



Bone Spring Database

Caza Petroleum BoneSpring Production Summary - Data Entry/Edit			
New Well Print Well Logs: Type Curve EMNRD: Close			
API:	30025401030100	12 Month Cumulative BOE:	0
Operator:	COG OPERATING LLC	24 Month Cumulative BOE:	0
Lease:	STRATOJET 31 STATE COM	60 Month Cumulative BOE:	0
Well Number:	3H	6 Month Cumulative MMCFGE:	1059.35
County:	LEA	12 Month Cumulative MMCFGE:	0
Legal:	S:31, T:20S, R:35E	24 Month Cumulative MMCFGE:	0
Field Name:	BERRY	60 Month Cumulative MMCFGE:	0
Reservoir Name:	BONE SPRING, NORTH	3 Month Decline Oil:	41.35
Prev Operator:		3 Month Decline Gas:	30
Reg#:	38554	12 Month Decline Oil:	0
PI Top:	11024	12 Month Decline Gas:	0
PI Bottom:	14962	24 Month Decline Oil:	0
PI Count:	360	24 Month Decline Gas:	0
Total Depth:	15062	60 Month Decline Oil:	0
True Vertical Depth:	10758	60 Month Decline Gas:	0
TD Source:	Completion	Gas Oil Ratio 2nd Month:	1,103.96
Well Type:	U	Gas Oil Ratio Latest Month:	723.85
Well Status:	Active Permit	CFGE/D Prac IP:	5,698,125.00
Elevation:	3725	CFGE/D Current Rate:	4,072,796.05
ElevationRef:	GF	MMCFGE Cumulative:	472.72
State:	NM	BCFGE Cumulative:	0.47
Vertical:	N	Cumulative Gas Oil Ratio:	912.48
		Lat:	32.522816
		Long:	-103.498314
		Well:	
		Zone:	2nd Bone Spring
		90 day Oil:	75,918.00
		90 day Gas:	67,994.00

Bone Spring Database set up to track key production, and completion information per zone in Lea & Eddy Counties, New Mexico Started with ~ 600 wells in 2012, now have over 1,800 wells in date base. Also tracking similar databases for the Wolfcamp and Lower Brushy Canyon. Have over 700 2nd & 3rd Bone Spring Sand wells

Oil Conservation Division
Case No. 18
Exhibit No. 18





Bone Spring Database

Vertical:	N	90 day Oil:	75,918.00
DI Unique#:	3075626	90 day Gas:	67,994.00
NMLot:	N	90 Day Oil Equiv:	87,250.33
Reporting Entity:	OCD	180 day Oil:	169,647.00
Operator City:	MIDLAND	180 day Gas:	169,865.00
Prac IP (BO/D):	812.80	180 day Oil Equiv:	197,957.83
Prac IP (MCF/D):	897.30	270 Day Oil:	229,060.00
First Prod:	01-Aug-11	270 Day Gas:	258,774.00
Avg (BO/D):	824.90	270 Day BOE:	272,189.00
Avg (MCF/D):	1,164.86	360 Day Oil:	278,698.00
Last Prod:	31-Mar-14	360 Day Gas:	323,891.00
Cumulative Oil:	398,064.00	360 Day BOE:	332,680.00
Cumulative Gas:	479,553.00	EUR Oil:	888673
Cumulative Water:	209,507.00	EUR GAS:	1085406
Max Month Avg (BO/D):	1,166.89	EUR BOE:	1069574
Max Month Avg (MCF/D):	1,372.17	EUR Oil/90 day Oil:	13.16
Max Month Avg (BOE/D) Equiv:	1,395.58	EUR Oil/180 day Oil:	5.89
Max Month Avg (BOE/D) Equiv:	1,395.58	EUR Gas/90 day Gas:	16.18
Avg (BW/D):	5,129.00	EUR Gas/180 day Gas:	6.48
Last Mo Oil:	4,444.00	EOR_E/90 BOE:	14
Last Mo Gas:	7,414.00	EOR_E/180 OE:	6
Max Monthly Oil Prod:	31,991.00	GOR_EUR:	1101
Max Monthly Gas Prod:	41,165.00	Days Prod:	890.00
CumBOE:	289,420.00	Oil Prod to Date:	398,064.00
6 Month Cumulative Oil:	169647	Gas Prod to Date:	479,553.00
		Vertical Section:	14962
		VS End of Curve:	11024





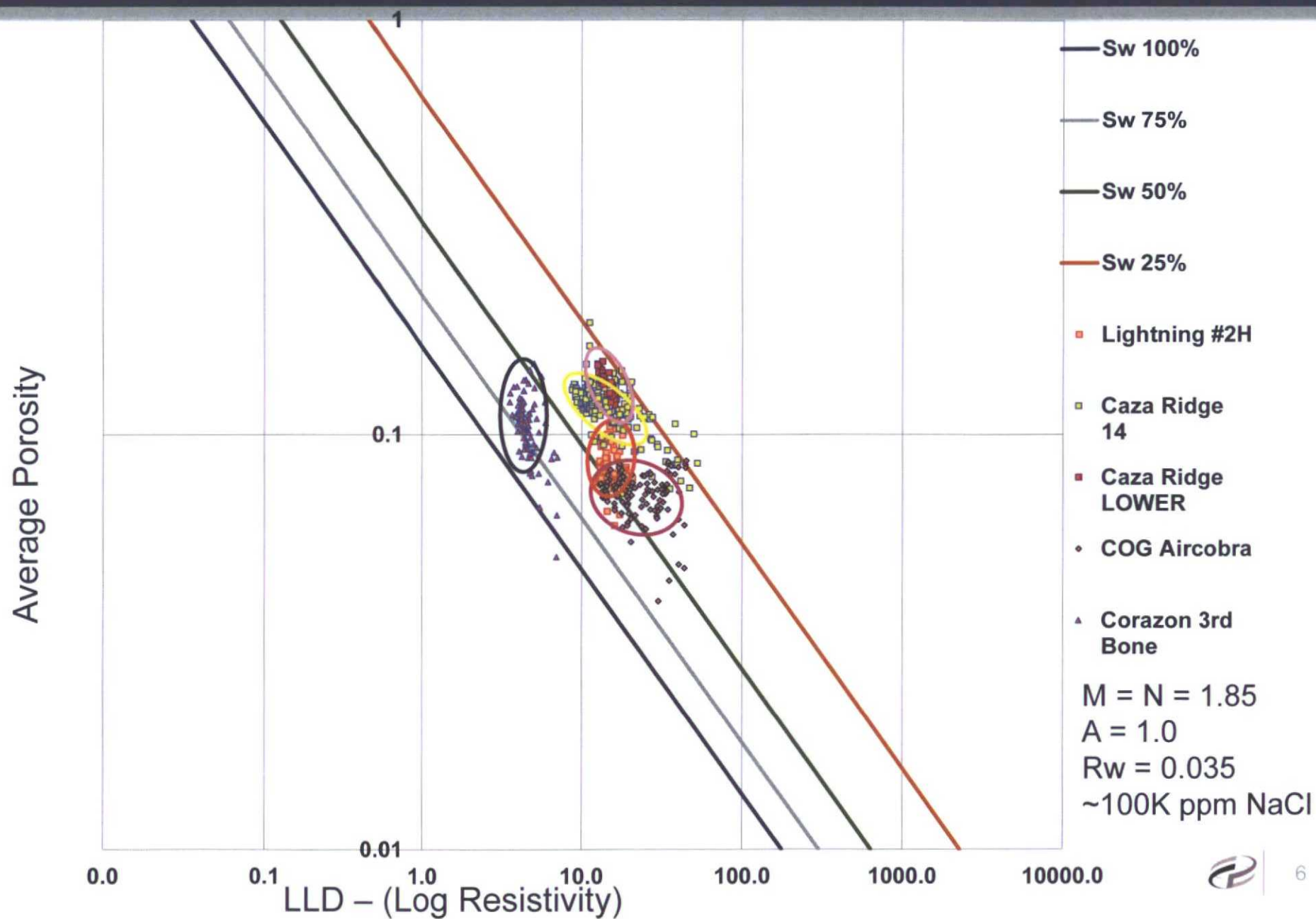
Bone Spring Database

Max Month Avg (MCF/D):	1,372.17	EUR Gas/180 day Gas:	6.48
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Max Monthly Gas Prod:	41,165.00	Vertical Section:	14962
CumBOE:	289,420.00	VS End of Curve:	11024
6 Month Cumulative Oil:	169647	Difference VS:	3938
6 Month Cumulative Gas:	169865	# Stages:	10
12 Month Cumulative Oil:	0	Stage Interval:	437.56
12 Month Cumulative Gas:	0	Gal:	2366434
24 Month Cumulative Oil:	0	# Proppant:	3011400
24 Month Cumulative Gas:	0	Proppant size:	30/50 SDC
60 Month Cumulative Oil:	0	Fluid:	Hybor G (R-21)
60 Month Cumulative Gas:	0		
6 Month Cumulative BOE:	197958		
EMNRD:	https://wwwapps.emnrd.state.nm.us/ocd/o	H2S:	
		Orientation:	0
		Comments:	11,024'-14,962 MD, 10735-10758 TVD (360 holes) Acid 29,820 gal 7.5 HCl
		Frac Method: 1 = Plug + Perf; 2a = Packers Plus; 2b = Halliburton sliding sleeve; 2c = Bakers; 2d = Peek; 2e = ??; 3 = Hybrid	1
		Toe Up (Yes or No):	YES
		Update:	MJG 5/22/14; JA 7/6/15



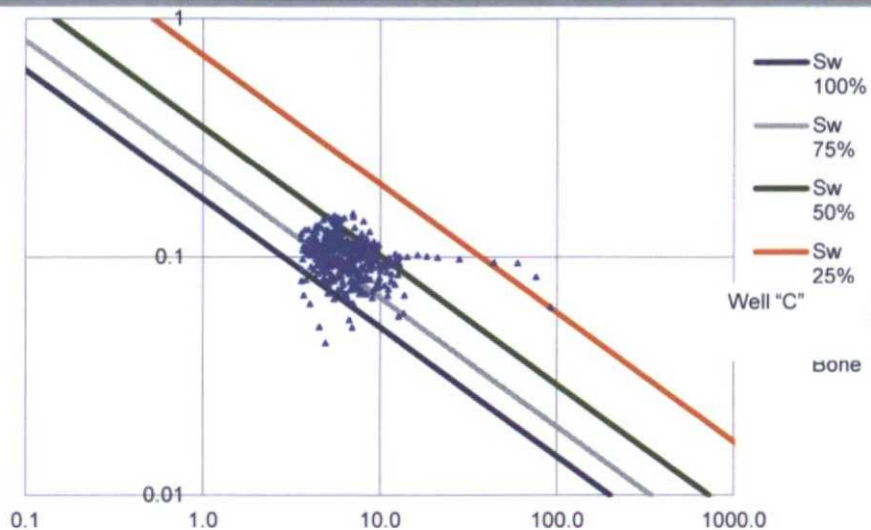
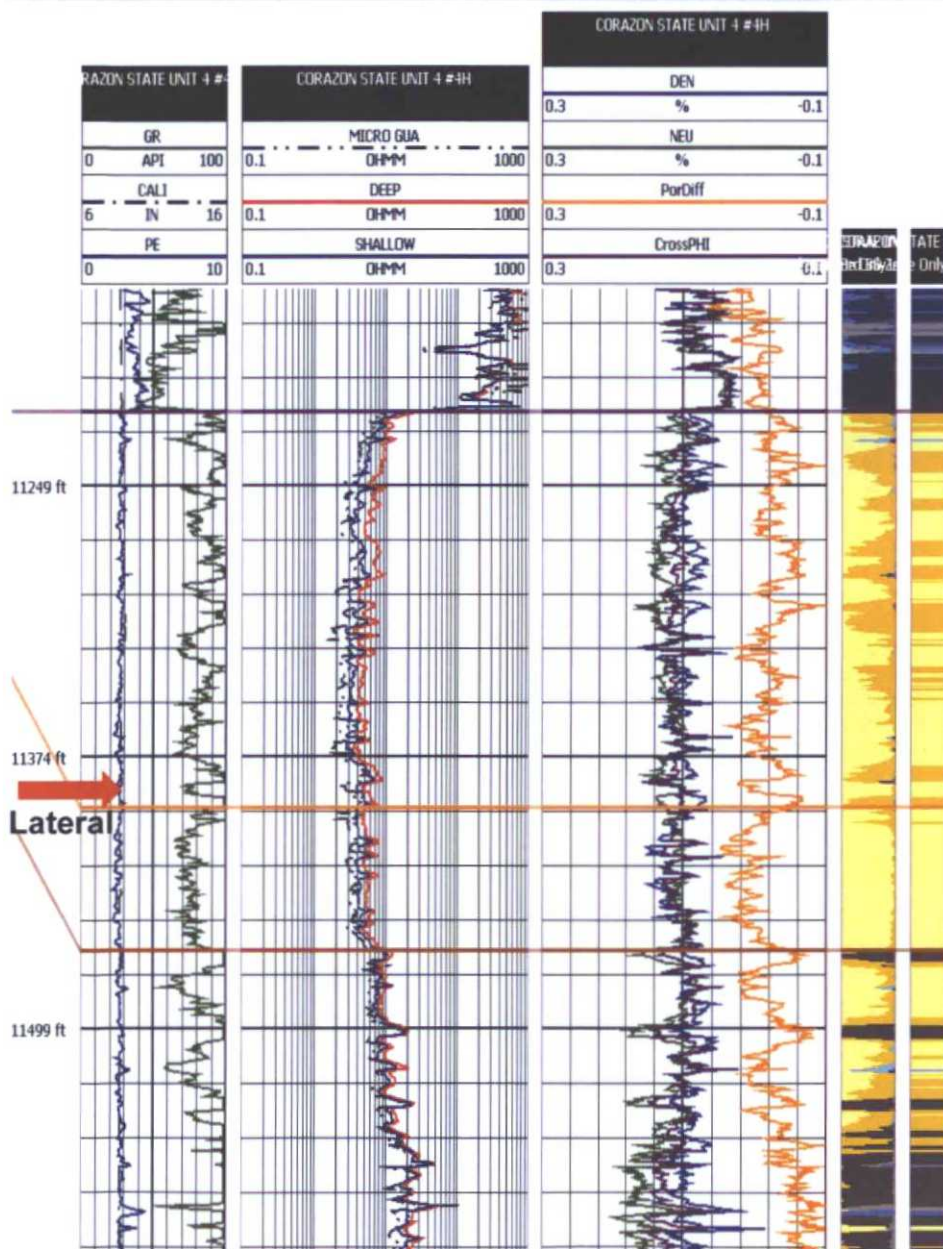


Pickett Plot 3rd Bone Spring – Crossplot Porosity





COG Corazon Sate Unit #4 (40130)



Cluster #	# Feet In Cluster	Ave. Phi (%)	Por Diff	Ave. GR	LLD	DPHI	PE	Pore Volume
9	187.5	10.2	-.07	79	6.1	9.8	2.70	19.1
7	0							
3	13.5	11.2	-1.6	75	8.8	10.4	2.79	1.5
1	122	10.6	-6.7	95	8.7	8.8	2.83	12.9
14	87	12.8	-6.0	119	23.1	9.8	2.88	

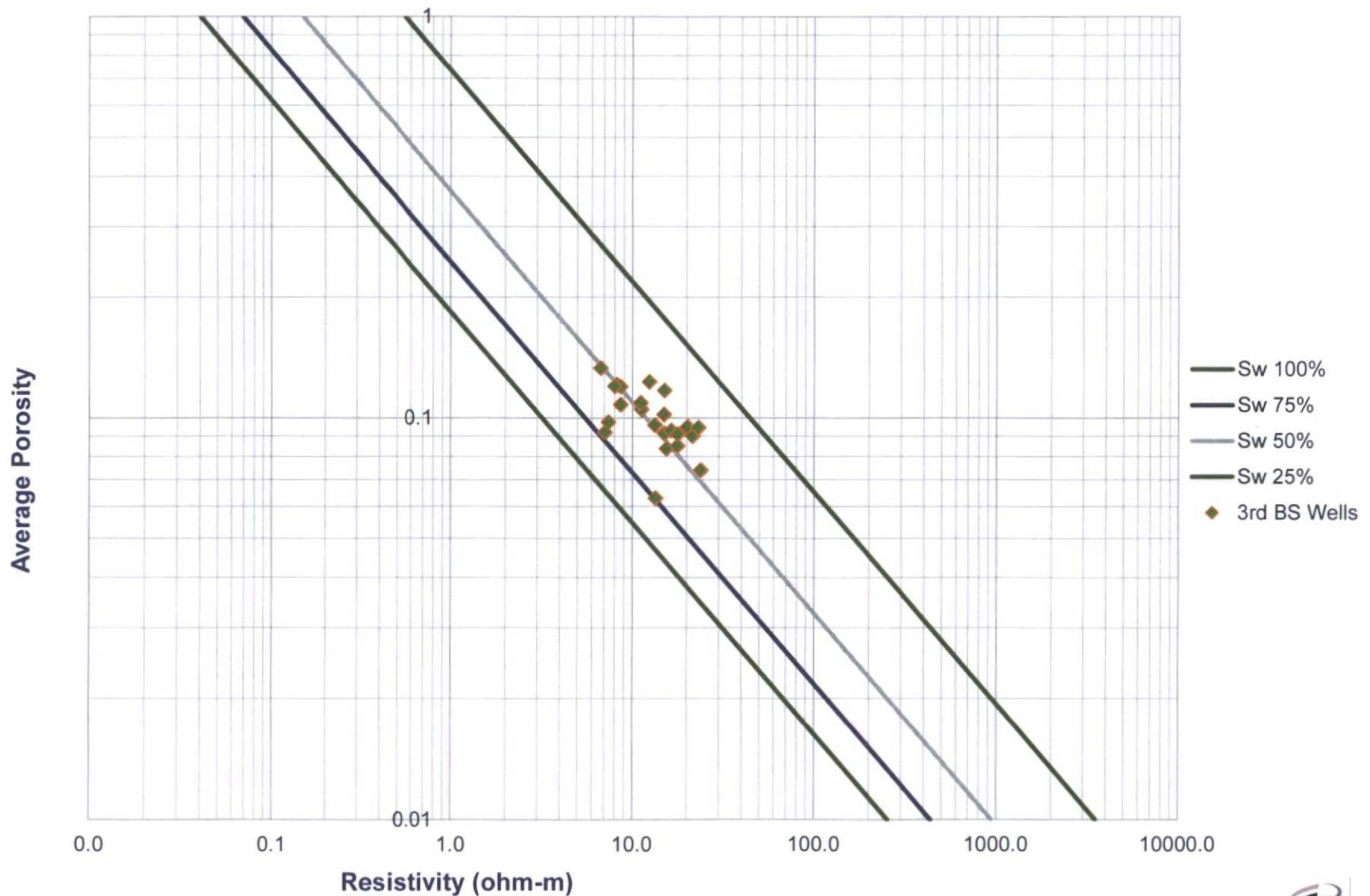
East- West
 Cum. Prod. : 134,533 Bo
 176,030 Mcfg, 308,468 Bw
 In 1,159 days
 5/31/2015

33.5' Total Pore Volume
 31% Oil Cut
 11.7' Hydrocarbon Pore Volume



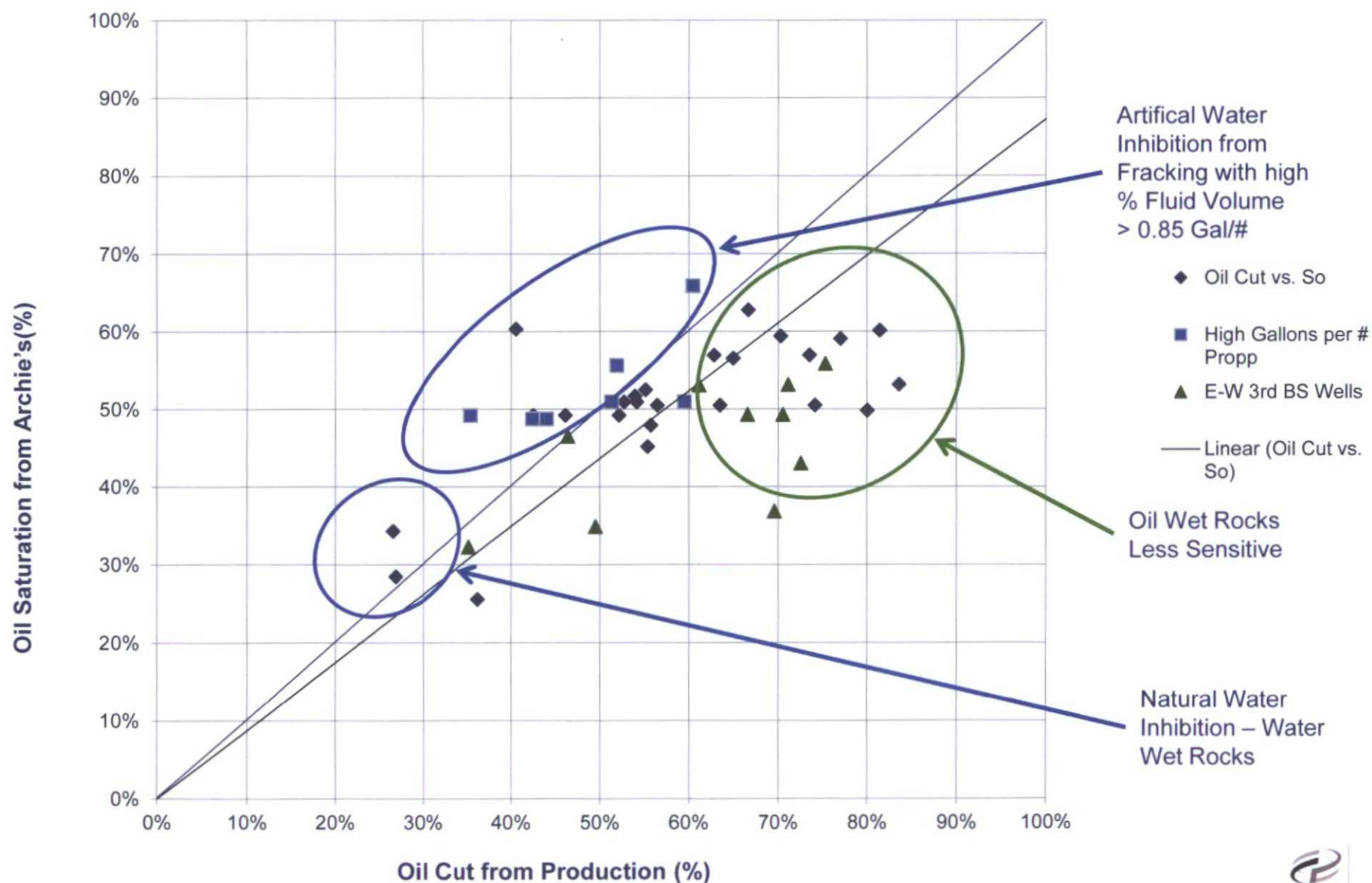


Water Saturation using Pickett Plot – North –South 3rd BS Laterals – Cluster Averages for Targeted Lateral



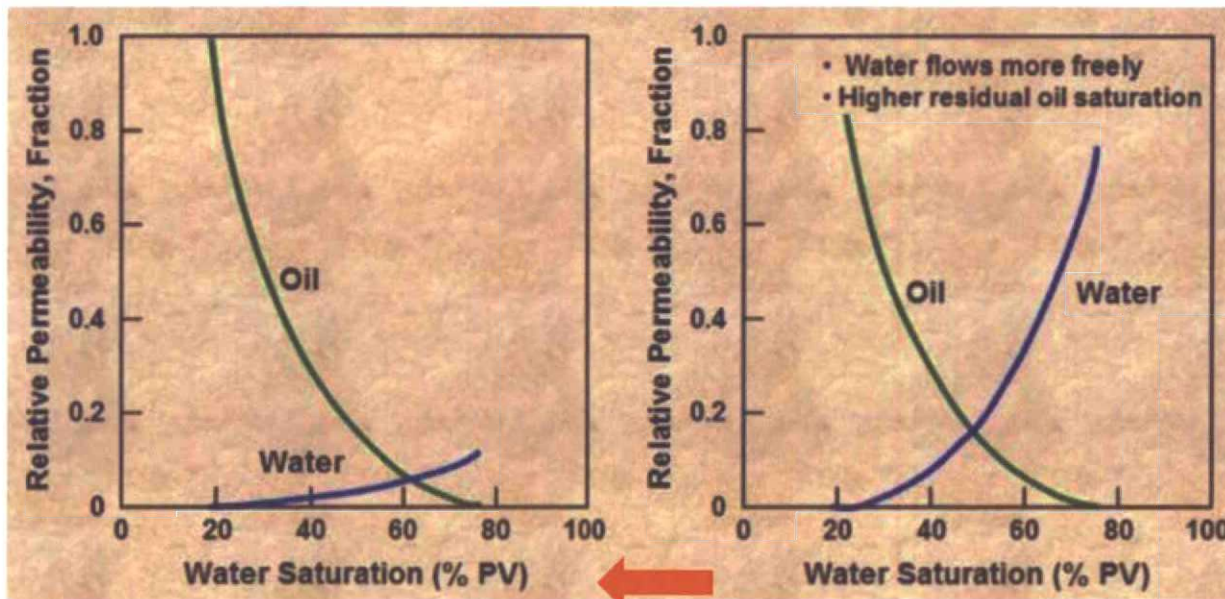


Calculated Oil Saturation vs. Oil Cut – 3rd BS Laterals

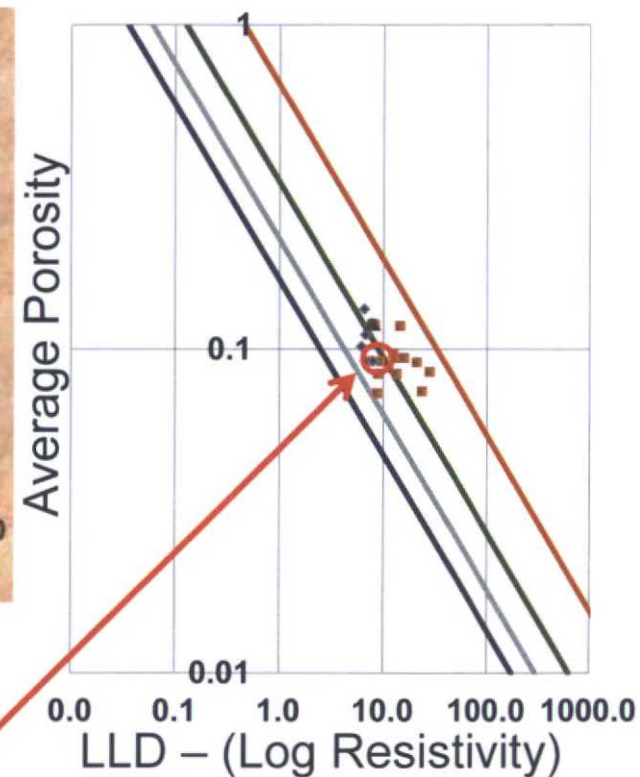




Fracking with Higher Fluid Concentration Decreases Wells Oil Cut??



Artificial with High Frac
Water Concentration



Well	# Proppant	Gal. Fluid	Gal. Fluid/# Proppant	Oil Cut
"N"	3,160,000	2,833,026	0.897	43%
"Z"	2,716,700	1,750,014	0.64	50%

— Sw 100%

— Sw 75%

— Sw 50%

— Sw 25%

▪ Wells with Sw < 50%

• Wells with Sw > 50%

▲ Wells in Question

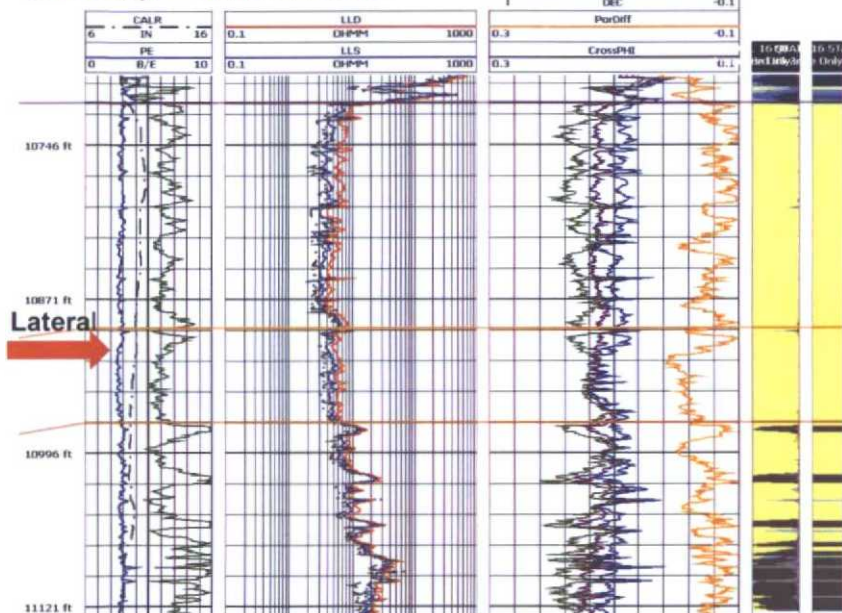




North-South 3rd Bone Spring Sand Wells (1/2 mile) apart)

Well "N"

209,789 Bo, 279,547 Mcfg, 298,270 Bw
In 708 days – Thru Dec. 2015



41.5' Total Pore Volume

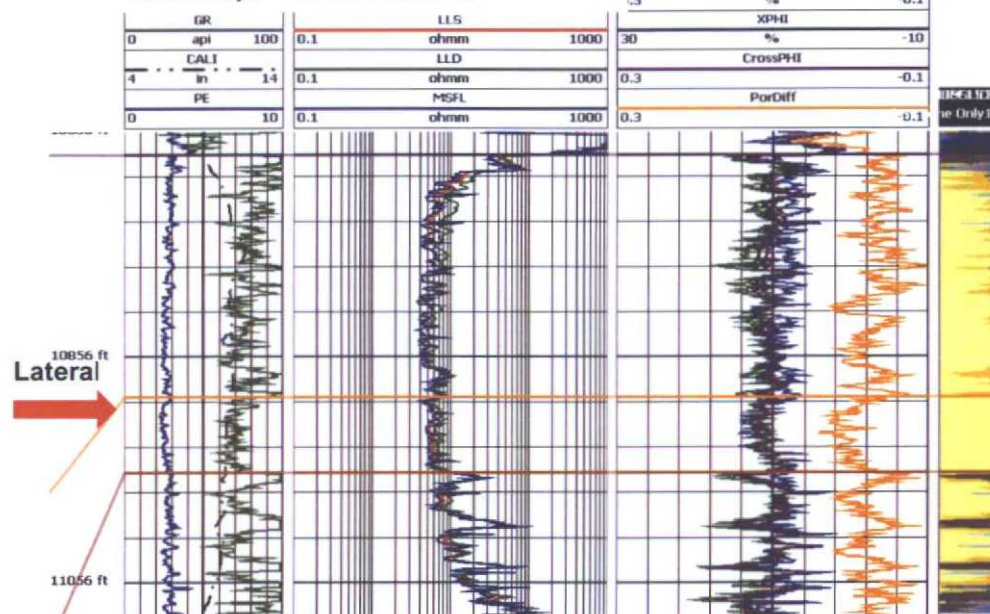
41% Oil Cut Overall (32% last 6 months)

17.4' Hydrocarbon Pore Volume – 3,100,182 gal. Fluid used to pump 2,728,870 #'s Proppant or 1.14 Gal/#Prop.

Cluster #	# Feet In Cluster	Ave. Phi (%)	Por Diff	Ave . GR	LLD	DPHI	PE	Pore Volume
9								
3	347.5	11.9	-5.0	65	7.3	9.5	2.89	41.5
1								

Well "Z" Offsetting Well "N" – 1/2 mile East

137,084 Bo, 107,898 Mcfg, 126,113 Bw
In 374 days – Thru Dec. 2015



34.1' Total Pore Volume

52% Oil Cut Overall (52% last 6 months)

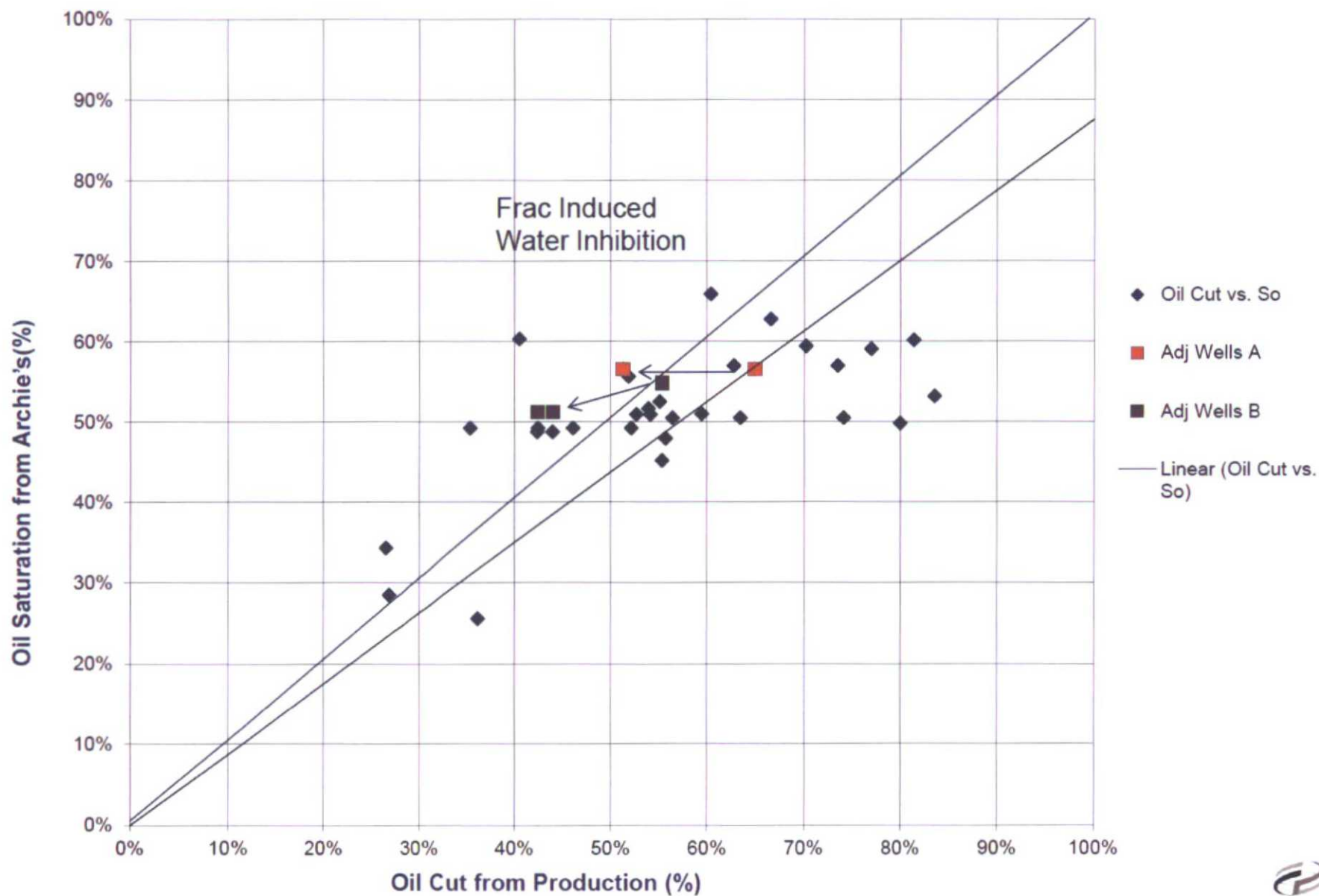
17.0' Hydrocarbon Pore Volume-1,854,300 gal. Fluid used to pump 2,610,867#'s Proppant or 0.71Gal/#Prop.

Cluster #	# Feet In Cluster	Ave. Phi (%)	Por Diff	Ave . GR	LLD	DPHI	PE	Pore Volume
9	169.5	9.6	-1.5	75	7.9	8.9	2.72	16.3
3	127	10.3	-2.5	76	10.1	9.0	2.82	13.1
1	47.5	9.9	-4.7	95	16.4	7.5	2.85	4.7





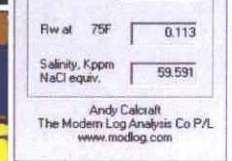
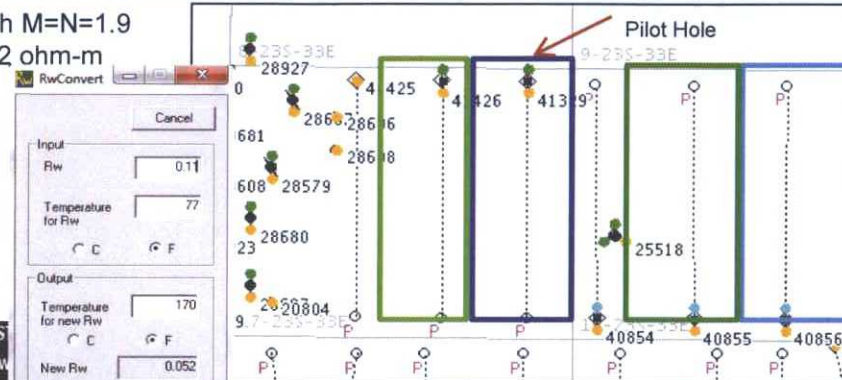
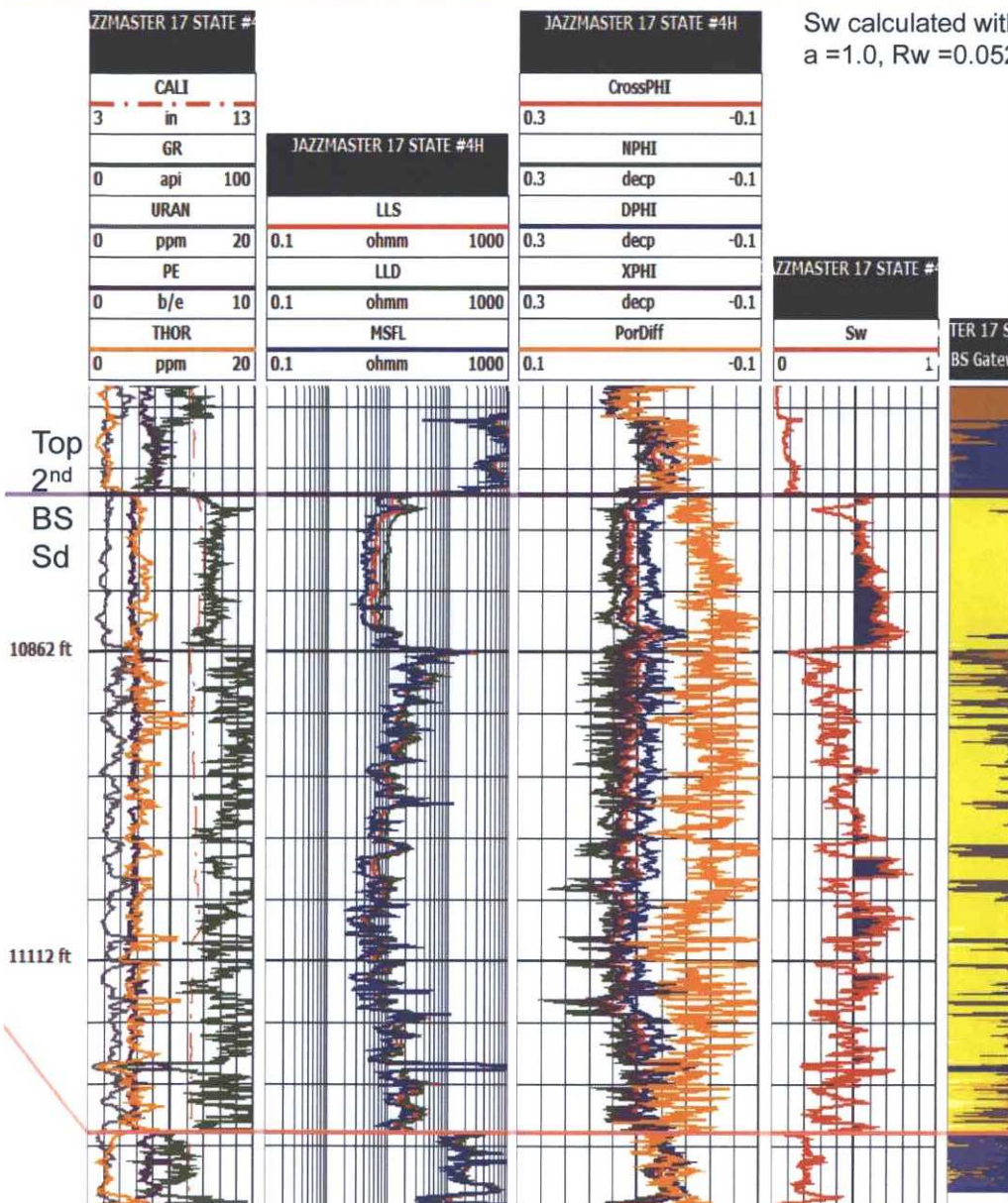
Calculated Oil Saturation vs. Oil Cut – 3rd BS Laterals Adjacent Wells



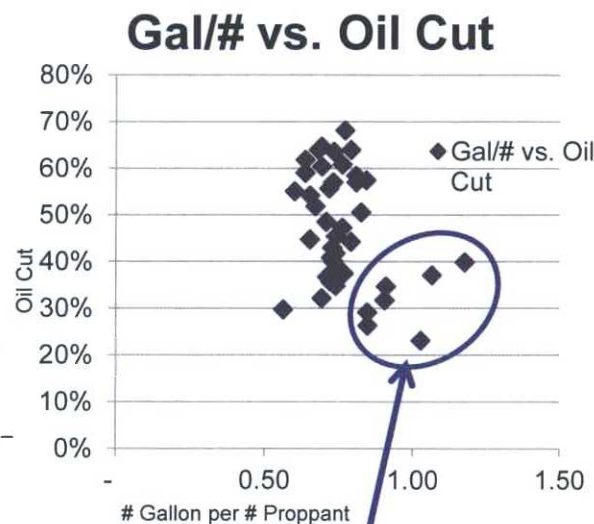


Critical Lateral Placement & Fluid Volume

Sw calculated with $M=N=1.9$
 $a=1.0$, $R_w=0.052$ ohm-m



- Lateral 40856- 26% Oil Cut - 0.85Gal/#
- Lateral Jazzmaster 17#3H 32% Oil Cut - 0.90Gal/#
- Lateral Jazzmaster 17#4H - 23% Oil Cut - 1.03 Gal/#
- Lateral 40855- 38% Oil Cut - 0.74Gal/#



High Fluid Volume
per # Proppant
used -artificially
imbibed water

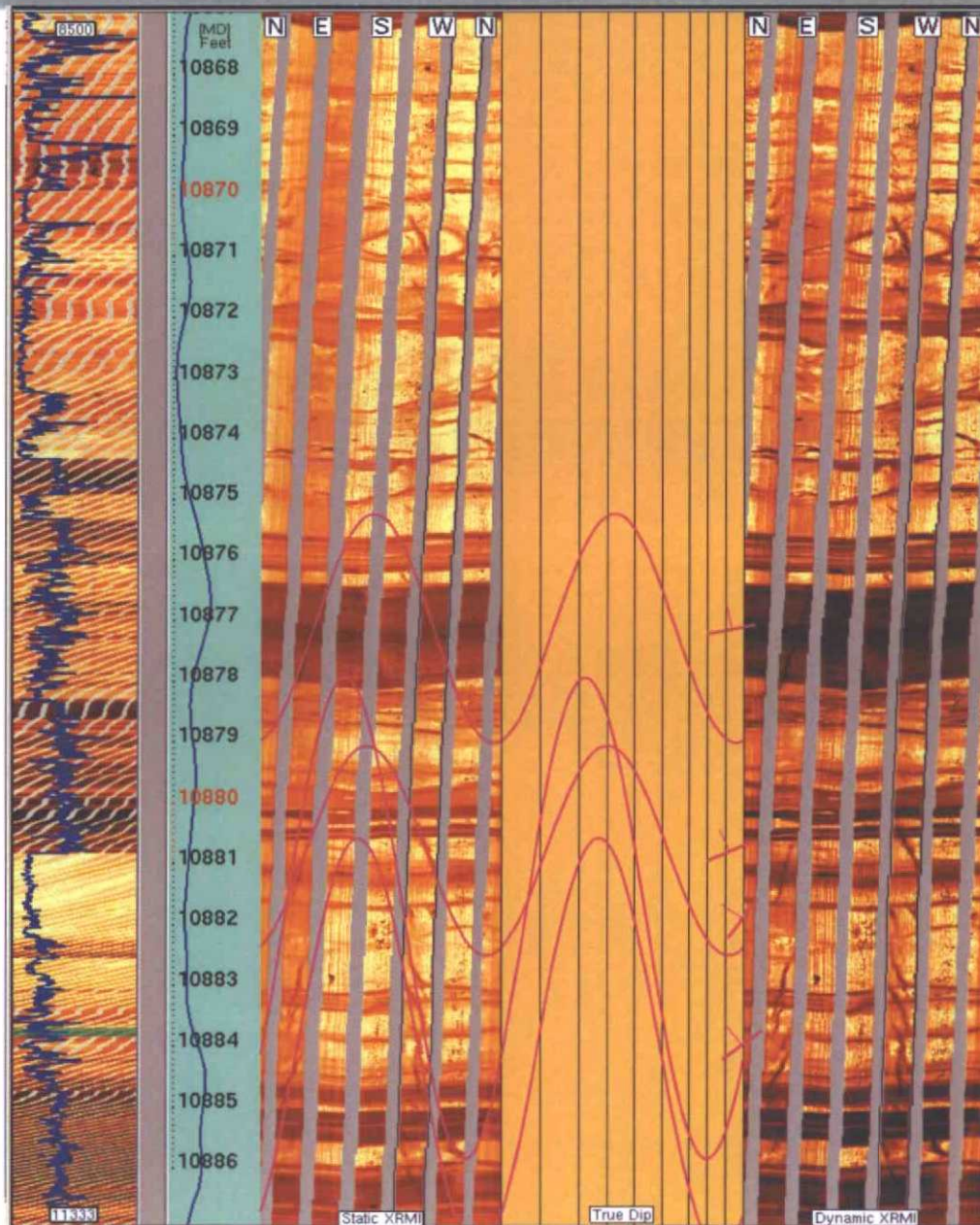


Lateral Direction

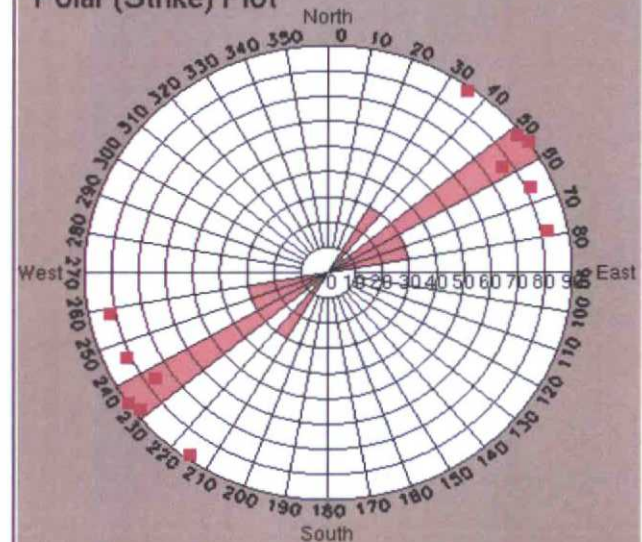
- XRFI
- Cross Dipole Sonic
- Well Bore Breakout
- Seismic
- Production results
- Microseismic – No examples



XRMI – Drilling Induced Fractures

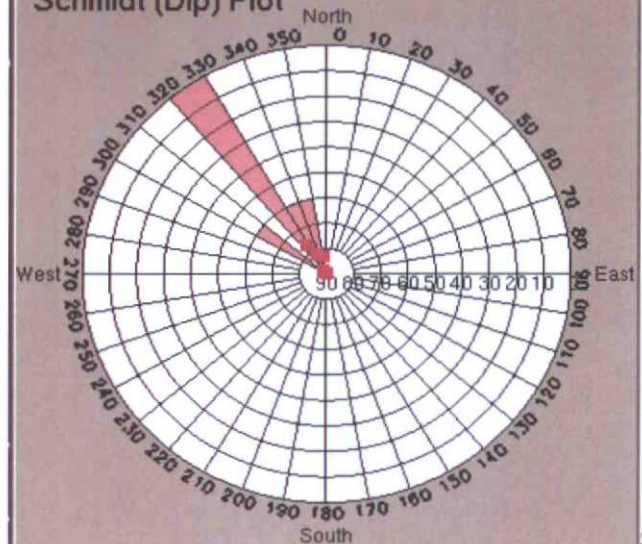


Polar (Strike) Plot



of dips : 6
Mean Strike = 57.302 x 237.302 degrees; Rmag = 0.974

Schmidt (Dip) Plot



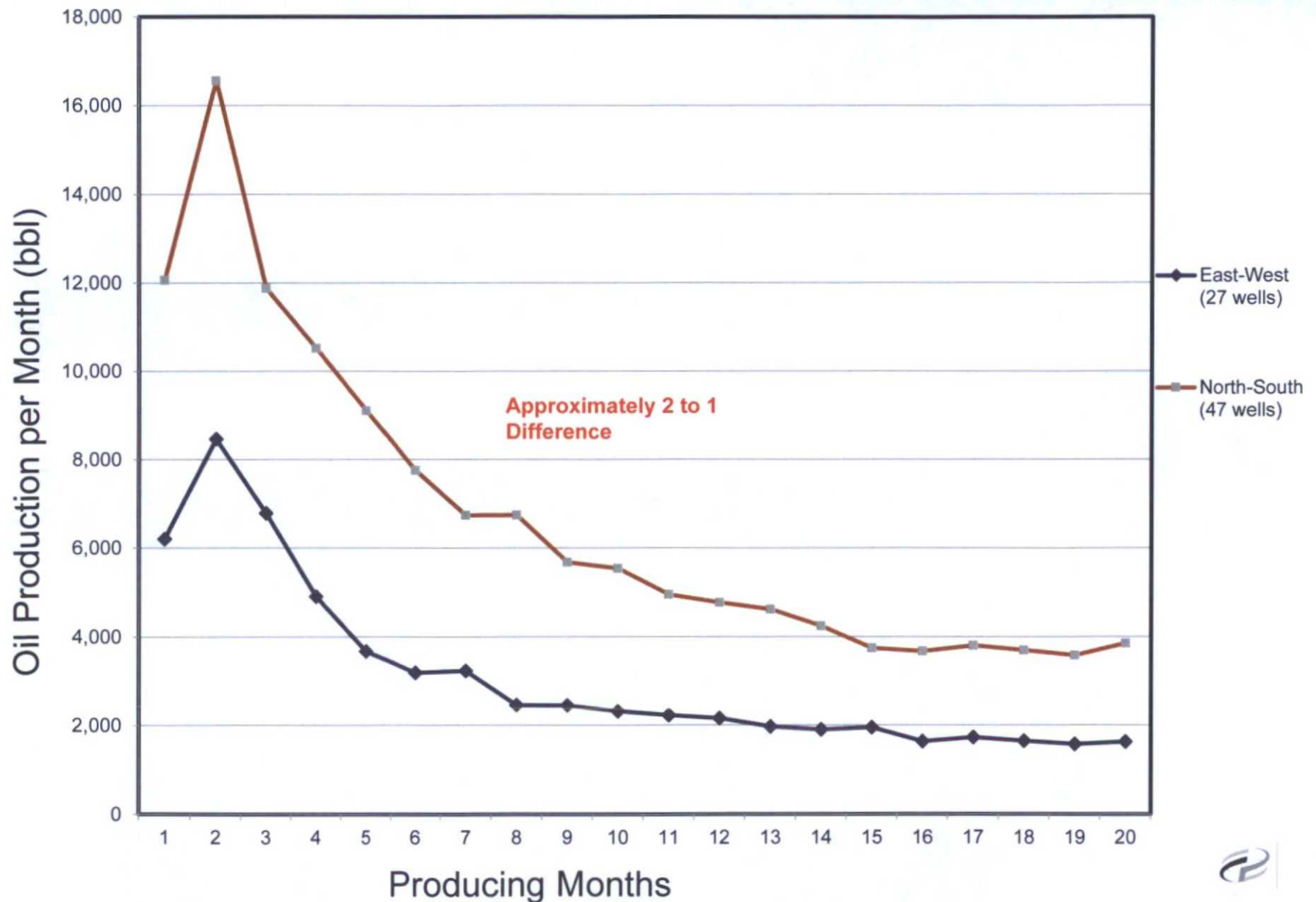
of dips : 6
Mean Strike = 57.302 x 237.302 degrees; Rmag = 0.974







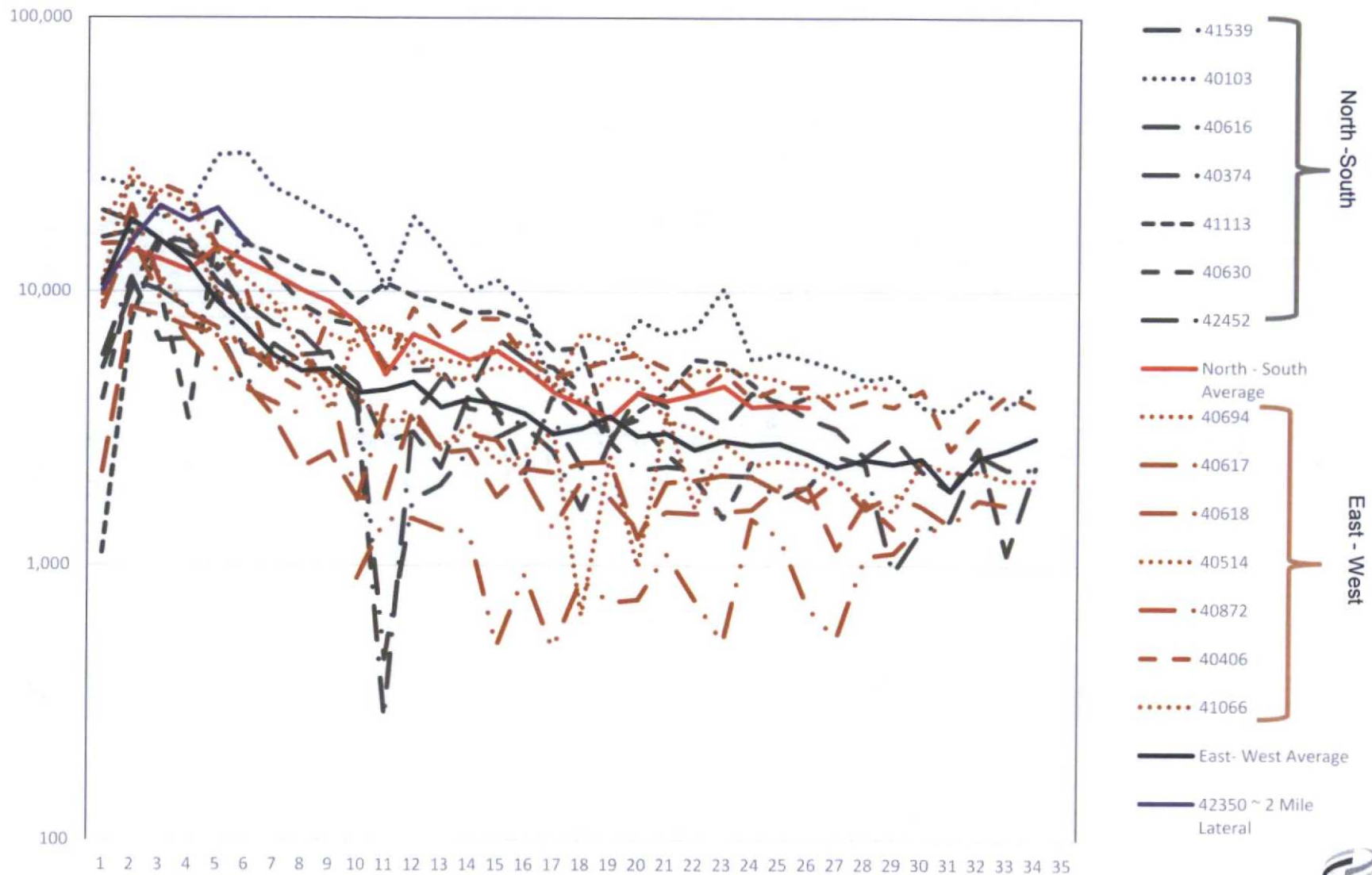
Average Monthly Production Comparing 3rd Bone Spring North – South Wells to East – West Wells





Average Monthly Production Comparing 2nd Bone Spring North – South Wells to East – West Wells

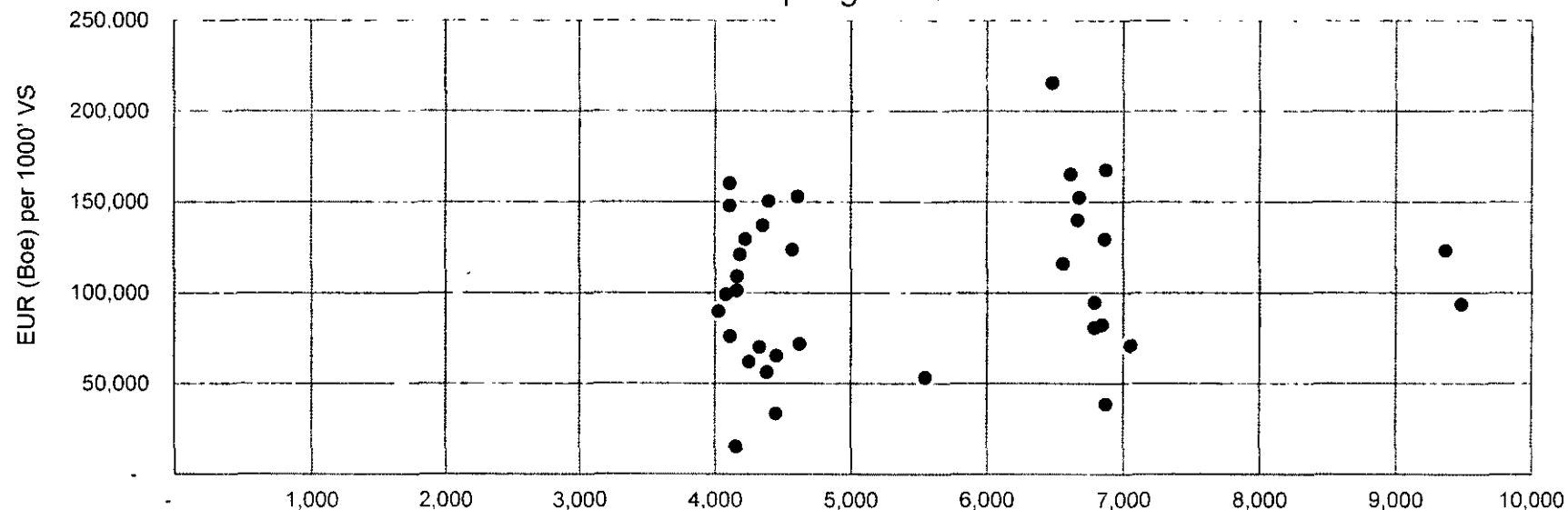
2nd Bone Spring Monthly Production N-S vs E-W Laterals



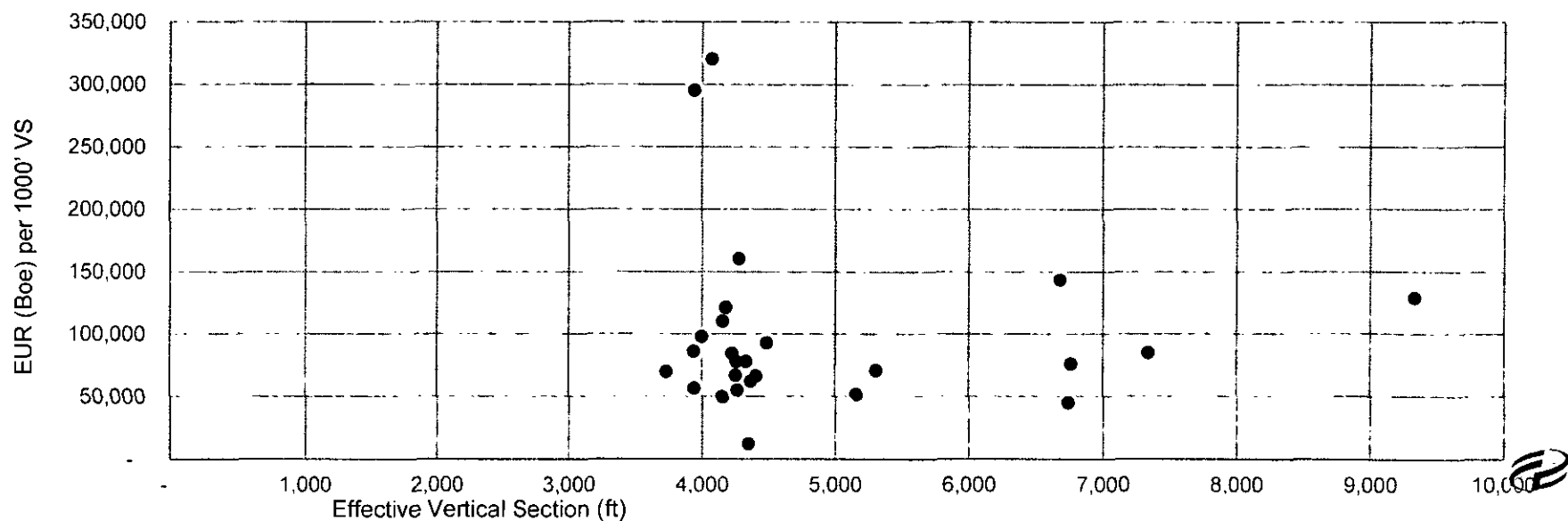


EUR per 1000' vs Effective Vertical Section

3rd Bone Spring Sand Wells



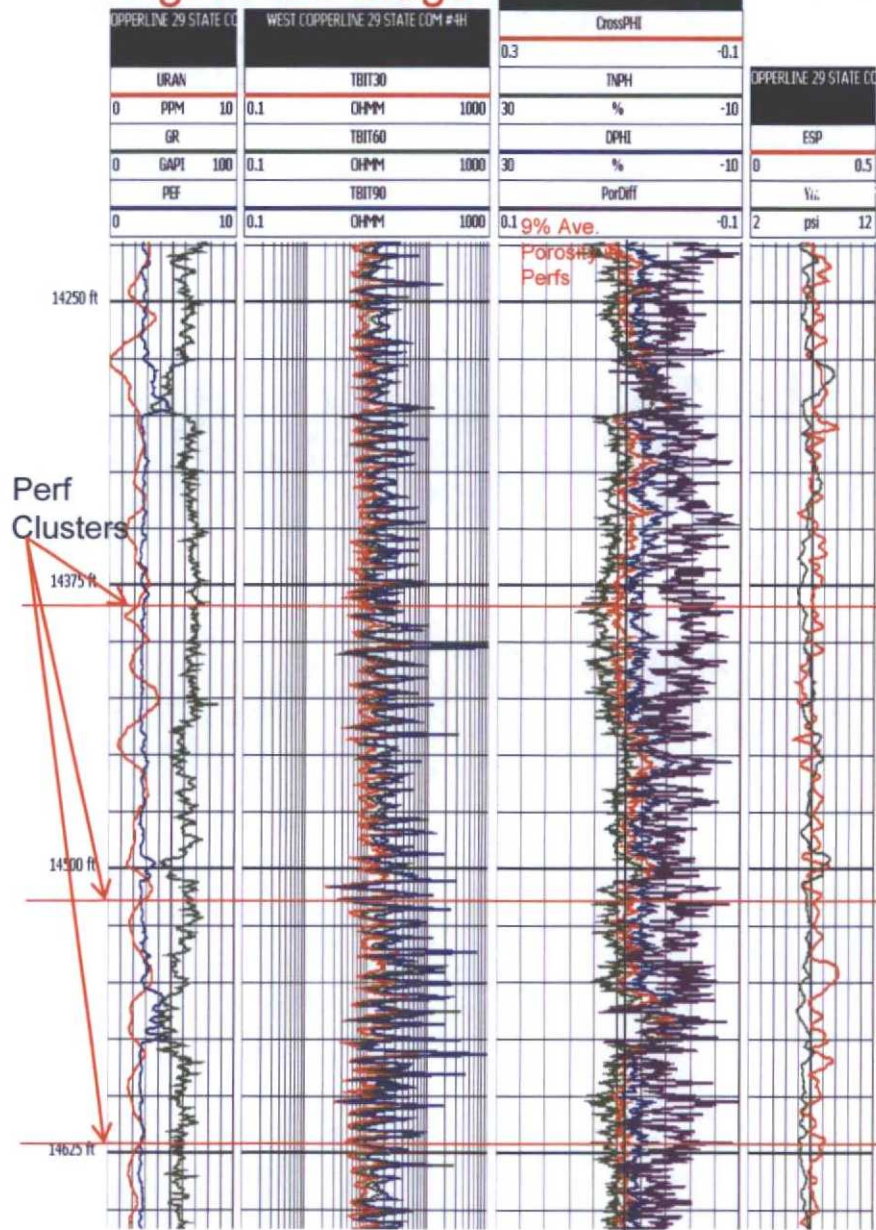
2nd Bone Spring Sand Wells



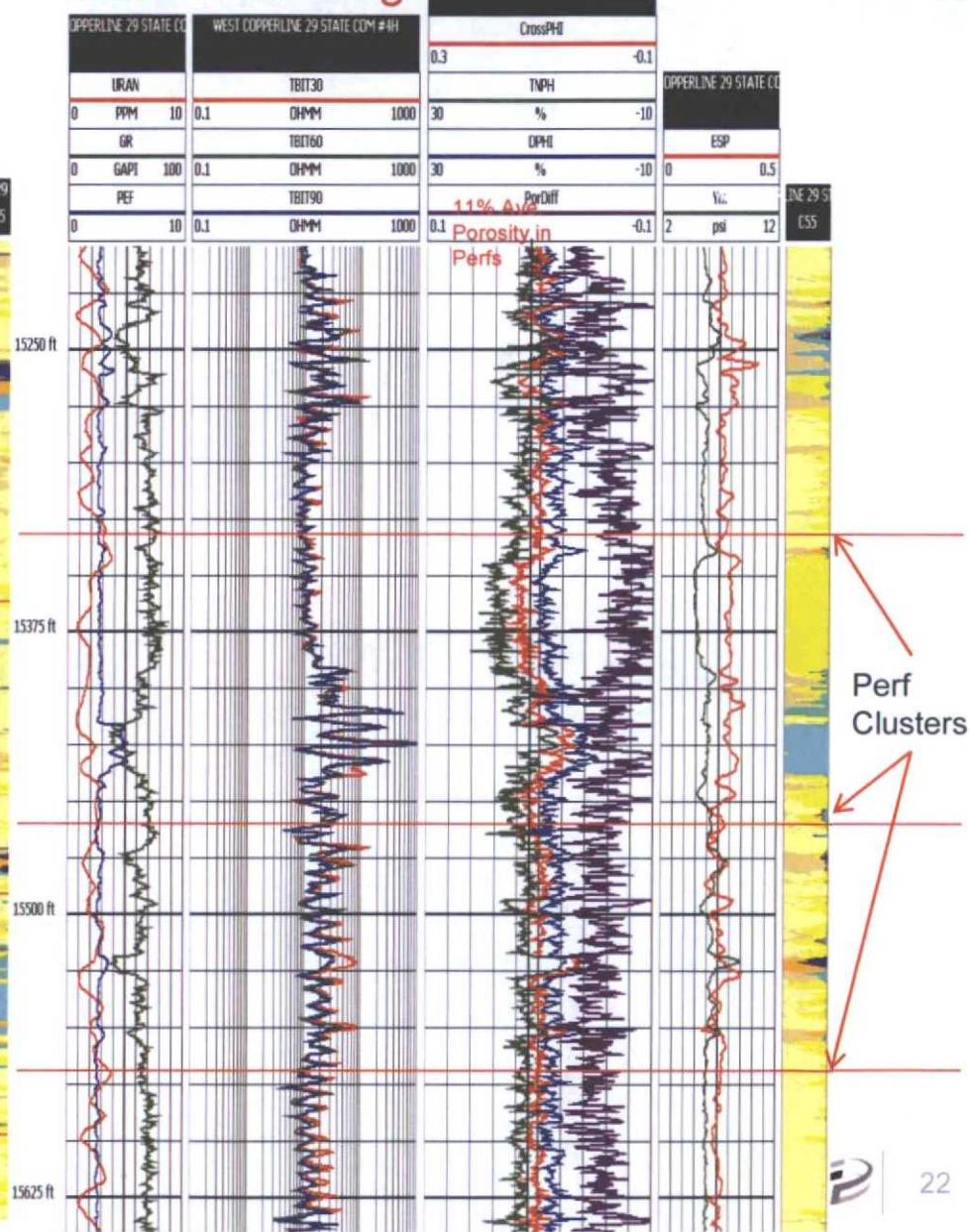


Thru-Bit Logging to Pick Perf Clusters

Tight Frac Stage



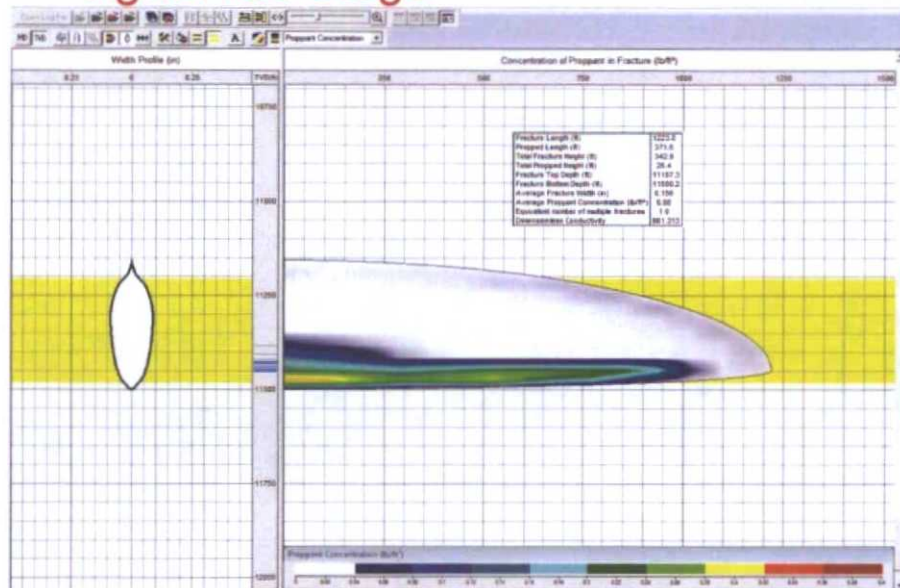
Good Frac Stage



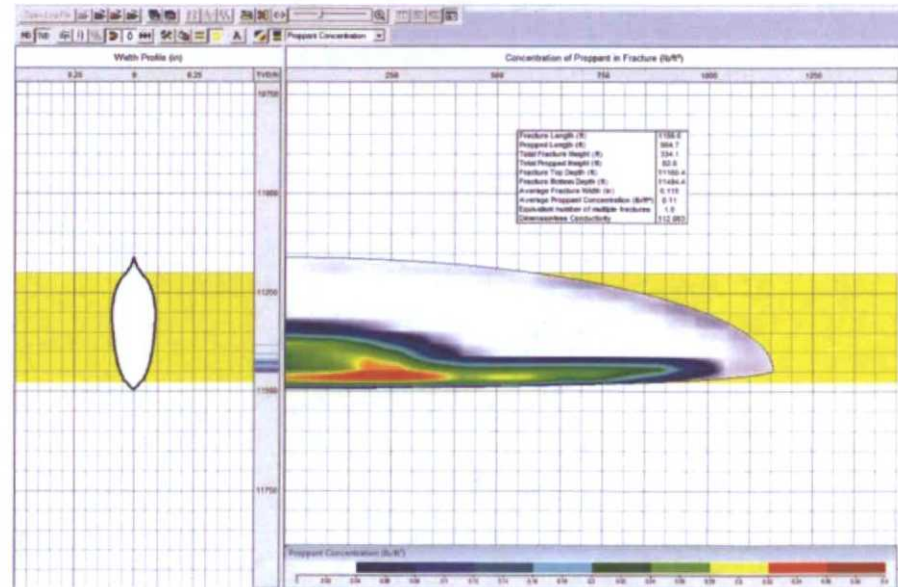
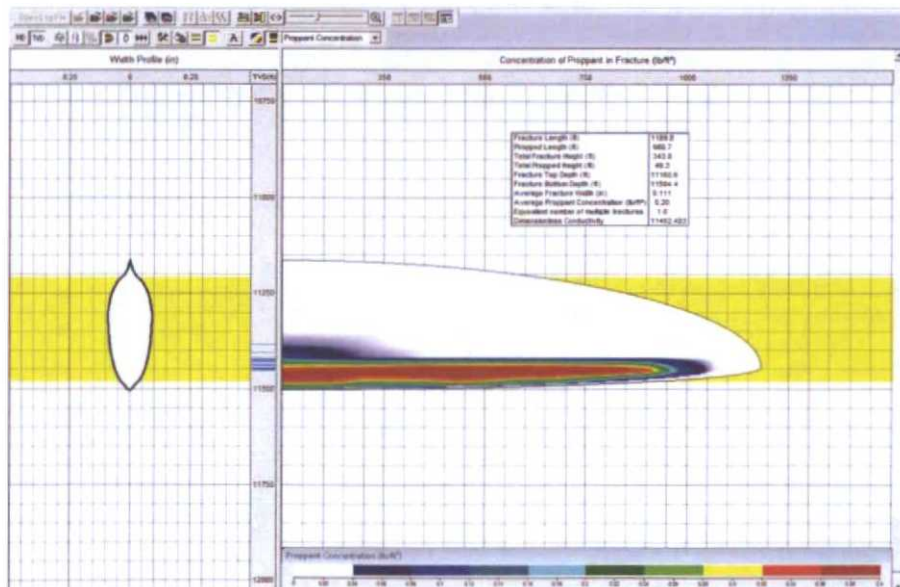
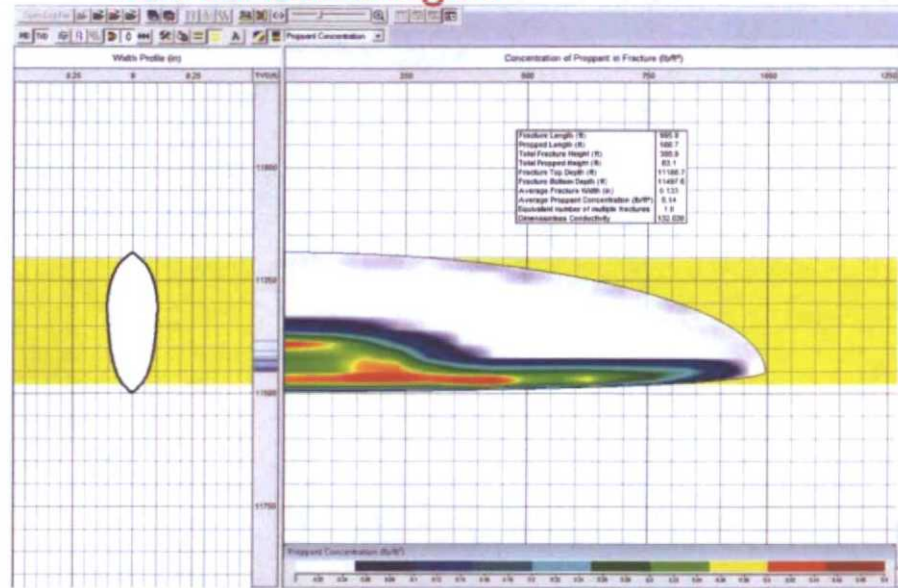


Thru-Bit Logging Design Perf Cluster Post Frac Modeling

Tight Frac Stage

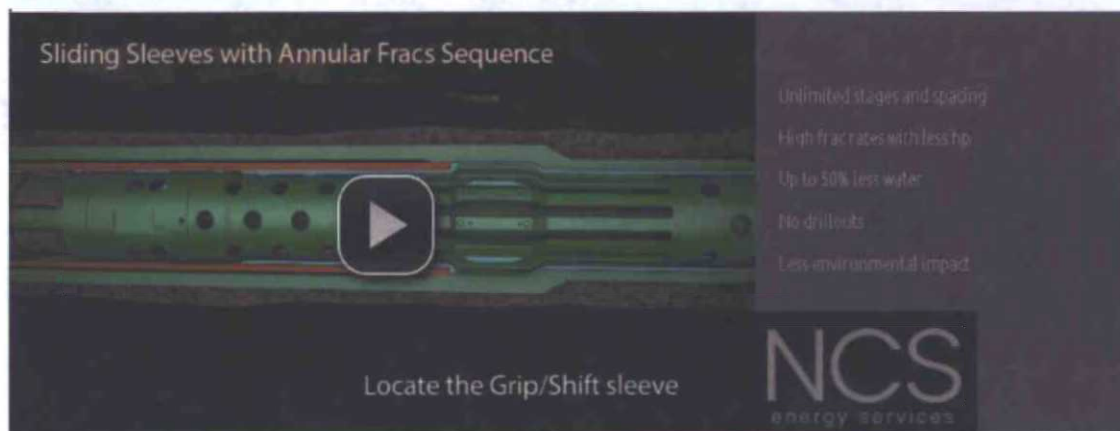


Good Frac Stages





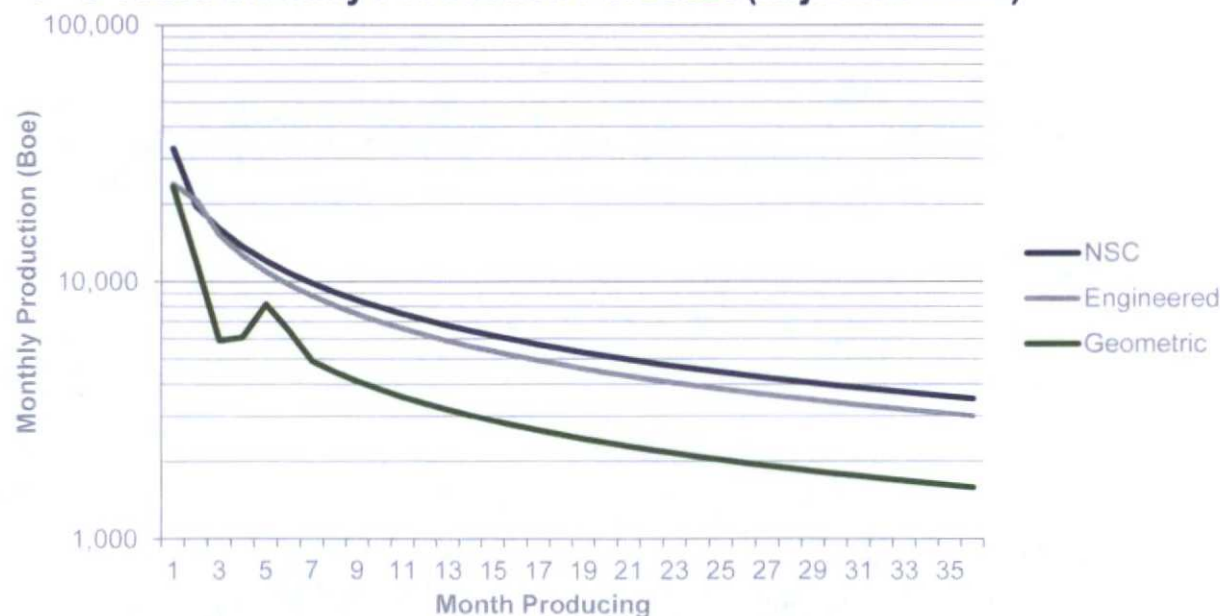
Completion Improvements – Fracking Design



Unconventional Reservoir Fracturing (Statistical Analysis of Production Logs)¹

- 61% of frac clusters produce less than the mean for any given well
- 41% of clusters produce less than half of the mean for any given well
- 34% of clusters may have entry, but produce less than detectable resolution of the PL logs

1st 3 Years Monthly Production Forecast (adjacent wells)²



- NCS System – 40 stage Frac down coiled tubing.
- Engineered – spacing perf cluster using Thru-Bit wireline logging.
- Geometric – equal perf cluster spacing throughout lateral.

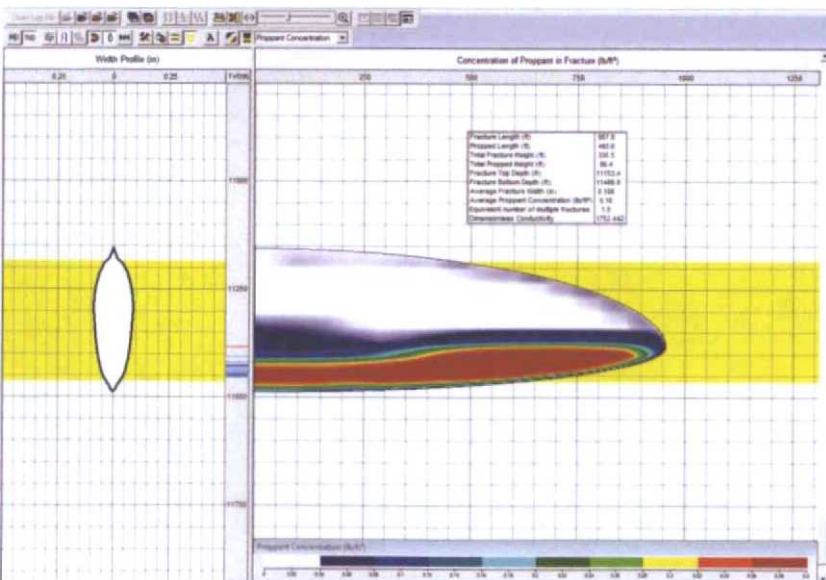
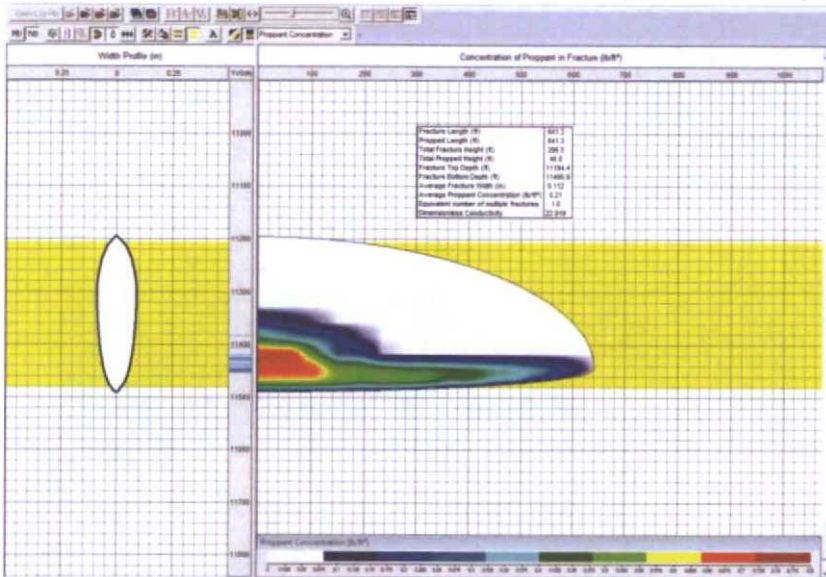
1) Society of Petroleum Engineers – SPE 144326

2) West Copperline/ Broadcaster – 3rd Bone Spring Completions within ½ mile of each other.

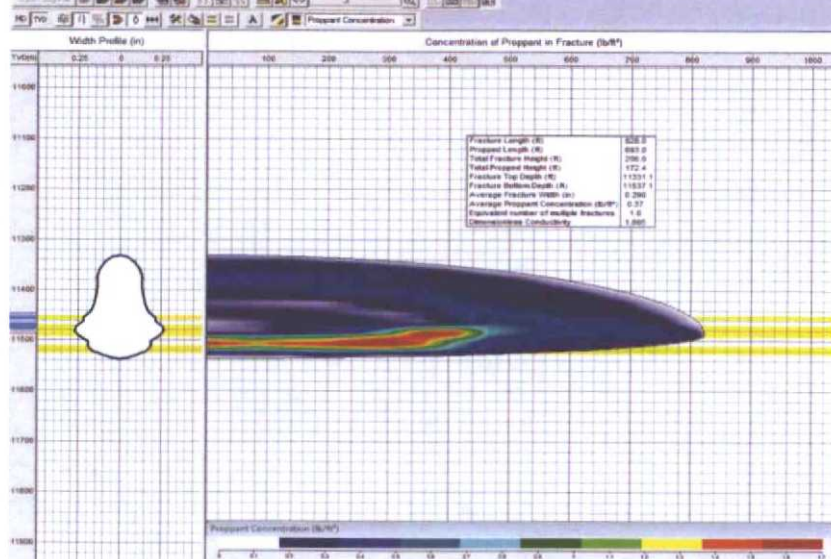
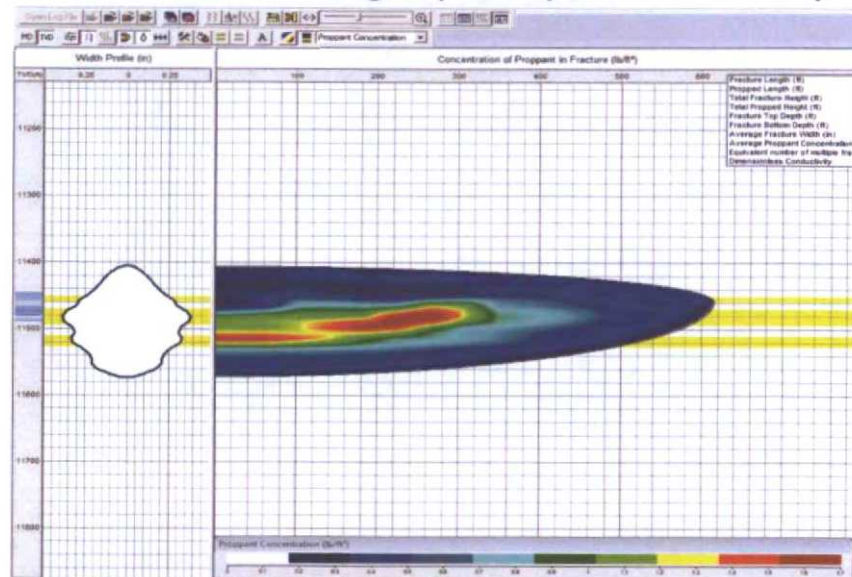


Post Frack Modeling – 3rd BS Wells ½ Mile Apart

Engineered Frack Stage (Plug & Perf)



NCS Frack Stage (Pump around CT)



Toe

Heel





Post Frack Modeling – 3rd BS Wells ½ Mile Apart

Engineered Frack Stage (Plug & Perf)

Stage	Frac Length	Propped Length	Frac Height	Propped Height	Frac Gradient
	Ft.	Ft.	Ft.	Ft.	psig/ft TVD
1	641.3	641.3	296.5	46	0.92
2	1223	371.6	342.9	25.4	0.88
3	995.9	588.7	308.9	63.1	0.90
4	1156.6	984.4	334.1	82.8	0.89
5	1189.8	989.7	343.8	49.3	0.89
6	1207.4	1009.7	340.9	36.3	0.92
7	812.9	735.7	306.4	41.1	0.89
8	360.8	242.7	315.6	52.6	0.88
9	437.2	284.7	282.8	59.1	0.89
10	354.1	247.1	272.3	69.8	0.90
11	357.5	237.9	374.8	97.4	0.89
12	237.6	190.8	265	70.1	0.89
13	252.4	196.5	271.7	103.8	0.89
14	957.8	493.6	335.5	86.4	0.89
Average	727.5	515	314	63	0.89

NCS Frack Stage (Pump around CT)

Stage	Frac Length	Propped Length	Frac Height	Propped Height	Frac Gradient
	Ft.	Ft.	Ft.	Ft.	psig/ft TVD
1	828.0	693.0	206.0	172.4	0.903
2	348.3	338.1	162.5	157.7	0.927
3	436.0	433.7	143.0	142.3	0.915
4	597.9	593.0	151.5	150.2	0.948
5	417.0	410.5	150.6	148.2	0.873
6	478.8	475.3	141.7	140.7	0.884
7	450.0	447.4	136.9	136.1	0.924
8	458.2	454.5	157.5	156.2	0.858
9	529.3	523.3	177.6	175.6	0.848
10	528.5	493.0	153.6	143.3	0.943
11	482.2	478.0	141.7	140.5	0.887
12	512.6	507.8	146.3	144.9	0.952
13	563.2	548.0	185.8	180.8	0.919
14	584.2	577.0	166.7	164.6	0.957
15	582.2	569.8	162.6	159.1	0.928
17	477.1	471.1	144.0	142.4	0.886
18	585.3	585.3	133.9	133.9	0.856
19	464.7	461.1	138.1	137.0	0.875
20	459.8	459.8	133.2	133.2	0.879
21	449.1	449.1	154.3	164.3	0.883
22	580.5	574.6	144.3	139.8	0.870
23	249.2	249.2	184.8	184.8	0.922
25	294.2	294.2	254.4	254.4	0.932
26	277.4	276.5	289.8	288.9	0.922
27	461.9	461.9	145.4	145.4	0.927
28	471.1	471.1	141.7	141.7	0.932
29	613.1	593.0	147.0	140.0	0.922
32	370.7	366.4	291.4	287.9	0.871
33	286.6	286.6	240.8	240.8	0.867
34	304.1	304.1	238.1	238.0	0.861
35	708.7	682.9	185.8	178.8	0.867
36	674.9	659.9	182.6	174.2	0.865
37	566.8	549.0	174.8	163.3	0.942
38	616.8	604.8	168.2	158.7	0.924
40	605.3	593.3	174.5	165.3	0.923
Average	494.7	483.9	173.2	169.3	0.9





Comparison Pure Slick Water Frack vs X-Link Frack 3rd Bone Spring Sand

Production Summary Report												
API: 30-025-40604												
IGLOO 19 STATE #002H												
Printed On: Wednesday, March 02 2016												
			Production					Injection				
Year	Pool	Month	Oil(BBLS)	Gas(MCF)	Water(BBLS)	Days P/I	Water(BBLS)	Co2(MCF)	Gas(MCF)	Other	Pressure	
2014	[37580] LEA;BONE SPRING, SOUTH	Dec	10105	5658	0	14	0	0	0	0	0	
2015	[37580] LEA;BONE SPRING, SOUTH	Jan	22941	10320	2807	25	0	0	0	0	0	
2015	[37580] LEA;BONE SPRING, SOUTH	Feb	17451	11360	7712	28	0	0	0	0	0	
2015	[37580] LEA;BONE SPRING, SOUTH	Mar	12621	10169	5781	31	0	0	0	0	0	
2015	[37580] LEA;BONE SPRING, SOUTH	Apr	7440	6765	3327	23	0	0	0	0	0	

Caza Operating LP ~ 1 Mile Lateral in the
3rd Bone Spring Sand – 3,223,930 #
Proppant, 2,570,778 Gallons Fluid – X-Link

Production Summary Report												
API: 30-025-42342												
LEA UNIT #032H												
Printed On: Thursday, February 25 2016												
			Production					Injection				
Year	Pool	Month	Oil(BBLS)	Gas(MCF)	Water(BBLS)	Days P/I	Water(BBLS)	Co2(MCF)	Gas(MCF)	Other	Pressure	
2015	[37570] LEA;BONE SPRING	Nov	10814	10439	0	30	0	0	0	0	0	
2015	[37570] LEA;BONE SPRING	Dec	19871	25828	0	31	0	0	0	0	0	

Legacy Reserves Operating LP ~ 1 ½ Mile
Lateral in the 3rd Bone Spring Sand

