

# North Dakota Department of Mineral Resources



<http://www.oilgas.nd.gov>

<http://www.state.nd.us/ndgs>

***600 East Boulevard Ave. - Dept 405***

***Bismarck, ND 58505-0840***

***(701) 328-8020***

***(701) 328-8000***

# North American shale plays (as of May 2011)



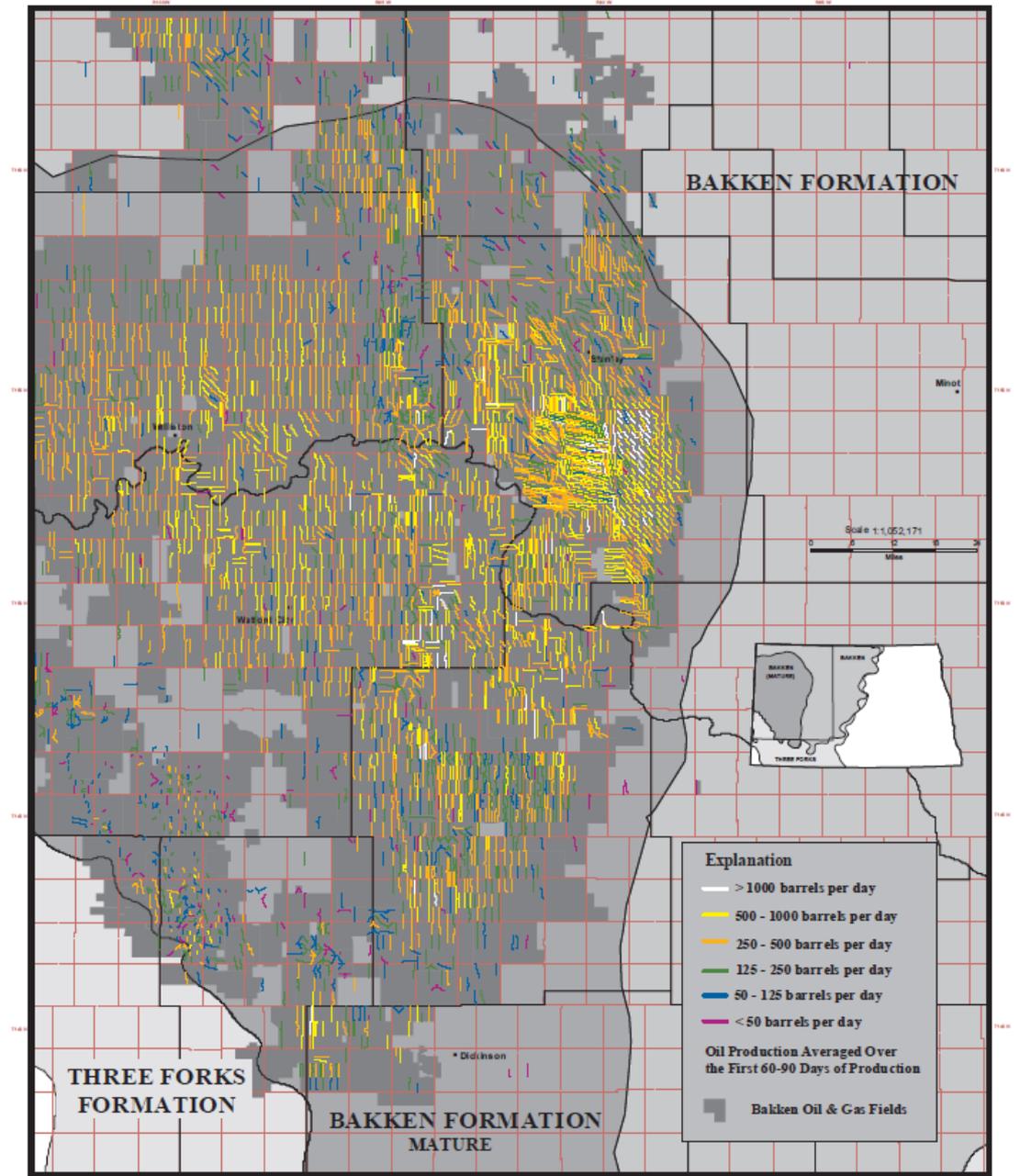
Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.  
 Updated: May 9, 2011

# First 60 - 90 Day Average Bakken Horizontal Production by Well

December 2012



Development area  
> 15,000 sq mi  
Size of West Virginia



## Bakken Formation

## Three Forks Formation

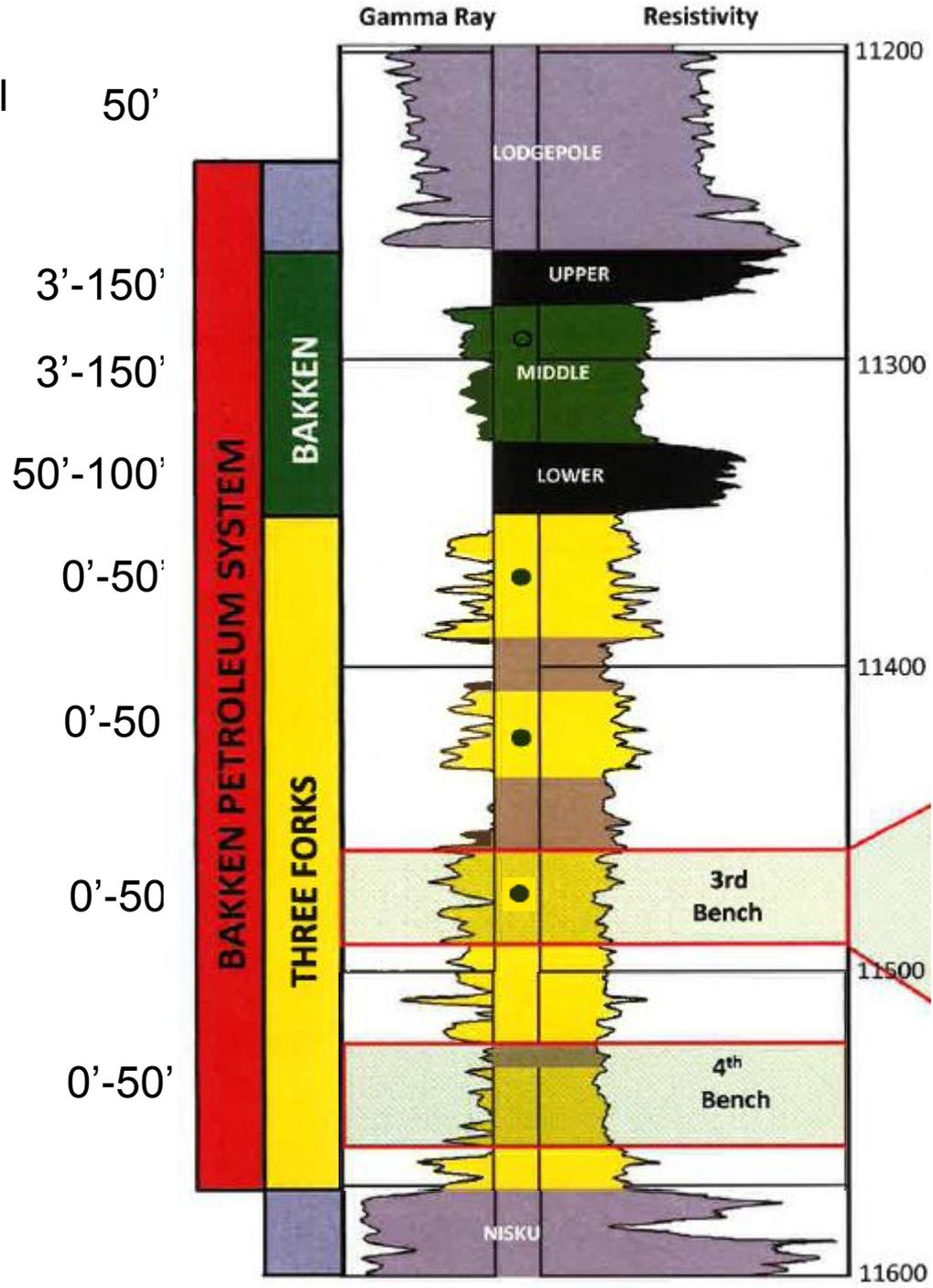
upper shale

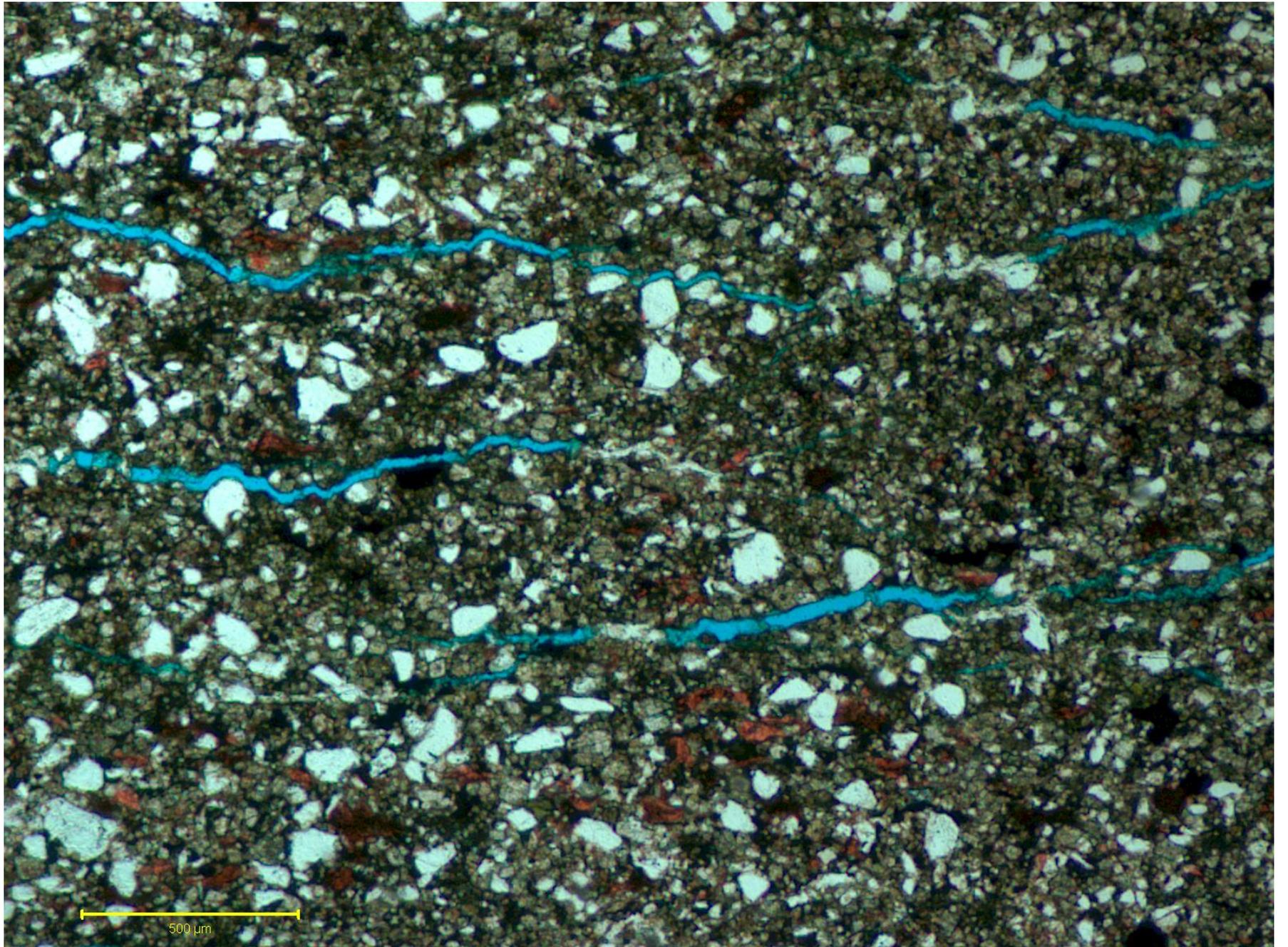
middle member

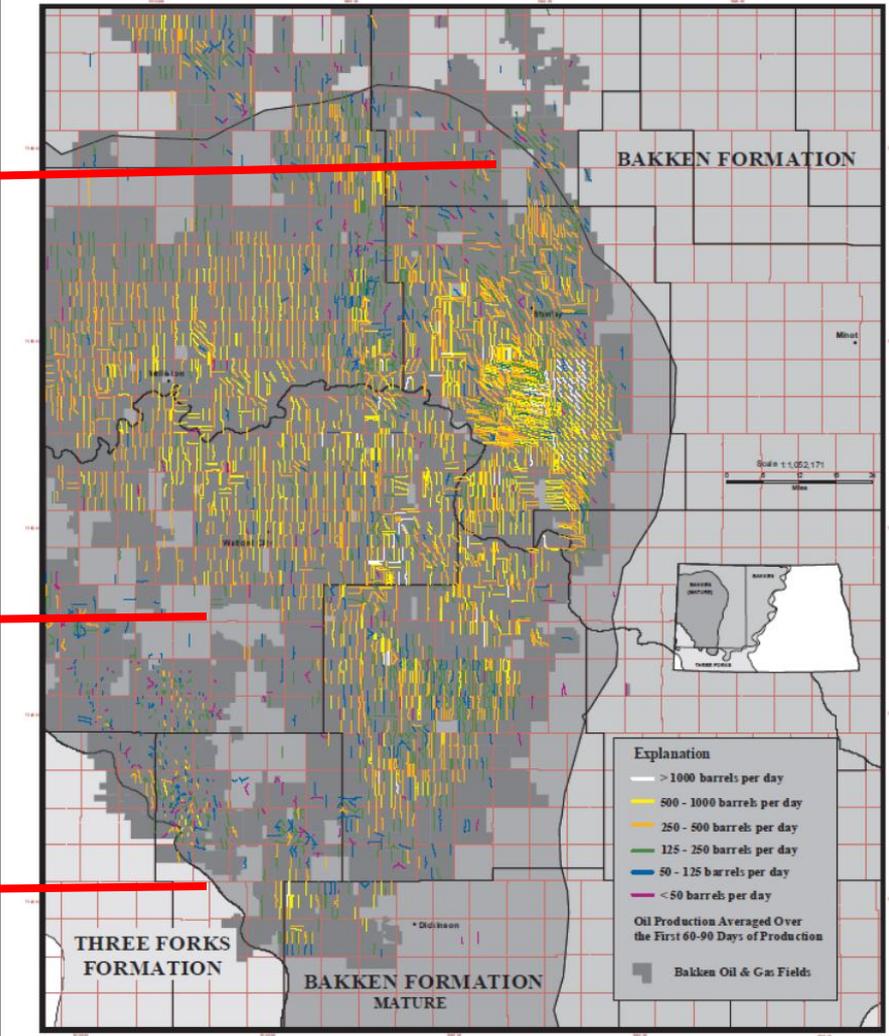
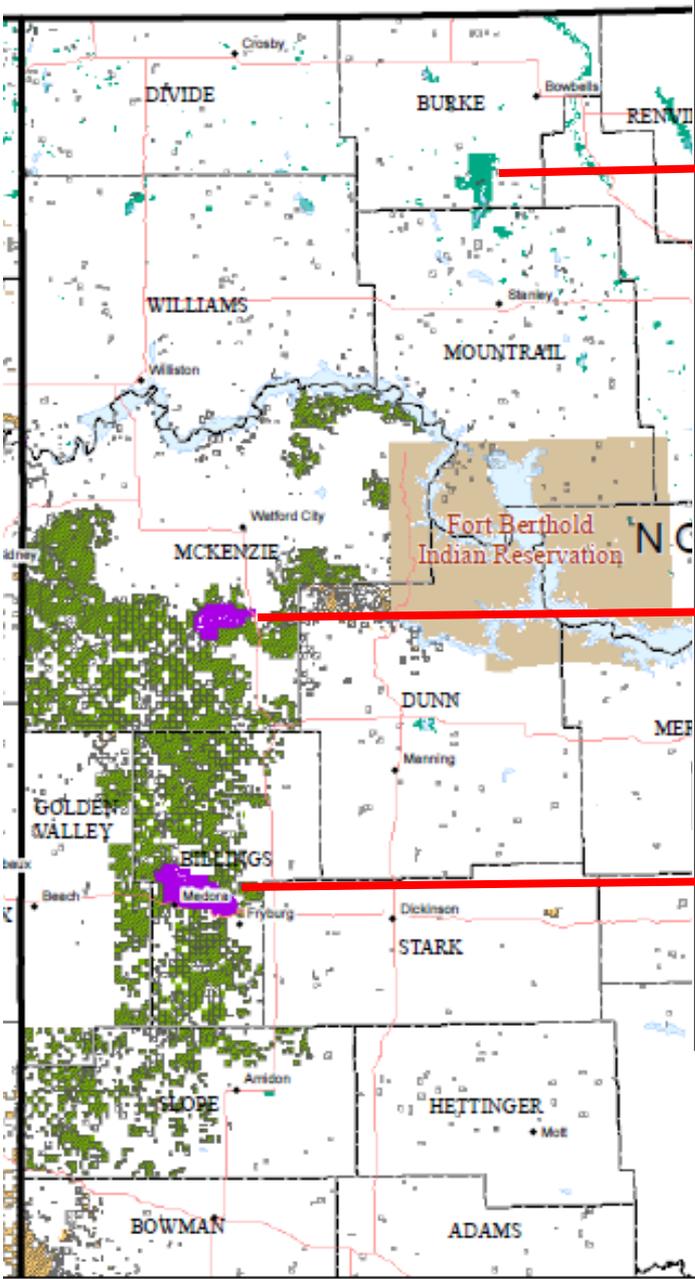
lower shale



Stimulated rock volume for one lateral  
150' vertical X 750' horizontal







- National Park Service
- U.S. Fish and Wildlife Service
- U.S. Forest Service



*No warranty is made by the BLM as to the accuracy, reliability, or completeness of this data for individual*



**38-08-07. COMMISSION SHALL SET SPACING UNITS.** The commission shall set spacing units as follows:

1. When necessary to **prevent waste, to avoid the drilling of unnecessary wells, or to protect correlative rights**, the commission shall establish spacing units for a pool. Spacing units when established must be of uniform size and shape for the entire pool, except that when found to be necessary for any of the purposes above mentioned, the commission is authorized to divide any pool into zones and establish spacing units for each zone, which units may differ in size and shape from those established in any other zone.
2. The size and shape of spacing units are to be such as will result in the **efficient and economical development** of the pool as a whole.

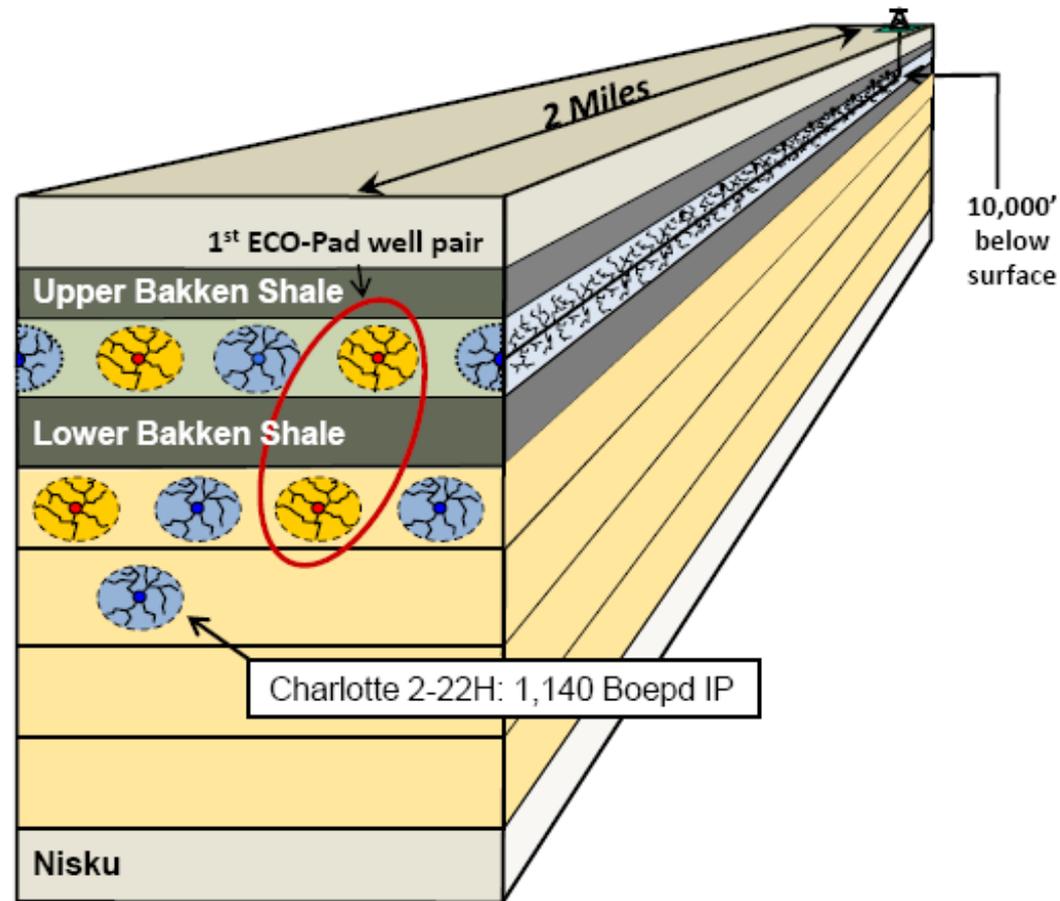
**38-08-07. COMMISSION SHALL SET SPACING UNITS.** The commission shall set spacing units as follows:

3. An order establishing spacing units for a pool must specify the size and shape of each unit and the location of the permitted well thereon in accordance with a reasonably uniform spacing plan. Upon application, if the commission finds that a well drilled at the prescribed location would not produce in paying quantities, that surface conditions would substantially add to the burden or hazard of drilling such well, or that the drilling of such well at a location other than the prescribed location is otherwise necessary either to protect correlative rights, to prevent waste, or to effect greater ultimate recovery of oil and gas, the commission is authorized to enter an order permitting the well to be drilled at a location other than that prescribed by such spacing order; however, the commission shall include in the order suitable provisions to prevent the production from the spacing unit of more than its just and equitable share of the oil and gas in the pool.

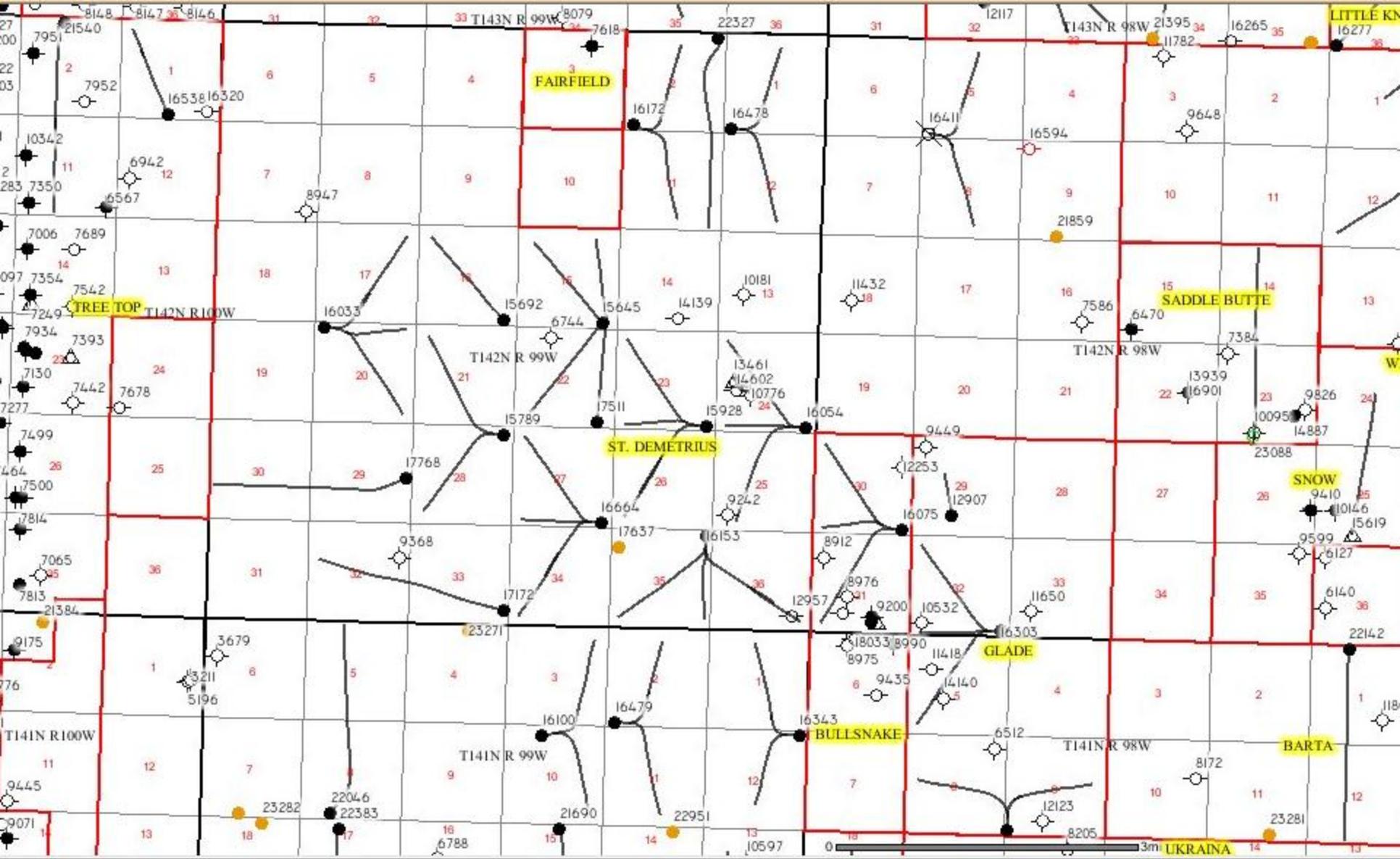
4. An order establishing units for a pool must cover all lands determined or believed to be underlaid by such pool, and may be modified by the commission from time to time to include additional areas determined to be underlaid by such pool. When found necessary for the prevention of waste, or to avoid the drilling of unnecessary wells, or to protect correlative rights, an order establishing spacing units in a pool may be modified by the commission to increase or decrease the size of spacing units in the pool or any zone thereof, or to permit the drilling of additional wells on a reasonably uniform plan in the pool, or any zone thereof, or an additional well on any spacing unit thereof.

# Bakken Development Plan

Think  
Outside  
The  
Box



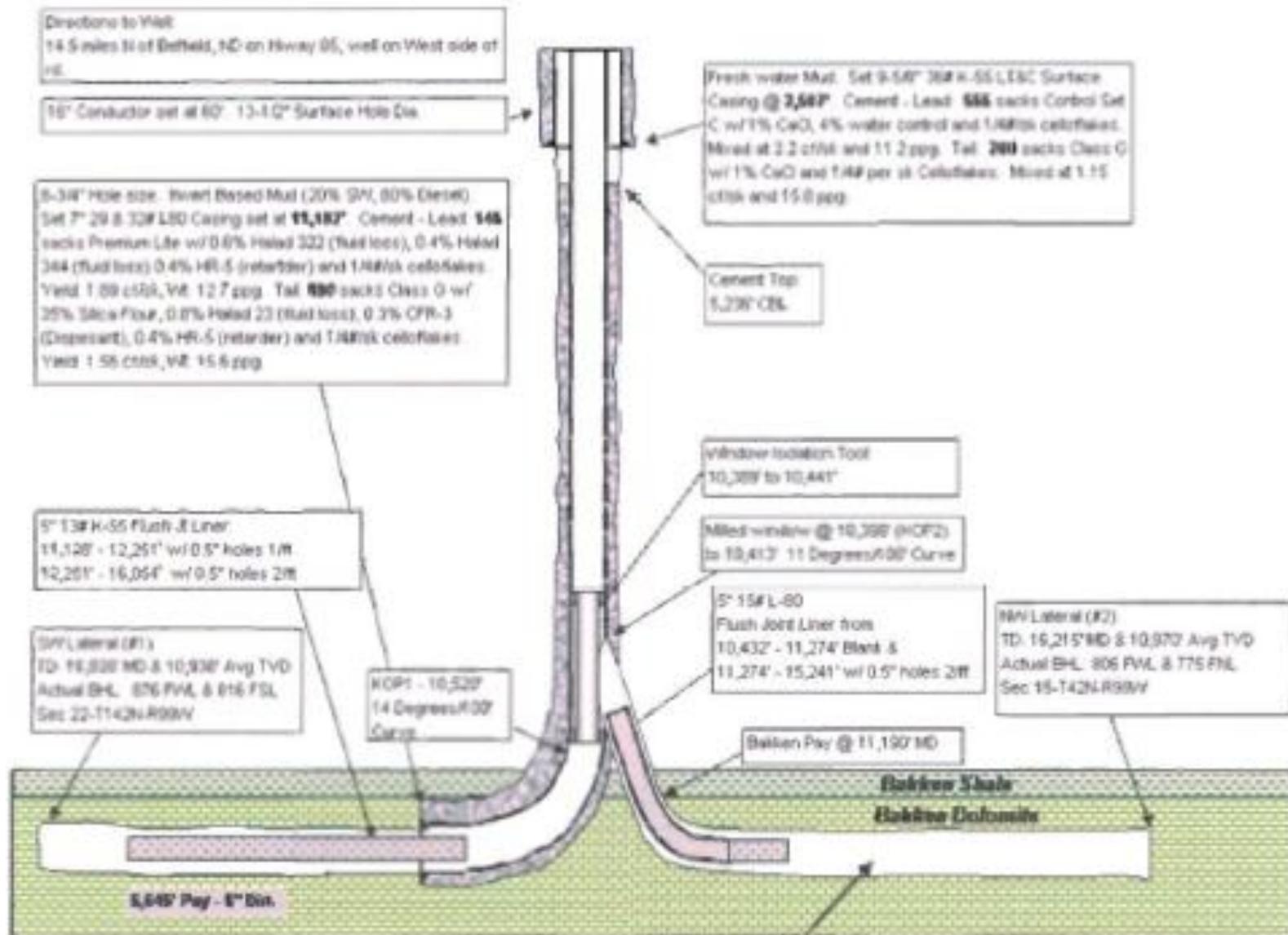


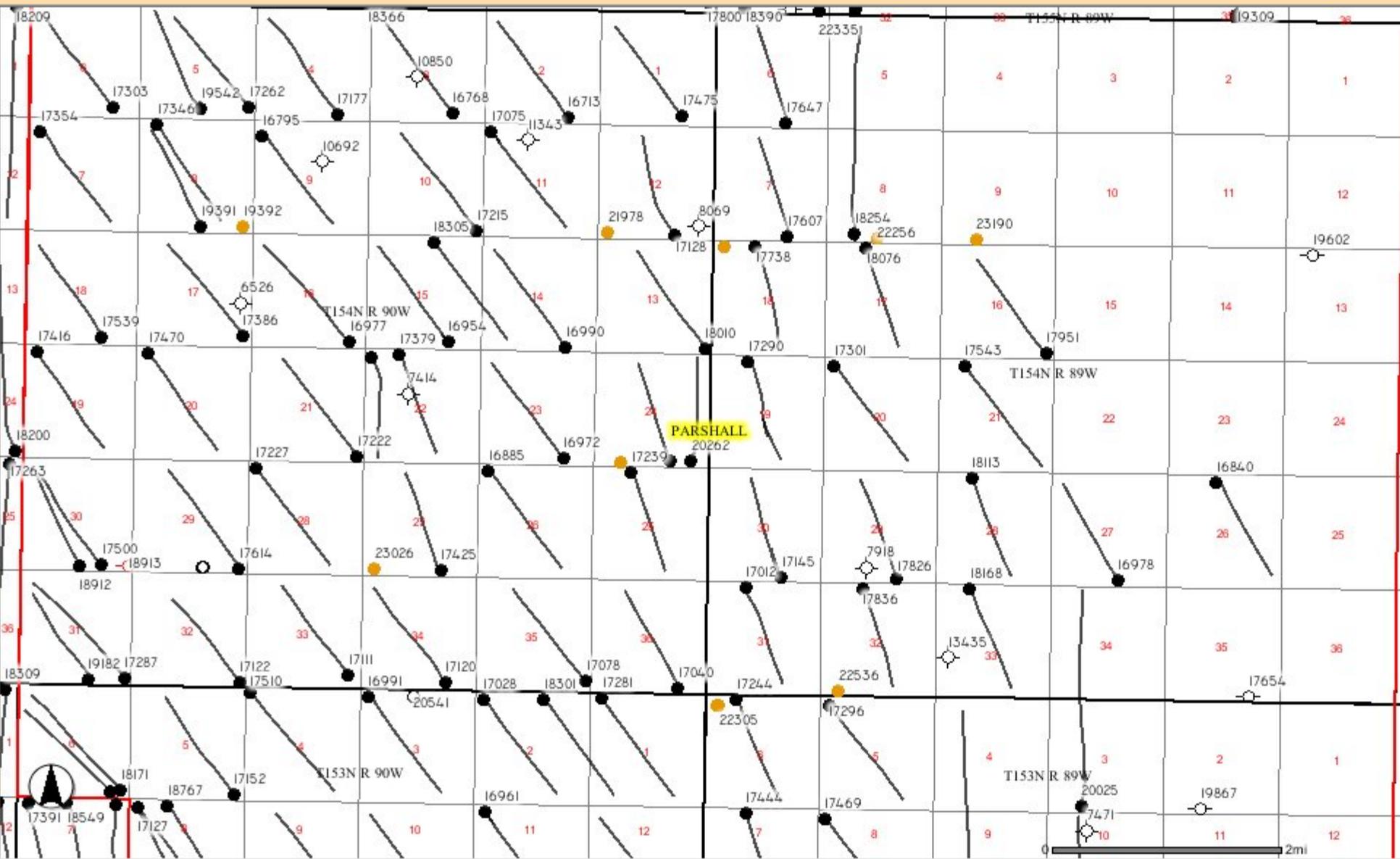


Ukraina Style 1280 acre spacing-horizontal wells - single frac each leg - less than 20% economic

# CONSTRUCTION DIAGRAM

## LOGOSZ 44X-15





**Wells**  
Selection cleared.

200 sq mi area

Extreme over pressure due to confining faults and mature/immature shale bound

99% economic

**9-13-07**  
**Liner Installation**

**Austin 1-02H 33-061-00549**

SHL 350' FSL & 1,400' FEL (SW/SE)  
BHL: ~4,344' N of SHL & ~3,256' W of SHL  
Sec. 2, T154, R90W  
Mountrail Co., ND  
GL 2,200' KB 2,226'

9-5/8" 36# J-55 set  
at 1,955' cmt @ surf

INDUSTRIAL COMMISSION  
STATE OF NORTH DAKOTA  
DATE 12/19/07 CASE NO. 9796/98  
Introduced By EOG  
Exhibit E1  
Identified By Koenig

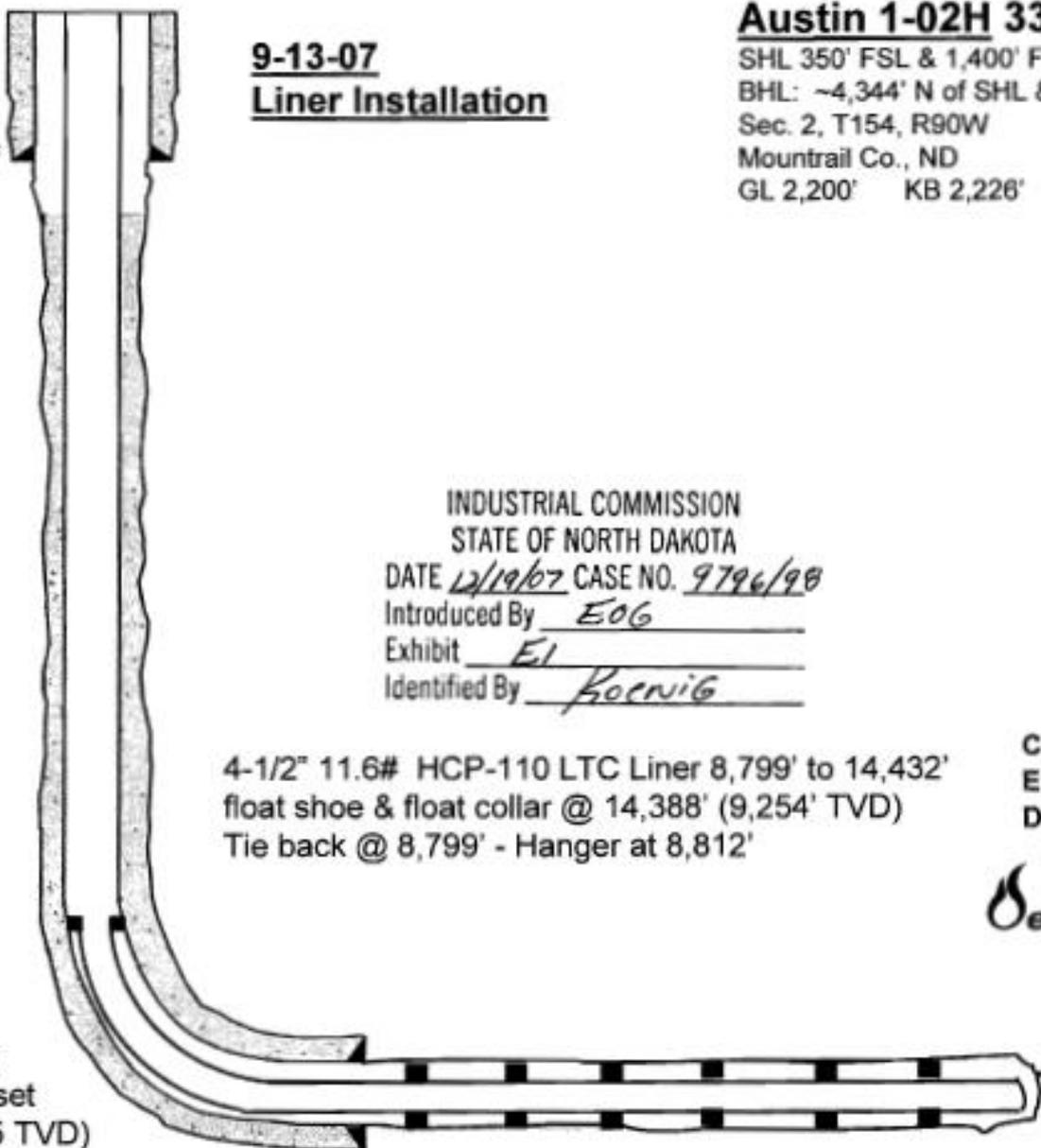
4-1/2" 11.6# HCP-110 LTC Liner 8,799' to 14,432'  
float shoe & float collar @ 14,388' (9,254' TVD)  
Tie back @ 8,799' - Hanger at 8,812'

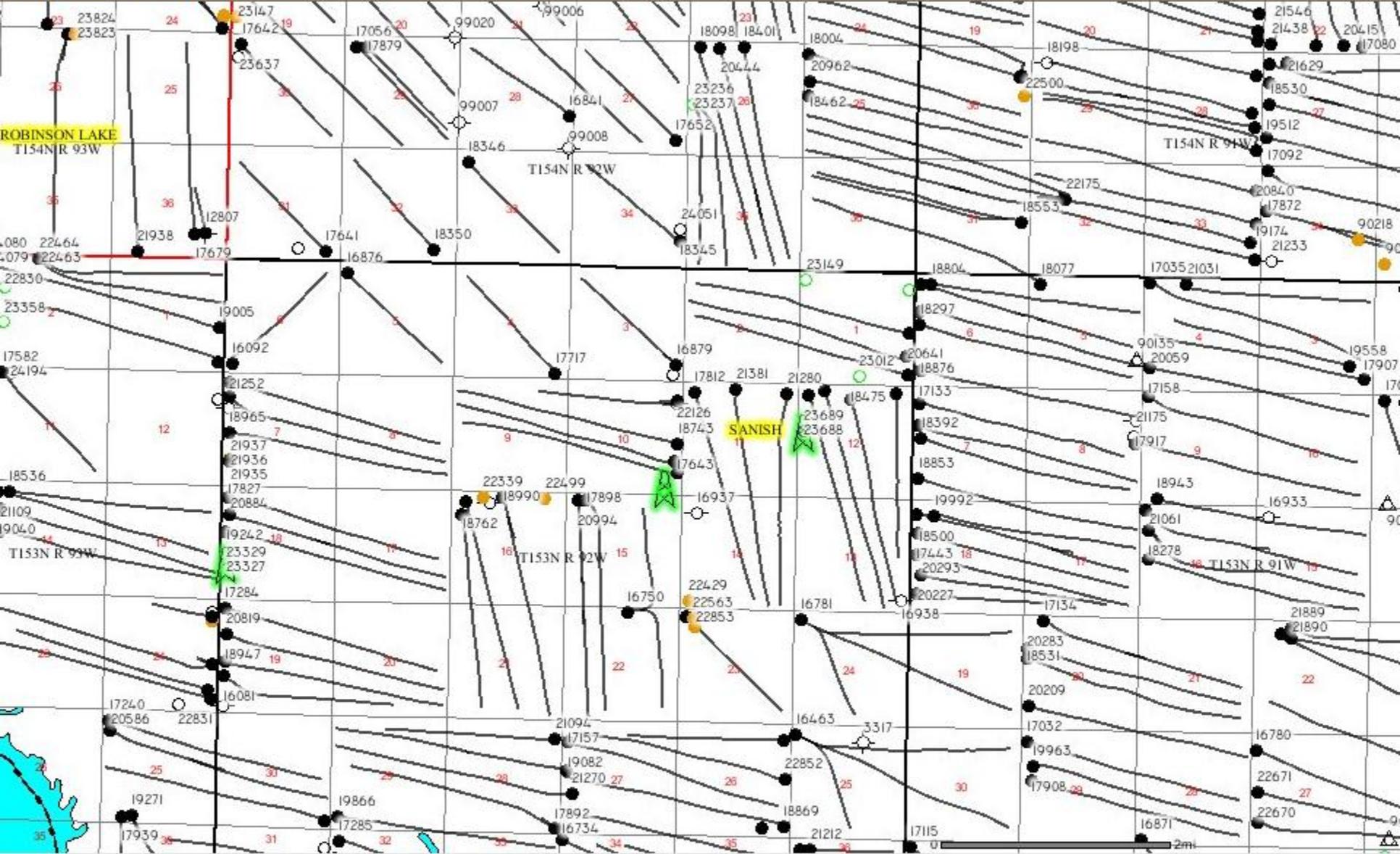
Case No. 9796/9798  
Exhibit E1  
December 19, 2007



7"32# HCP-110 LTC  
intermediate casing set  
at 9,484' MD; (9,235 TVD)

Ball Sub 14,387'  
MD 14,435';  
TVD 9,254'

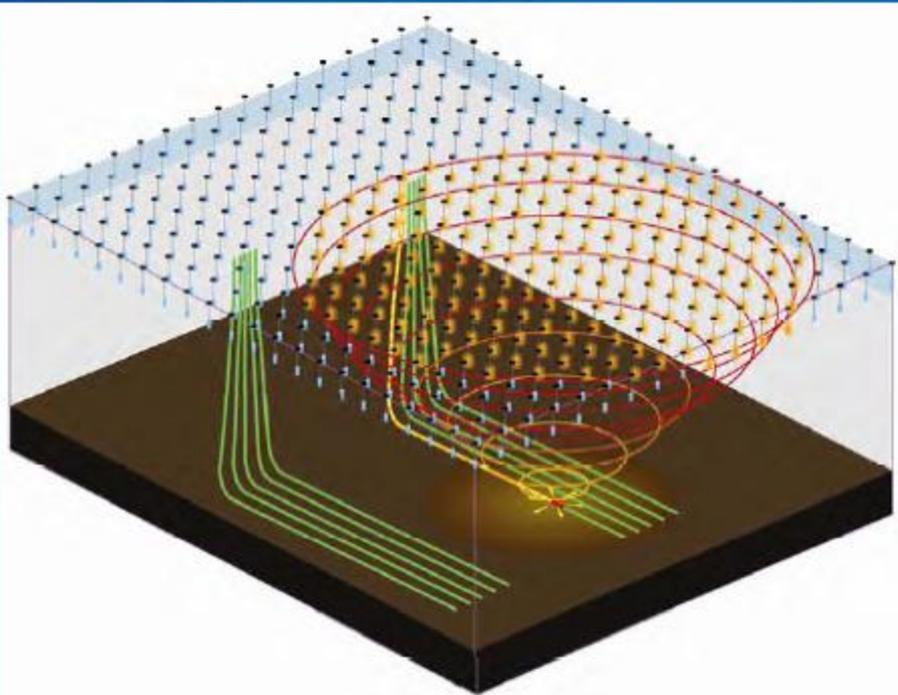




200+ sq mi area - Less over pressure  
 320 acre & 640 acre wells uneconomic – more and longer laterals with single stage frac uneconomic  
 Requires 2mi laterals with more than 10 frac stages

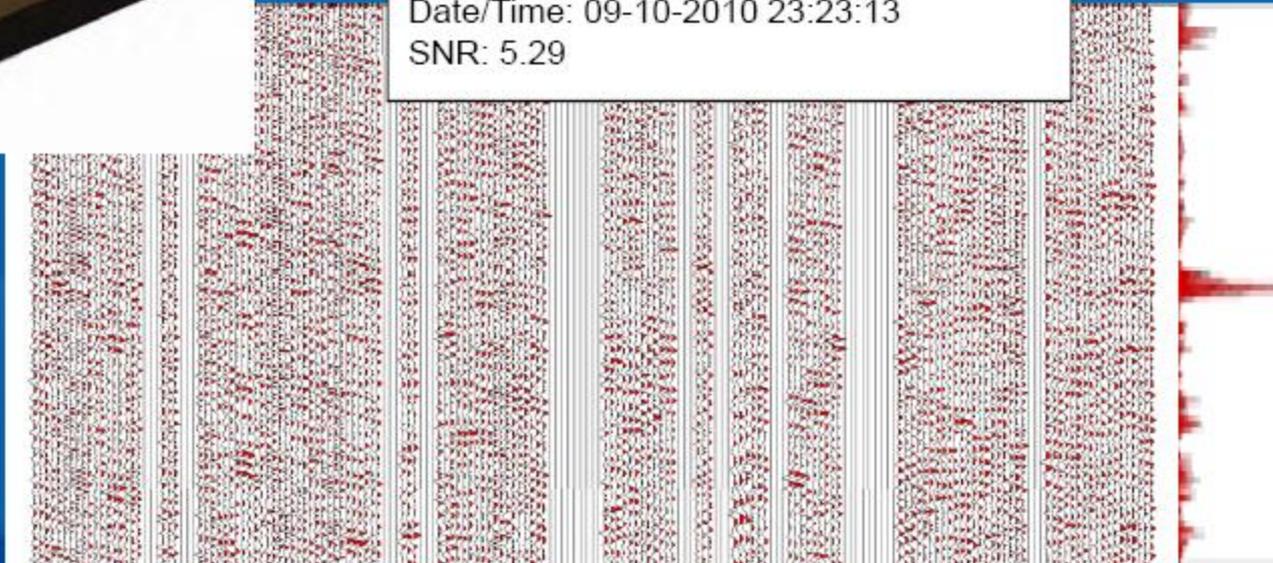
# PSET Imaging

Four installed in various parts of North Dakota

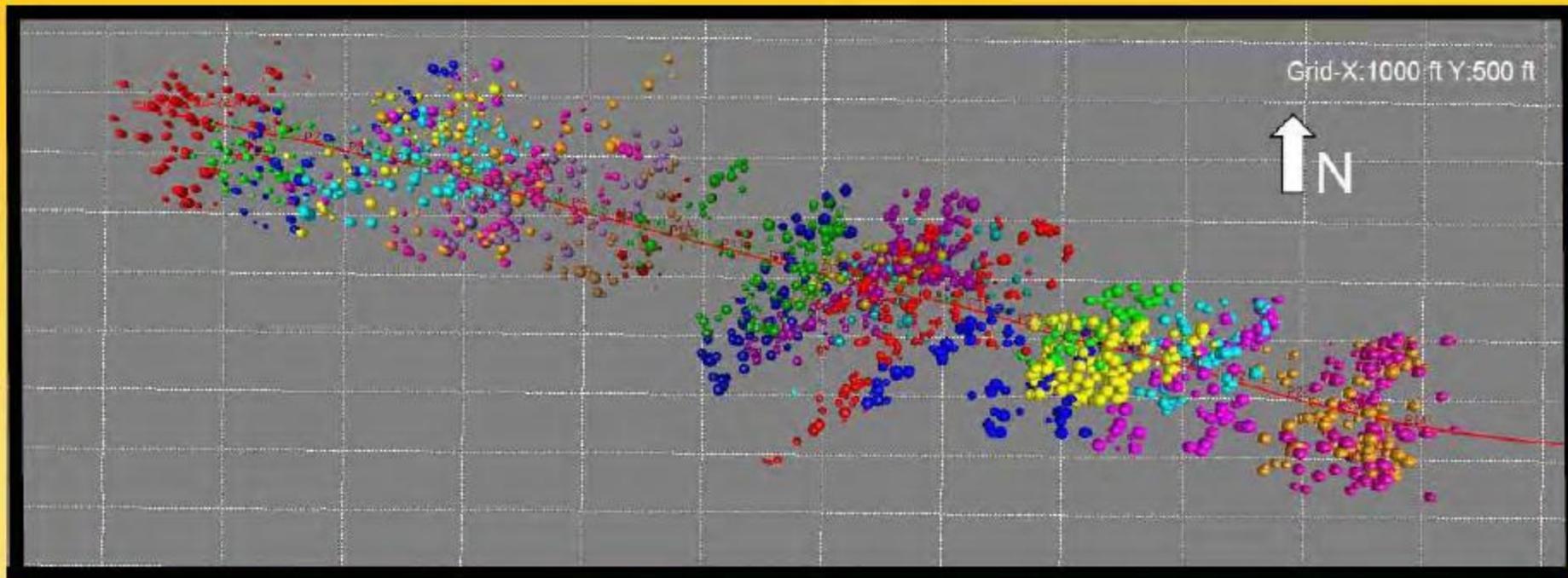


Microseismic events are imaged via PSET, a migration based imaging algorithm.

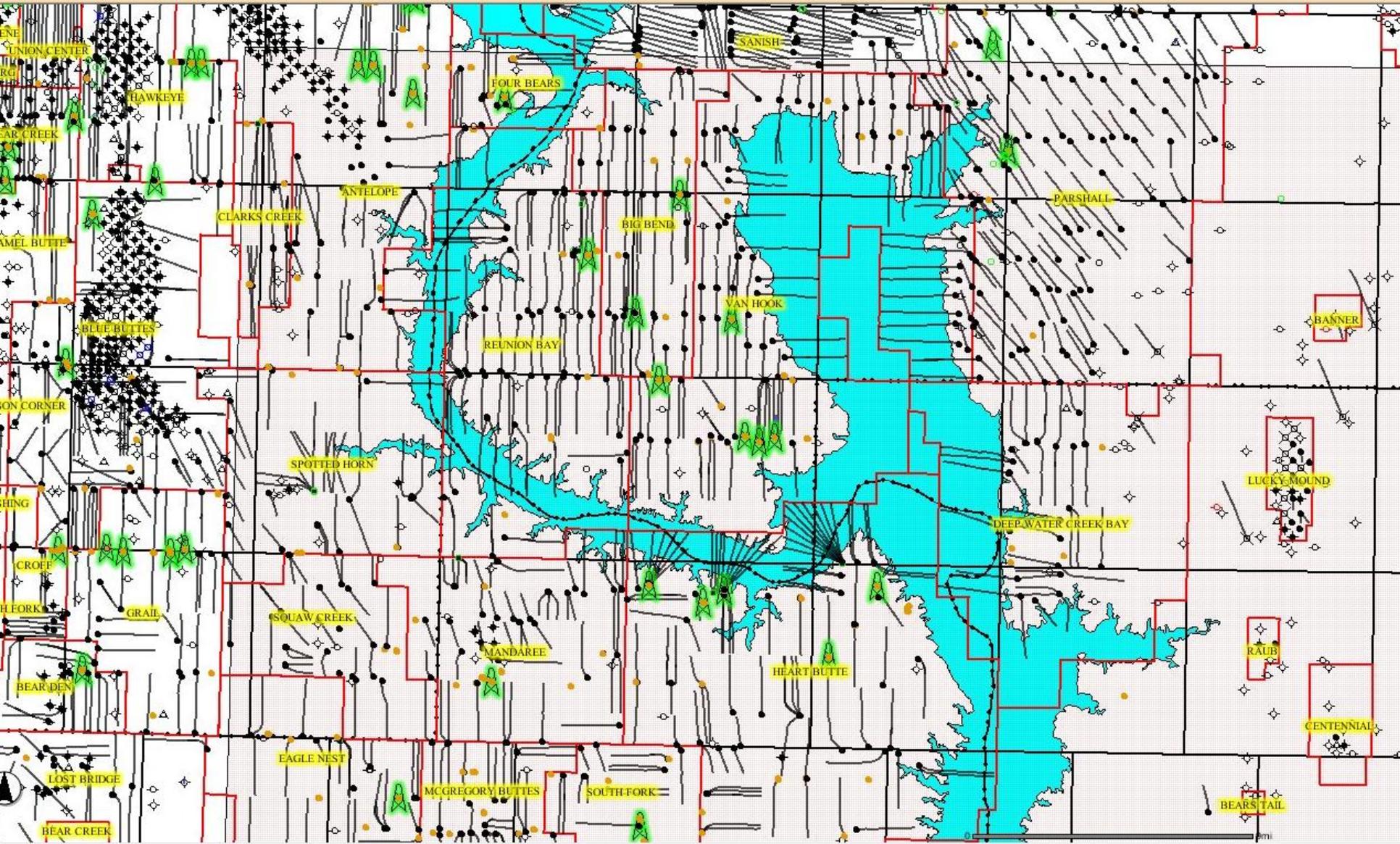
X: 2235819 Y: 17474568 Z: 9854  
Date/Time: 09-10-2010 23:23:13  
SNR: 5.29



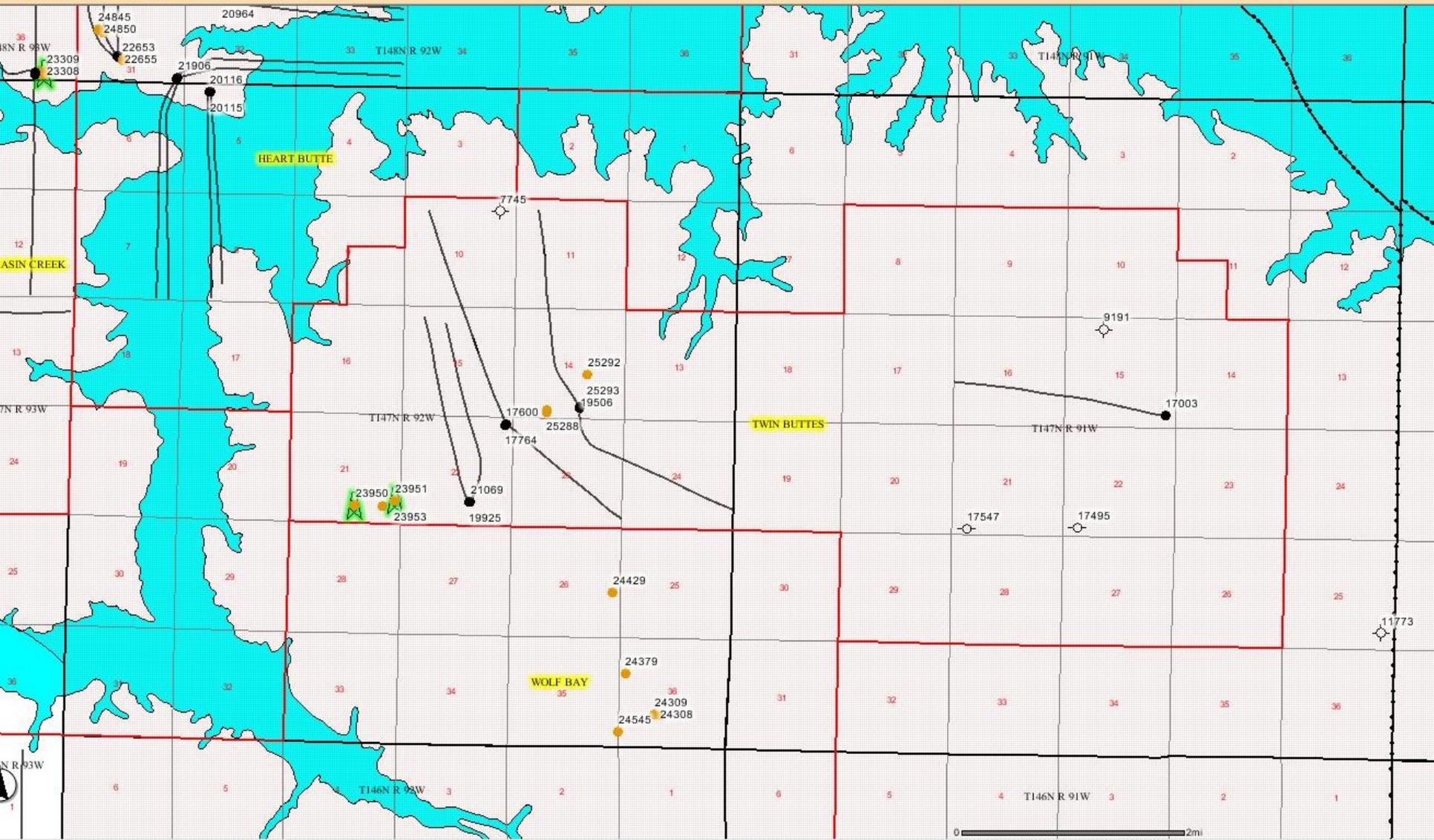
# “Excellent ‘frac saturation’ ....”



- **24-Stage Frac / IP: 2,558 BOE/D**
- **Excellent “frac saturation”** evidenced by minimal gaps of unfraced rock along the wellbore with some stages impacting the same rock volume.
- **Minimal gaps along NE trending natural fractures** where the frac follows large regionally extensive fractures. These areas already have good naturally occurring fractures.
- **Lateral frac wings that average 750’** on either side of the wellbore. This is consistent with our other fracs and planned spacing pattern for full field development.

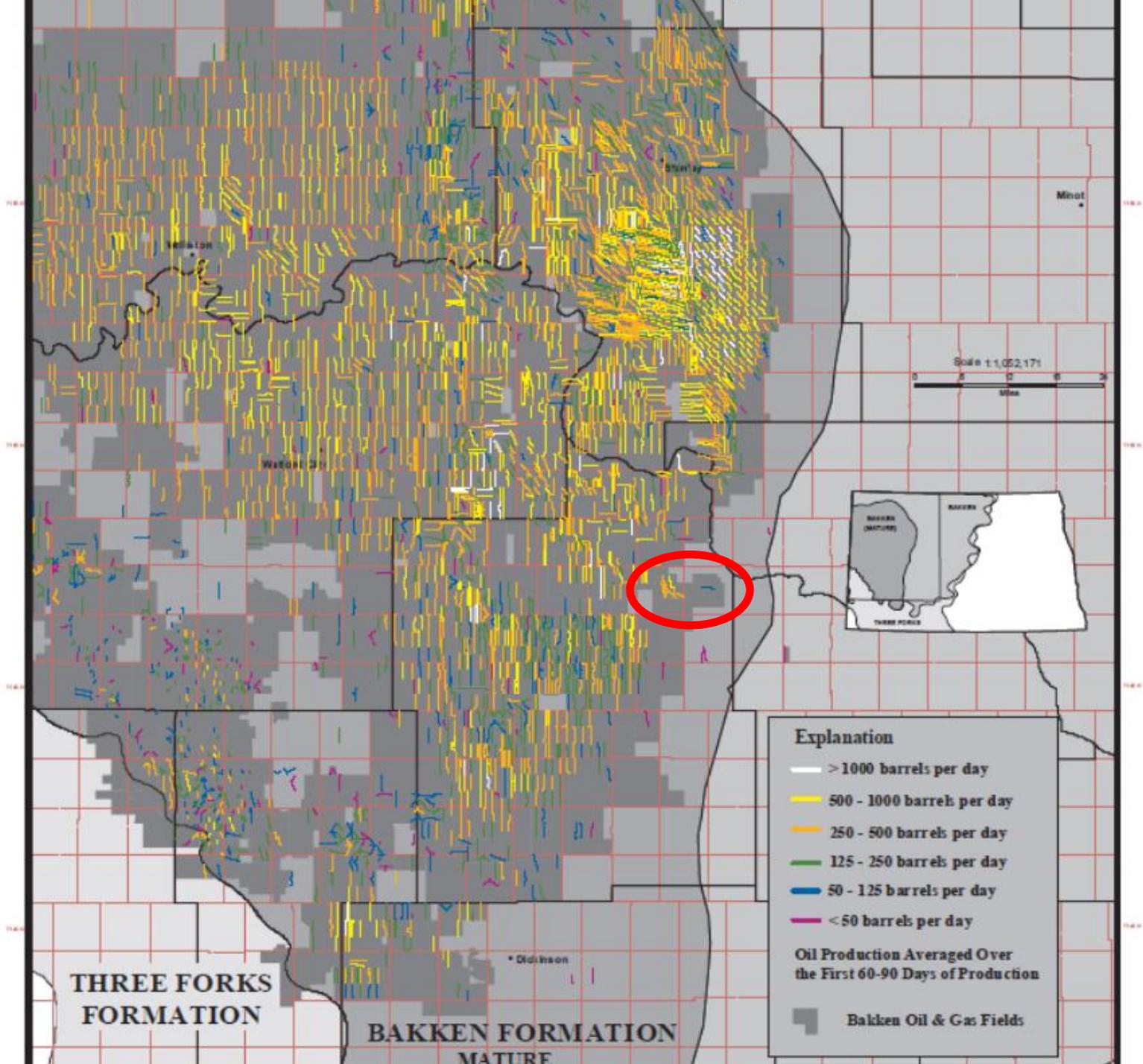






tion cleared.

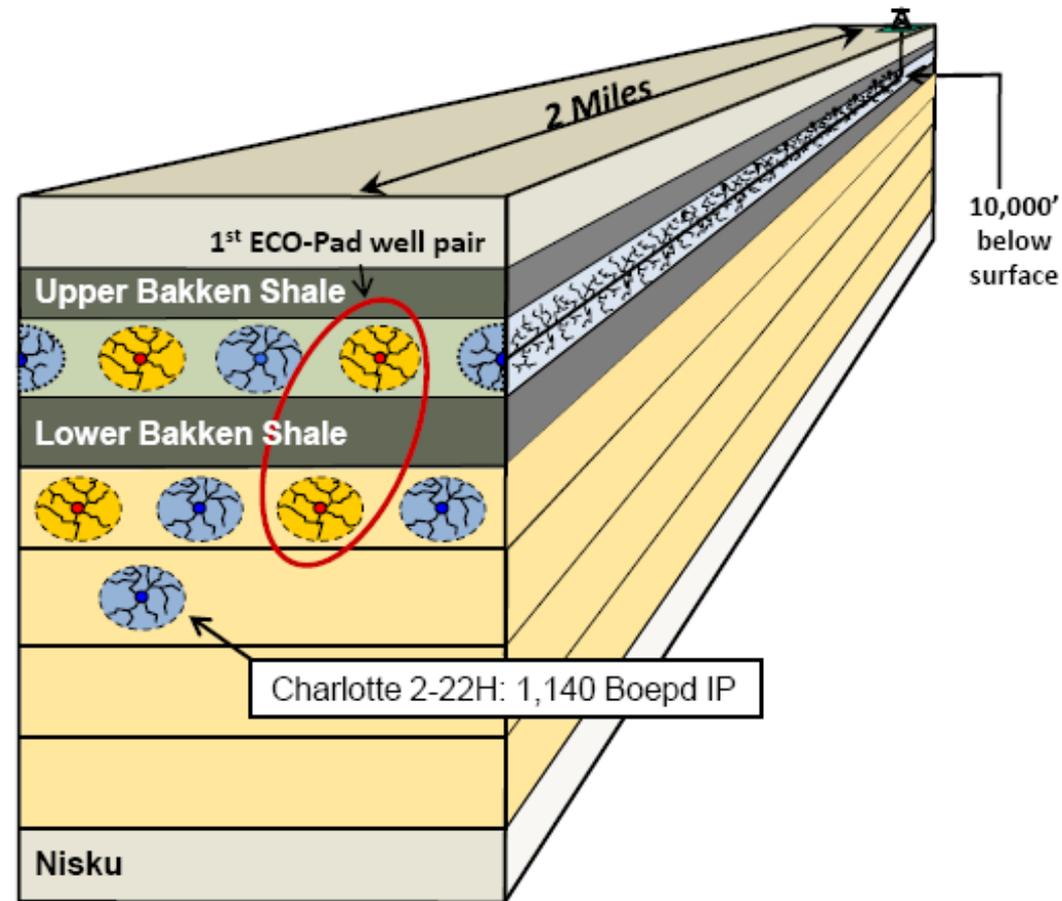
Federal Exploratory Unit  
5-15 fold greater oil production in western wells than in eastern well

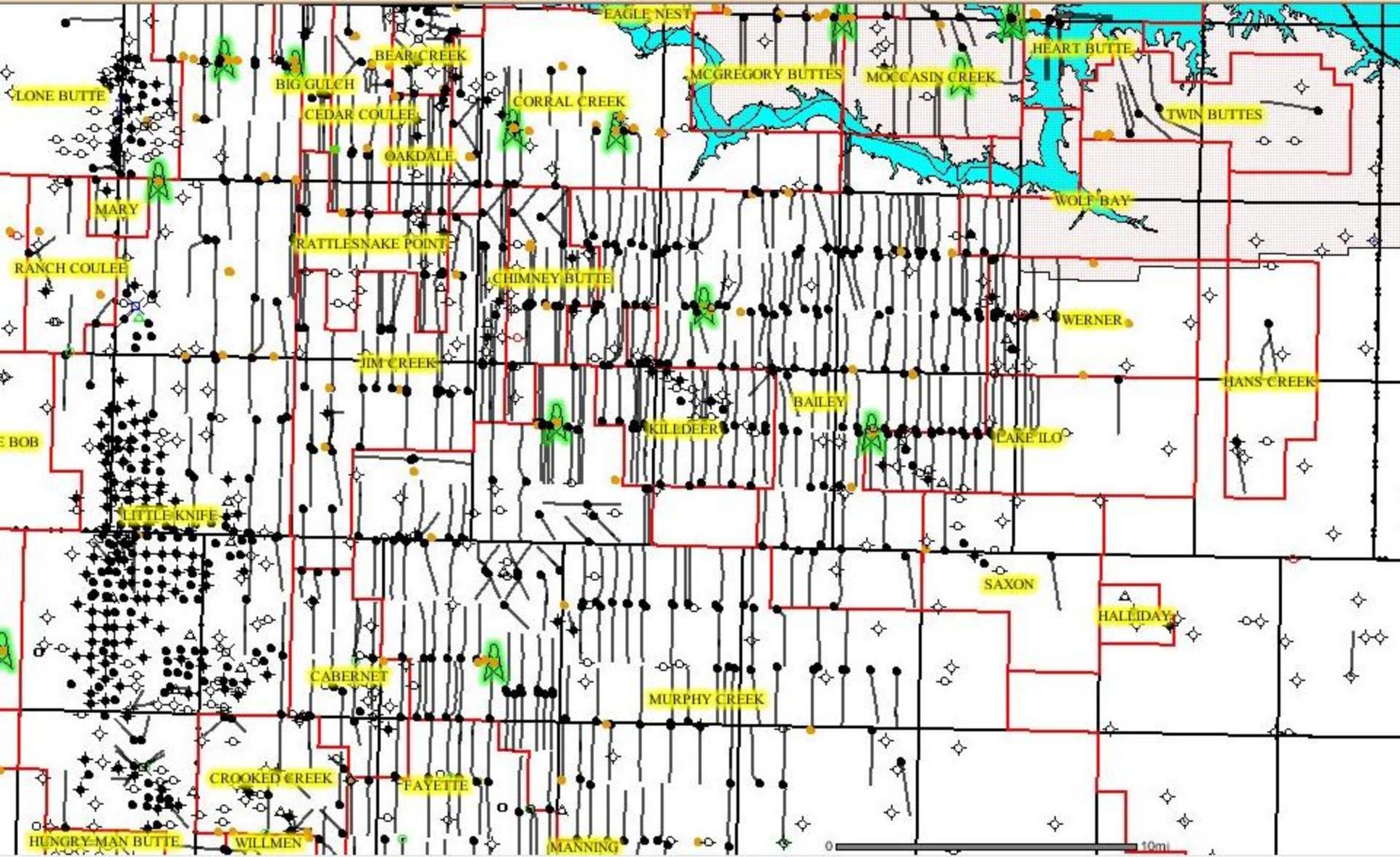


# Bakken Development Plan

7 – 28 wells per 1,280 acres proposed  
= 160-320 acre spacing X 2–5 layers

NDIC issued order 14497  
standard spacing = N-S 1,280  
Multi-well pads preferred





4,000 miles of road for E-W corridors on 4 mile spacing

3,000 miles of road for E-W corridors on 2 mile spacing

30,000 - 60,000 miles of road for section line access over entire mature area

# ArcIMS Viewer



on cleared.

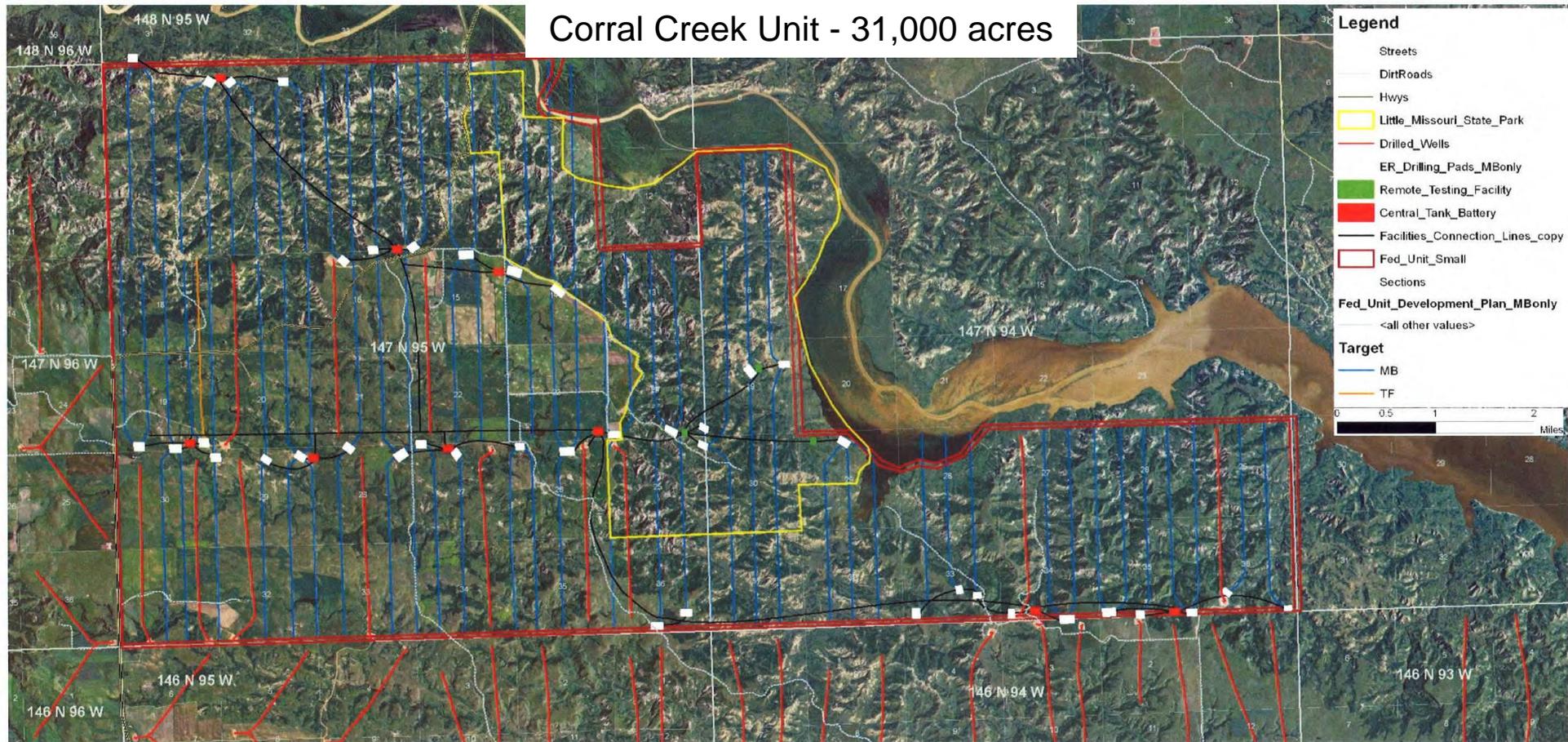
**38-08-09.1. LEGISLATIVE FINDING.** The legislative assembly finds and determines that it is desirable and necessary, under the circumstances and for the purposes hereinafter set out, to authorize and provide for unitized management, operation, and further development of the oil and gas properties to which sections 38-08-09.1 through 38-08-09.16 are applicable, to the end that a greater ultimate recovery of oil and gas may be had therefrom, waste prevented, the drilling of unnecessary wells eliminated, and the correlative rights of the owners in a fuller and more beneficial enjoyment of the oil and gas rights be protected.

**38-08-09.2. POWER AND AUTHORITY OF COMMISSION.** The commission is hereby vested with continuing jurisdiction, power and authority, including the right to describe and set forth in its orders all those things pertaining to the plan of unitization which are fair, reasonable, and equitable and which are necessary or proper to protect, safeguard, and adjust the respective rights and obligations of the several persons affected, and it is its duty to make and enforce such orders and do such things as may be necessary or proper to carry out and effectuate the purposes of sections 38-08-09.1 through 38-08-09.16.

**38-08-09.5. RATIFICATION OR APPROVAL OF PLAN BY LESSEES AND OWNERS.**

. . . No order of the commission creating a unit and prescribing its plan of unitization becomes effective until the plan of unitization has been signed, or in writing ratified or approved by those persons who, under the commission's order, will be required to pay at least sixty percent of the costs of the unit operation and by the owners of at least sixty percent of the royalty interests, excluding overriding royalties, production payments, and other interests carved out of the working interest, and in addition it is required that when there is more than one person who will be obligated to pay costs of the unit operation, at least two nonaffiliated such persons and at least two royalty interest owners, are required as voluntary parties, and the commission has made a finding either in the order creating the unit or in a supplemental order that the plan of unitization has been so signed, ratified, or approved by lessees and royalty owners owning the required percentage interest. . . .

5 well pads with 11 wells and no tank batteries or compressor stations within the park.  
Development of the area without a unit would result in 5 additional well pads 4 of which would have to be on the Little Missouri River floodplain



8 tank batteries and compressor stations are needed for the unit.  
Development of the area without a unit would result in 26 tank batteries and compressor stations 3 of which would have to be within the park and 2 of which would have to be in the Little Missouri River floodplain

