd.nm.gov](mailto:phillip.goetze@emnrd.nm.gov)>; [Gebremichael, Million, EMNRD](mailto:gebremichael.million@emnrd.nm.gov) <[Million.Gebremichael@emnrd.nm.gov](mailto:Million.Gebremichael@emnrd.nm.gov)>  
**Subject:** Re: [EXTERNAL] FW: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

Some people who received this message don't often get email from [rdavis@all-llc.com](mailto:rdavis@all-llc.com). [Learn why this is important](#)

Anthony,

ALL Consulting assisted Mack Energy in completing the seismic analysis letters required as part of their Glacier & Manitoba SWDs C-108 applications. They recently received additional information requests (as outlined below) for both applications.

It is our understanding that an FSP model has been requested for these deep injection applications; subsequently, we have a couple of questions regarding these FSP requests:

1. The email chain indicates that a Precambrian Basement structural contour map is to be included. However, we do not believe there are sufficient well data/basement penetrations in the vicinity of the proposed wells to construct such a map in a quality manner. Can you please advise on how NMOCD would like us to handle this situation? **Based upon the lack of data / basement penetrations to construct a map, the requirement is waived.**

2. Within the email chain, it is stated that "If basement penetrating faults **are** identified, include an analysis of Fault Slip Potential..." however, no basement penetrating faults were identified within 2-miles (or 100 square miles) of the proposed SWDs (according to the BEG public data set at the time of submission). Given the lack of publicly known basement faults, is it intended for us to run the FSP model with simulated faulting, or is there possibly additional fault data in the area that ALL is unaware of? If there are additional data sources, please let us know and we will gladly acquire that public data for our analysis. **Based upon the lack of available data the requirement is waived.**

Thanks for your time, please feel free to call if that is an easier way to discuss!

Reed Davis  
ALL Consulting LLC  
1718 S Cheyenne Ave  
Tulsa, OK 74119

Office: 918-382-7581

Cell: 918-361-8375

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**From:** Jerry Sherrell <[jerrys@mec.com](mailto:jerrys@mec.com)>

**Sent:** Friday, September 6, 2024 10:38 AM

**To:** Oliver Seekins <[oseekins@all-llc.com](mailto:oseekins@all-llc.com)>; Reed Davis <[rdavis@all-llc.com](mailto:rdavis@all-llc.com)>; Mark Kidder <[mkidder@all-llc.com](mailto:mkidder@all-llc.com)>; Tom Tomastik <[ttomastik@all-llc.com](mailto:ttomastik@all-llc.com)>; Ben Bockelmann <[bbockelmann@all-llc.com](mailto:bbockelmann@all-llc.com)>

**Cc:** Deana Weaver <[dweaver@mec.com](mailto:dweaver@mec.com)>

**Subject:** FW: [EXTERNAL] FW: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

Just forwarding this email.

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**From:** Jerry Sherrell

**Sent:** Wednesday, September 04, 2024 11:21 AM

**To:** 'Oliver Seekins' <[oseekins@all-llc.com](mailto:oseekins@all-llc.com)>

**Cc:** Deana Weaver <[dweaver@mec.com](mailto:dweaver@mec.com)>

**Subject:** FW: [EXTERNAL] FW: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

Oliver,

Please the email below from NMOCD. They are requiring a Fault Slip Potential for the Glacier SWD #1 as part of their Deep Injection guidance. Can you please provide the necessary information?

Jerry W. Sherrell

Regulatory Supervisor

Mack Energy Corporation

Bulldog Operating Company

PO Box 960

Artesia, NM 88210

Office 575-748-1288

Cell 575-703-7382

[jerrys@mec.com](mailto:jerrys@mec.com)

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**From:** Harris, Anthony, EMNRD <[Anthony.Harris@emnrd.nm.gov](mailto:Anthony.Harris@emnrd.nm.gov)>

**Sent:** Wednesday, September 04, 2024 11:08 AM

**To:** Jerry Sherrell <[jerrys@mec.com](mailto:jerrys@mec.com)>

**Cc:** Deana Weaver <[dweaver@mec.com](mailto:dweaver@mec.com)>

**Subject:** RE: [EXTERNAL] FW: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

EXTERNAL EMAIL - Verify the sender and use caution before opening attachments or clicking links

Good Morning, Jerry

I can confirm that a FSP analysis will be required. Please follow the guidance for “Deep Injection” as outlined in the e-mail below.

Regards

Tony

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**From:** Harris, Anthony, EMNRD

**Sent:** Wednesday, September 4, 2024 10:17 AM

**To:** Jerry Sherrell <[jerrys@mec.com](mailto:jerrys@mec.com)>

**Cc:** Deana Weaver <[dweaver@mec.com](mailto:dweaver@mec.com)>

**Subject:** RE: [EXTERNAL] FW: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

Good Morning

I did review it, and it does satisfy the minimum (shallow injection) requirements. Considering the injection will be deep (Devonian) and the proximity to an active Seismic Response Area, I will need to review with management to confirm if a FSP analysis is required. I will advise ASAP

Thanks

Tony

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**From:** Jerry Sherrell <[jerrys@mec.com](mailto:jerrys@mec.com)>  
**Sent:** Wednesday, September 4, 2024 10:12 AM  
**To:** Harris, Anthony, EMNRD <[Anthony.Harris@emnrd.nm.gov](mailto:Anthony.Harris@emnrd.nm.gov)>  
**Cc:** Deana Weaver <[dweaver@mec.com](mailto:dweaver@mec.com)>  
**Subject:** [EXTERNAL] FW: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

CAUTION: This email originated outside of our organization. Exercise caution prior to clicking on links or opening attachments.

Anthony,

Did you have a chance to look at this report? It appears to meet the guidelines, but wanted to make sure.

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**From:** Jerry Sherrell  
**Sent:** Tuesday, September 03, 2024 11:25 AM  
**To:** 'Harris, Anthony, EMNRD' <[Anthony.Harris@emnrd.nm.gov](mailto:Anthony.Harris@emnrd.nm.gov)>  
**Cc:** Deana Weaver <[dweaver@mec.com](mailto:dweaver@mec.com)>  
**Subject:** RE: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

Anthony,

The section about induced seismicity minimum requirements. This was sent in March. Just wanted to make sure you received it.

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**From:** Harris, Anthony, EMNRD <[Anthony.Harris@emnrd.nm.gov](mailto:Anthony.Harris@emnrd.nm.gov)>

**Sent:** Friday, August 30, 2024 1:26 PM

**To:** Jerry Sherrell <[jerrys@mec.com](mailto:jerrys@mec.com)>

**Cc:** Deana Weaver <[dweaver@mec.com](mailto:dweaver@mec.com)>; Goetze, Phillip, EMNRD <[phillip.goetze@emnrd.nm.gov](mailto:phillip.goetze@emnrd.nm.gov)>; Gebremichael, Million, EMNRD <[Million.Gebremichael@emnrd.nm.gov](mailto:Million.Gebremichael@emnrd.nm.gov)>; Sandoval, Stacy, EMNRD <[Stacy.Sandoval@emnrd.nm.gov](mailto:Stacy.Sandoval@emnrd.nm.gov)>; Chavez, Carl, EMNRD <[Carlj.Chavez@emnrd.nm.gov](mailto:Carlj.Chavez@emnrd.nm.gov)>

**Subject:** Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

**Importance:** High

**EXTERNAL EMAIL - Verify the sender and use caution before opening attachments or clicking links**

Good Day, Jerry

Below are the list of deficiencies and or items requiring clarification before the application can be reviewed. If possible, I would like to take 30 mins to review some of these items with you before I send this to Mack.

1. Page 3/61 – C-108 Section VII
  1. Please provide chemical analysis for the disposal zone formation water (Item VII.5)
2. Page 3/61 – C-108 Section VIII
  1. Provide the geologic name, and depth to bottom of all USDW overlying the proposed injection zone as per C-108 Section VIII
  2. Provide the geologic name, and depth to bottom of all USDW underlying the proposed injection zone as per C-108 Section VIII
3. Page 7/61 Section VII.4
  1. Please specify the Source of the Produced Water – San Andres? Other?
4. Page 18/61- “Before” Wellbore diagram for proposed Glacier SWD#1 well
  1. No plugging details included on wellbore diagram. Please provide plugging details

if available.

5. Page 22/61 – No Label / Titles included on the Map. AOR is less than 1 mile

1. 1-Mile AOR not shown on this map.

i. Refer to attached map labelled “**Page 22.. AOR deficiencies**” illustrating the unit letters (denoted by X’s) that need to be included to encompass the 1-mile AOR

1. Please update the map on Page 22 to include a circle clearly showing the 1-mile AOR.
2. Please update “proof of notice” requirement to verify that the surface owner and lease operators (ie. including the 30 Unit letters denoted by an “X” in the attached map) have been notified (**Refer to item 5b below**)
3. Please provide a separate map (**with label / Title**) that clearly identifies the Surface Owner upon which the proposed well is located
4. Please provide a separate map (**with label / Title**) that clearly identifies the Leasehold Operators within 1 mile radius of the proposed well.

1. Refer to Eastern portion of map that identifies Grizzly Operating as an owner

i. Ownership of well 30-015-30667 was transferred from Grizzly to Contango effective 1-29-2021 (ie. prior to Mack Energy Glacier Application being submitted)

1. Please submit “proof of notice” requirements to verify that Contango has been notified.

6. Refer to Page 52/61 – Water Analysis Report

1. No Label / Title include on this Water Sample

i. Is this a Fresh Water Sample ?

1. Report lists the sample point as “*Glacier SWD#1- Wellhead Sample*”

i. If the sample was collected from the Glacier well, please clarify how the sample was collected along with details of the zone that was sampled.



- ii. If this is a fresh water sample, please clarify (with appropriate Label / Title) the location of the well and date the sample was collected (Refer to C-108 Item XI)

#### 7. General notes:

1. Proposed cement volume for Production casing (885 sks) is not sufficient to reach surface
  - i. If there is a DV tool(s) planned for cement job, please clarify and update the wellbore diagram?
1. CBL will be required for the Surface casing (set and cemented in 2001)
  - i. Note that well is in high Karst area, and surface casing cement quality has to be confirmed by CBL.
1. Please provide a brief description of the planned workover operations to convert this well
2. Provide a technical narrative and geologic assessment to demonstrate how the injected fluids will be contained within the Devonian

### **Induced Seismicity Potential (Minimum requirements)**

The well is proposed for disposal into the Devonian and is located near, and along the trend line of, the Dagger Draw SRA (refer to attached image). Considering the ongoing seismic activity in the southern region of New Mexico, OCD requests an assessment of the Induced Seismicity potential. Below is an outline of the minimum requirements to assess the risks of Induced Seismicity for wells in close proximity to a known Seismic Response Area.

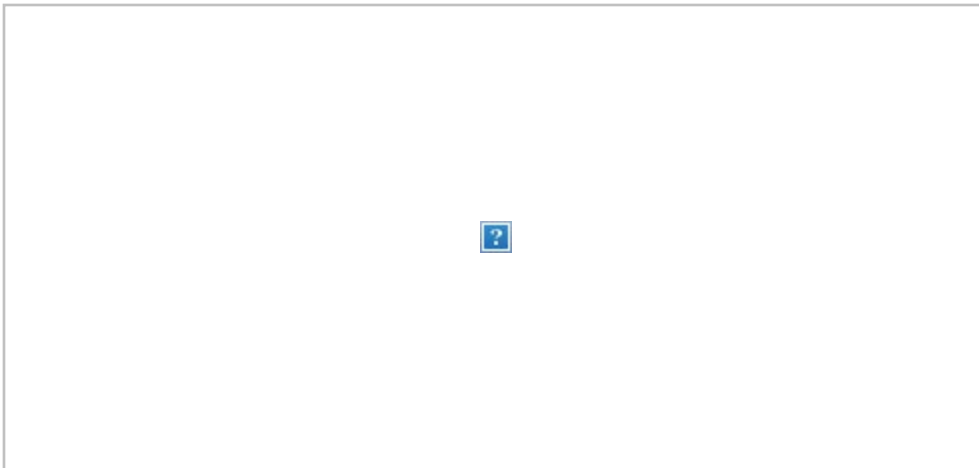
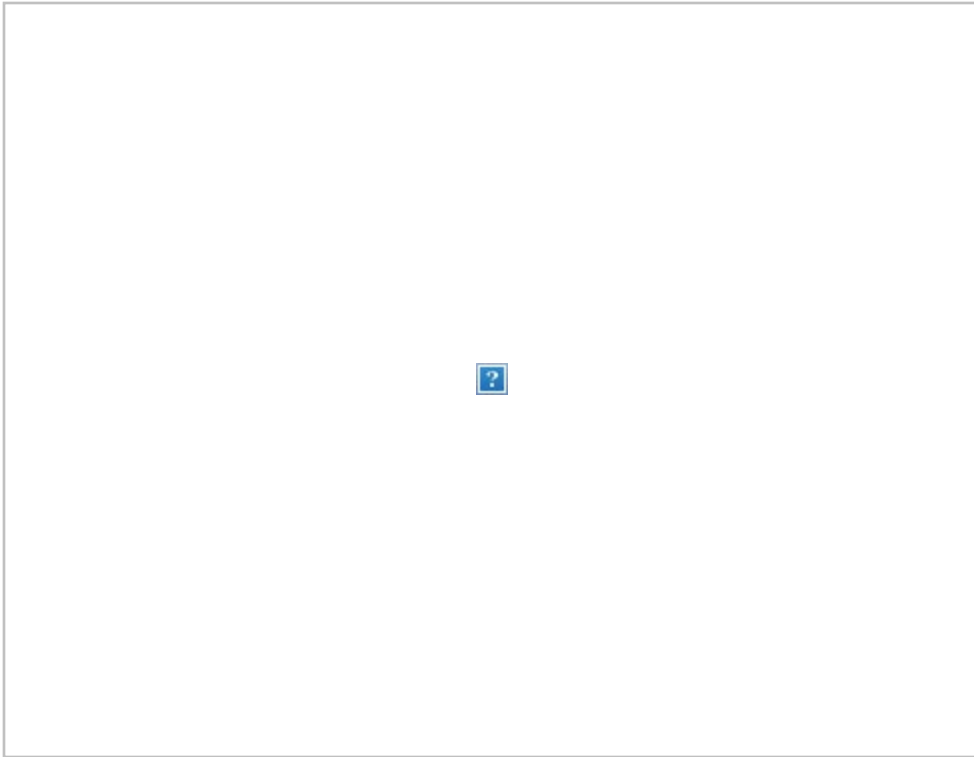
### **Minimum Requirements (for shallow injection wells)**

1. General Information / overview:
  1. Operator to provide a brief narrative on the location of the proposed SWD well (Section, township, range, County etc)
  2. Geologic description (ie. Interbedded carbonate, limestones, siltstones, sandstones etc) of the proposed injection interval
  3. Proposed formation and the depth of the injection interval
  4. Statement on potential for communication with the Precambrian via faulting or other geologic features

5. Statement on potential for communication with USDW.
2. Seismic Risk assessment based on USGS data
  1. Statement on the Historical seismicity in the area of the proposed SWD
    - i. Number of earthquakes above 2.5 magnitude within 10 miles of the proposed well
    - ii. Location and depth of nearest earthquake and the distance to the proposed well.
  1. Subsurface Conditions / Faulting
    - i. Distance and depth to the nearest basement-penetrating fault(s)
    - ii. Narrative on the maximum stress direction, the stress regime and potential for communication with basement-penetrating faults.

**Deep Injection – Minimum requirements** Provide all items listed for Shallow injection, in addition to the following:

1. 1-mile AOR required for all Devonian-Silurian injection wells
2. Include a structural contour map of the Precambrian basement
  1. Highlight basement-penetrating faults on the map as applicable
  2. Include a 2 Mile radius around the proposed well showing proximity to basement-penetrating faults if applicable
3. If basement penetrating faults are identified, include an analysis of Fault Slip Potential utilizing Stanford-Zoback model which should include the following:
  1. Construction of a hydrologic model to simulate the impact of injection from the proposed well (and nearby injection wells) over a 30 year period to estimate the Fault-slip potential associated with injection.
    - i. Simulate injection scenarios based on maximum proposed injection rate for the well, and offset wells if applicable
    - ii. An example of parameters to be utilized in the model are included in Table 8,9 & 10 below
  1. Identification of subsurface faults and a description of the faults (strike direction, type of fault – normal, extensional, etc)
  2. Include a record of all USGS documented seismic events of magnitude 2.5 or greater within a 10 mile radius, including details on the depth (focus) and epicenter
  3. A narrative on whether injection in the vicinity the faults will result in an elevated risk for injection-induced fault slip



**Conclusion – Induced Seismicity potential:**

Operator representative(s), with skills and competencies suitable to assess the risk of induced seismicity, to provide an affirmative statement / summary on the potential for Induced seismicity based upon the parameter listed above. Example wording included below

1. "After examination of publicly available / Operator's geologic and engineering data, there (is / is not) evidence of open faults or other hydrologic connections between the proposed disposal zone and any USDW.
2. "After examination of publicly available / Operator data, it is concluded that there is (low/high) risk for induced seismicity based upon the following parameters":
  - i. Vertical separation between the proposed injection zone and the pre-cambrian
  - ii. Narrative on the existence of basement-penetrating faults in the area of the proposed SWD
  - iii. Distance from proposed well to the nearest known basement-penetrating fault(s)
  - iv. Distance from the closest historic earthquake
  - v. Summary of Fault Slip potential based on Stanford-Zoback model.
  - vi. Other items as applicable..

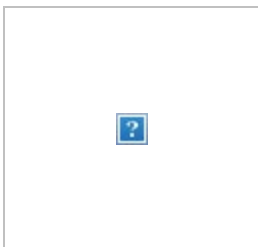
Regards

Tony Harris

Petroleum Specialist

[Anthony.harris@emnrd.nm.gov](mailto:Anthony.harris@emnrd.nm.gov)

505 549 8131.



**From:** [Harris, Anthony, EMNRD](#)  
**To:** [Jerry Sherrell](#)  
**Cc:** [Deana Weaver](#); [Goetze, Phillip, EMNRD](#); [Gebremichael, Million, EMNRD](#); [Sandoval, Stacy, EMNRD](#); [Chavez, Carl, EMNRD](#)  
**Subject:** RE: [EXTERNAL] RE: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.  
**Date:** Monday, September 16, 2024 2:57:00 PM  
**Attachments:** [jimage005.png](#)

Hi Jerry

Please see my response below highlighted in blue

Hope this helps

Tony

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**From:** Jerry Sherrell <jerrys@mec.com>  
**Sent:** Tuesday, September 10, 2024 9:14 AM  
**To:** Harris, Anthony, EMNRD <Anthony.Harris@emnrd.nm.gov>  
**Cc:** Deana Weaver <dweaver@mec.com>; Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>; Gebremichael, Million, EMNRD <Million.Gebremichael@emnrd.nm.gov>; Sandoval, Stacy, EMNRD <Stacy.Sandoval@emnrd.nm.gov>; Chavez, Carl, EMNRD <Carlj.Chavez@emnrd.nm.gov>  
**Subject:** [EXTERNAL] RE: Mack Energy Glacier SWD#1 - List of deficiencies and clarification required.

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Good Morning,

Mack Energy is close to having all the concerns addressed and submitted. I have a couple questions(below) could you please advise.

1. Page 3/61 – C-108 Section VII
  - a. Please provide chemical analysis for the disposal zone formation water (Item VII.5) **There is not a Devonian well in the area to get a sample. Can we provide the sample during completion. YES We can perf and swab the well to provide a sample. Just curious why this is necessary? It is necessary as per Section VII.5 of the C-108 (see snapshot below). Your application simply states “N/A” which does not provide much insight for a person reviewing the application. Alternatively, and for future reference, it would be helpful if your application included a statement similar to what you included above highlighting that no sample is available from offset wells, together with a commitment to collect the data via swab test during the drilling/completion operations.**

VII. Attach data on the proposed operation, including:

1. Proposed average and maximum daily rate and volume of fluids to be injected;
2. Whether the system is open or closed;
3. Proposed average and maximum injection pressure;
4. Sources and an appropriate analysis of injection fluid and compatibility with the receiving formation if other than reinjected produced water; and,
5. If injection is for disposal purposes into a zone not productive of oil or gas at or within one mile of the proposed well, attach a chemical analysis of the disposal zone formation water (may be measured or inferred from existing literature, studies, nearby wells, etc.).

4. Page 18/61- “Before” Wellbore diagram for proposed Glacier SWD#1 well
  - a. No plugging details included on wellbore diagram. Please provide plugging details if available. **The Well file in the OCD online system is incomplete. Apparently it never got entered into the system. We are aware of incomplete online dataset, and hence the reason for stating “if available”. If you are unable to locate any information as part of your pre-intervention due-diligence then this requirement will be waived. Should this re-entry be unsuccessful Mack Energy will P&A per OCD regulations. Thank you for the clarification.**



September 25, 2024

PN 1904.SEIS.00

Mr. Phillip Goetze, P.G.  
NM EMNRD – Oil Conservation Division  
1220 South St. Francis Drive  
Santa Fe, NM 87505

Subject: **Mack Energy Corporation**  
**Glacier SWD #1 - Seismic Potential Letter**

Dear Mr. Goetze,

At the request of Mack Energy Corporation (Mack Energy), ALL Consulting, LLC (ALL) has assessed the potential injection-induced seismicity risks in the vicinity of Mack Energy's Glacier SWD #1 (Subject SWD), a proposed saltwater disposal (SWD) facility in Eddy County, New Mexico, and summarized the findings in this letter. This assessment used publicly available data to identify the proximity and characteristics of seismic events and known faults to evaluate the potential for the operation of the Glacier SWD #1 to contribute to seismic activity in the area.

## Geologic Evaluation

The Subject SWD is requesting a permit to inject into the Devonian Formation at a depth of 9,385-9,780 feet below ground surface (bgs). The Devonian Formation consists of cherty limestone and dolomites and is overlain by approximately 80 feet of low porosity and permeability Woodford Shale, which would prevent the upward migration of injection fluid and serve as the upper confining layer (see **Attachment 1**). Additionally, the Devonian Formation is underlain by various low porosity and permeability zones within the Silurian and Montoya Groups, both of which consist of limestones, dolomites, and interbedded shale zones. No geophysical logs penetrating the Silurian and Montoya Groups were available within 10 miles of the Subject SWD. A stratigraphic chart depicting the geologic setting is included as **Figure 1**.<sup>1</sup>

## Seismic Events and Fault Data

A review of United States Geological Survey (USGS) and New Mexico Tech Seismological Observatory (NMTSO) earthquake catalogues determined that zero (0) seismic events have been recorded within a 100 square mile area [9.08-kilometer (km) radius] around the Subject SWD.

<sup>1</sup> Yang, K.-M., & Dorobek, S. L. (1995). The Permian Basin of west Texas and New Mexico: Tectonic history of a "composite" Foreland Basin and its effects on stratigraphic development. *Stratigraphic Evolution of Foreland Basins*, 149–174. <https://doi.org/10.2110/pec.95.52.0149>

Mack Energy Corporation  
Glacier SWD #1 Seismic Information  
September 25, 2024

The closest recorded seismic event was a M1.78 that occurred on May 25, 2021, and was located approximately 6.22 miles south of the Subject SWD (see **Attachment 2**). **Per the USGS earthquake catalog, no seismic events M2.5 or greater have been recorded within 10 miles of the proposed SWD.**

Fault data from United States Geological Survey (USGS) and the Texas Bureau of Economic Geology (BEG)<sup>2</sup> indicates that the closest known fault is located approximately 14.71 miles south/southeast of the Subject Well (see **Attachment 2**). This identified fault is within the Precambrian basement, which is approximately 3,220 feet below the proposed injection interval.<sup>3</sup> **No Precambrian basement faults were identified within two miles of the subject well, or within the 100 square mile area of review centered on the subject well.** A map of the seismic events and faults within 9.08 km of the Subject SWD is included as **Attachment 2**.

## Seismic Potential Evaluation

Experience in evaluating induced seismic events indicates that most injection-induced seismicity throughout the U.S. (e.g., Oklahoma, Ohio, Texas, New Mexico, and Colorado) occurs as a result of injection into Precambrian basement rock, into overlying formations that are in hydraulic communication with the Precambrian basement rock, or as a result of injection near critically stressed and optimally oriented faults. Seismicity at basement depths occurs because critically stressed faults generally originate in crystalline basement rock and may also extend into overlying sedimentary formations.<sup>4</sup>

Injection into either the Precambrian basement rock or its overlying formations that are hydraulically connected to the basement rock through faulting or fracture networks can increase the pore pressure and may lead to the fault slipping, resulting in a seismic event.<sup>4</sup> As such, the vertical distance between the injection formation and Precambrian basement rock and the

**Figure 1 – Delaware Basin Stratigraphic Chart  
(Adapted from Yang and Dorobek 1995)**

SYSTEM	SERIES/STAGE	CENTRAL BASIN PLATFORM	DELAWARE BASIN
PERMIAN	OCHOAN	DEWEY LAKE RUSTLER SALADO	DEWEY LAKE RUSTLER SALADO CASTILE
	GUADALUPIAN	TANSILL YATES SEVEN RIVERS QUEEN GRAYBURG SAN ANDRES GLORIETA CLEAR FORK WICHITA	DELAWARE MT GROUP BELL CANYON CHERRY CANYON BRUSHY CANYON
	LEONARDIAN		BONE SPRING
	WOLFCAMPIAN	WOLFCAMP	WOLFCAMP
PENNSYLVANIAN	VIRGILIAN	CISCO	CISCO
	MISSOURIAN	CANYON	CANYON
	DESMOINESIAN	STRAWN	STRAWN
	ATOKAN	ATOKA	ATOKA
	MORROWAN	(ABSENT)	MORROW
MISSISSIPPIAN	CHESTERIAN MERAMECIAN OSAGEAN KINDERHOOKIAN	CHESTER MERAMEC OSAGE KINDERHOOK WOODFORD DEVONIAN	CHESTER MERAMEC OSAGE KINDERHOOK WOODFORD DEVONIAN
DEVONIAN			
SILURIAN		SILURIAN SHALE FUSSELMAN	MIDDLE SILURIAN FUSSELMAN
ORDOVICIAN	UPPER	MONTOYA	SYLVAN MONTOYA
	MIDDLE	SIMPSON	SIMPSON
	LOWER	ELLENBURGER	ELLENBURGER
CAMBRIAN	UPPER	CAMBRIAN	CAMBRIAN
PRECAMBRIAN			

<sup>2</sup> Horne E. A. Hennings P. H., and Zahm C. K. 2021. Basement structure of the Delaware Basin, in The Geologic Basement of Texas: A Volume in Honor of Peter Flawn, Callahan O. A., and Eichubl P., The University of Texas at Austin, Bureau of Economic Geology.

<sup>3</sup> G. Randy Keller, J. M. Hills & Rabah Djeddi, A regional geological and geophysical study of the Delaware Basin, New Mexico and West Texas, Trans Pecos Region (West Texas) (1980).

<sup>4</sup> Ground Water Protection Council and Interstate Oil and Gas Compact Commission. *Potential Injection-Induced Seismicity Associated with Oil & Gas Development: A Primer on Technical and Regulatory Considerations Informing Risk Management and Mitigation*. 2015. 141 pages.

Mack Energy Corporation  
Glacier SWD #1 Seismic Information  
September 25, 2024

presence or lack of faulting within the injection interval are major considerations when determining the risk of injection-induced seismicity.

Geophysical data from nearby well records, aeromagnetic surveys, and gravity surveys indicates the top of the Precambrian Basement to be approximately 13,000 feet bgs at the Subject SWD, or approximately 3,220 feet below the proposed injection interval.<sup>3</sup> In addition, publicly available fault data does not indicate any transmissive faulting is present above the Precambrian basement around the Subject SWD. **There are insufficient Precambrian basement penetrations and/or well data regarding Precambrian basement depth to generate an accurate structural contour map of the Precambrian basement in the vicinity of the proposed SWD.**

Class II SWDs in New Mexico are administratively permitted with a maximum pressure gradient of 0.2 psi/ft. Review of New Mexico Oil Conservation Division (OCD) Order IP-537 from the Mack Energy Round Tank SWD #1, which is located approximately 16 miles east/northeast of the Subject SWD, determined the fracture gradient of the Devonian Formation in the region is 0.41 psi/ft from an approved step-rate test. Typical SWD permitting standards in New Mexico would indicate that formation parting pressure would not be exceeded by the Subject SWD.

## Conclusion

As an expert on the issue of induced seismicity, seismic monitoring, and mitigation, it is my opinion that the potential for the Subject SWD to cause injection-induced seismicity is expected to be minimal, at best. This conclusion assumes the Subject SWD will be operated below formation parting pressure and is based on (1) the presence of numerous confining layers above and below the injection interval, (2) the significant vertical and lateral distance between the injection zone and Precambrian basement rock in which the nearest fault has been identified, and (3) the lack of historic seismicity or mapped faults in the vicinity of the Subject SWD.

Sincerely,  
ALL Consulting



Reed Davis  
Geophysicist

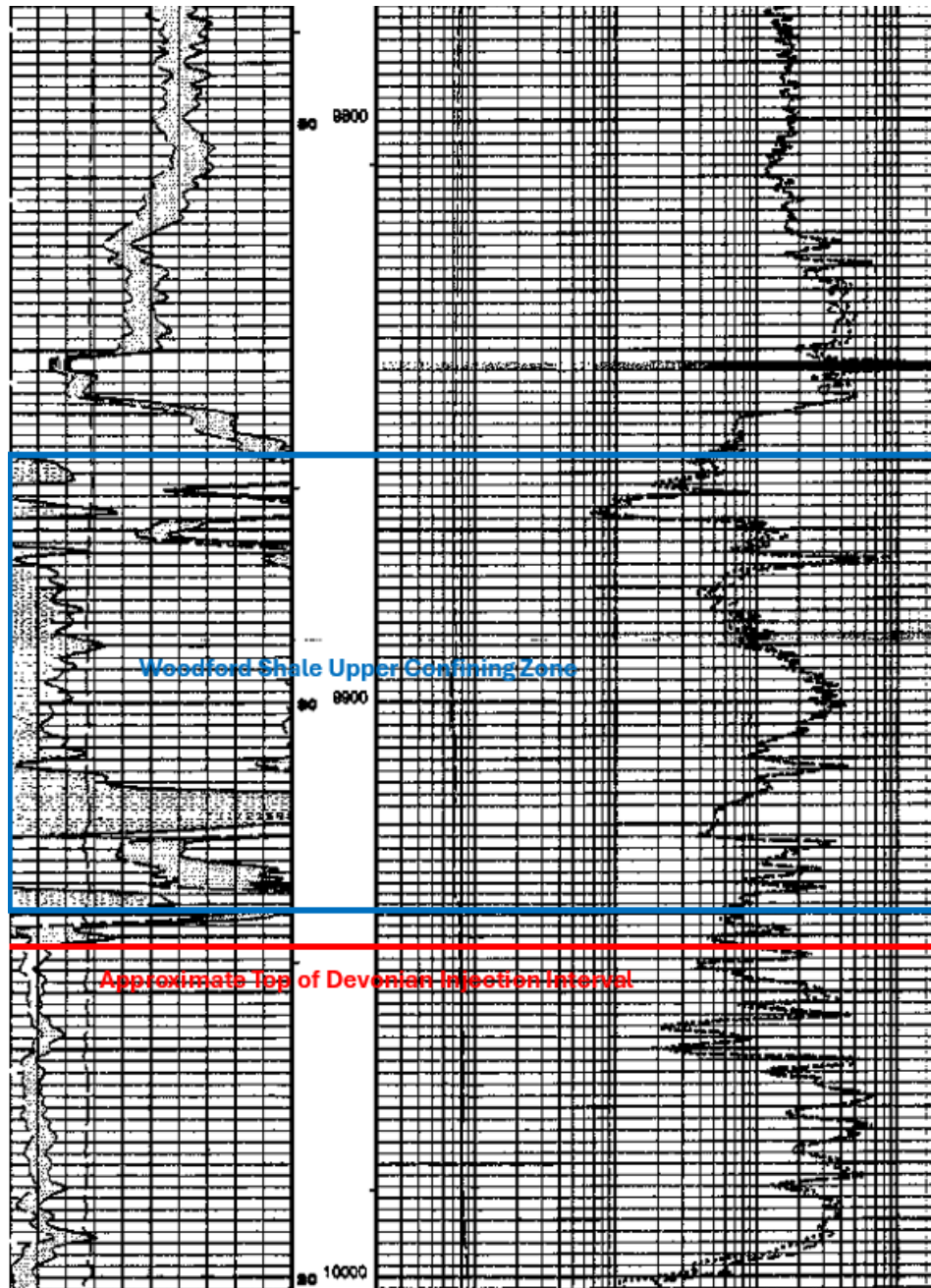


Mack Energy Corporation  
Glacier SWD #1 Seismic Information  
September 25, 2024

**Attachment 1**  
**Woodford Shale Upper Confining Zone**

Mack Energy Corporation  
Glacier SWD #1 Seismic Information  
September 25, 2024

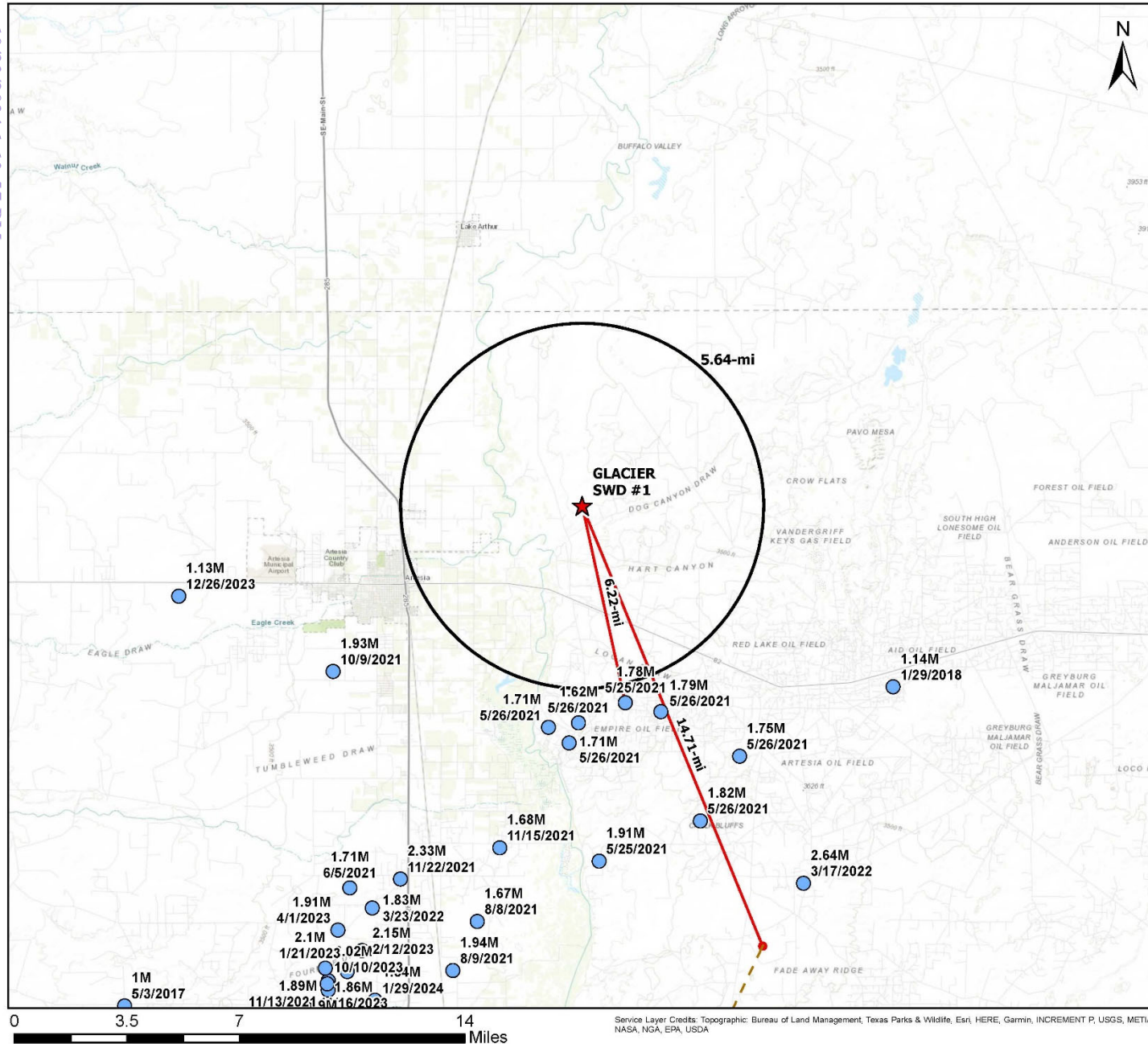
### Woodford Shale Upper Confining Zone from API No. 015-32444



Mack Energy Corporation  
Glacier SWD #1 Seismic Information  
September 25, 2024

**Attachment 2**  
**Seismic Event Map**

### Glacier SWD #1 Nearby Seismic Events and Faults



Seismic Analysis Map		
GLACIER SWD #1 EDDY COUNTY, NEW MEXICO		
Proj Mgr: Oliver Seekins	February 19, 2024	Mapped by: Ben Bockelmann
Prepared for: <b>MACK</b> Energy Corporation	Prepared by: <b>ALL</b> CONSULTING	

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State of New Mexico  
Energy, Minerals and Natural Resources  
Oil Conservation Division  
1220 S. St Francis Dr.  
Santa Fe, NM 87505

CONDITIONS  
  
Action 395189

CONDITIONS

Operator:  MACK ENERGY CORP P.O. Box 960 Artesia, NM 882110960	OGRID:  13837
	Action Number:  395189
	Action Type: [IM-SD] Admin Order Support Doc (ENG) (IM-AAO)

CONDITIONS

Created By	Condition	Condition Date
anthony.harris	None	10/23/2024