

February 26, 2024

# *History of Identifying Wells of Concern, Corrective Action Plans, and How Area of Reviews Have Evolved for UIC Wells in Oklahoma*

UIC GWPC Conference



**OKLAHOMA**



# TOPICS OF DISCUSSION

- OKLAHOMA UIC DEPARTMENT
- OKLAHOMA HISTORY
- IDENTIFYING PROBLEM WELLS
- AREA OF REVIEW EXAMPLE



Figure 12. Steamboat on Arkansas River

# Oklahoma Underground Injection Control (UIC)



# MEET THE TEAM



Patricia Downey

**UIC Manager**



Butch Will

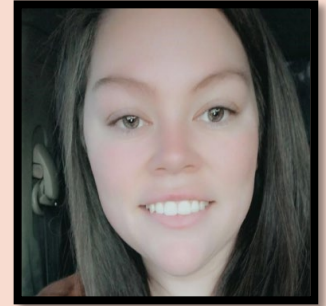


Justin Lazzari

**UIC Area of Review Engineers**



Jim Phelps



Michaela Stephens

**UIC Admin Support**



# ACTIVE CLASS II UIC WELLS

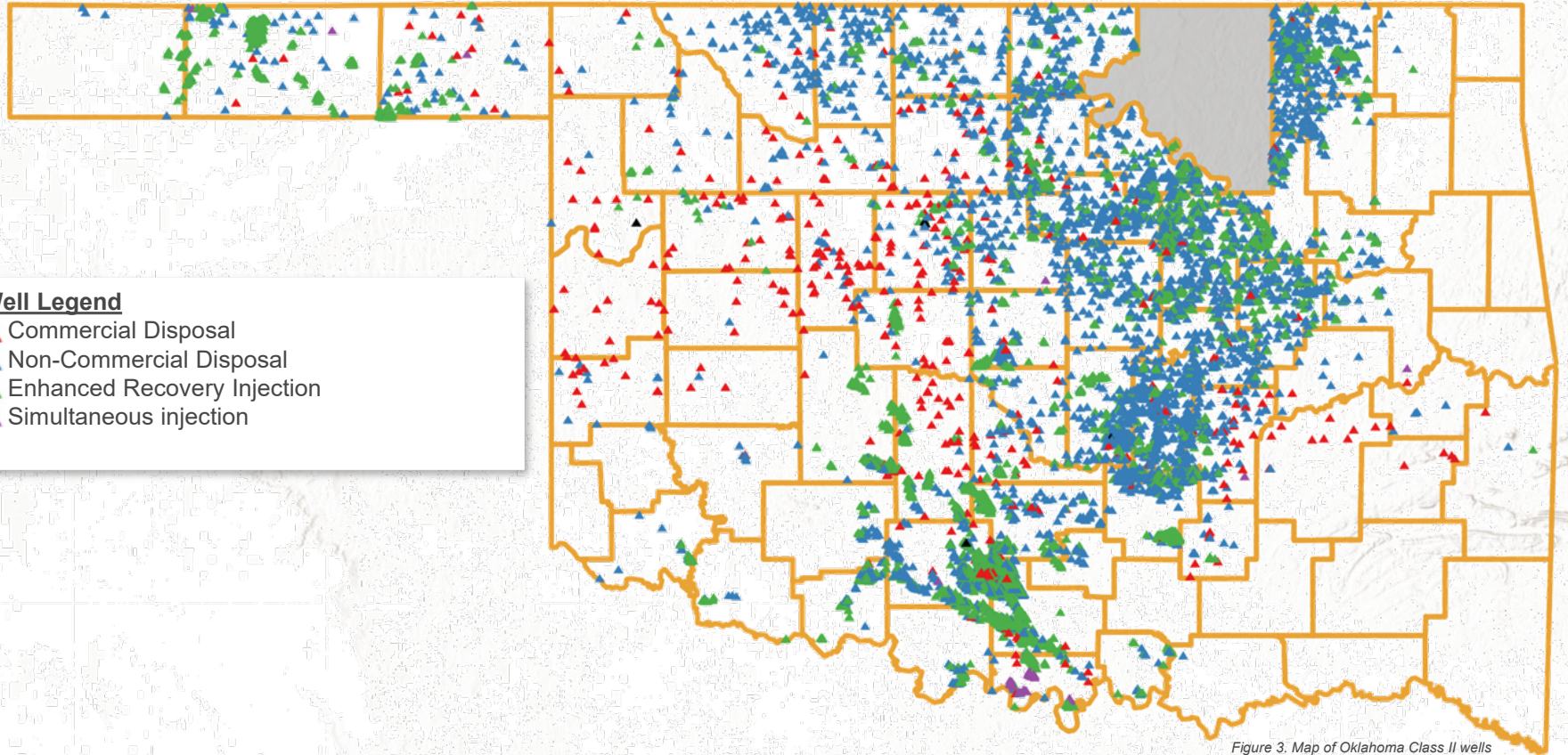


Figure 3. Map of Oklahoma Class II wells

# **Brief History of Oklahoma Oil, Gas, and Injection Wells**



# OKLAHOMA HISTORY: PRE-WATERFLOOD

- 1870s Prospecting in Indian Territory begins
- 1897 Nellie Johnstone Number One, first commercial well
- 1901 University of Oklahoma begins offering geology courses
- 1907 Statehood and Corporation Commission created
- 1914 Corporation Commission begins regulating oil and gas
- 1920s Oklahoma City Oil Field discovered and developed

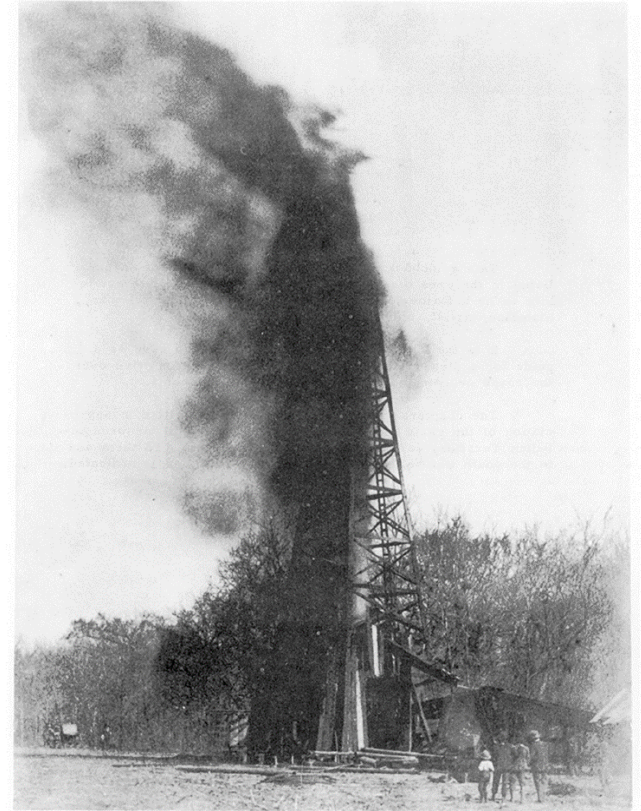


Figure 4.

The Cudahy Oil Co. no. 1 Nellie Johnstone, NE 1/4 12-26N-12E, in what is now Johnstone Park, Bartlesville, Oklahoma. This was the first commercial oil well in Oklahoma. (Photo courtesy Mrs. Howard Cannon, nee Nellie Johnstone, Bartlesville)



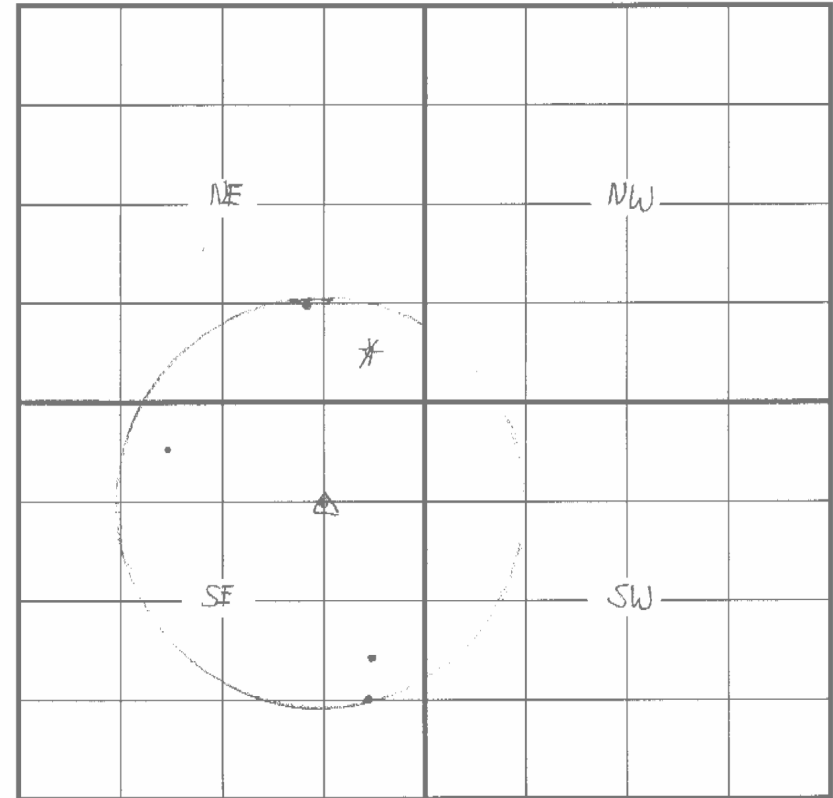
# OKLAHOMA HISTORY: PRE-PRIMACY

- 1931 First water-flood project approved
- 1950s Research into EOR begins in Bartlesville, OK
- 1955 Pollution Abatement Department is created
- 1974 Enactment of Safe Drinking Water Act (SDWA)
- 1976 USA Congress passes Resource Conservation and Recovery Act (RCRA)
- 1980 Oil and Gas waste exempt from RCRA



# OKLAHOMA HISTORY: POST PRIMACY

- 1981 Oklahoma gains primacy for Class II wells
- 1985 New well categories and radius of area of review (AOR)
- 2005 Cement in offset wells factored into AOR
- 2007 Full review of all UIC orders to track stipulations
- 2010 UIC wells can now be administratively approved



# OKLAHOMA HISTORY: DIGITAL ERA

- 2011 Research begins on seismic activity
- 2013 First documented case of earthquakes connected to disposal wells
- 2015 Regional directives begin for the Arbuckle
- 2017 Induced Seismicity Department (ISD) created
- 2019 UIC becomes its own department
- 2020 Corrective Action Plans are revised
- 2022 Introduction of OCC Well Data Finder

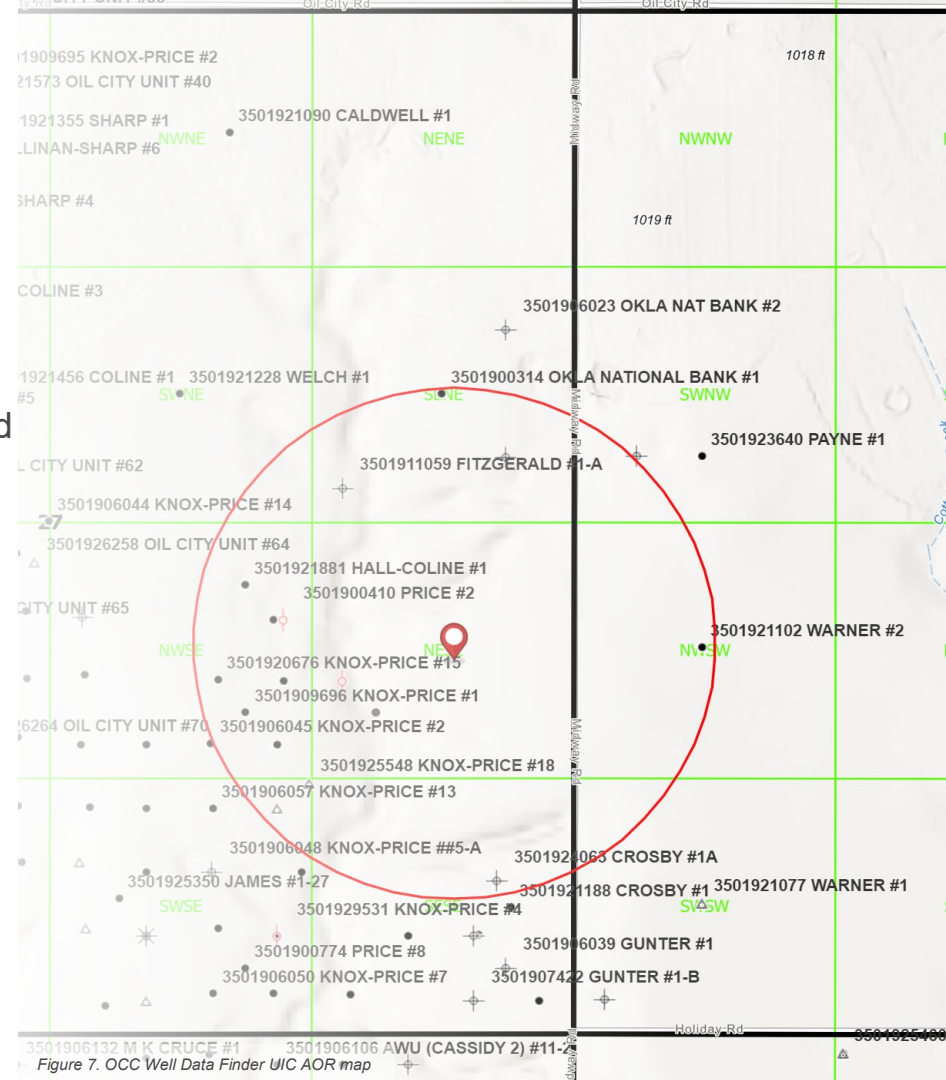


Figure 7. OCC Well Data Finder UIC AOR map

# **AREA OF REVIEW AND IDENTIFYING PROBLEM WELLS**



# AREA OF REVIEW - THEN

## BASICS

- ½ mile radius review
- Pen, paper, and dusty files
- UIC well needs surface casing and cement

## PROBLEM WELLS

- Mud plugged Wells – No casing

## CORRECTIVE ACTION PLANS

- Modification of wells
- Periodic testing of fluid of wells within the AOR
- Additional permit conditions



Figure 8. Oklahoma state capitol 1938. Looking northeast.



# AREA OF REVIEW - TODAY

## BASICS

- ¼ mile – ½ mile AOR
- More stringent cementing requirements
- Digitized documents and tools

## PROBLEM WELLS

- Wells without isolating cement
- Wells without cementing documentation
- Abandoned or improperly plugged wells

## CORRECTIVE ACTION PLANS

- Plugging or re-plugging wells
- Additional permit stipulations
- Prove there is no environmental danger

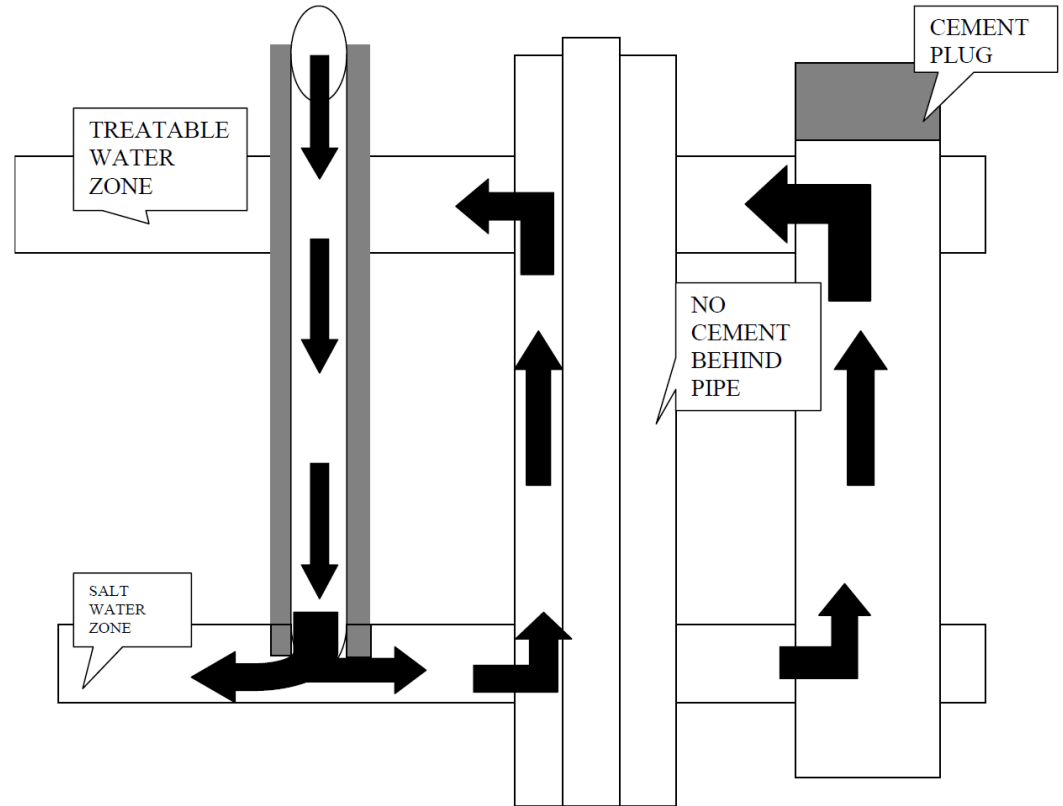


Figure 9. Fluid flow from injection zone to Base Treatable Water

# CORRECTIVE ACTION PLAN CHANGES

- No new monitoring wells
- Elimination Opsi as a corrective action plan
- New standards for radius of endangerment calculations
- Reduced maximum injection pressure surface gradient
- Restrictions and Directives in designated areas of interest



Figure 10.

# COMMON CORRECTIVE ACTION PLANS

- Historical documents filling in missing information in OCC records
- Radius of Endangerment Calculations with extra monitoring stipulations
- Logs demonstrating well of concern doesn't intercept injection formation
- Finding and plugging well of concern
- Changing depth of injection interval

1111

Sec. 24 Twp. 9N Range 4E  
 Well No. 1 (Meazell) Hollingsworth Farm  
 R. Olsen Oil Company  
 Location C NW SW Date FEB 27 1942  
 2 1/4 M. 1/2 W

10' @ 100'	Rig
01468	MAR 8
0 2 3 5 8	MAR 10
117	MAR 17
Cal. 3395	117
Vendor 3610	
General 3630	
Bulk 3750	
Carls. 3780	
Enals 3810	
Bern L. 3950	
Mayer 4020	
W.D.P. 4085	
4150	4185

OKLAHOMA DEPARTMENT OF GEOLOGY

P. No. Sec. 24 Twp. 9N Range 4E  
 11 No. 1 Farm Hemington  
 R. Olsen Company  
 North C. 2 1/2 Quarter  
 from Line  
 from Line  
 Casg. 5 in 225 ft.  
 in ft.  
 in ft.  
 in ft.  
 in ft.  
 in ft.  
 in ft.  
 in ft.

4231	South
4231	CO W D O P 4289
444	Q T O 4261 H 4234
460	5 B O P W
	Keegan Company
	Old land 25/100
	New Prop
	4349
7	4290 T O Mac 4263 83 5
440	4479 1, T O Hem acid mac
	4263 83 / 76. 38
	45' 02' T O B O P 4273
	450' acid 76. up 4273
	70 P
	W 45' 00
8	P 25 44 / 16 44
	P 55 " / 24 "

Figure 11. Historical records

# **CORRECTIVE ACTION PLAN EXAMPLE**

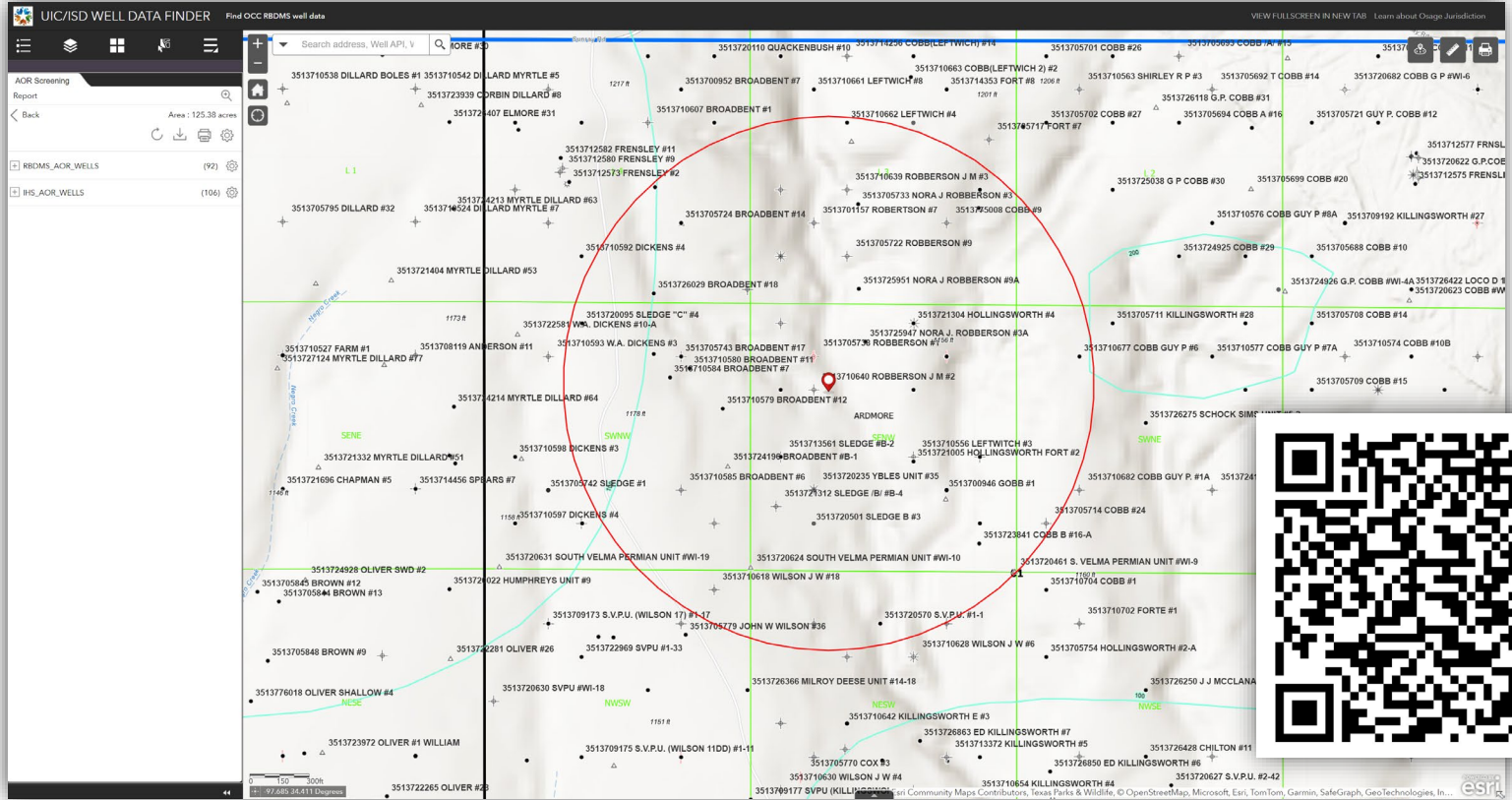


# UIC APPLICATION FORM 1015

## Well Data:

Is well within 1/2 mile of an active or reserve municipal well?		<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO				
Does injection zone contain oil, gas, or fresh water within 1/2 mile?		<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO				
Location of source of fluids: Gant Dunlap Battery (34.179288,-97.371616)		Perforation of injection interval: Top <u>2800</u> Bottom <u>3000</u>				
Geologic name(s) and depth of source(s): UPPER BAYOU (2214-2408) CHUBBEE (2757-2793)		Unit Order Number:				
Geologic name(s) of formations of injection zone:		<b>CHUBBEE</b>				
Base of treatable water:		Intervening thickness (top perforation minus base of treatable water): <b>2330</b>				
<input type="checkbox"/> Commission maps		<input checked="" type="checkbox"/> Other Source (specify): <u>470' OGBTW</u>				
Average Porosity <b>28</b> %	Average permeability (Kw):		Present formation pressure or Shut-in static fluid level from surface:			
Injection rates and pressures:	Requested Injection Rate	999	BPD/MCF	Requested Injection Pressure	933	PSI
	Approved Injection Rate		BPD/MCF	Approved Injection Pressure		PSI
Name of String	Size	Setting Depth	Sacks of Cement	Top Cement	Determined By	
Surface						
Intermediate						
Production	5 1/2	3000	587	SURFACE	VISUAL	
Liner						
Tubing			N/A	N/A	N/A	
Packer Type: <u>BAKER AD-1</u>		Packer Depth: <u>2750</u>		Total Depth: <u>3000</u>		Plug Back Total Depth: <u>3000</u>

# OCC WELL DATA FINDER

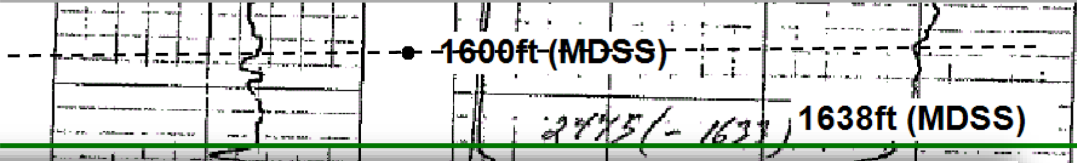
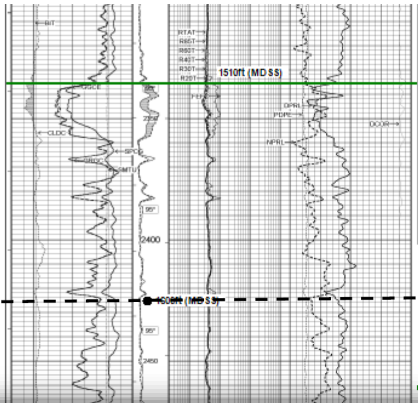


# PROBLEM WELL LIST

ITEM	LOCATION	LEASE/WELL NAME	API	OPERATOR	WELL TYPE	YEAR COMPLETED	Surface Casing			Intermediate Casing			Production Casing			TD/PTB (ft)	Perforations		Formation	Distance From Application		PROBLEM WELL	NOTES
							SIZE (in)	DEPTH (ft)	TOC (ft/sax)	SIZE2 (in)	DEPTH2 (ft)	TOC2 (ft/sax)	SIZE3 (in)	DEPTH3 (ft)	TOC3 (ft/sax)		TOP (ft)	BOTTOM (FT)		(MI)	WELL (FT)		
9	25-4-2 NE NW SW 2145 FSL 825 FWL	WILSHIRE 3	3501920914	OTC/OCC NOT ASSIGNED	PLUGGED	8/15/1971	8 5/8	318	0						3000	318	3000	UNKNO WN	0.15	792	yes	Calculated TOC does not cover injection zone and/or BTW	
15	26-4-2 SE 660 FSL 150 FEL	GILL 2	3501911791	TRIPLEDEE OPERATING CO LLC	TA	3/24/1922	8 1/4	2255				6 5/8	2803		2869			UNKNO WN	0.2	1056	yes	No information showing injection zone and/or BTW is properly isolated.	
18	25-04S-02W SWSWSW 130W 90S	HARTS #4	3501911784	OTC/OCC NOT ASSIGNED	ORPHAN	8/3/1923	8 1/4	2081	?	6 5/8	2420	?	5 3/16	2810	?	2842		UNKNO WN	0.22	1162	yes	Calculated TOC does not cover injection zone and/or BTW	
21	26-04S-02W N2SESESE 2310W 500S	C.J. GILL #1	3501911787	TRIPLEDEE OPERATING COMPANY LLC	INJECTION	12/13/1945	13 3/8	360	0				6	3824	3434	5007	3607	3624	lone grove	0.25	1320	yes	Calculated TOC does not cover injection zone and/or BTW

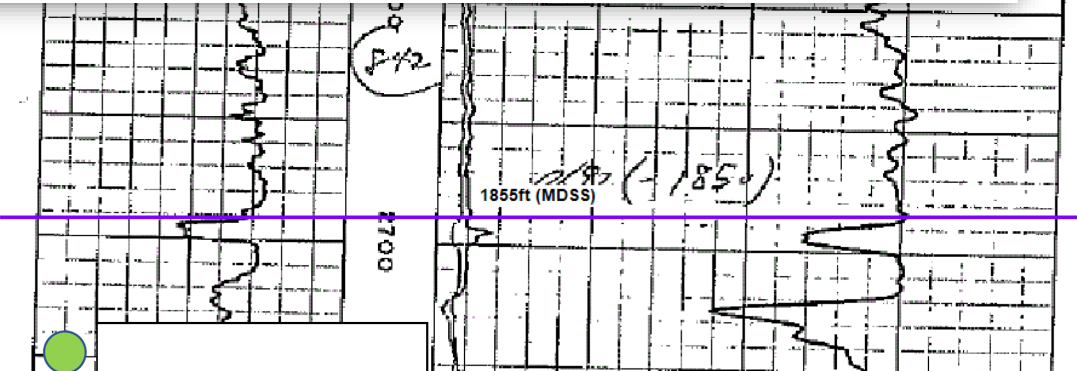
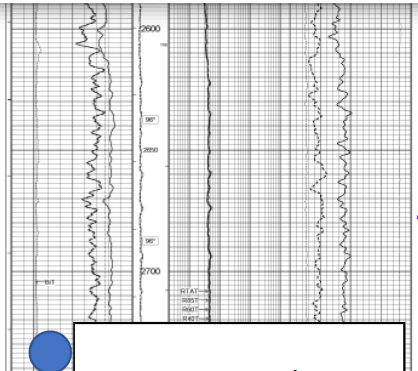
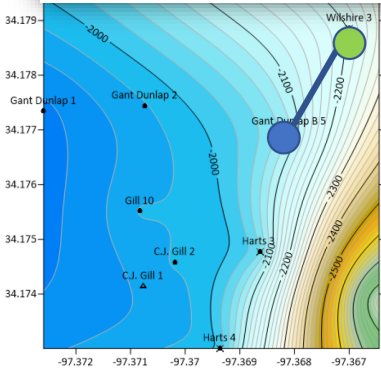


# Structural Cross-Section



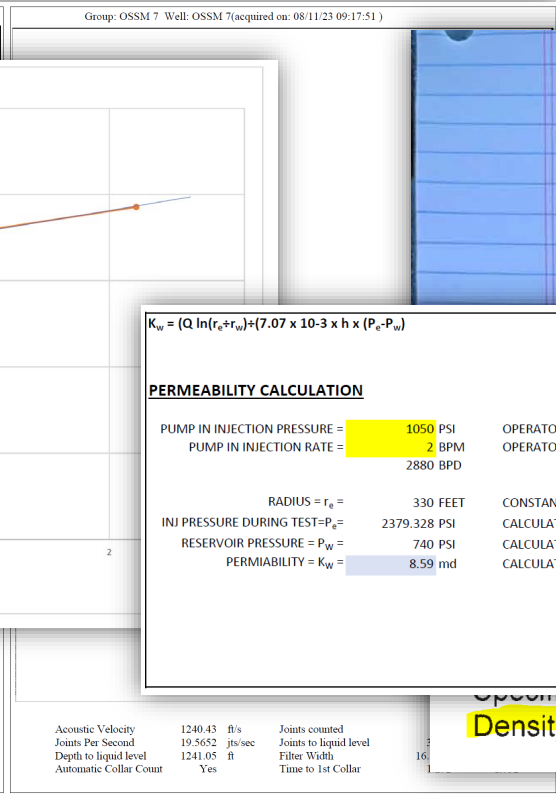
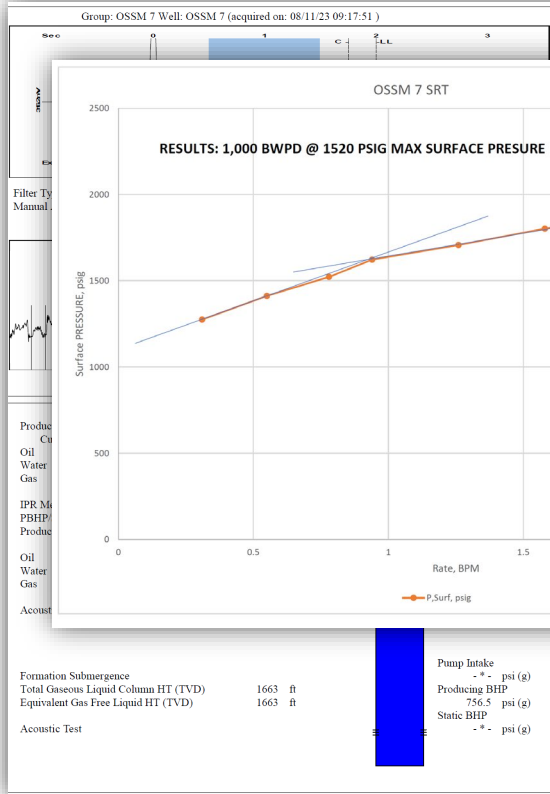
DATUM

ITEM	LOCATION	LEASE/WELL NAME	API	OPERATOR	WELL TYPE	YEAR COMPLETED	Surface Casing			Intermediate Casing			Production Casing			Perforations			Distance From Application		PROBLEM WELL	NOTES	
							SIZE (in)	DEPTH (ft)	TOC (ft/sax)	SIZE2 (in)	DEPTH2 (ft)	TOC2 (ft/sax)	SIZE3 (in)	DEPTH3 (ft)	TOC3 (ft/sax)	TD/PTB (ft)	TOP (ft)	BOTTOM (FT)	Formation	(MI)			WELL (FT)
9	25-4-2 NE-NW-5W 2145-FSL-825-FWL	WILSHIRE-3	3501920914	OTC/OCC-NOT ASSIGNED	PLUGGED	8/15/1971	8-5/8	318	0							3000	318	3000	UNKNO WN	0.15	792	yes	Calculated TOC does not cover injection zone and/or BTW
15	26-4-2 SE 660 FSL 150 FEL	GILL 2	3501911791	TRIPLEDEE OPERATING CO LLC	TA	3/24/1922	8 1/4	2255				6 5/8	2803			2869			UNKNO WN	0.2	1056	yes	No information showing injection zone and/or BTW is properly isolated.
18	25-04S-02W SWSWSW 130W 90S	HARTS #4	3501911784	OTC/OCC NOT ASSIGNED	ORPHAN	8/3/1923	8 1/4	2081	?	6 5/8	2420	?	5 3/16	2810	?	2842			UNKNO WN	0.22	1162	yes	Calculated TOC does not cover injection zone and/or BTW
21	26-04S-02W N2SESESE 2310W 500S	C.J. GILL #1	3501911787	TRIPLEDEE OPERATING COMPANY LLC	INJECTION	12/13/1945	13 3/8	360	0			6	3824	3434	5007	3607	3624	lone grove	0.25	1320	Yes	Calculated TOC does not cover injection zone and/or BTW	





# CALCULATIONS - GATHERING VARIABLES



Shut in Htg. Pressure 935 psi

Time	Pressure (psi)	Pump track Rate (bpm)	Inj. Rate (bpd)	
Start	9:10	1010 psi	0.20 bpm	290 bpd
9:15	1060 psi	0.20 bpm	310 bpd	
9:20	1085 psi	0.20 bpm	310 bpd	
9:25	1100 psi	0.20 bpm	320 bpd	
9:30	1120 psi	0.20 bpm	325 bpd	
9:35	1135 psi	0.20 bpm	325 bpd	
9:40	1145 psi	0.20 bpm	325 bpm	
9:45	1220 psi	0.31 bpm	500 bpd	
9:50	1245 psi	0.31 bpm	510 bpd	
9:55	1260 psi	0.31 bpm	510 bpd	
10:00	1270 psi	0.21 bpm	500 bpd	
10:05	1280 psi	0.21 bpm	500 bpd	

**MMCFD:**

olved Solids (mg/L):	137,833
Strength:	2.699
Specific Gravity:	1.095
Density, (lbs/gal):	9.13

# EVALUATING THE DATA

## INITIAL PRESSURE AT DISTANCE AND FRAC GRADIENT CALCULATIONS

ALLOWABLE CONDITIONS FOR API: 3501234567 Well Name: OSSM 7 UIC App: 2301002007

PROBLEM WELL CAN BE NO CLOSER THAN	488	FT FROM INJECTION WELL
MAX ALLOWED INJECTION PRESSURE	933	PSI
MAX ALLOWED INJECTION RATE	999	BBLs/DAY
FLUID LEVEL HAS TO REMAIN	620	FT OR DEEPER FROM SURFACE

### INPUTS

INJECTION RATE = Q =	999	BBLs/DAY	UIC APPLICATION
DAY THICKNESS = h =	300	FT	PERF

## EQUATIONS

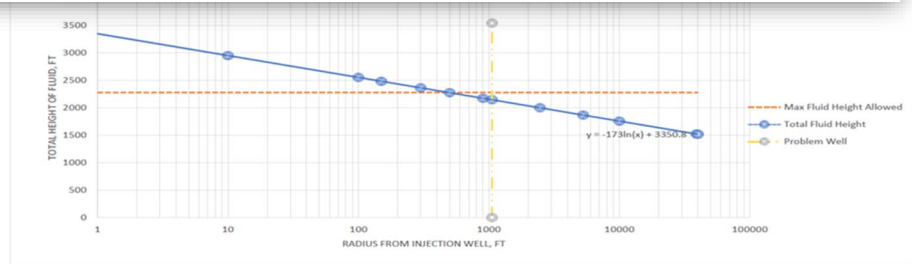
$$\Delta P = P(r,t) - P_i = 162.6 (Q\mu/kh) (\log(kh/70.4\phi\mu C_r r^2))$$

### PRESSURE AT DISTANCE TABLE ( BWPDI)

RADIUS, FT	Δ PRESSURE, PSI	HEIGHTH F/ PRESSURE, FT	TOTAL HEIGHTH, FT	% PRESSURE LOSS	CUMM PRESSURE LOSS
0	895	1885	3544		
10	614.100	1293.500	2952.500	0.314	0.314
100	425.000	895.200	2554.200	0.211	0.525
150	391.700	825.000	2484.000	0.037	0.562
300	334.800	705.200	2364.200	0.064	0.626
500	292.800	616.700	2275.700	0.047	0.673

ITEM	LOCATION	LEASE/WELL NAME	API	OPERATOR	WELL TYPE	YEAR COMPLETED	Surface Casing			Intermediate Casing			Production Casing			Perforations			Distance From Application		PROBLEM WELL	NOTES	
							SIZE (in)	DEPTH (ft)	TOC (ft/sax)	SIZE2 (in)	DEPTH2 (ft)	TOC2 (ft/sax)	SIZE3 (in)	DEPTH3 (ft)	TOC3 (ft/sax)	TD/PTB (ft)	TOP (ft)	BOTTOM (FT)	Formation	(MI)			WELL (FT)
9	25-4-2-NE-NW-SW 2145-FSL-025-FWL	WILSHIRE-3	3501920914	OTG/OCC-NOT ASSIGNED	PLUGGED	8/15/1971	8-5/8	318	0											0.15	792	yes	Calculated TOC does not cover injection zone and/or BTW
15	26-4-2-SE-660-FSL 150-FEL	GILL-2	3501911791	TRIPLEDEE OPERATING CO LLC	TA	3/24/1922	8-1/4	2255				6-5/8	2803							0.2	1056	yes	No information showing injection zone and/or BTW is properly isolated.
18	25-045-02W SWSWSW-130W-90S	HARTS#4	3501911784	OTG/OCC-NOT ASSIGNED	ORPHAN	8/3/1923	8-1/4	2081	?	6-5/8	2420	?	5-3/16	2810	?					0.22	1162	yes	Calculated TOC does not cover injection zone and/or BTW
21	26-045-02W N25E5E5E-2310W 500S	CJ-GILL#1	3501911787	TRIPLEDEE OPERATING COMPANY LLC	INJECTION	12/13/1945	13-3/8	360	0				6	3824	3434	5007	3607	3624	lone grove	0.25	1320	yes	Calculated TOC does not cover injection zone and/or BTW

INITIAL BHP=Pi=	787.62684	PSI	CALCULATED
<b>FINAL MAX CONDITIONS</b>			
FINAL FLUID LEVEL FROM SURFACE =	620	FEET TO FLUID	CALCULATED
FINAL FLUID COLUMN HEIGHT =	2280	FEET OF FLUID	CALCULATED
FINAL BHP =	1082.4528	PSI	CALCULATED
<b>PERFORATION INTERVALS</b>			
INTERVAL 1	TOP PERF= 2800	FEET	UIC APPLICATION
	BOTTOM PERF = 3000	FEET	UIC APPLICATION
INTERVAL 2	TOP PERF= 0	FEET	UIC APPLICATION
	BOTTOM PERF = 0	FEET	UIC APPLICATION
DISTANCE TO CLOSEST PROBLEM WELL=	1056	FEET	UIC AOR
ISIP =	NA	PSI	OPERATOR



# QUESTIONS

Contact the UIC Department at

Email: [OGUIC@occ.ok.gov](mailto:OGUIC@occ.ok.gov)



**OKLAHOMA**  
Corporation Commission

Oklahoma | Underground Injection Control |  
February 26, 2024



Figure 13

# SOURCES OF ILLUSTRATIONS

*Figure 4.* Nellie Johnstone #2, photograph, 1897~; (<https://gateway.okhistory.org/ark:/67531/metadc1594773/>: accessed February 25, 2024), The Gateway to Oklahoma History, <https://gateway.okhistory.org>; crediting Oklahoma Historical Society.

*Figure 5.* Looking east on g street Oklahoma City, photograph, 1932; crediting Oklahoma Heritage Association.

*Figure 8.* Hart, Alpha O., and Turner, Bennie, OIL WELLS / OIL DERRICKS / OIL FIELDS / OKLAHOMA / AERIAL PHOTOGRAPH / OKLAHOMA STATE CAPITOL, photograph, 2/9/1938;(<https://www.oklahoman.com/picture-gallery/news/2007/10/15/oil-wells-collection/20404536007/>: accessed February 25, 2024), The Daily Oklahoman.

*Figure 10.* Natives of Healdton oil field 1000 years behind the times, drilling by hand, photograph, 1915~;(23139.IO.O.F.H.1.3, Devon/Dunning Petroleum Industry Collection), crediting Oklahoma Historical Society.

*Figure 12.* Steamboats, photograph, 1906~; (<https://gateway.okhistory.org/ark:/67531/metadc1619033/>: accessed February 25, 2024), The Gateway to Oklahoma History, <https://gateway.okhistory.org>; crediting Oklahoma Historical Society.

# REFERENCES

Kenny A. Franks, “Petroleum Industry,” The Encyclopedia of Oklahoma History and Culture, <https://www.okhistory.org/publications/enc/entry?entry=PE023>.

Taliaferro, David Benjamin & Logan, David M. History of Water Flooding of Oil Sands in Oklahoma, report, November 1943; [Washington D.C.]. (<https://digital.library.unt.edu/ark:/67531/metadc38419/>: accessed February 25, 2024), University of North Texas Libraries, UNT Digital Library, <https://digital.library.unt.edu>; crediting UNT Libraries Government Documents Department.

“Oklahoma’s First Waterflood,” Exploring Oklahoma History, <https://blogoklahoma.us/place/150/rogers/oklahomas-first-waterflood>

“Bartlesville History,” Office of Fossil Energy and Carbon Management, <https://www.energy.gov/fecm/bartlesville-history>.