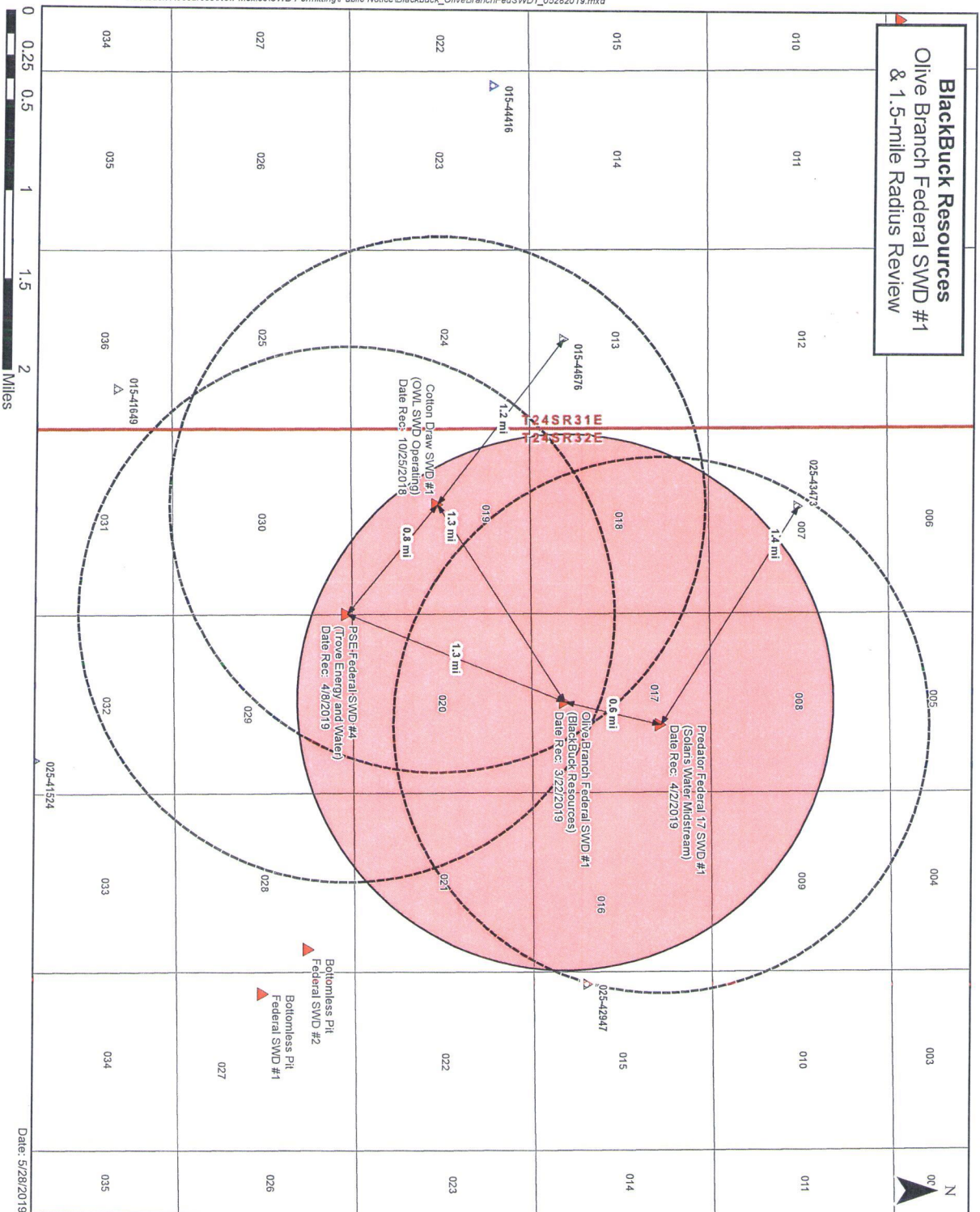




Legend

- ▲ Pending Deep SWDs (7)
- ↔ Distance (mi)
- Pending Deep SWDs - 1.5-mile Radius
- Blackbuck SWD - 1.5-mile Radius
- Deep Devonian/Silurian SWDs
- ▲ Salt Water Injection, Active (5)
- ▲ Salt Water Injection, New (1)

Note: All Pending Deep SWDs were plotted using Footage calls from Sec. 17n, & Ring lines. Locations should be considered approximate.

Prepared by:
ALICONSULTING

OCD #'s 20463
Blackbuck Resources, LLC
May 30, 2019
Ex# 2

Devonian and Silurian Injection Reservoir and Confinement

Blackbuck Resources LLC – Olive Branch SWD Fed 1

- **Upper Confining Zone:**

- **Woodford Shale** – The Upper Devonian Woodford Shale Formation consists of black shale with low porosity and permeability development. This formation acts as an upper confining layer for the Devonian and Silurian injection reservoir (Broadhead 2005).

- **Devonian/Silurian Injection Formations:**

- **Thirty-One Formation** – The Thirty-One Formation is Lower Devonian in age and consists of cherty limestone and dolomite that has undergone significant alteration since deposition, primarily by means of carbonate dissolution, leading to karst zones. It is a highly heterogeneous formation due to localized variations in porosity development, which generally ranges from 5 to 25% (Hill 1996, Ruppel 2006).
- **Wristen Formation** – The Upper Silurian Wristen Formation consists of dolomite with some shale zones, and varying amounts of karst zones (Hill 1996).
- **Fusselman Formation** – The Fusselman Formation is Lower Silurian in age and consists of crystalline dolomite with a heavily eroded top surface. Paleokarst is distributed throughout the formation, which adds to heterogeneity of porosity and permeability development (Hill 1996, Ruppel 2006).

- **Lower Confining Zone:**

- **Montoya and Simpson Group:** The lower confining zone for the Devonian and Silurian injection zone is the Montoya Group and the Simpson Group. The Montoya Group is Upper Ordovician in age and is composed of calcareous dolomite with some units of interbedded shales or limestones with chert and is dense, impermeable, and non-porous (Hill 1996). The Middle Ordovician Simpson Group contains a series of shales that has some limestones and sandstone units in it (Hill 1996).

References:

Broadhead, R.F. 2005. "Regional aspects of the Wristen petroleum system, southeastern New Mexico." New Mexico Bureau of Geology and Mineral Resources, Open-File Report No. 485.

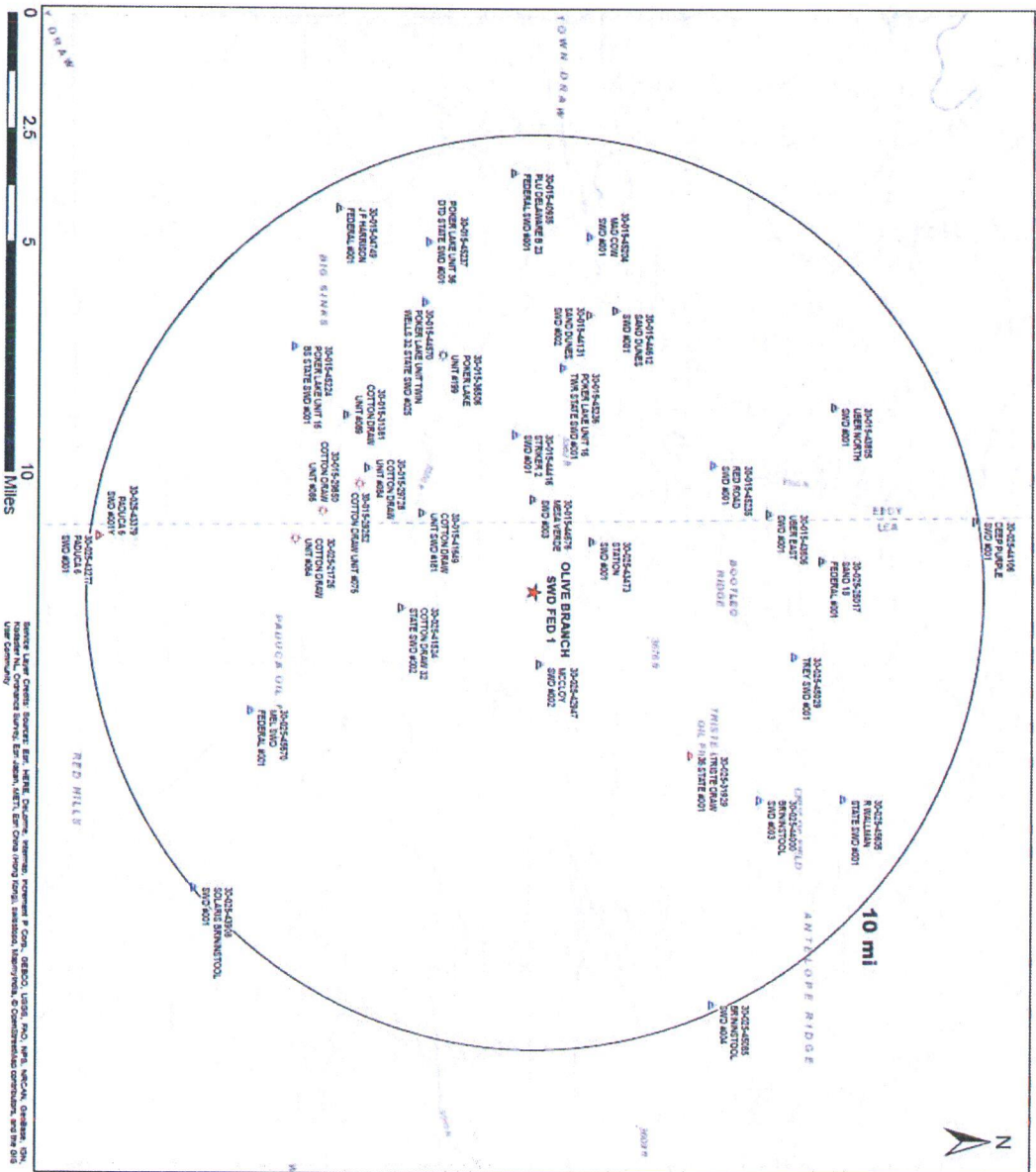
Hill, Carol. 1996. "Geology of the Delaware Basin Guadalupe, Apache, and Glass Mountains, New Mexico and Texas." SEPM Permian Basin Section Publication No. 96-39.

Ruppel, Stephen C. 2006a. "The Fusselman of the Permian Basin: Patterns in Depositional and Diagenetic Facies Development on a Stable Platform During the Late Ordovician - Early Silurian Icehouse." Bureau of Economic Geology.

Ruppel, Stephen C. 2006b. "The Lower Devonian Thirtyone Formation of the Permian Basin: Dominance of Deep-Water, Siliceous Sedimentation." Bureau of Economic Geology.

System	Series	Lithostratigraphic unit		
Mississippian	Chesterian	undivided		
	Meramecian			
	Osagian			
	Kinderhookian			
Devonian	Upper	Woodford Shale		
	Middle			
	Lower			
Silurian	Pridolian	Wristen Gp.	Fasken Fm.	Frame Fm.
	Ludlovian			
	Wenlockian			Wink Fm.
	Llandoveryan			
Ordovician	Upper	Fusselman Fm.		
	Middle	Montoya Fm.		
		Simpson Gp.		
	Lower	Ellenburger Fm.		

Broadhead, R.F. 2005. "Regional aspects of the Wristen petroleum system, southeastern New Mexico." New Mexico Bureau of Geology and Mineral Resources, Open-File Report No. 485.



Legend

★ Proposed SWD

NMCCD Devonian/Silurian O&G Wells

Symbology

- ★ Gas, Active
- ▲ Gas, Plugged
- ▲ Salt Water Injection, Active
- ▲ Salt Water Injection, New
- ▲ Salt Water Injection, Plugged

O&G Wells Area of Review		
Olive Branch SWD FED 1		
Lea County, New Mexico		
Proj Mgr	May 22, 2019	Mapped by:
Dan Arthur		Ben Boekmann
Prepared by: ALI CONSULTING		

Data Source: Data Source: New Mexico OCD. "Public FTP Server." <http://www.enmrnd.state.nm.us/OCD/ocdonline.html> (accessed April 22, 2019).

Completion Report Data from Devonian-Silurian SWDs within Ten Miles				
Devonian-Silurian SWDs within Ten-Mile Radius of Proposed Location				
API	Woodford Top (ft)	Woodford Thickness (ft)	Dev/Sil Top (ft)	Dev/Sil Thickness (ft)
30-015-04749	16,495	128	16,623	ND
30-015-29252	16,264	129	16,393	ND
30-015-29728	16,205	137	16,342	ND
30-015-29850	16,326	ND	ND	ND
30-015-31381	16,894	151	17,045	ND
30-015-36506	ND	ND	16,539	ND
30-015-40935	ND	ND	16,383	ND
30-015-41649	ND	ND	16,749	1,369
30-015-43805	ND	ND	16,260	1,232
30-015-43806	16,475	109	16,584	1,321
30-015-44131	16,420	110	16,530	ND
30-015-44416	ND	ND	16,362	1,390
30-015-45204	16,399	21	16,420	1,010
30-015-45235	16,275	164	16,439	1,261
30-025-21726	ND	ND	16,492	ND
30-025-42947	17,012	193	17,205	1,501
30-025-43379	ND	ND	17,302	1,552
30-025-43473	16,642	116	16,758	1,485
30-025-44106	16,156	105	16,261	ND
30-015-44612	ND	ND	16,430	1,281
30-015-44676	16,740	173	16,913	ND
ND = No Data				
Data Source: New Mexico OCD, "Public FTP Server," http://www.emmrd.state.nm.us/OCD/ocdonline.html (accessed April 22, 2019).				

Volumetric Fill-Up Analysis

Blackbuck Resource LLC – Olive Branch SWD Fed 1

OCD #'s 20463

Blackbuck Resources, LLC

May 30, 2019

Ex# 5

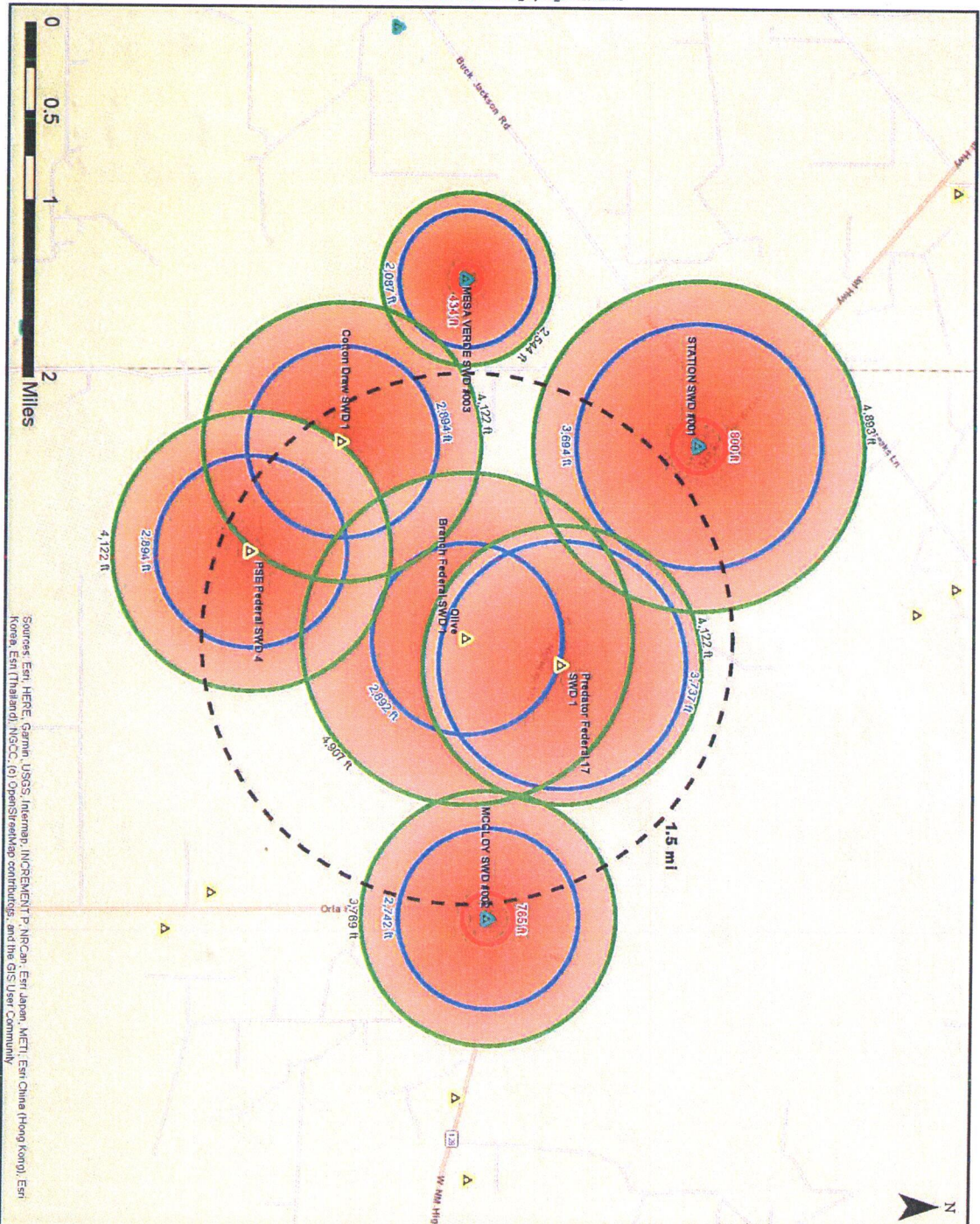
Assumptions & Methodology

- Formation Characteristics:
 - Devonian/Silurian Injection Interval
 - Homogenous with Isotropic Conditions
 - Average Porosity: 8%
 - Injection Interval Thickness: Injection interval thickness was derived as follows:
 - Existing Deep SWDs: Injection interval thickness for the existing Deep SWDs and was pulled from OCD records.
 - Blackbuck's Olive Branch SWD Fed #1: C-108 Application
 - Pending Deep SWDs: Average injection interval thickness of Deep SWDs within 2 miles.
 - Porous Injection Interval %: 20% of each SWD's listed injection interval thickness.
- Injection Rates:
 - Average Injection Rates:
 - Existing Deep SWDs: Calculated average daily injection rate over the lifetime of the SWD.
 - Blackbuck Olive Branch SWD Fed #1: Data from C-108 (15,000 BWPD)
 - Solaris Predator Federal 17 SWD #1: Data from C-108 (25,000 BWPD) ~~20,000~~
 - Other Pending Deep SWD Applications: 15,000 BWPD
 - Maximum Injection Rates:
 - Existing Deep SWDs: Calculated maximum daily injection rate over the lifetime of the SWD.
 - Blackbuck Olive Branch SWD Fed #1: Data from C-108 (15,000 BWPD)
 - Solaris Predator Federal 17 SWD #1: Data from C-108 (25,000 BWPD)
 - Other Pending Deep SWD Applications: 15,000 BWPD
 - Annual Injection Decline Rate: 5%
- Equation:
 - R: is the radius of volumetric fill-up
 - V: is the cumulative injected volume in barrels
 - H: is the thickness of the injection zone in feet, 20% of zone accepting fluid
 - p: is porosity and is set at 8%

$$R=(V*5.62H*\tau*p)^{1/2}$$

20-Year Volumetric Fill-up Analysis

Document Path: H:\Blackduck Resources\New Mexico\Volumetric Fill-up\Olive Branch\07-19-2019\OliveBranchSWDFed1_20yrVF_07192019.mxd



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NISCC, (c) OpenStreetMap contributors, and the GIS User Community

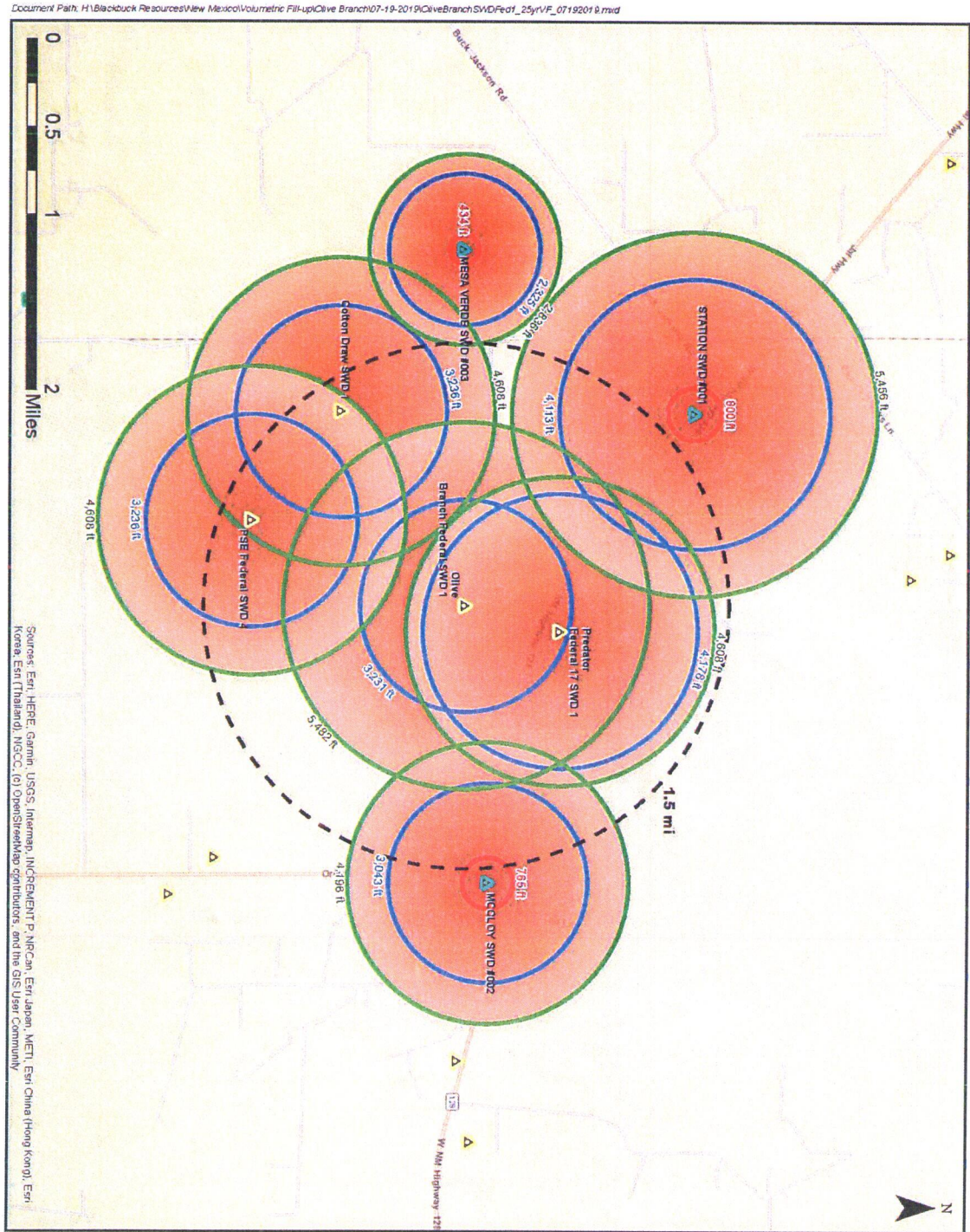
Blackduck Resources
Olive Branch Federal SMD 1 -
Radial Limit of Cumulative
Injected Volume Offset Wells - 20 years

- Legend**
- Active Deep
 - Devonian/Silurian SMD
 - Pending Deep
 - Devonian/Silurian SMD
 - Radius of Volumetric Fillup as of May 2019
 - Radius of Volumetric Fillup as of May 2039
 - Radius of Volumetric Fillup using Average Rate
 - Max Possible Radius of Volumetric Fillup as of May 2039
 - 1.5 mi AOR



Date: 7/20/2019

25-Year Volumetric Fill-up Analysis



Sources: Esri HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGSC, (c) OpenStreetMap contributors, and the GIS User Community

Blackbuck Resources
Olive Branch Federal SMD 1 -
Radial Limit of Cumulative
Injected Volume Offset Wells - 25 years

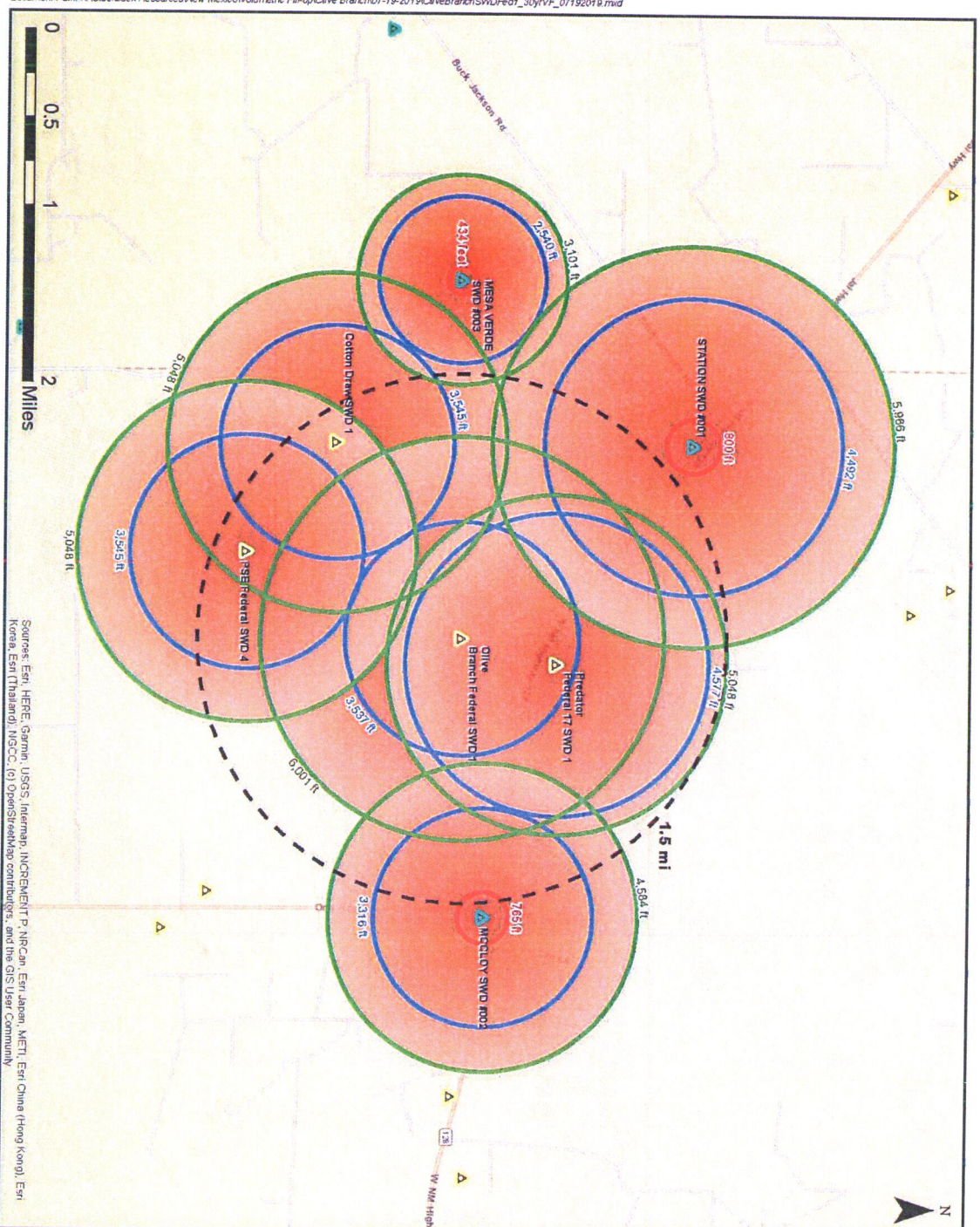
- Legend**
- Active Deep Devonian/Silurian SMD
 - Pending Deep Devonian/Silurian SMD
 - Radius of Volumetric Fillup as of May 2019
 - Radius of Volumetric Fillup as of May 2044
 - Max Possible Radius of Volumetric Fillup as of May 2044
 - 1.5 mi AOR



Date: 7/20/2019

30-Year Volumetric Fill-up Analysis

Document Path: H:\Blackduck Resources\New Mexico\Volumetric Fill-up\Olive Branch\07-19-2019\OliveBranchSWD\Fed1_30yrVF_07192019.mxd



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, INC, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NOAA, (c) OpenStreetMap contributors, and the GIS User Community

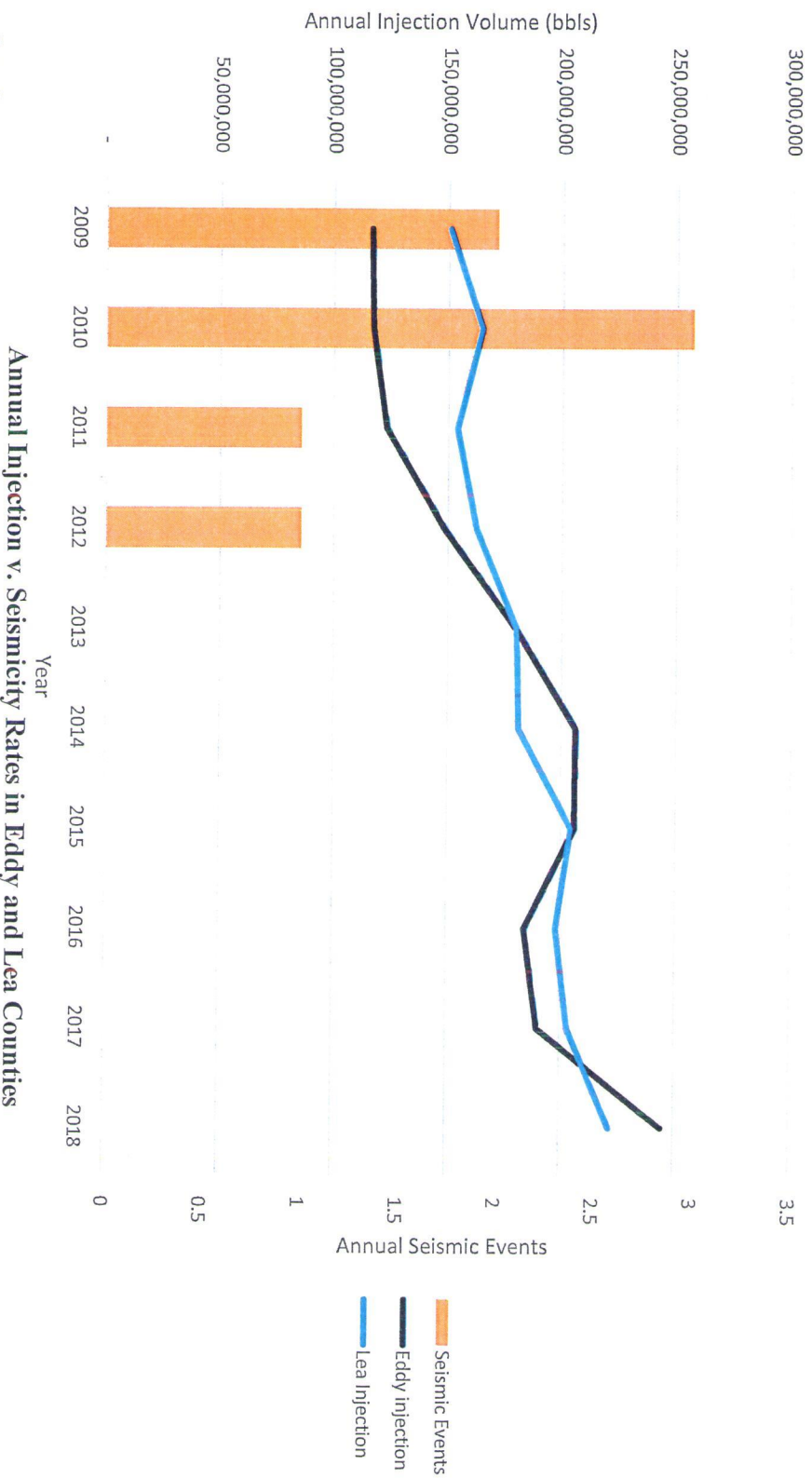
Blackduck Resources
Olive Branch Federal SVD 1 -
Radial Limit of Cumulative
Injected Volume Offset Wells - 30 years

- Legend**
- Active Deep
 - Devonian/Silurian SVD
 - Pending Deep
 - Devonian/Silurian SVD
 - Radius of Volumetric Fillup as of May 2019
 - Radius of Volumetric Fillup as of May 2049
 - Radius of Volumetric Fillup as of May 2049
 - Max Possible Radius of Volumetric Fillup as of May 2049
 - 1.5 mi AOR



Date: 7/20/2019

Total Injection v. Seismicity 2009 - 2018



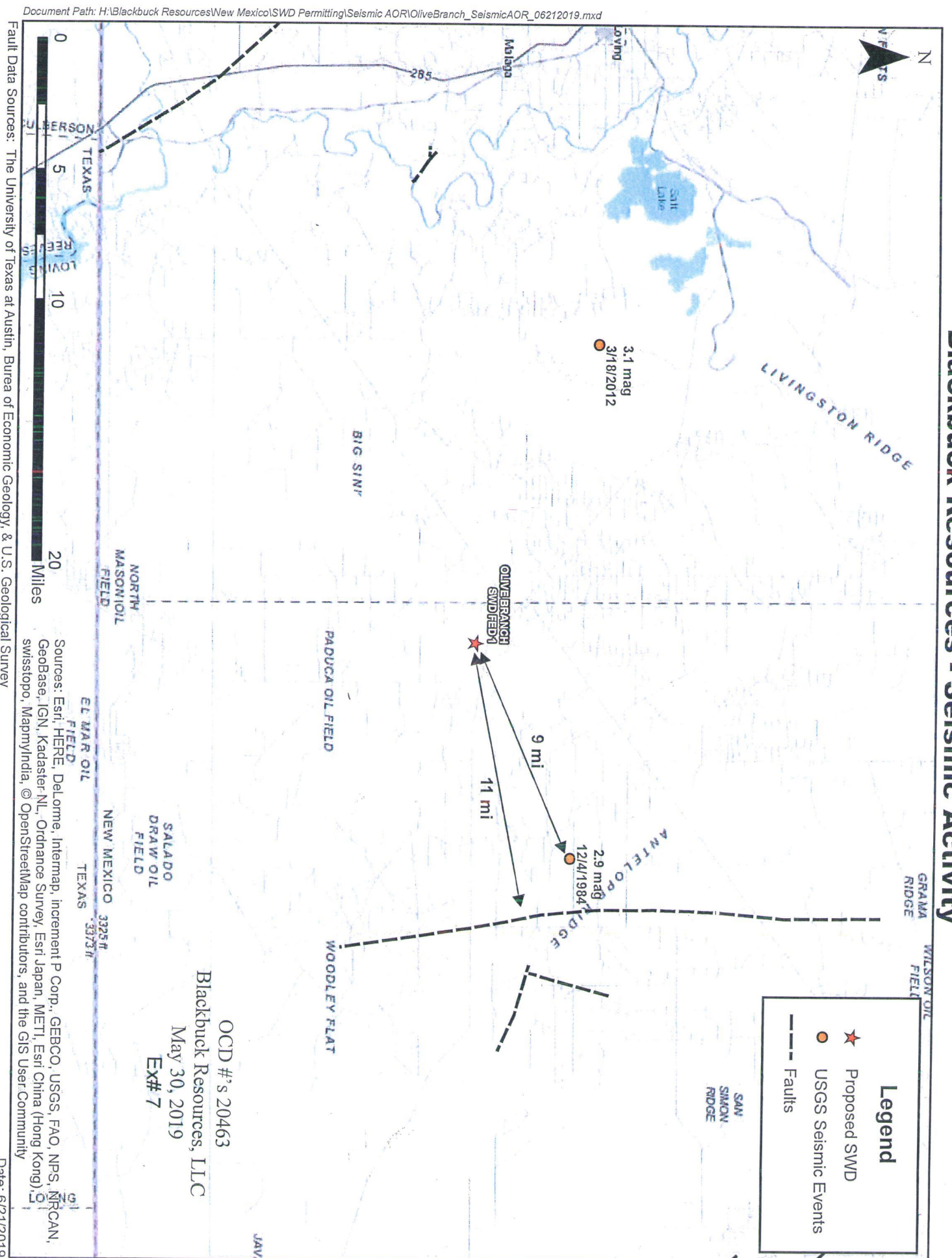
Data Sources:

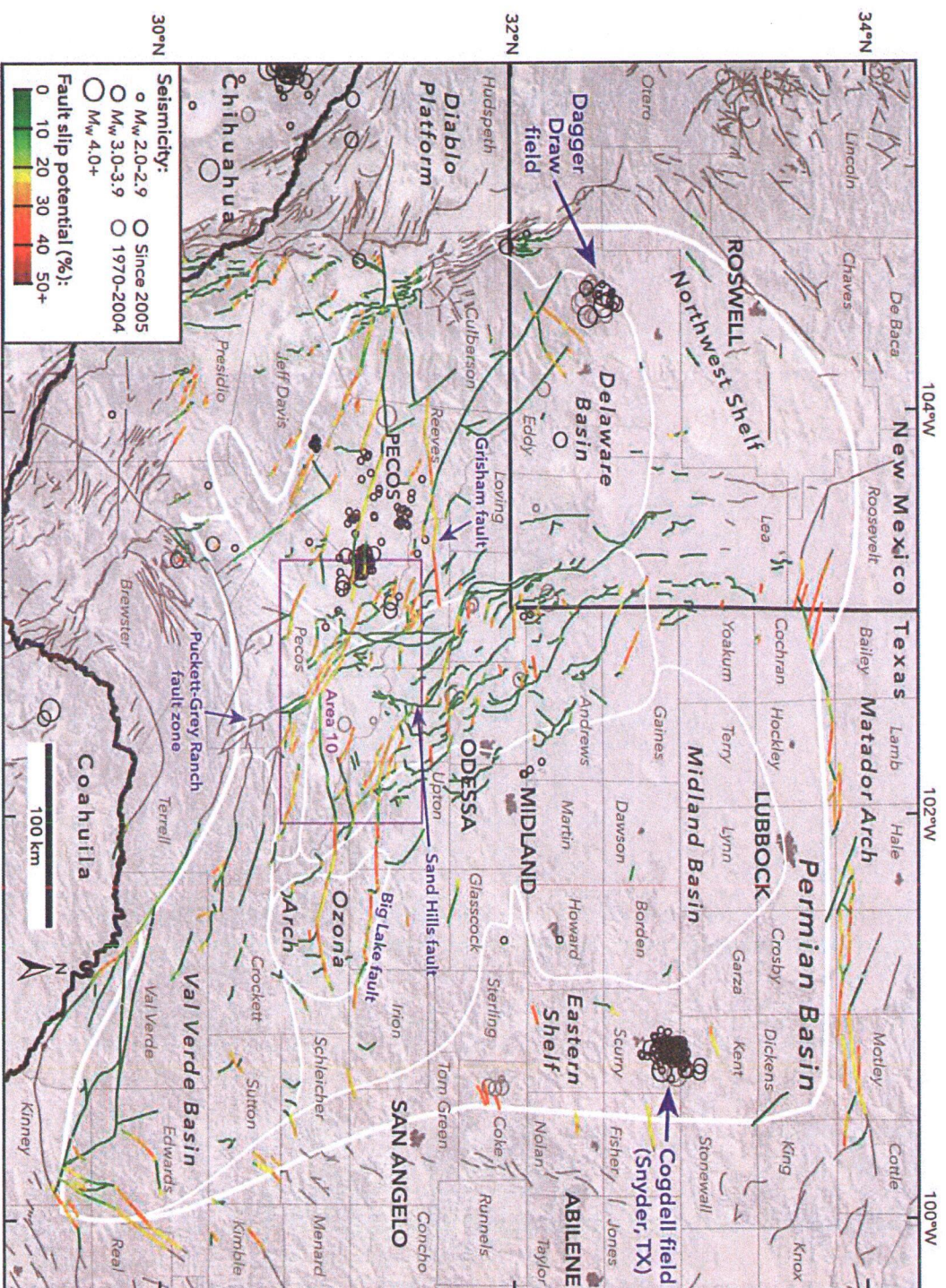
U.S. Geological Survey. No date . "Earthquake Hazards Program: Information by Region-New Mexico." <https://earthquake.usgs.gov/earthquakes/byregion/newmexico.php> (accessed April 18, 2019)

New Mexico OCD. "Public FTP Server." <http://www.emnrd.state.nm.us/OCD/ocdonline.html> (accessed April 22, 2019).

Annual Injection v. Seismicity Rates in Eddy and Lea Counties

Blackbuck Resources - Seismic Activity





Results of the Snee and Zoback (2018) FSP Analysis of the Permian Basin

Source: Snee, Jens-Erik Lund, and Mark D. Zoback. 2018. "State of Stress in the Permian Basin, Texas and New Mexico: Implications for Induced Seismicity." *The Leading Edge* 37, no. 2 (February 2018): 127-34.