

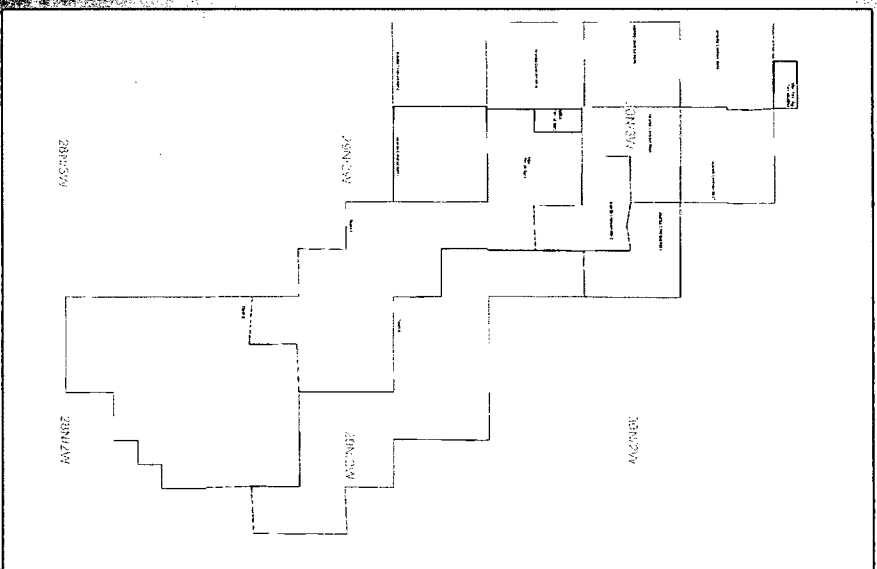
Black Hills Gas Resources

Black Hills Gas Resources East Blanco Field 80-Acre Application

**East Blanco Increased Density
Application**

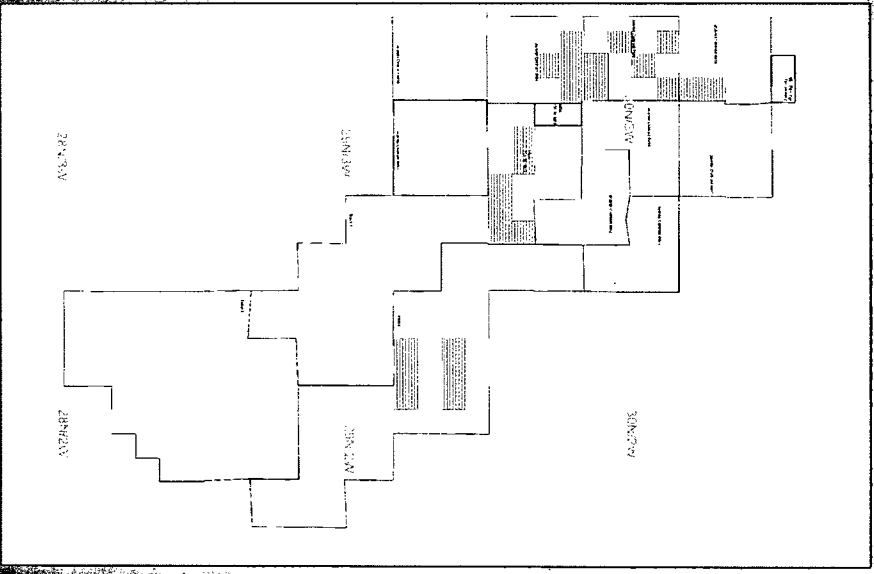
BEFORE THE OIL CONSERVATION DIVISION
Santa Fe, New Mexico
Case No. 13816 Exhibit No. 1
Submitted by:
BLACK HILLS EXPLORATION & PROD., INC.
Hearing Date: November 30, 2006

BHRG Leasehold on Jicarilla Lands



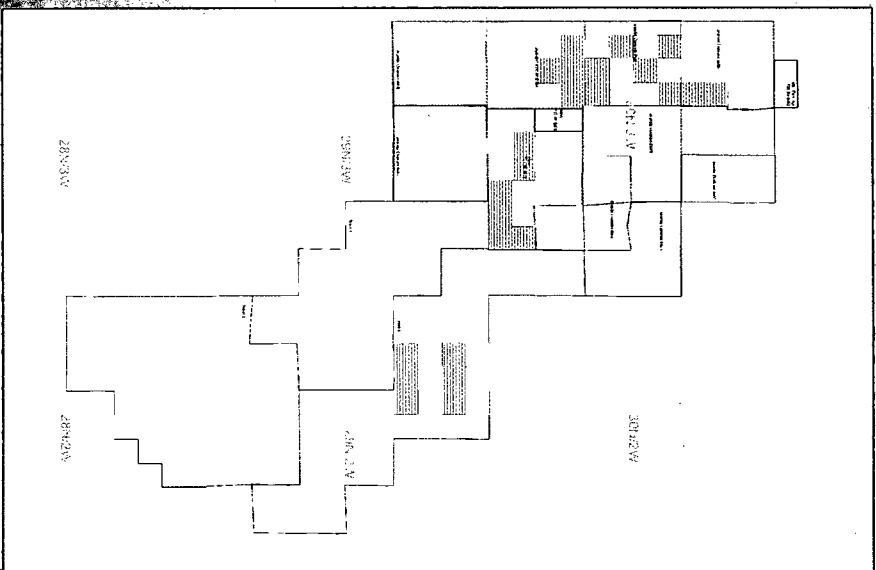
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Original Pilot Program



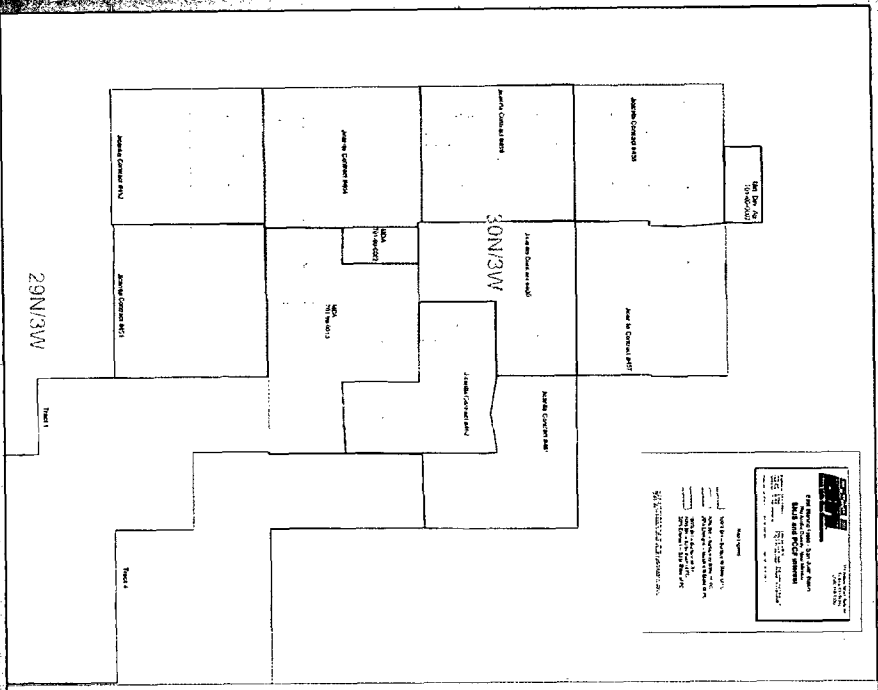
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Proposed Project Outline



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Black Hills Working Interest in Project Area

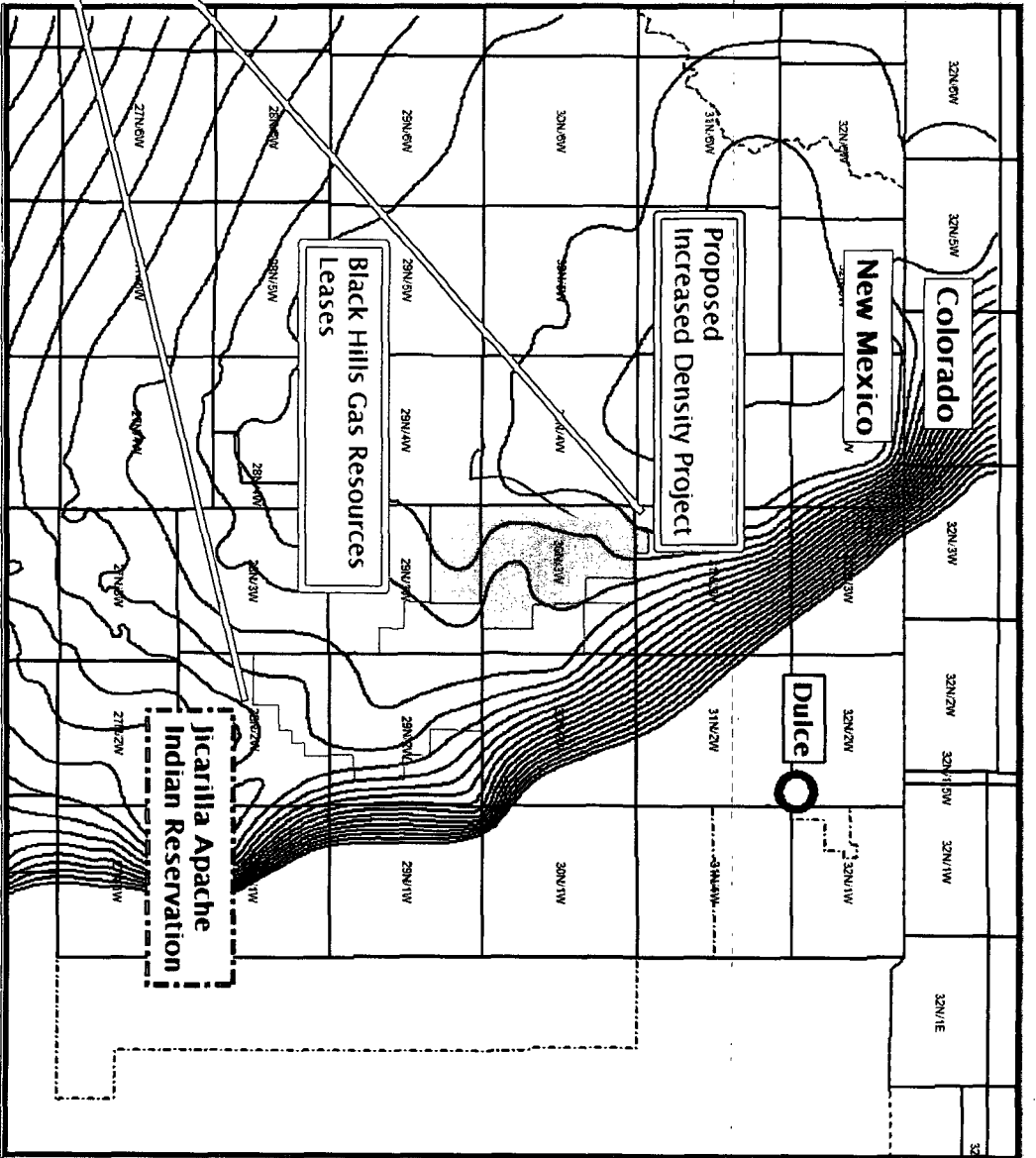
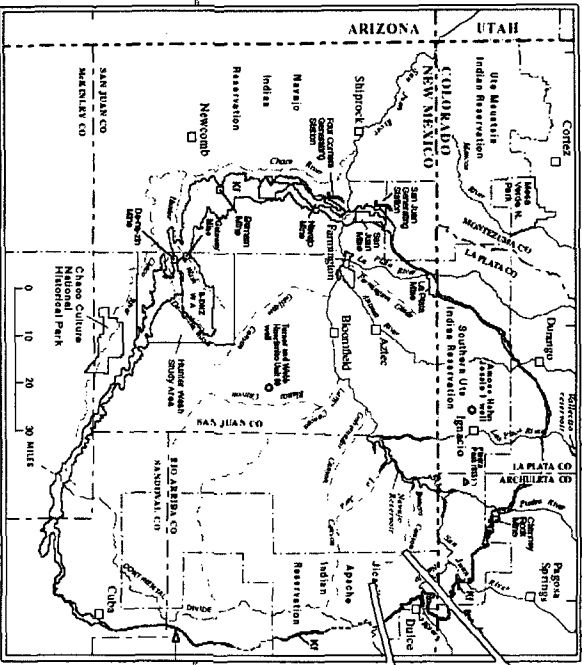


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San Juan Basin

Location Maps



Structural Datum - Huerfanito Bentonite

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San Jose

Nacimiento

Ojo Alamo

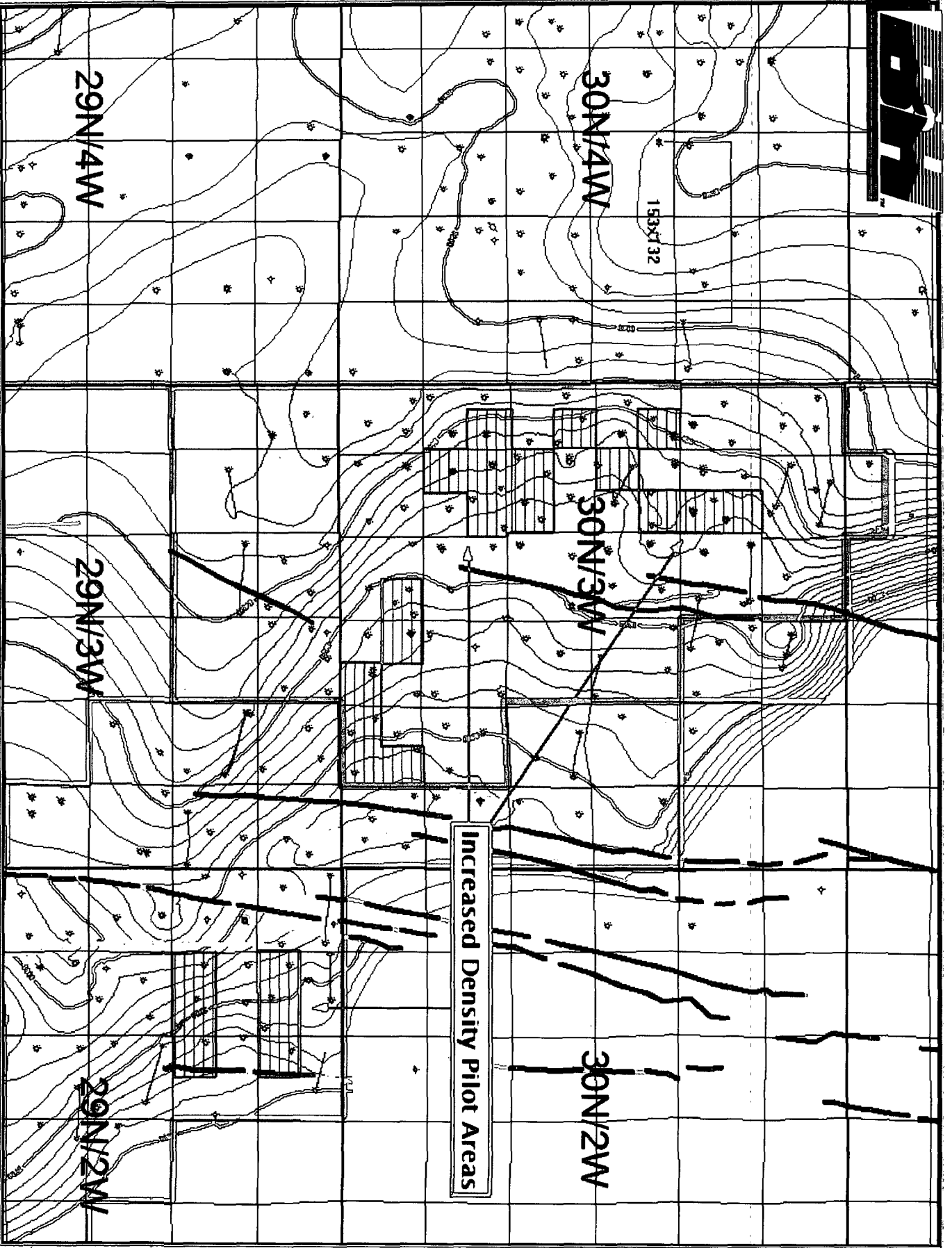
Kirtland / Fruitland

Pictured Cliffs

T

K





Increased Density Pilot Areas

29N/4W

30N/4W

153x132

29N/3W

30N/3W

29N/2W

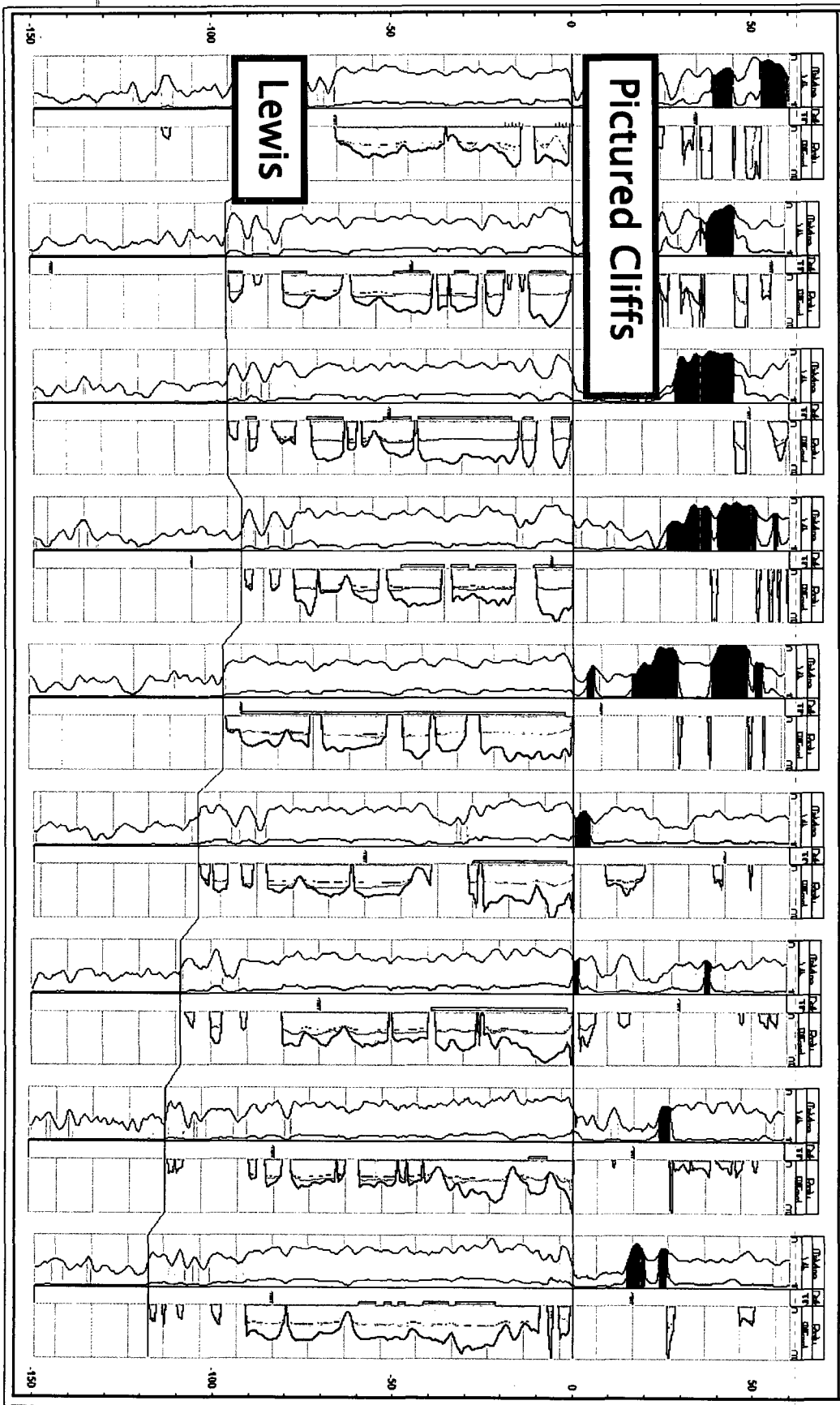
30N/2W



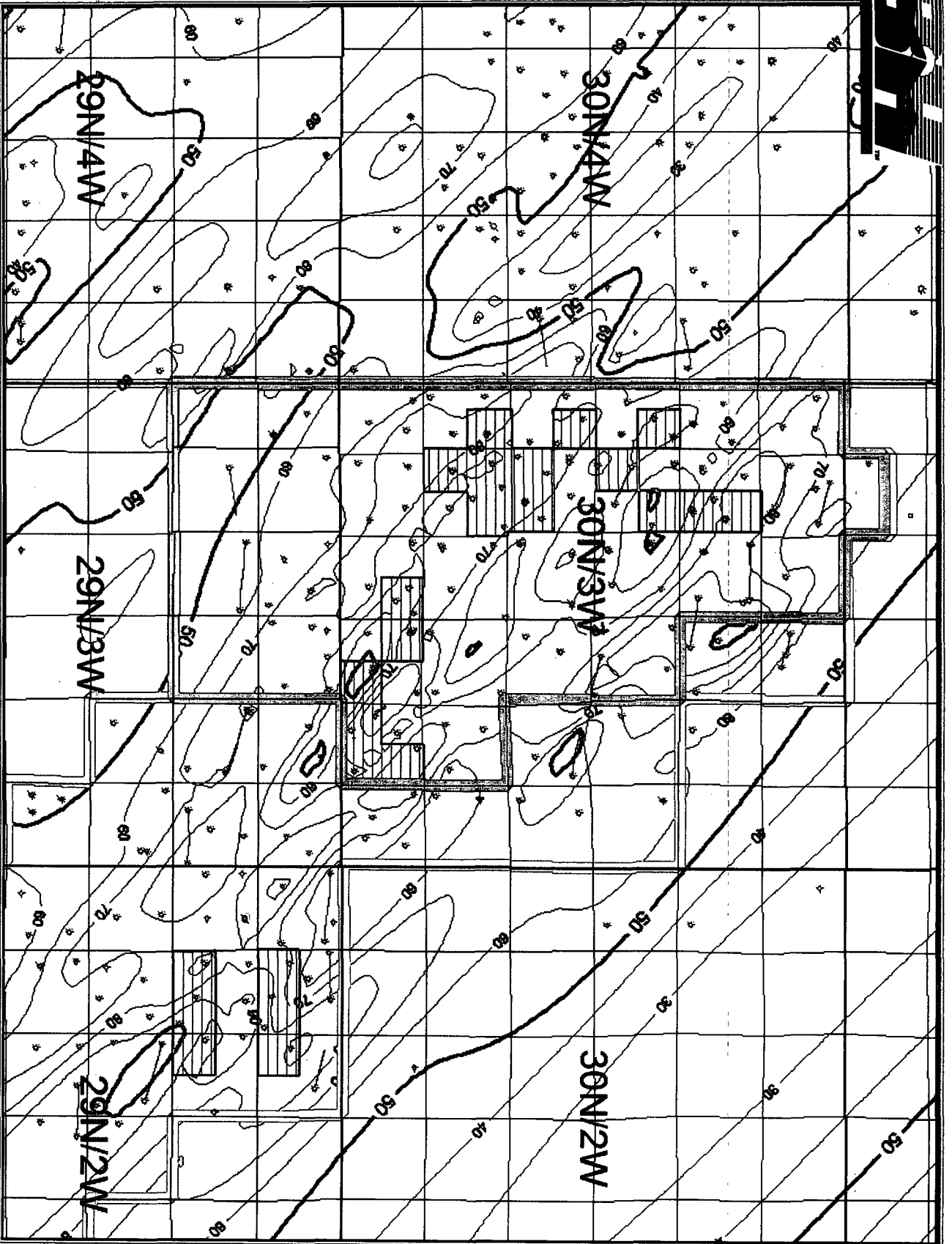
N

S

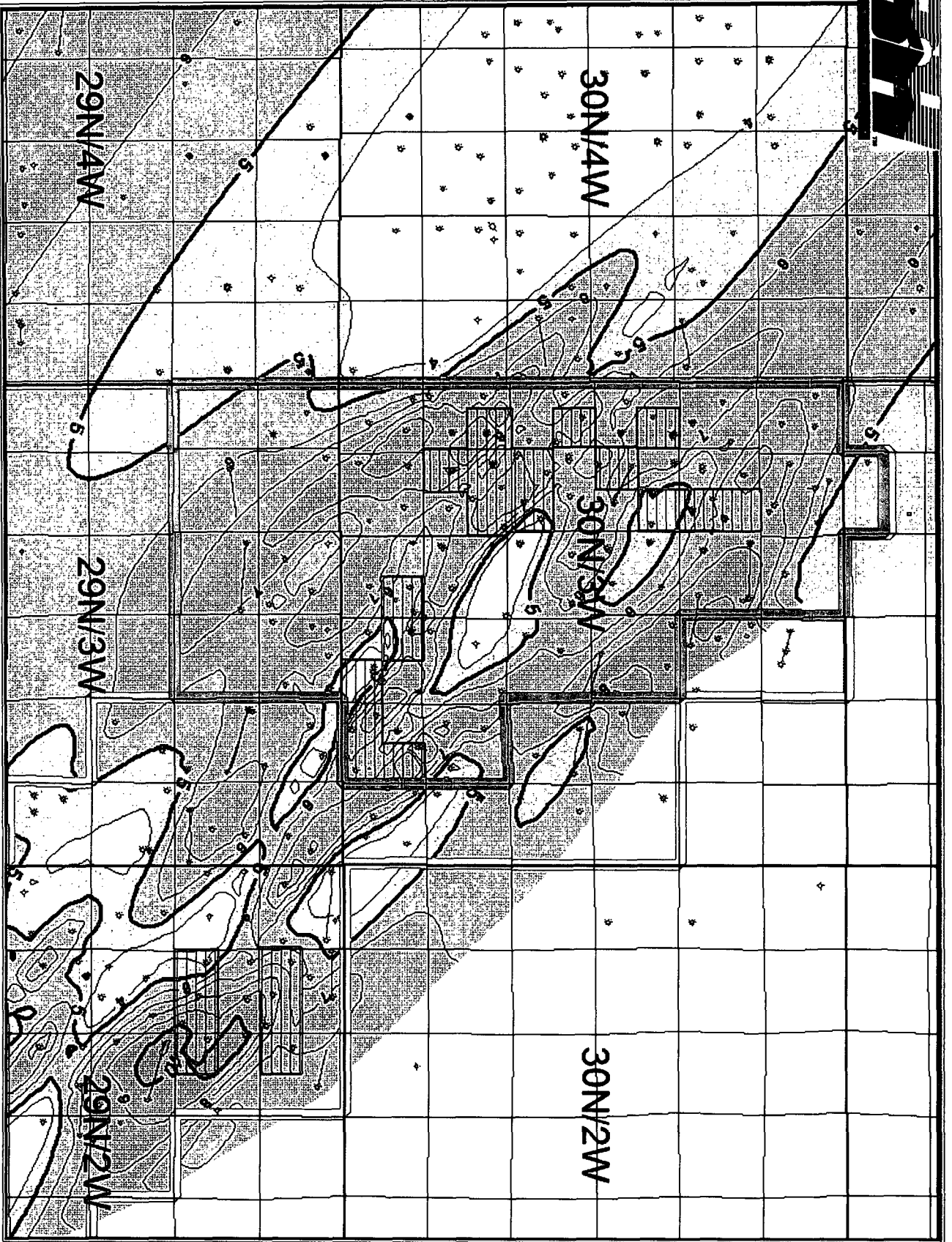
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⊛ BHGR	⊛ BHGR	⊛ BHGR	⊛ BHGR	⊛ BHGR	⊛ BHGR	⊛ BHGR	⊛ BHGR	⊛ BHGR
JIC 458 05 5	JIC 459 3	JIC 459 4	JIC 459 20 8	JIC 464 3	JIC 451 04 1	JIC 30 03 35 4	JIC 30 03 35 1	JIC 30 03 35 3



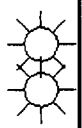
Pictured Cliffs NS Stratigraphic Cross Section



Pictured Cliffs Net Sand



Pictured Cliffs Hydrocarbon Pore Height



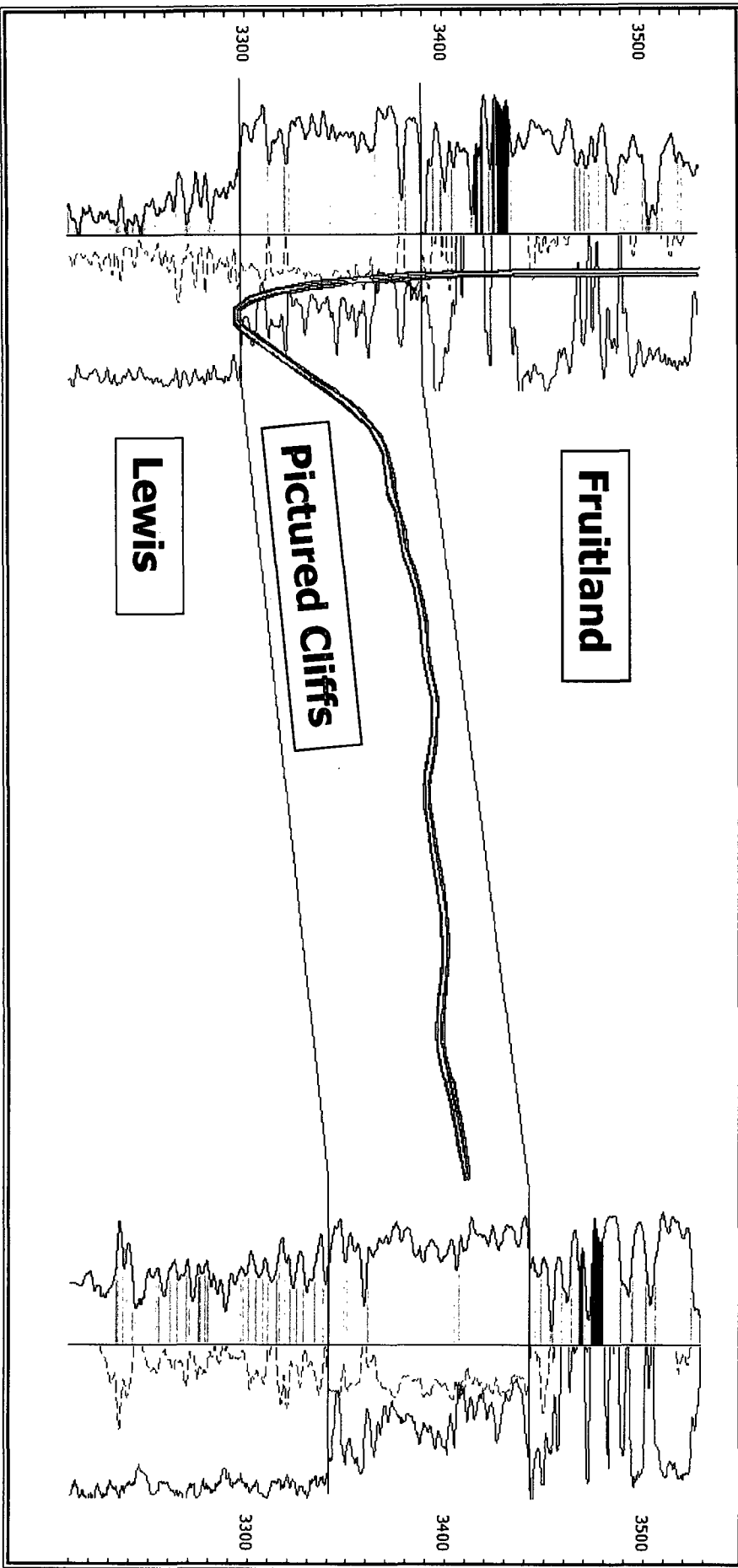
BHGR
JIC 458 05 #2 and #2H



3252 feet



BHGR
JIC 458 05 #3



Pictured Cliffs Uppdip Horizontal Well

Application



San Jose

Nacimiento

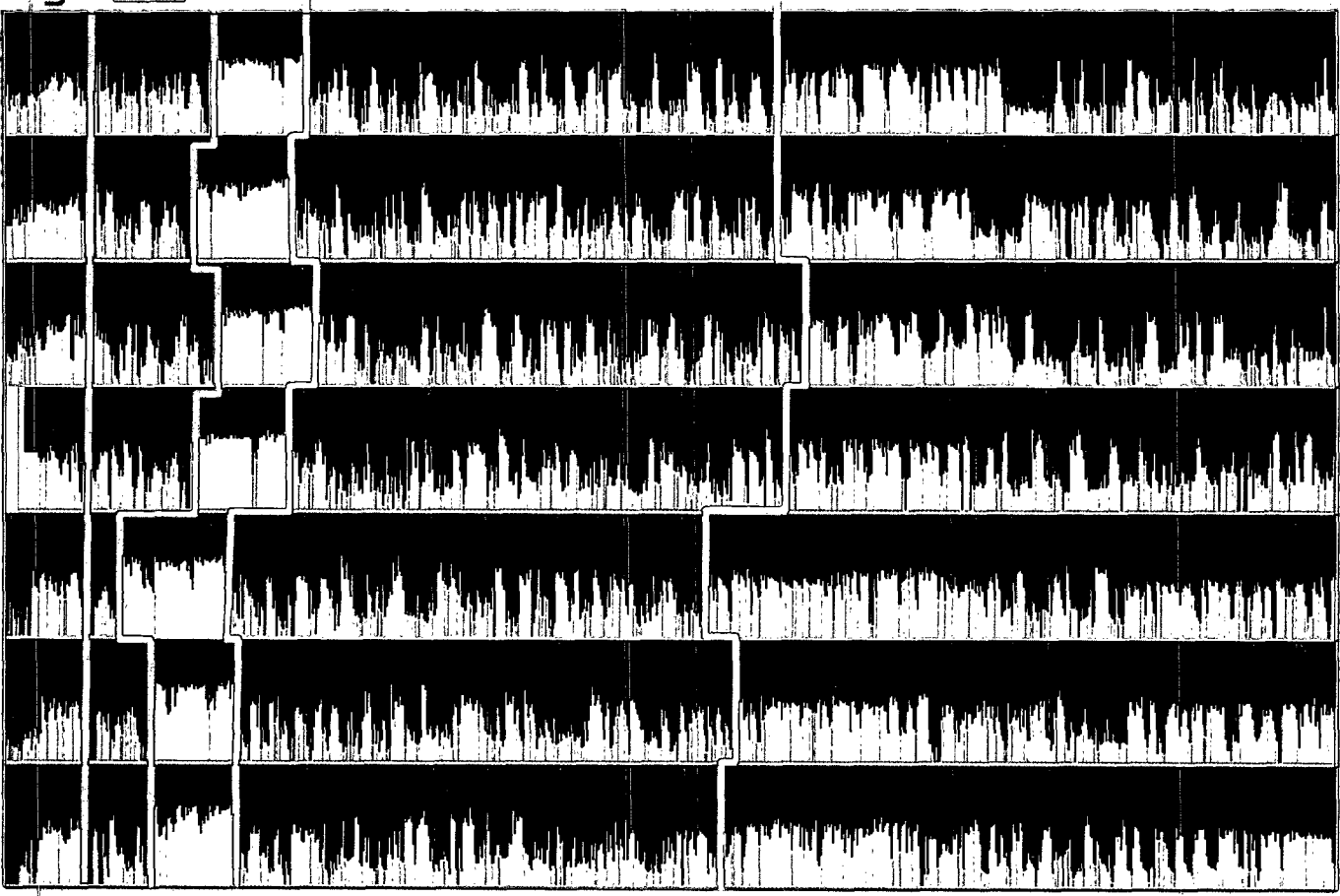
Ojo Alamo

Kirtland / Fruitland

Pictured Cliffs

T

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N

JIC 458 05 2

BHGR
JIC 459 5

BHGR
JIC 484 29 9

BHGR
JIC 30 03 28 3

BHGR
JIC 30 03 33 1

BHGR
JIC 30 03 27 2

BHGR
JIC 30 03 34 1

BHGR
JIC 30 03 34 4

BHGR
JIC 481 03 21

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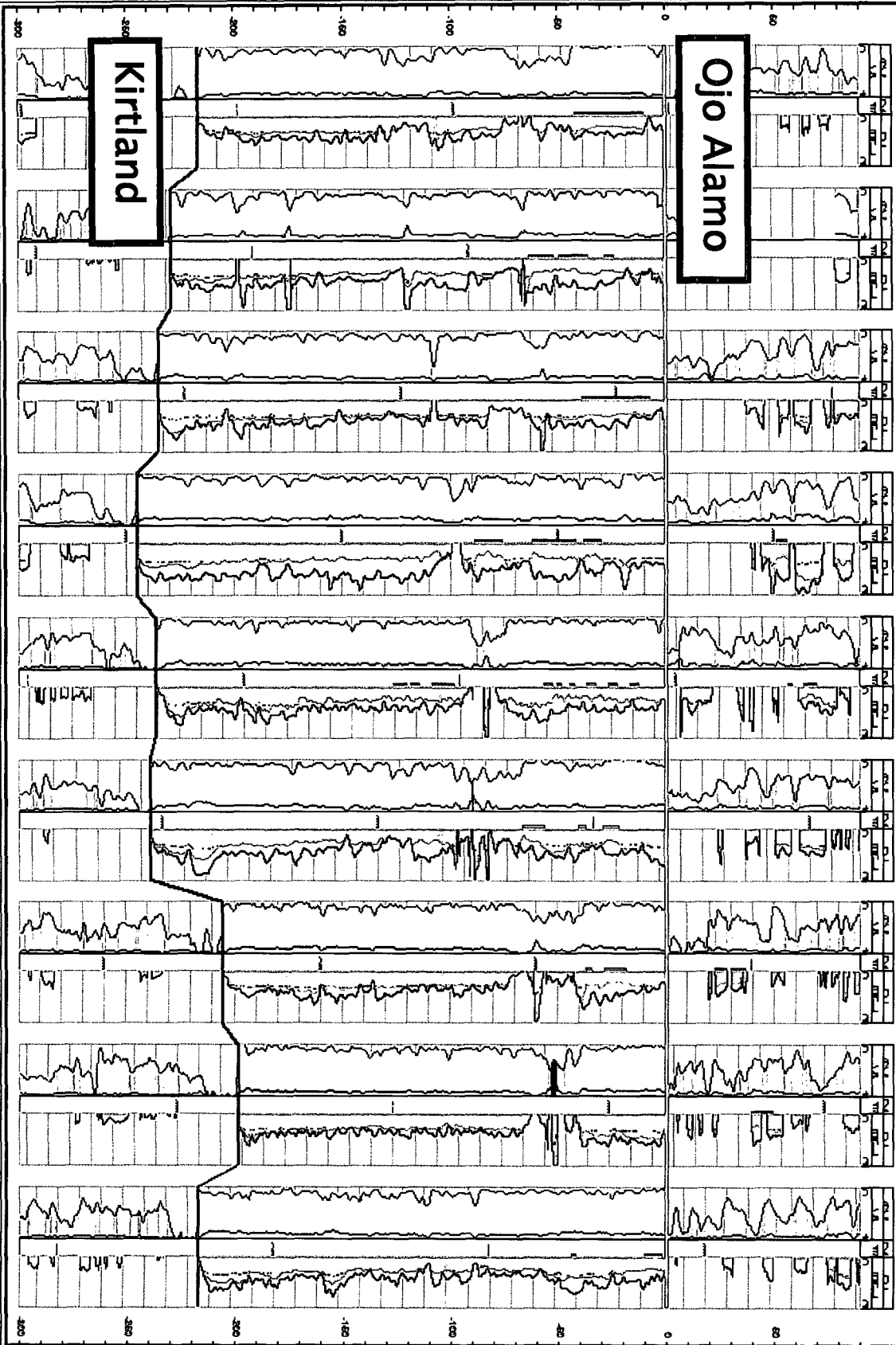
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Ojo Alamo NS Stratigraphic Cross Section

Overview – Reservoir Engineering Pictured Cliffs (PC)

- Recommendation
- RTA analysis
- Idealized recovery
- EUR vs. OGIP
- Recovery Efficiency vs. OGIP

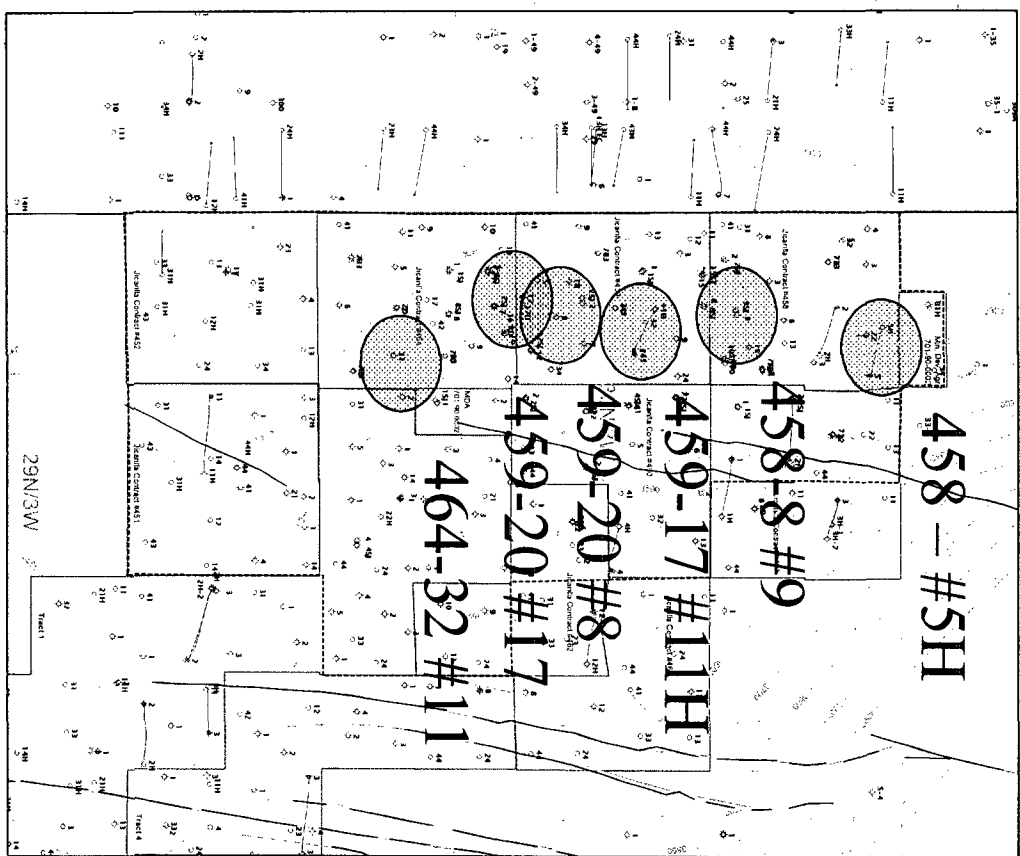
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Recommendation – (PC)

Increased well density in the PC project area is technically justified

- **Two vertical wells per 160-acre drainage unit, or**
- **Two horizontal wells per 320-acre drainage unit.**

RTA Analysis -



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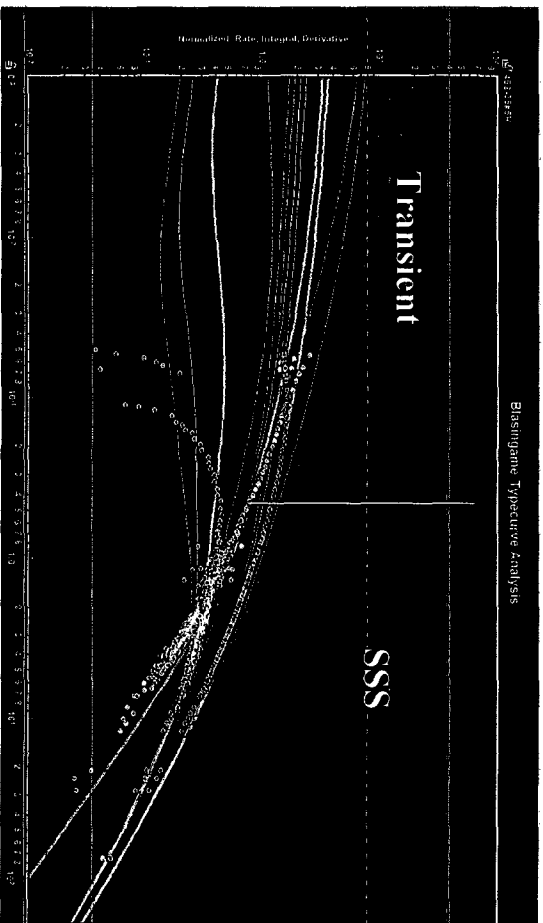
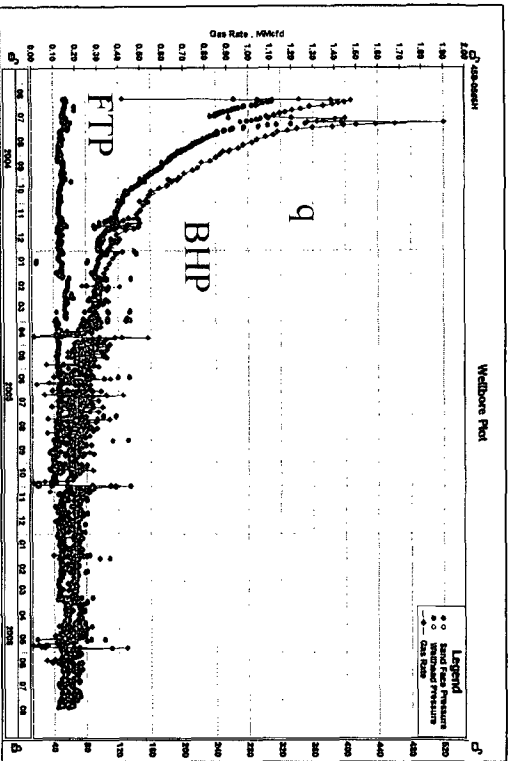
RTA Analysis

Assumptions/Requirements

- Hurst Van Everdingen (H-VE) idealized reservoir
- Measured or calculated sand-face pressures and rates
- Radial, fractured or horizontal well
- Well petrophysics and fluid properties
- Well diagram
- Model computes normalized productivity (q/dp) and material balance time ($Q/(qp)$)
- Continuous well test without shutting the well in

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RTA Technique



S
K, md
Xf, ft
OGIP
A

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RTA Results PC

RTA Results Well	Picture Cliffs						NPI						FMB			Trad		Fetk
	RTA	Blasingame	h	Phi	k	Xf/2	Leff	A	OGIP	h	Phi	k	Xf/2	A	OGIP	OGIP	OGIP	OGIP
JIC 464-32#11		64	0.114	0.283	<10		47	707	64	0.114	0.09	80	45	630	740	650	587	
JIC 459-20#8		57.5	0.115	0.09	653		123	618	57.5	0.115	0.08	630	115	1520	2508	1727	na	
JIC 459-20#17		55	0.115	0.05	82		47	597	55	0.115	0.01	388	44	380	650	803	476	
JIC 459-17#11H		57	0.123	0.012		1800	42	540	57	0.123	0.04	382	42	640	850	880	1186	
JIC 458-8#9		50	0.113	0.03	<10		19	233	50	0.113	0.016	20	12	100	452	540	116	
JIC 458-5#5H		46	0.113	0.006		3000	42	516	46	0.113	0.029	760	42	460	575	520	650	

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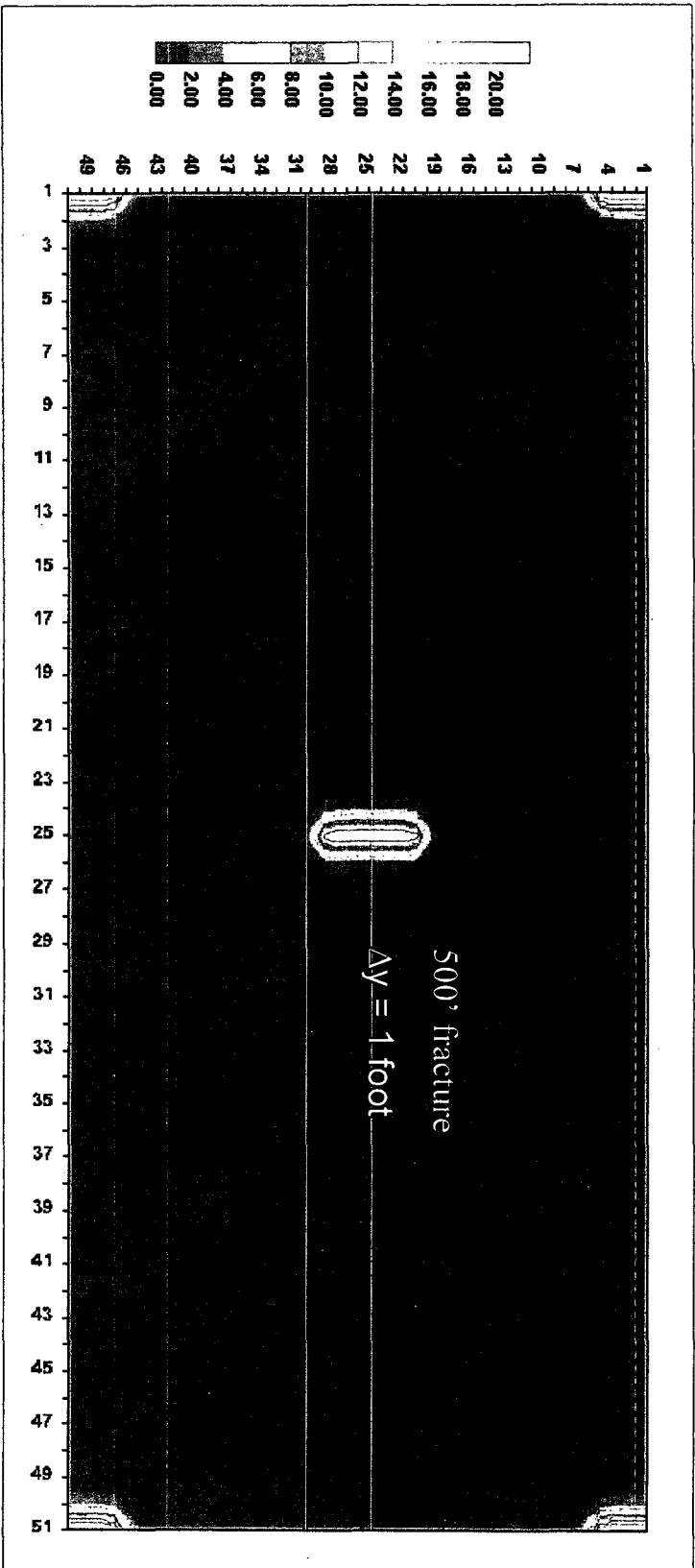
Idealized Recovery Factors

- H-VE Reservoir
- 160-acre well spacing
- Average PC properties
- 51 x 50 x 1 3-d model
- Single phase reservoir
- Fractured well (in grids)

PC2		
Parameter	Units	Value
h	ft	55
phi	dim	0.115
kx	md	0.061
ky	md	0.061
Swc	dim	0.5
Pinit	psia	1150
Tres	ft	120
Rhog	dmf	0.66
z	dim	0.88
OGIP	MMcf	1755
Xf/2	ft	250
Kf	md	21

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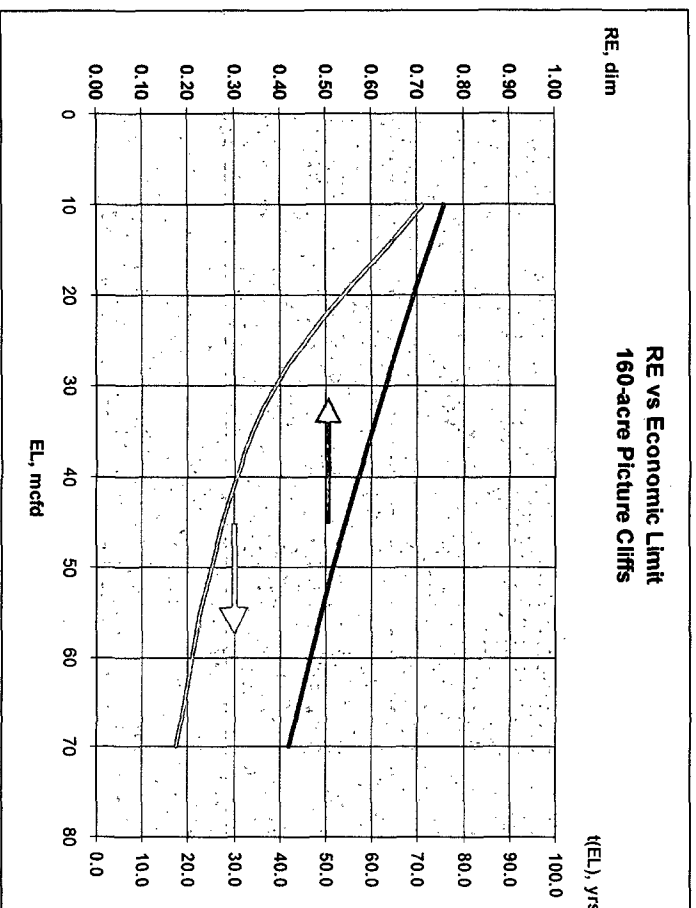
Grid Permeability



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Ideal PC Recovery Efficiency Results

- RE very sensitive to EL
- RE not as sensitive to k
- Time to EL is excessive
- Ideal model results in higher RE than actually observed in practice
- Even simple reservoir heterogeneity can impact RE
- Ideal RE is .76 at 10 EL



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PC single zone statistics

Project area only

	EUR	OGIP	RE
N	41	41	41
max	2107	3171	1.060
min	0	633	0.000
average	617	1953	0.316
geomean	246	1859	0.132
median	490	1998	0.247

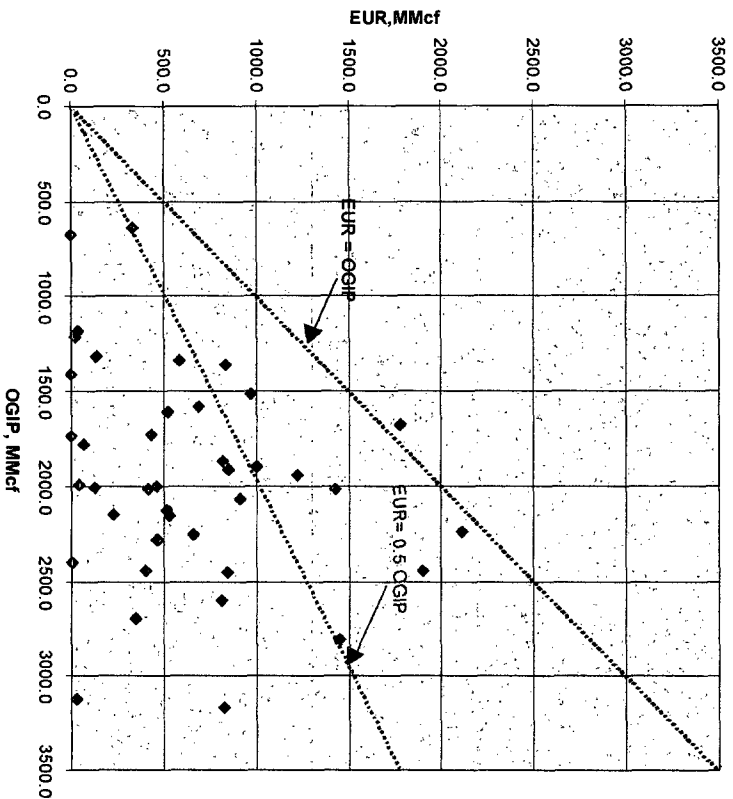
OGIP is volume in 160-acre drainage

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PC EUR vs. OGIP

Picture Cliffs EUR vs OGIP

EUR from decline curve analysis and OGIP from 160 acre volumetrics

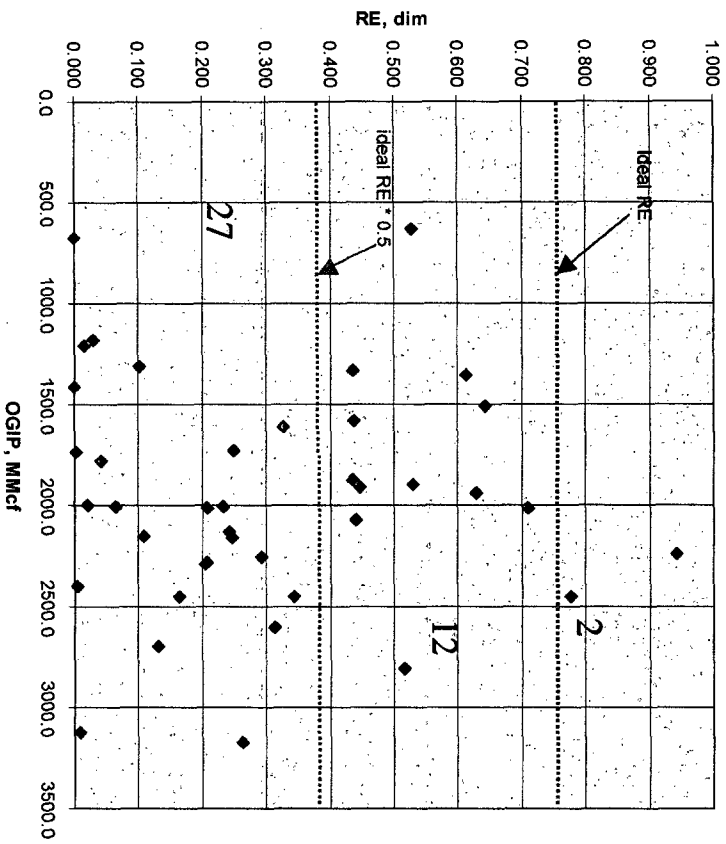


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PC RE vs. OGIP

Picture Cliffs RE vs OGIP

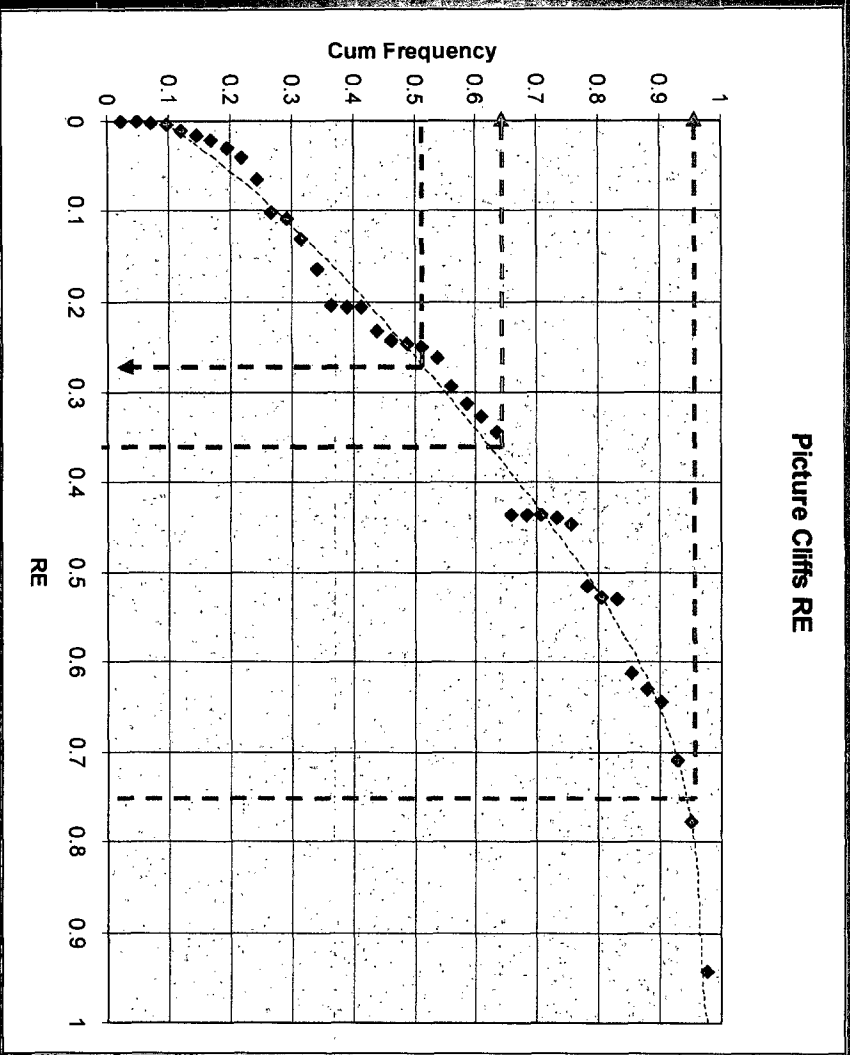
RE is EUR/OGIP per 160 acre drainage



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Cum Frequency Plot for RE

Picture Cliffs RE



East Bianco Increased Density Application

Pictured Cliffs

Engineering Conclusions

- 80-acre well density is recommended in the project area to improve recovery
- RTA analysis indicates most wells are draining less than 80 acres
- Idealized model indicates high recovery within drainage volume
- Complex reservoir behavior (layers, anisotropy and limited continuity)
- Statistics on existing PC only completions supports recommendation
 - Half of the wells drain less than 30 acres
 - 65 % have less than idealized 80-acre RE
 - 5 % of wells have exceeded idealized 160-acre RE
- Additional tests (RFT and logs) are necessary to optimize PC recovery
- Additional experience with horizontal wells required to optimize design and reduce cost

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Tertiary Expansion of Project Area

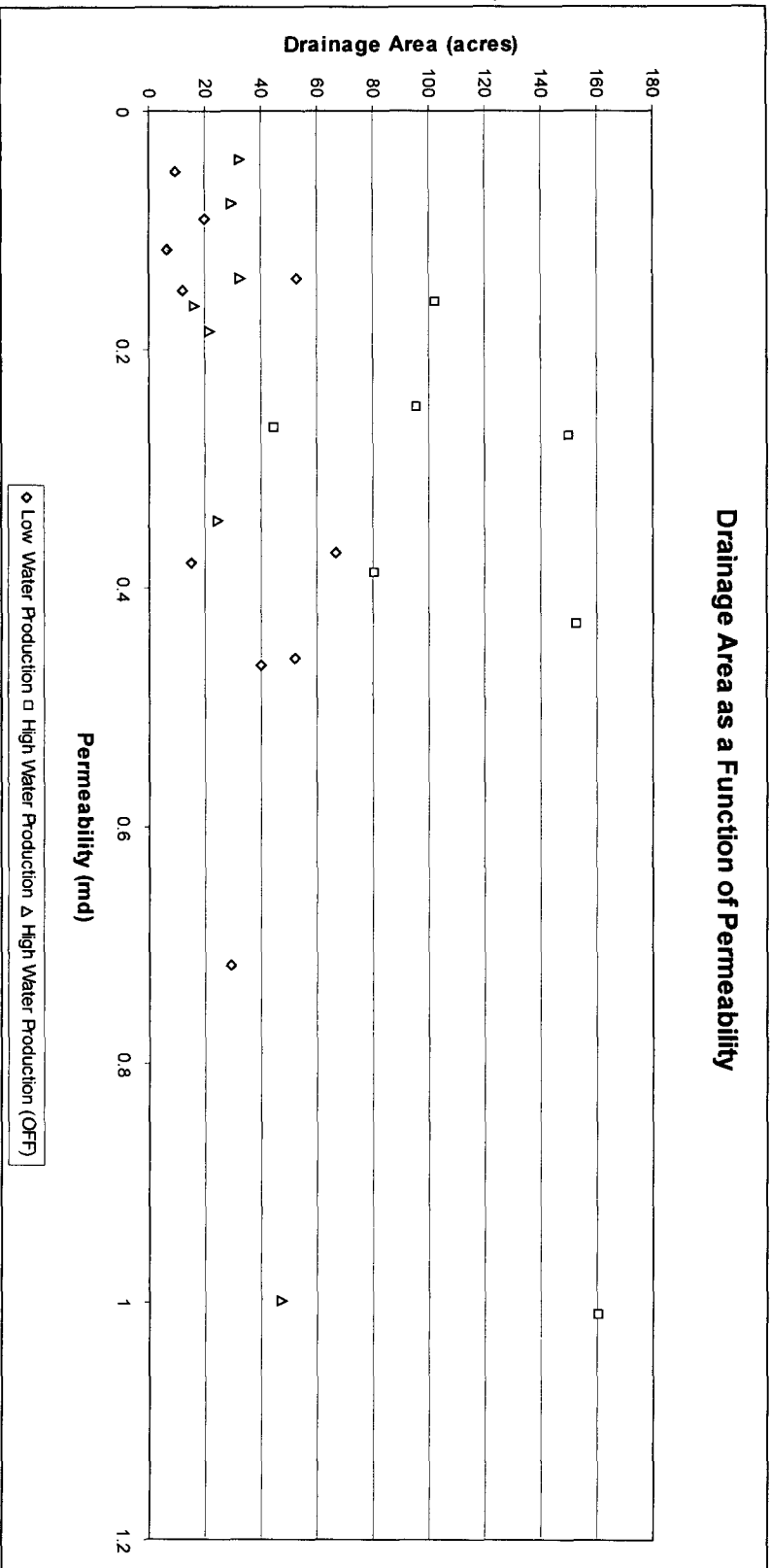
- **Geology is complex**
- **Additional Engineering data required for proper evaluation.**
- **Data collected and analyzed to date indicates increased well density will result in incremental production.**
- **Tertiary zones will be penetrated as we drill to PC.**

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Tertiary RPI evaluation

Drainage Area as a Function of Permeability



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