

**OVERFLOW ENERGY, LLC  
SUPPLEMENTAL AFFIDAVIT OF REED JAMESON DAVIS  
Case No. 20964**

**STATE OF NEW MEXICO  
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT  
OIL CONSERVATION DIVISION**

**APPLICATION OF OVERFLOW ENERGY,  
LLC FOR APPROVAL OF A SALT WATER  
DISPOSAL WELL, EDDY COUNTY, NEW  
MEXICO**

**CASE NO. 20964**

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**SUPPLEMENTAL AFFIDAVIT OF GEOPHYSICIST REED JAMESON DAVIS  
IN SUPPORT OF APPLICANT'S FAULT SLIP POTENTIAL ANALYSIS**

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I, being duly sworn on oath, state the following:

1. I am over the age of 18 and have the capacity to execute this Affidavit, which is based on my personal knowledge.
2. I previously submitted an affidavit and testified before the New Mexico Oil Conservation Division ("NMOCD") in this matter as an expert witness on December 18, 2020 ("2020 Hearing"). I submit this affidavit to supplement the record as requested by the hearing examiners at the 2020 Hearing. I fully incorporate herein my previous affidavit and testimony.
3. Exhibit 4 attached hereto consists of a Powerpoint with pertinent slides that I prepared for this supplemental presentation. The slides contain revised fault slip potential ("FSP") results for the Rita SWD #1, including parameter changes requested by NMOCD during previous testimony, that is, plus or minus 15 degrees of uncertainty for the maximum horizontal stress direction and the orientation of the fault of concern.

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4. Slides 7 and 8 display the injection data and well locations utilized for the revised FSP analysis. Per NMOCD request, the Buckner 9 SWD #1, Red Devil SWD #1, and Quintana SWD #1 pending SWD locations have been added to the model.<sup>1</sup>

5. No UIC wells that inject or that are authorized to inject produced water into the same approved injection interval are permitted within three miles of the Well.

6. With regards to modeled injection rates, the three SWDs that were added to the model are assumed to inject at 25,000 BWPD. These modeled rates were derived from a review of OCD data, which indicated that none of the active SWDs within the 100 square mile area of interest have reported an injection rate >25,000 barrels of water per day (BWPD) in a given month. Therefore, these modeled rates are expected to be overestimated, resulting in the model representing a worst-case scenario.

7. Slide 10 details the additional parameter changes applied to the model per NMOCD request. These additional changes include: 15 degrees of variability added to fault strike angle and 15 degrees of variability added to maximum horizontal stress direction. No additional parameter changes were made.

8. Slide 14 represents the results of the revised FSP model. The model, including the additional SWDs and other parameter changes requested by NMOCD, indicates that fault slip potential for the area is 0.00.

9. In light of ALL's analysis described herein, I have reached the following conclusions: First, there is only one known Precambrian fault in the 100 square mile area of

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<sup>1</sup> None of these additional wells have been permitted or drilled.

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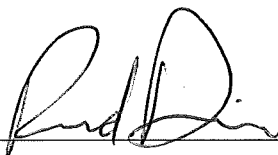
review. That known fault does *not* align with the horizontal stress field and therefore is not likely to slip. The modeling that we have conducted through 25 years was performed with injection rates that are likely overestimated. That modeling shows no risk of potential fault slip in the area. Thus, the area presents little to no risk for injection induced seismicity. Moreover, the applicant intends to install a seismic monitoring system to monitor seismicity in the area of the proposed Rita SWD #1.

10. Based on this analysis, it is my opinion that the drilling and operation of and disposal of salt water in the proposed Rita SWD #1 will protect correlative rights, prevent waste, and be in the interest of conservation.

11. The attached exhibits were prepared by me or under my supervision.

OVERFLOW ENERGY, LLC  
SUPPLEMENTAL AFFIDAVIT OF REED JAMESON DAVIS  
Case No. 20964

FURTHER AFFIANT SAYETH NAUGHT



Reed Jameson Davis

STATE OF OKLAHOMA   )  
  )ss  
COUNTY OF TULSA    )

Subscribed to and sworn before me this 19<sup>th</sup> day of January 2021.

  
Notary Public

My Commission expires 6-4-23.



# Overflow Energy Rita SWD #1

## Fault Slip Potential Analysis (FSP)

# FSP Methodology

## Model Methodology

- FSP provides a probabilistic estimate of fault slip due to nearby fluid injection.
  - Calculates probability of a fault exceeding the Mohr-Coulomb slip criteria (failure point between normal and shear stresses).
  - Utilizes Monte Carlo simulation to account for potential errors in input parameters.

## Model Inputs

- Stress gradients and pore pressure gradients derived from nearby frac report provided by Overflow Energy.
- Injection interval thickness, porosity, and permeability provided by Overflow Energy and ALL Consulting.
- One known Precambrian fault in the 100 square mile area of review (USGS 2020, Wilson 2018, Overflow Energy).

# Parameters

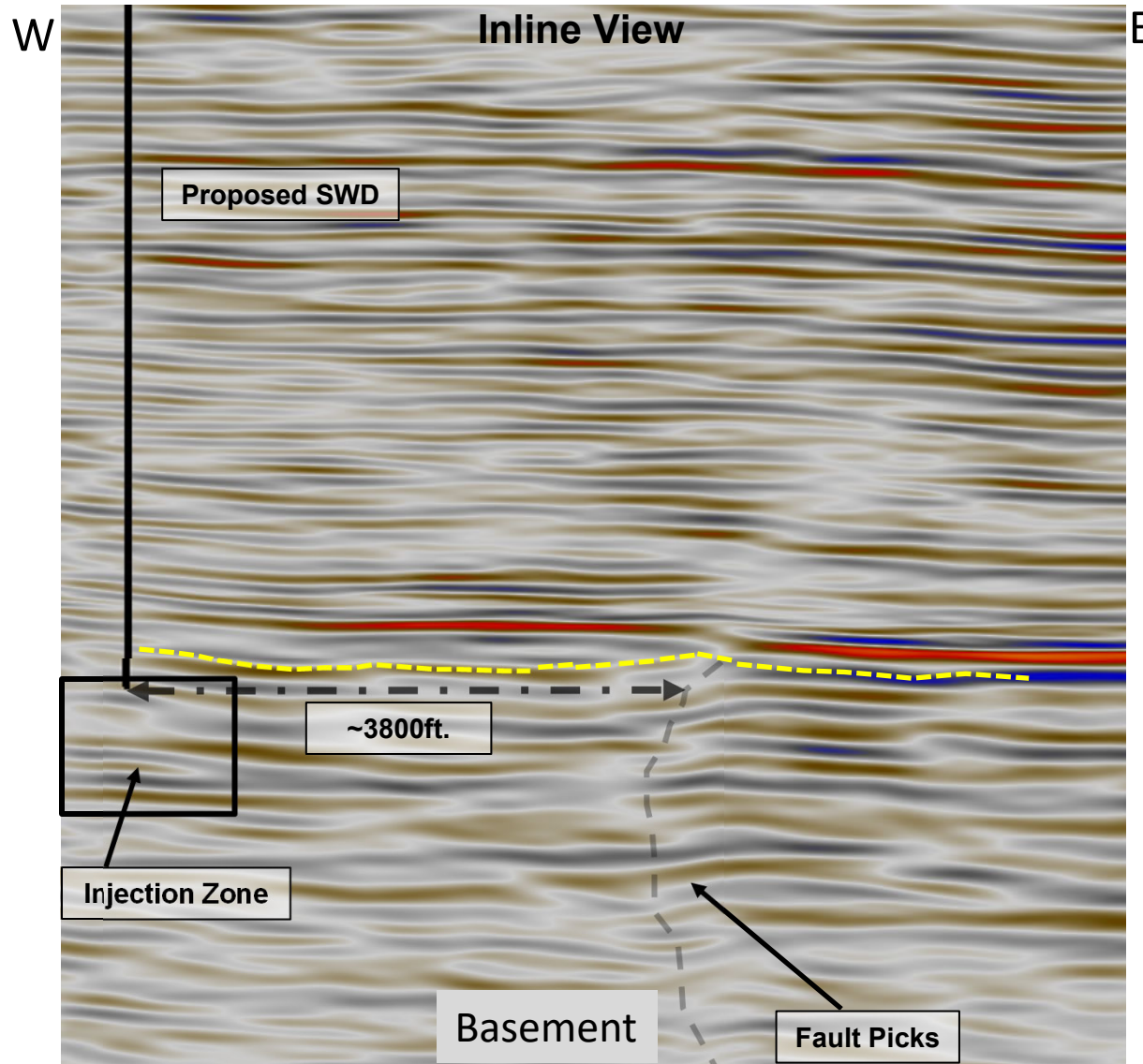
Parameter	Value	Source
Vertical Stress Gradient (psi/ft)	1.05	Overflow Energy (2020)
Horizontal Stress Direction (degrees azimuth)	20	Lund Snee (2020)
Reference Depth (ft)	13,700	Overflow Energy (2020)
Initial Reservoir Pressure Gradient (psi/ft)	0.43	Overflow Energy (2020)
Min. Horizontal Stress Gradient (psi/ft)	0.71	Nearby Frac Report (2020)
Max Horizontal Stress Gradient (psi/ft)	0.86465	Overflow Energy (2020)
Friction Coefficient	0.6	Lund Snee (2020)
Injection Interval Thickness (ft)	304	Nearby Geophysical Logs - ALL (2020)
Porosity (%)	5	Overflow Energy (2020)
Permeability (mD)	35	Overflow Energy (2020)
Fault Strike (degrees)	45	Overflow Energy (2020)
Fault Dip	80	Overflow Energy (2020)
Fluid Density (kg/m <sup>3</sup> )	1000	ALL Research and Reynolds (2020)
Dynamic Viscosity (Pa*s)	0.0003	ALL Research and Reynolds (2020)
Fluid Compressibility (Pa <sup>-1</sup> )	4.70E-10	ALL Research and Reynolds (2020)
Rock Compressibility (Pa <sup>-1</sup> )	8.70E-10	ALL Research and Reynolds (2020)

# Parameter Changes from Previous FSP

Parameter	Overflow Value	Marathon Value	ALL Value	Notes & Sources
Horizontal Stress Direction (degrees azimuth)	155	35	20	<b>Overflow:</b> Initial Overflow stress orientation based on a distant old frac report. <b>Marathon:</b> Orientation based on Stanford stress data. <b>ALL:</b> Review of recently updated Stanford stress data indicates stress field is oriented approximately N20E (see following slide).
Min. Horizontal Stress Gradient (psi/ft)	0.62875	0.62875	0.71	<b>Overflow:</b> Min. stress gradient set per distant old frac report. <b>Marathon:</b> Used value provided by Overflow. <b>ALL:</b> Further discussion between Overflow & ALL revealed a slightly higher minimum horizontal stress gradient, per new frac report data within one mile of Rita SWD.
Fault Details	Northeast extension of fault modeled in true location	Fault modeled directly beneath Rita SWD #1	Fault modeled in true location	<b>Overflow:</b> Fault modeled via nearby seismic data. <b>Marathon:</b> Fault modeled directly beneath Rita SWD #1. <b>ALL:</b> Fault modeled via nearby seismic data provided by Overflow & available published research.
Injection Interval Thickness (ft)	200	200	304	<b>Overflow:</b> Estimated from nearby wells. <b>Marathon:</b> Used value provided by Overflow. <b>ALL:</b> Review of nearest geophysical logs (API# 15-44530).

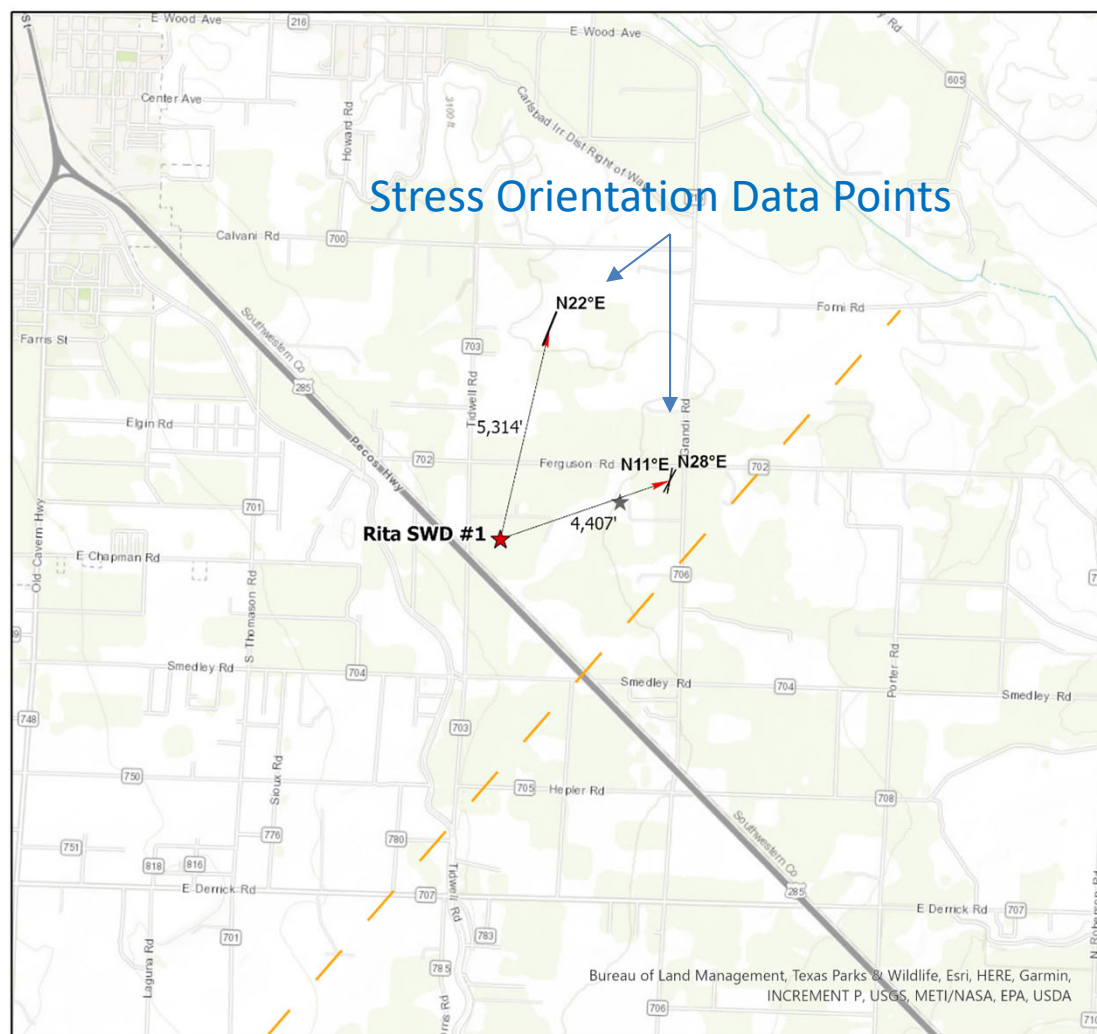


# Seismic Data



Near vertical faults observed on seismic on inline (E-W) view at ~3800 ft. east of proposed Rita SWD #1.

# Stanford Stress Orientation Data Near Rita SWD #1



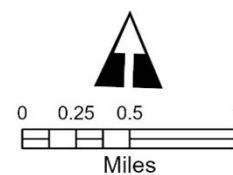
Prepared for:  
**OE** OVERFLOW ENERGY

## Legend

- ★ Proposed SWD
- ★ Fracture Gradient Data Point 30-015-32847
- - Fault

$S_{Hmax}$  orientation quality:

- | A (1)
- | B (2)



1 inch equals 1 miles

Prepared by:  
**ALL**CONSULTING

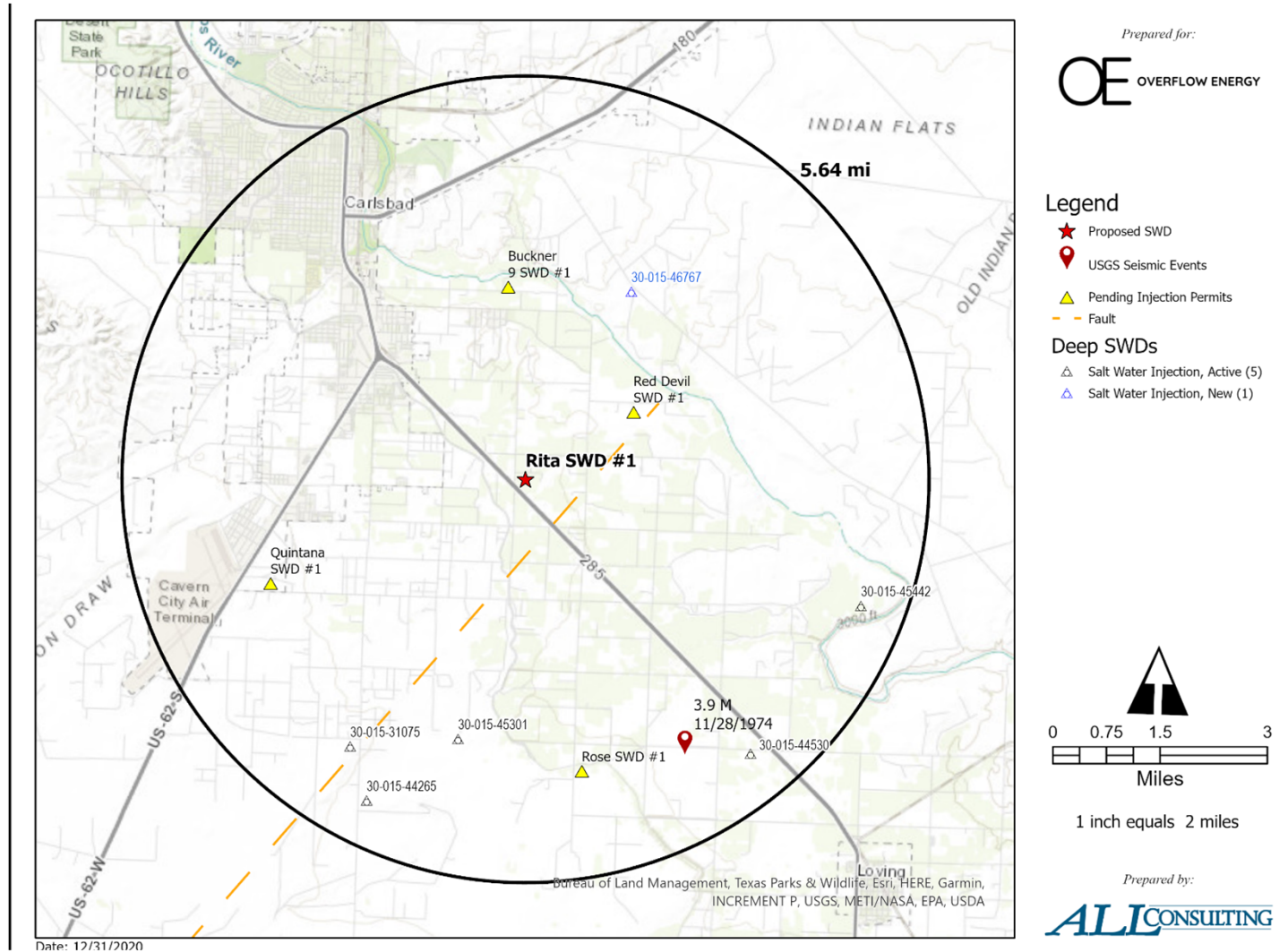
Date: 10/29/2020

Data Source: Lund Snee 2020

# Injection Data

- **Modeled SWDs:** 10 Class II Injection Wells (5 Active, 5 Inactive) are located within the 100 square mile area of review (AOR) and were included in this model.
- **Modeled Injection Rates:**
  - Subject SWD: the Rita SWD #1 was modeled at 25,000 barrels of water per day (BWPD) based on the maximum injection rate included in its C-108.
  - Inactive SWDs (Not-Permitted or Not-Drilled): Two Inactive SWDs were modeled at 30,000 BWPD (Rose SWD #001) and 35,000 BWPD (Pecos River 11 SWD #001) based on the maximum injection rates included in their C-108s. Three Inactive SWDs (Not-Permitted and Not-Drilled) were modeled at 25,000 BWPD (Quintana SWD #1, Buckner 9 SWD #1, and Red Devil SWD #1) based on a review of active SWDs in the area.
  - Active SWDs: actual injection volumes were reviewed for the active SWDs and none reported volumes >25,000 BPWD in a single month. A rate of 25,000 BWPD was used to provide a conservative scenario.
- **Modeled Injection Timeframe:** Each SWD was modeled at the constant rate listed above from 2020 – 2045.

# Rita SWD #1 FSP Area Map





# Geomechanics Probability

## Calculations:

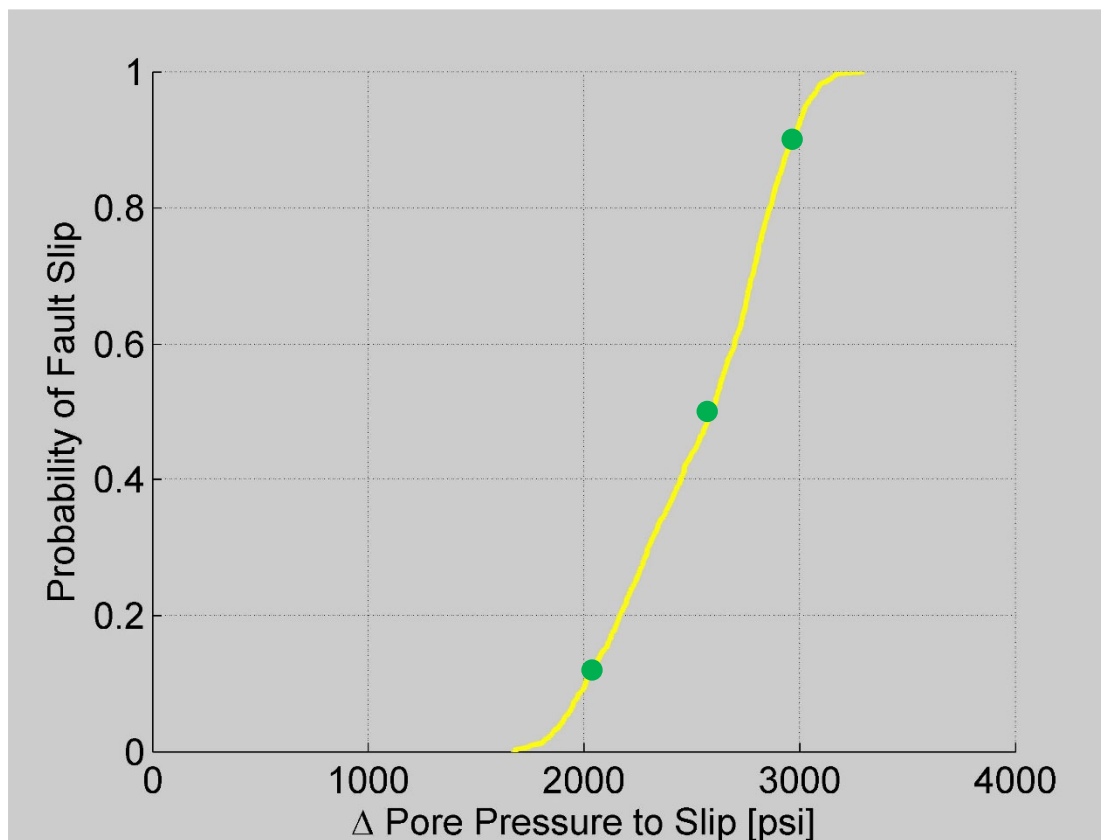
- (psi/12,200 ft) + 0.44 psi/ft
- 12,200 ft used as TVD for consistency with frac report – leads to more conservative estimate than 13,700 ft reference depth.
- 0.44 psi/ft used as estimate for 60,000 TDS brine.

**10% Slip Probability :** 2,007 psi - .60 psi/ft

**50% Slip Probability :** 2,560 psi - .65 psi/ft

**90% Slip Probability :** 2,974 psi - .68 psi/ft

## Monte Carlo Simulation



# Geomechanics Probability

Revisions per NMOCD Request

## Revisions:

- Added 15 degrees of variability to fault strike angle.
- Added 15 degrees of variability to maximum horizontal stress direction.
- Added 3 additional Not-Permitted/Not-Drilled SWDs (see slide 13).

Uniform Distribution bounds

Gradient based stress model is being used

	Plus/Minus
Vertical Stress Grad [1.05 psi/ft]	0.01
Min Horiz. Grad [0.71 psi/ft]	0.01
Max Horiz. Grad [0.86465 psi/ft]	0.01
Initial PP Grad [0.43 psi/ft]	0
Strike Angles [45 degrees]	15
Dip Angles [80 degrees]	15
Max Horiz. Stress Dir [20 degrees]	15
Friction Coeff Mu [0.6]	0

OK

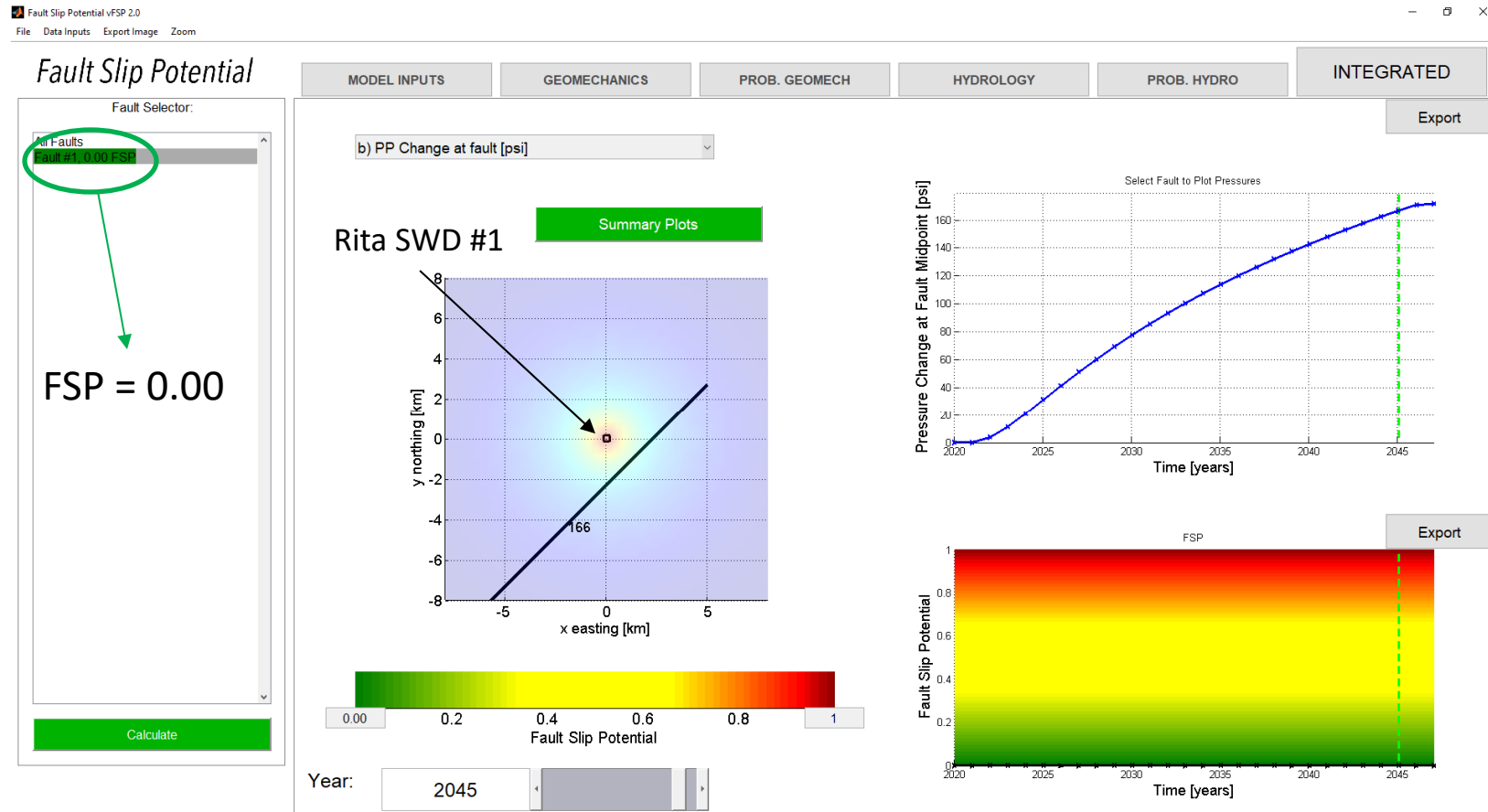
# Scenario 1

Rita SWD #1 Only

SWD	Injection Rate (bpd)	Modeled Time Period
Rita SWD #1	25,000	2020 - 2045

# FSP After 25 Years

Rita SWD #1 Only





# Scenario 2

All deep SWDs within 100 square miles of Rita SWD #1

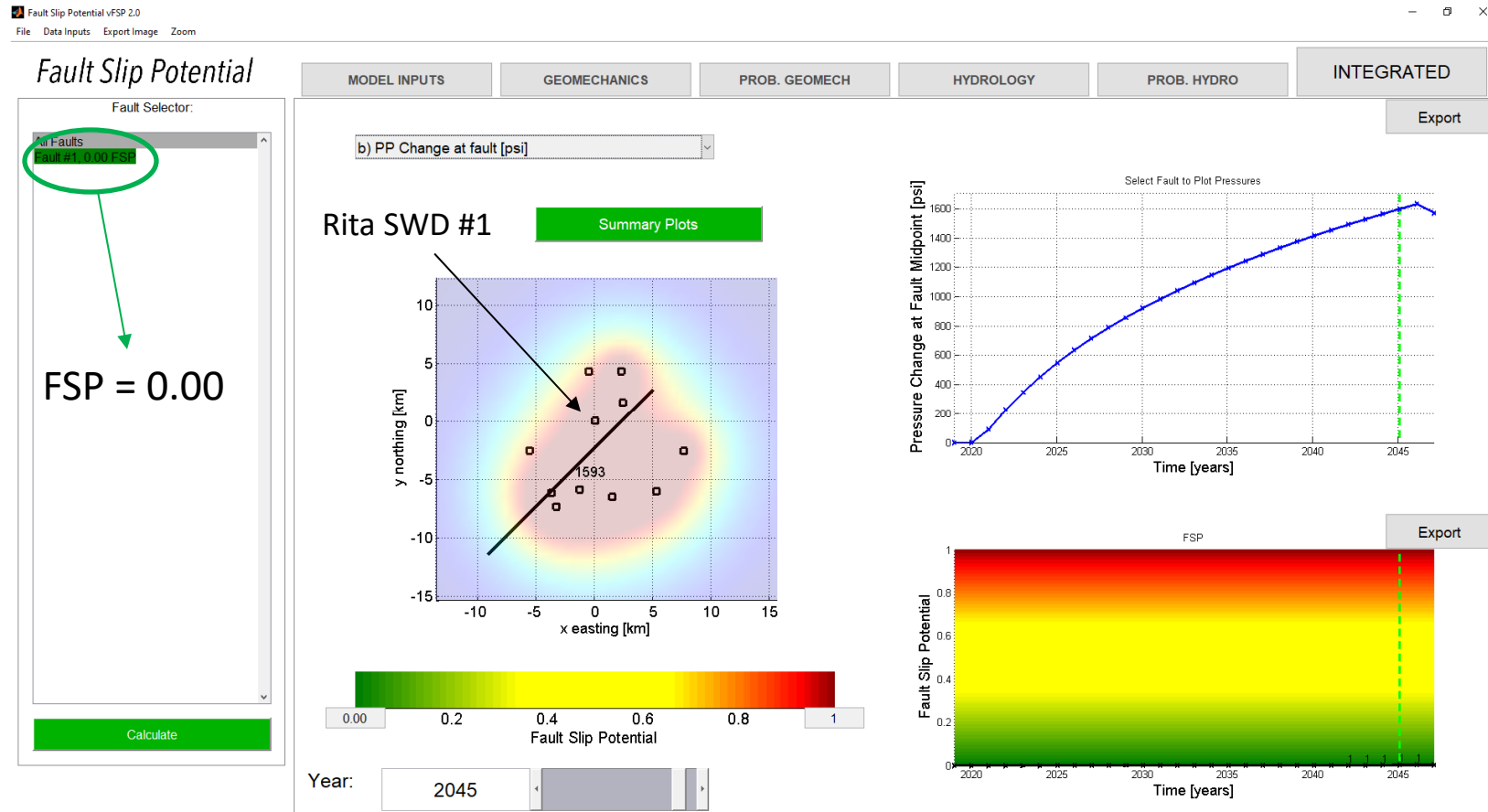
SWD Name	SWD Status	Injection Rate (bpd)	Modeled Time Period
Rita SWD #1	Proposed	25,000	2020 - 2045
Rose SWD #001 (15-45221)	Drilled/Not-Permitted	30,000	2020 - 2045
Pecos River 11 SWD #001 (15-46767)	Permitted/Not-Drilled	35,000	2020 - 2045
Faulk SWD #007 (15-45442)	Active	25,000	2020 - 2045
Alpha SWD #002 (15-44530)	Active	25,000	2020 - 2045
Patriot SWD #008 (15-45301)	Active	25,000	2020 - 2045
Iceman State SWD #001 (15-44265)	Active	25,000	2020 - 2045
Top Gun Federal SWD #001 (15-31075)	Active	25,000	2020 - 2045
Red Devil SWD #1	Not-Permitted/Not-Drilled	25,000	2020 - 2045
Buckner 9 SWD #1	Not-Permitted/Not-Drilled	25,000	2020 - 2045
Quintana SWD #1	Not-Permitted/Not-Drilled	25,000	2020 - 2045

**Notes:**

- Injection rates for the Active SWDs are estimated based on review of injection history. None of the active SWDs in the area have reported >25,000 BWPD in a single month.
- Injection rates for Proposed or Permitted/Not-Drilled SWD are based on the maximum injection rate included in the C-108 application.
- Injection rates for Not-Permitted/Not-Drilled SWDs are estimated based on a review of injection history for active SWDs in the area.

# FSP After 25 Years

All deep SWDs within 100 square miles of Rita SWD #1



# Conclusions

- There is only one known Precambrian fault in the 100 square mile area of review.
- Known fault in the area of review does not align with the horizontal stress field and is not likely to slip.
- FSP modeling through 25 years, with injection rates that are likely overestimated, show no risk of potential fault slip in the area.
- This area presents little to no risk for injection induced seismicity.

# References

U.S. Geological Survey. "Information by Region-New Mexico."  
<https://earthquake.usgs.gov/earthquakes/byregion/newmexico.php> (Accessed October 14, 2020)

U.S. Geological Survey. "Faults." <https://earthquake.usgs.gov/hazards/qfaults/> (Accessed October 15, 2020)

EMNRD Oil Conservation Division. "Welcome to the New Mexico Mining & Minerals Division."  
<http://www.emnrd.state.nm.us/OCD/ocdonline.html> (Accessed October 27, 2020)

Lund Snee, Jens-Erik, 2020, State of Stress in North America: Seismicity, Tectonics, and Unconventional Energy Development [Ph.D. thesis]: Stanford University, 254p.

Wilson, Scott J. 2018. "Affidavit of Scott J. Wilson, Amended Applications of NGL Water Solutions Permian, LLC for Approval of Saltwater Disposal Wells in Lea County, New Mexico." New Mexico Oil Conservation Division Case No. 16438 and Case No. 16440.

Reynolds, Todd. 2019. "FSP Analysis (Fault Slip Potential) Exhibits." New Mexico Oil Conservation Division Case No. 20313, Case No. 20314, and Case No. 20472.

**STATE OF NEW MEXICO  
DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES  
OIL CONSERVATION DIVISION**

**APPLICATION OF OVERFLOW ENERGY, LLC  
FOR APPROVAL OF SALT WATER DISPOSAL WELL,  
EDDY COUNTY, NEW MEXICO.**

**CASE NO. 20964**

**APPLICANT'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW**

In accordance with the request of the examiner at the continued hearing held December 18, 2020, Applicant OVERFLOW ENERGY, LLC ("Overflow" or "Applicant") provides the following proposed findings of fact and conclusions of law.

**FINDINGS OF FACT**

1. In this case, Applicant seeks authority for its Rita SWD Well No. 1, API No. 30-015-45719, to inject up to 25,000 barrels water per day (BWPD) into the Devonian formation [96101] at a depth interval from approximately 12,900 feet to 14,000 feet below surface at a surface location 1876' from the North line and 807' from the West line (Unit E) in Section 27, Township 22 South, Range 27 E, NMPM, in Eddy County, NM. Hearing Transcript 12:4-12 (Dec. 9, 2019) ("2019 H'g Tr."); *see* Dec. 12, 2019 Hearing Exhibits, Exhibit 1 (Dec. 12, 2019) ("2019 Exhibit 1").

2. Applicant proposes this well as commercial operations for disposal of produced water from multiple production sources. *See* 2019 Exhibit 1 at -006; 2019 H'g Tr. 7:25-8:5, 15:24-16:4.

3. Applicant provided the information required by 19.15.26 NMAC and the Form C-108 for an application to inject produced water into a Class II Underground Injection Control ("UIC") well. *See* 2019 Exhibit 1.

4. Applicant complied with the notice requirements of 19.15.26.8 NMAC. *See* 2019 Exhibit 1 at 010, 044-058; *see also* Dec. 12, 2019 Hearing Exhibits, Exhibit 2 (Affidavit of Notice).

5. Marathon Oil Permian LLC (“Marathon”) and NGL Water Solutions Permian LLC entered appearances objecting to the application on or about December 4, 2019.

6. The matter was first heard on December 12, 2019 (“2019 Hearing”) and taken under advisement at that time. Neither Marathon nor NGL offered evidence at the 2019 Hearing.

7. At the time the application was prepared in July 2019, there were two existing salt water disposal wells within a two-mile radius of the proposed well, neither of which disposed into the target interval at issue here. 2019 H’g Tr. 14:1-19.

8. On February 27, 2020, Marathon filed its Supplemental Information for the Record (“Supplemental Information”), objecting to the granting of Overflow’s application based on Marathon’s concern about proximity to a fault.

9. On April 9, 2020, the Division issued an order striking Marathon’s Supplemental Information from the record and reopening this matter for the limited purpose of taking additional evidence regarding the potential for induced seismicity related to the proposed well (“FSP Analysis”). Order No. 21248 ¶¶ 1-2 (Apr. 9, 2020).

10. On December 11, 2020, Marathon withdrew its objections to the application in light of Overflow’s revised FSP Analysis, which had been reviewed by Marathon and was subsequently presented to the Division at hearing on December 18, 2020. Marathon’s Pre-Hearing Statement at 2 (Dec. 11, 2020).

11. On December 18, 2020, the Division heard testimony from Applicant’s witnesses relating to the FSP Analysis (“2020 Hearing”). Neither Marathon nor NGL cross-examined

Applicant's witnesses nor offered evidence at the 2020 Hearing. *See* NGL's Pre-hearing Statement at 2 (Dec. 11, 2020). *See generally* 2020 H'g Tr.

12. At the 2020 Hearing, NGL's attorney made a brief statement regarding NGL's concern about the proximity of the proposed well to the City of Carlsbad brine well and related remediation project and NGL's continued opposition to the application, notwithstanding the revised FSP. Hearing Tr. 39:13-22 (Dec. 18, 2020) ("2020 H'g Tr."); *see* 2019 H'g Tr. at 56-60 (discussing the distance from the fault to the City of Carlsbad brine well remediation project).

13. At the 2020 Hearing, the Division cross-examined Applicant's witnesses and requested supplemental information regarding the FSP Analysis. *See* 2020 H'g Tr. 26:13-27:16. The Division clarified its requests for supplemental information by email from Hearing Examiner Coss on Dec. 22, 2020 at 4:53 PM. The Division requested that the model be rerun to include plus or minus 15 degrees of uncertainty for the maximum horizontal stress direction and the orientation of the fault of concern and should also include three additional proposed wells that have not been permitted or drilled, the Quintana SWD #1 (Case No. 20140), the Buckner 9 SWD #1, and the Red Devil SWD #1. *See id.*<sup>1</sup>; Supp. Affidavit of Geophysicist Reed Jameson Davis ¶¶ 3-4 (Jan. 19, 2021) ("Davis Supp. Aff.").

14. Applicant provided the supplemental information to the Division on January 19, 2021. *See id.*

15. The produced water injected into the Well will be confined by layers above and below the approved injection interval. 2019 H'g Tr. 31:9-17.

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<sup>1</sup> The Rose SWD No. 1 was included in the previous modeling submitted to the Division prior to the 2020 Hearing.

16. No UIC wells that inject or that are authorized to inject produced water into the same approved injection interval are permitted within three miles of the Well. Davis Supp. Aff. ¶ 5.

17. Applicant affirmed in a sworn statement by a qualified person that it examined the available geologic and engineering data and found no evidence of open faults or other hydrologic connection between the approved injection interval and any underground sources of drinking water. Affirmative Statement for C-108 Application, Part XII (uploaded to the docket on Dec. 26, 2019).

18. Applicant offered sworn statements and testimony by a qualified person that the injection of produced water over the predicted service life of the Well will not increase the potential for an induced seismic event. *See* Davis Supp. Aff. ¶¶ 7-8. *See generally id.*; Affidavit of Geophysicist Reed Jameson Davis (Dec. 18, 2020); 2020 H'g Tr.

19. Applicant intends to install a seismic monitoring system to monitor seismicity in the area of the proposed Rita SWD #1. Davis Supp. Aff. ¶ 9.

20. The Division takes judicial notice that the proposed well is not located within the city limits of the City of Carlsbad.

21. Applicant is in compliance with 19.15.5.9 NMAC.

### **PROPOSED CONCLUSIONS OF LAW**

1. OCD has authority under the Oil and Gas Act, NMSA 1978, §§70-2-1 *et seq.*, and its implementing regulations, 19.15.1 *et seq.* NMAC, and under the federal Safe Drinking Water Act, 42 U.S.C. 300f *et seq.*, and its implementing regulations, 40 CFR 144 *et seq.*, to issue this permit for an UIC Class II injection well. *See* 40 CFR 147.1600.



2. Based on the information and representations provided in the Application and in the testimony of Applicant's witnesses, the proposed injection, if conducted in accordance with the Application and the terms and conditions of the Standard Template for Underground Injection Control Permits, which was issued by the Division's Notice to Oil and Gas Operators on December 18, 2020, ("Permit") and the attached Appendix A, (a) will not result in waste of oil and gas; (b) will not adversely affect correlative rights; (c) will protect underground sources of drinking water; and (d) will protect the public health and environment.

3. Applicant is authorized to inject subject to the terms and conditions of the Permit and the attached Appendix A.

Respectfully submitted,

**MONTGOMERY & ANDREWS, P.A.**

By: /s/Sharon T. Shaheen

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*Attorneys for Overflow Energy, LLC*

**CERTIFICATE OF SERVICE**

I hereby certify that a true and correct copy of the foregoing was served on counsel of record by electronic mail on January 19, 2021, as follows:

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*Attorneys for Marathon Oil Permian, LLC and  
NGL Water Solutions Permian, LLC*

/s/ Sharon T. Shaheen

**STATE OF NEW MEXICO  
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT  
OIL CONSERVATION DIVISION**

**UIC CLASS II PERMIT SWD- \_\_\_\_\_**

**APPENDIX A – AUTHORIZED INJECTION**

Permittee:      Overflow Energy, LLC

OGRID No.:    292641

Well name:     Rita SWD 1

Surface location:      SW4 NW4 Section 27, T22S, R27E, 1876' FNL and 807' FWL, Eddy County

Bottom hole location (if different):    N/A

Type of completion:    Open Hole

Type of injection:    Class II Commercial Disposal Well

Injection fluid:           Produced water from various sources

Injection interval:      12,900 – 14,000

Injection interval thickness (feet): 1100'

Confining layer(s): Woodford Shale and Barnett Shale

Prohibited injection interval(s): The Operator shall take all steps necessary to ensure that the disposed fluid enters only the permitted injection interval and is not allowed to escape to other formations or onto the surface. This order does not authorize disposal into the Brushy Canyon formation below the injection interval or lost circulation intervals directly on top and obviously connected to these formations.

Liner, tubing, and packer set: Approximately 12,850'

Maximum daily injection rate: 25,000 BWPD

Maximum surface injection pressure: 2,580 psi

## **II. SPECIAL CONDITIONS**

Permittee shall comply with the following special conditions:

- Permittee shall install a seismic monitoring system capable of monitoring seismic activity in the area.