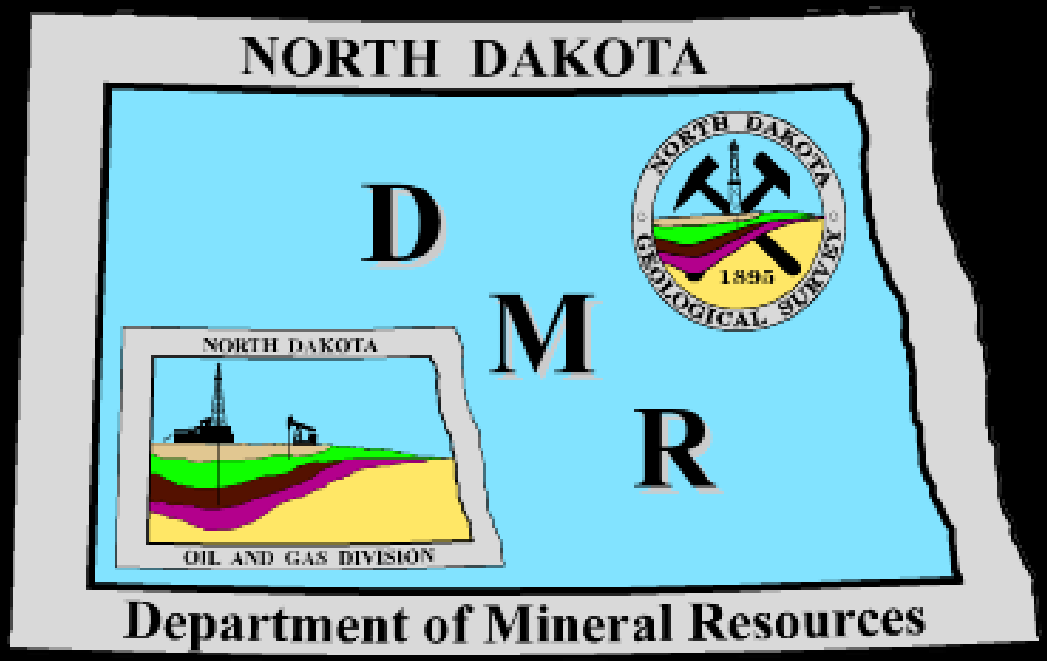
North Dakota Department of Mineral Resources



http://www.oilgas.nd.gov

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

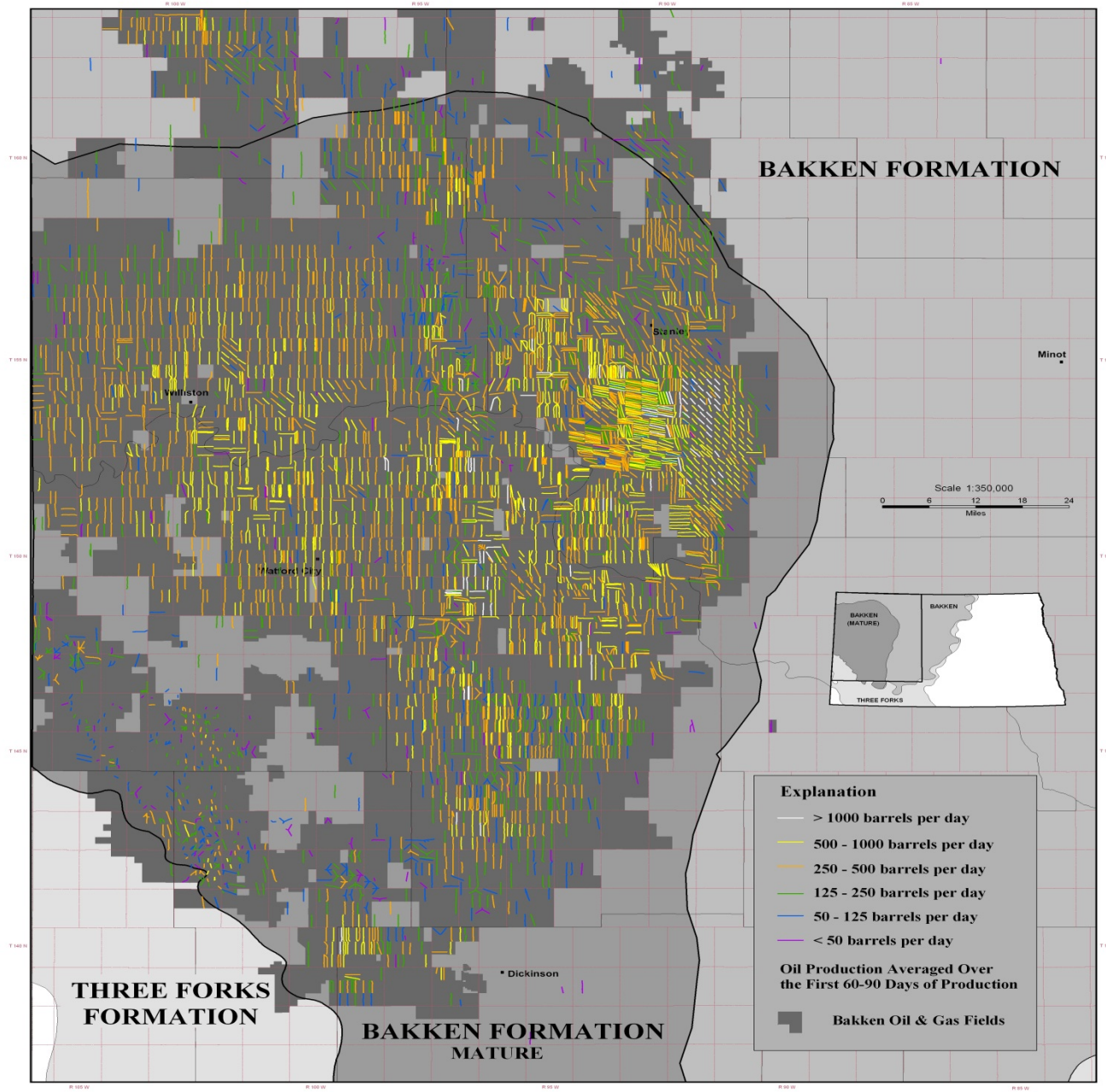
600 East Boulevard Ave. - Dept 405
Bismarck, ND 58505-0840
(701) 328-8020 (701) 328-8000

North Dakota Geological Survey
Geologic Investigations No. 149 - April 2013

Edward C. Murphy, State Geologist
Lynn D. Helms, Director Dept. of Mineral Resources

First 60 - 90 Day Average Bakken Horizontal Production by Well

April 2013



NORTH DAKOTA UPDATE

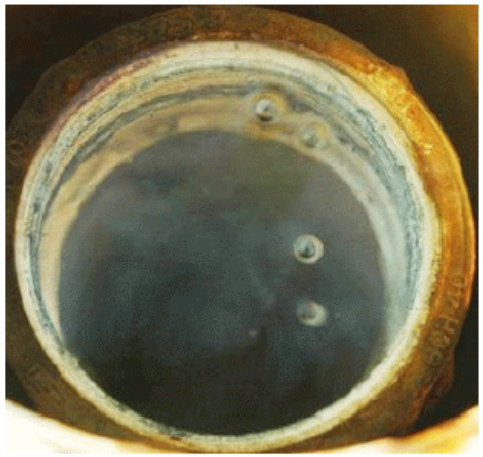
- **Tyler = est. 2500 wells**
  - **SW North Dakota**
- **Spearfish = est. 2500 wells**
  - **Bottineau County**
- **Red River= est. 100 wells**
  - **Golden Valley, Bowman Counties**
- **Mission Cannon = unclear at this point**
  - **Burke, Renville Counties**

SHALLOW GAS PROJECT

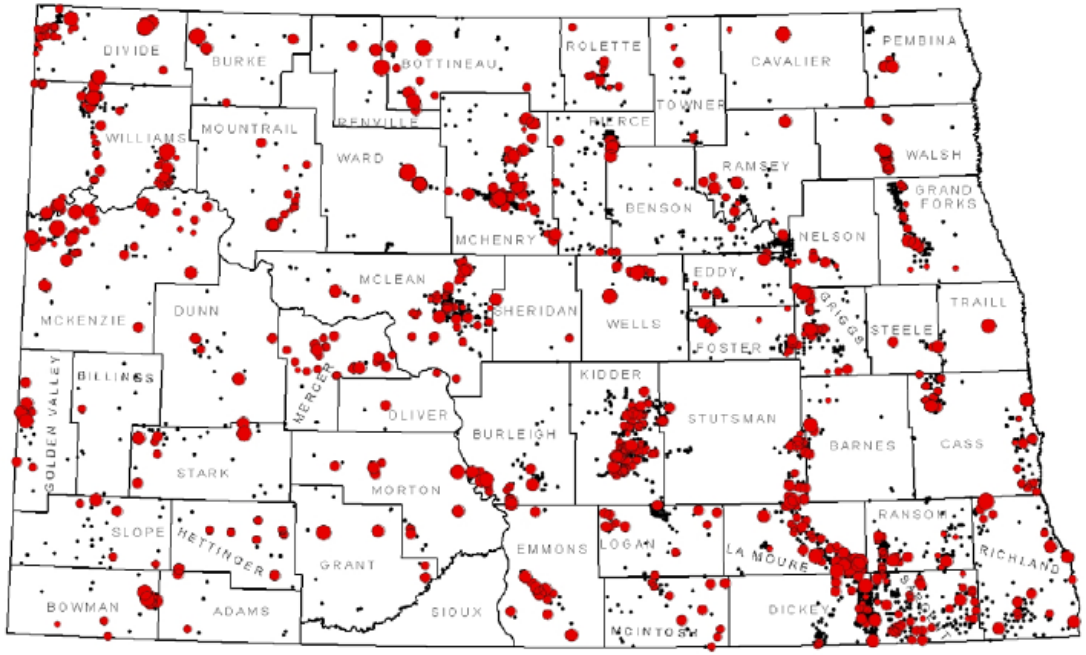
The Geological Survey tested 4,325 NDSWC monitoring wells for methane in 52 of the 53 counties in North Dakota from 2006-2010.

The Geological Survey recently completed phase I of a study of shallow natural gas in North Dakota. We investigated 9,400 ND State Water Commission monitoring well sites, tested 4,325 wells, and detected methane in 905 wells. Approximately 20% of the wells contained detectable gas.

During the second phase of the project, thirty groundwater samples, primarily from eastern North Dakota, will be analyzed for dissolved gas composition, isotopes, and general chemistry. This will enable us to determine the source of the gas and identify chemical groundwater signatures that might assist the oil and gas industry in natural gas exploration.

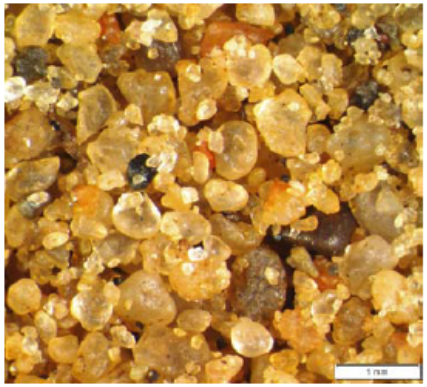


Methane bubbling to the surface in a two-inch NDSWC monitoring well.



Monitoring wells that contained methane are indicated with red dots, black dots are wells that contained no detectable methane. The red dots are sized to reflect the concentration of methane -- the higher the concentration, the larger the dot.

PROPPANT PROJECT

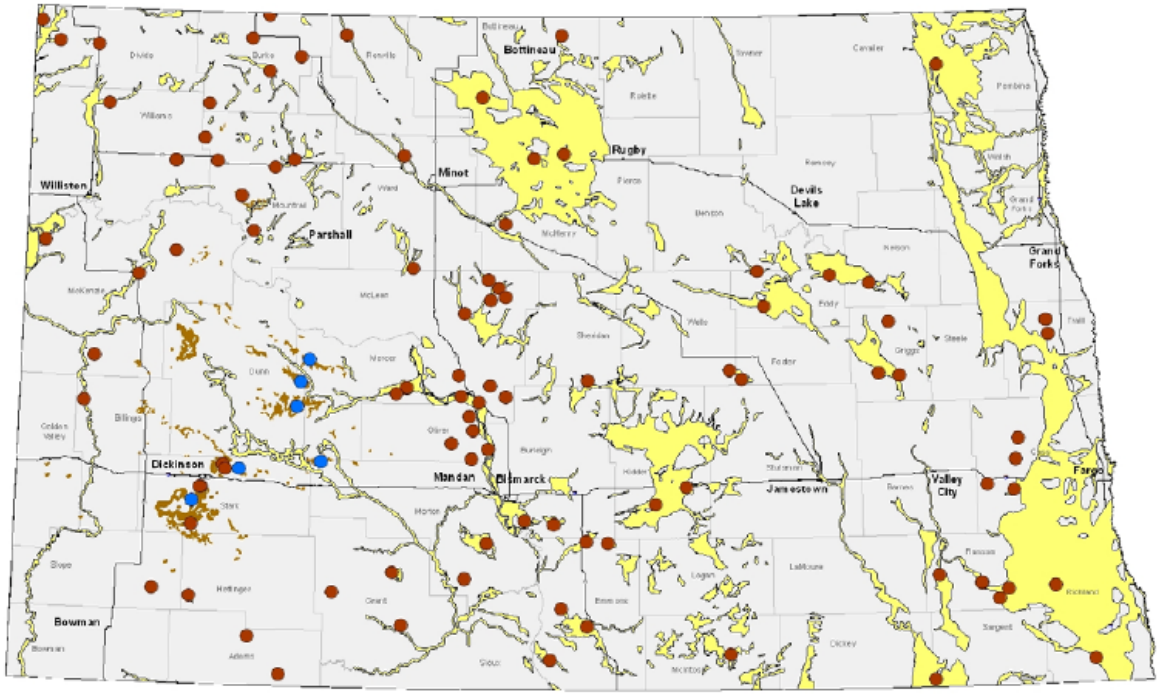


Photomicrograph of sand grains collected in McHenry County.

Photomicrograph of ceramic proppant from a batch that was used in a Bakken well in North Dakota. This proppant was manufactured in China.

Millions of tons of sand and ceramic proppants are used every year in the Williston Basin, part of a multi-billion dollar industry. The Geological Survey has collected 125 sand samples throughout the state in our search for deposits that could be utilized for oil and gas proppants in the well fracing process. We are in the process of performing preliminary analysis on those samples to determine if any would fit the proppant criteria. We have also collected clay samples and will be testing those samples for their kaolin content to determine their suitability in the manufacturing of ceramic proppants.

Under the second phase of this project, the ten most promising sand samples will undergo full ISO analysis (including bulk density, specific gravity, crush resistance, etc), mineralogy (XRD), and stack conductivity analysis to determine which are the most suitable proppant candidates and we will continue to evaluate the clay beds.



Locations of sand samples (red dots) and clay samples (blue dots) collected during this study. The areas in yellow are known sand deposits and the areas in brown are kaolinitic claystones within the Golden Valley Formation.

Estimate 20-50 billion tons of ND Mineable Reserves

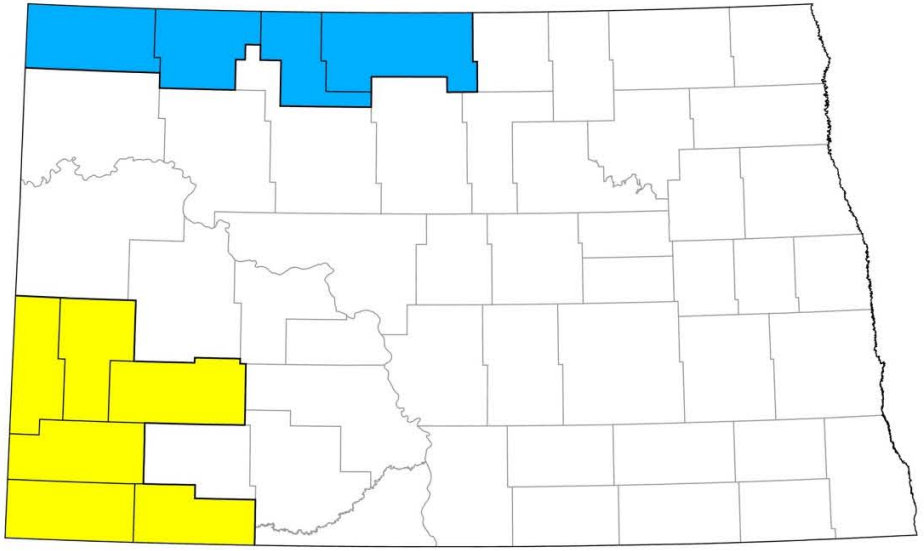
$6 trillion -15 trillion

Potash core from a depth of 9,000 feet in Burke County.

We have received a number of enquires from the mineral industry in the past 18 months as the price increased for a variety of elements and minerals. Chief among these enquiries has been uranium and potash. Uranium was mined in North Dakota in the 1960s. It was heavily explored for in the 1970s, but has been of little interest for the last 30 years until the price for uranium oxide reached an all time high in June of 2007. Companies have also expressed interest in associated elements molybdenum and germanium. We are aware of three companies that are contemplating mining uranium in southwestern North Dakota.

Potash or potassium salts are primarily used in the production of fertilizer. Potash exploration took place in northwest North Dakota in the 1970s. Since 2006, the price of potash rose from $190 to $1,050 per ton then fell to $300 per ton and is rising again. Based on increasing demand in rice growing regions. There are two companies that we know are actively pursuing potash exploitation.

Formation Resources drilling for uranium, molybedenum, and germanium under a subsurface mineral permit in Billings County during the fall of 2008.



Counties that contain uranium deposits are in yellow and those that contain the shallowest potash deposits are in blue.

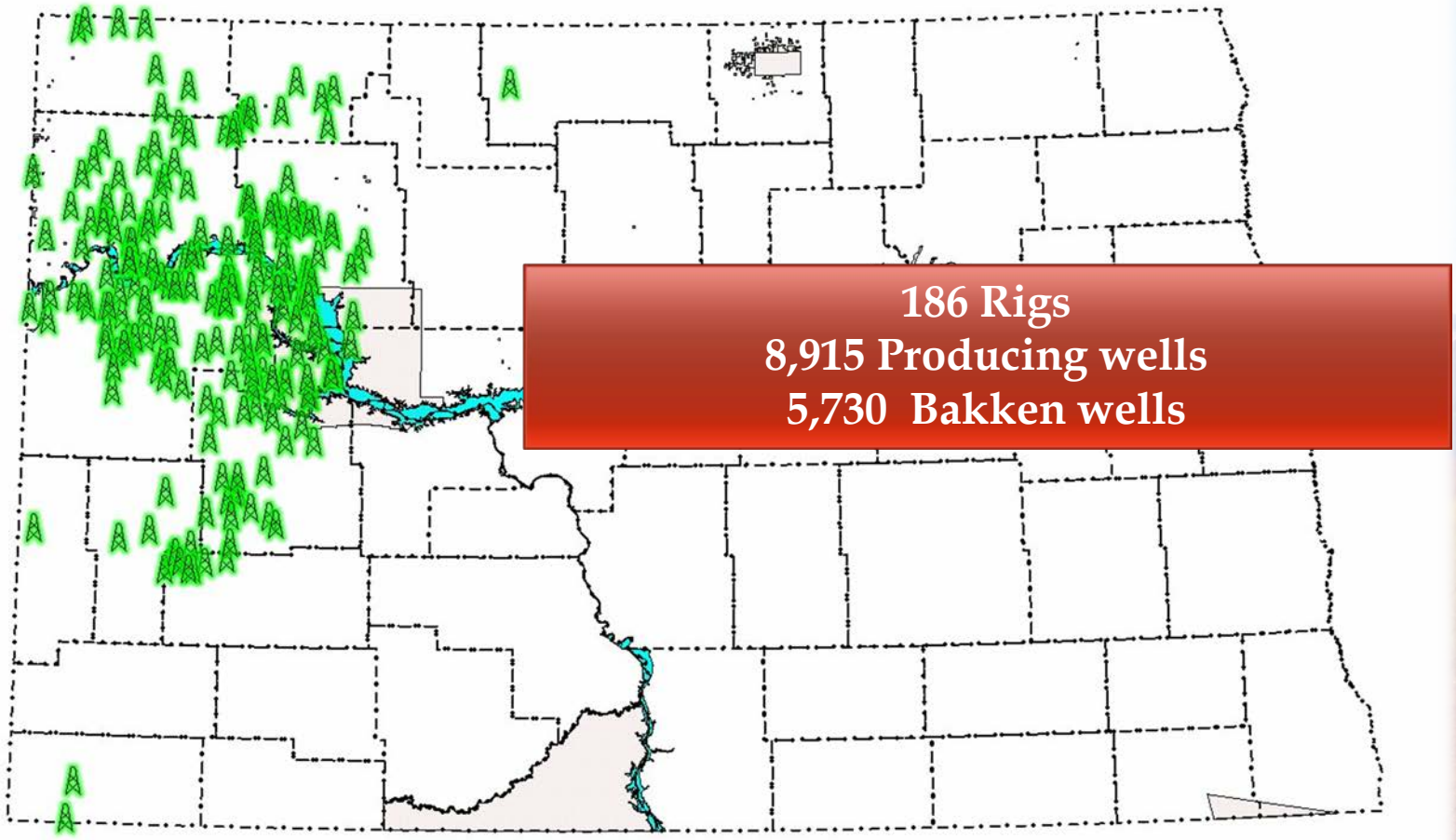
NORTH DAKOTA UPDATE

- **Became #3 Oil Producing state in March 2012**
  (January figures)
- **Became #2 Oil Producing state in May 2012**
  (March Figures)
- **May production 25.1 million barrels of oil or 810,129 barrels of oil per day**
- **27.8 Billion cubic feet of natural gas or 899 million cubic feet per day**

NORTH DAKOTA UPDATE

- **2 Billionth barrel of oil produced in November 2011**
- **1 Billionth barrel of oil produced in October 1989**
- **First barrel of oil produced in April 1951**

NORTH DAKOTA UPDATE



NORTH DAKOTA UPDATE

What Does Every New Bakken Well Mean to North Dakota

A typical 2012 North Dakota Bakken well will produce for 45 years

If economic, enhanced oil recovery efforts can extend the life of the well

In those 45 years the average Bakken well:

Produces approximately 725,000 barrels of oil

Generates about $24 million net profit

Pays approximately $5,325,000 in taxes
- $2,400,000 gross production taxes
- $2,500,000 extraction tax
- $425,000 sales tax

Pays royalties of $8,600,000 to mineral owners

Pays salaries and wages of $2,100,000

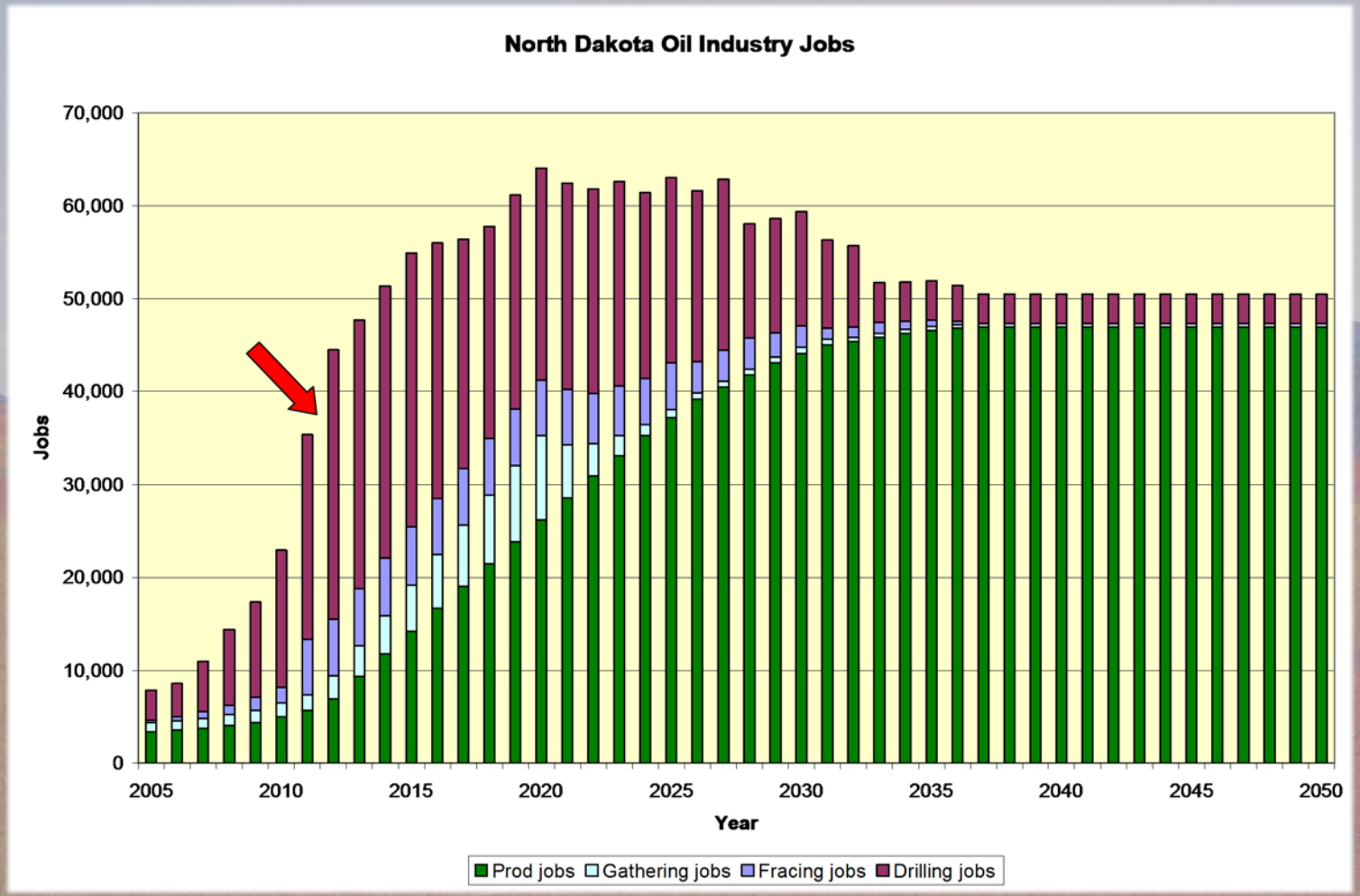
Pays operating expenses of $2,300,000

Cost $9,000,000 to drill and complete

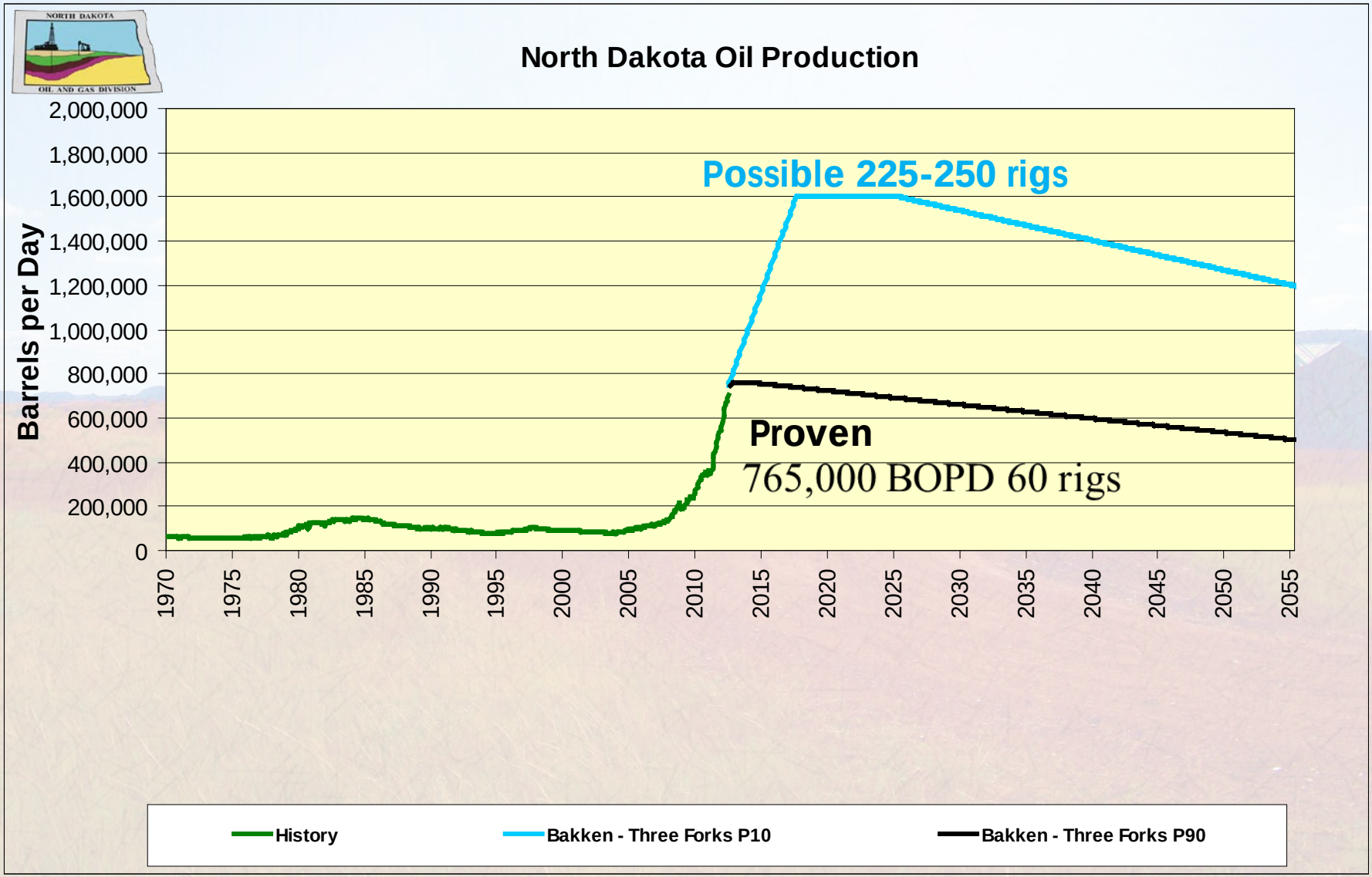
NORTH DAKOTA UPDATE

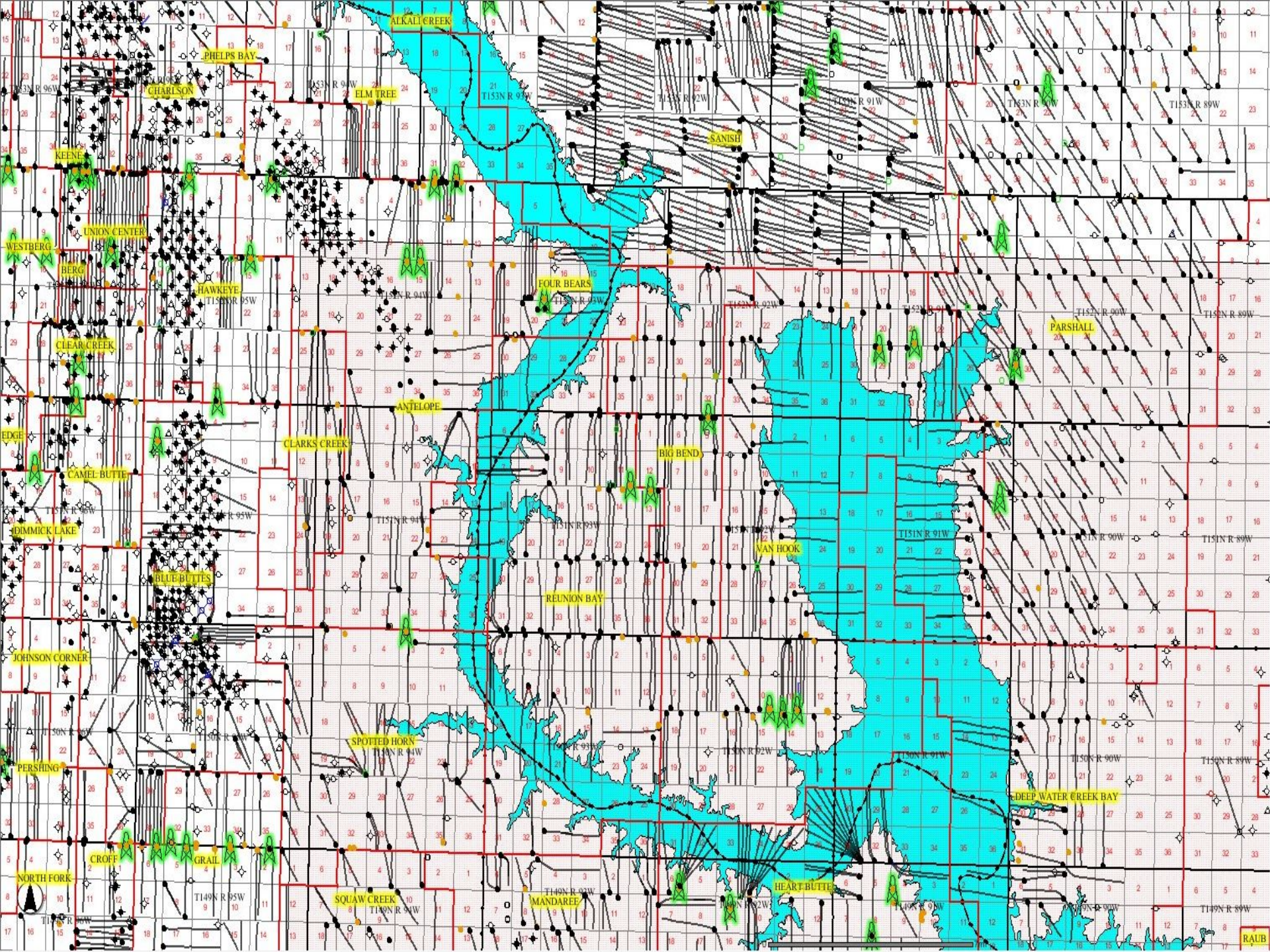
- **1,100 to 2,700 wells/year = 2,000 expected**
  - **170 rigs = 20,000 temporary drilling jobs**
  - **Another 12,000 temporary jobs building infrastructure**
  - **2,000-3,000 permanent jobs added each year**
  - **170 rigs can complete the first phase of drilling in 14 months**
  - **170 rigs will require more than 21 years to complete phase 2 drilling**
  - **2,000 new wells per year require 11-22 million gallons of frac water per day**
  - **40,000-45,000 new wells = 40,000-70,000 long term jobs**

NORTH DAKOTA UPDATE



NORTH DAKOTA UPDATE




ALKALI CREEK
PHELPS BAY
CHARLSON
ELM TREE
KEENE
SANISH
UNION CENTER
WESTBERG
BERG
HAWKEYE
FOUR BEARS
PARSHALL
CLEAR CREEK
ANTELOPE
CLARKS CREEK
BIG BEND
CAMEL BUTTE
DIMMICK LAKE
VAN HOOK
BLUE BUTTES
REUNION BAY
JOHNSON CORNER
SPOTTED HORN
PERSHING
DEEP WATER CREEK BAY
CROFF
GRAIL
NORTH FORK
SQUAW CREEK
MANDAREE
HEART BUTTE
RAUB
T153N R 96W
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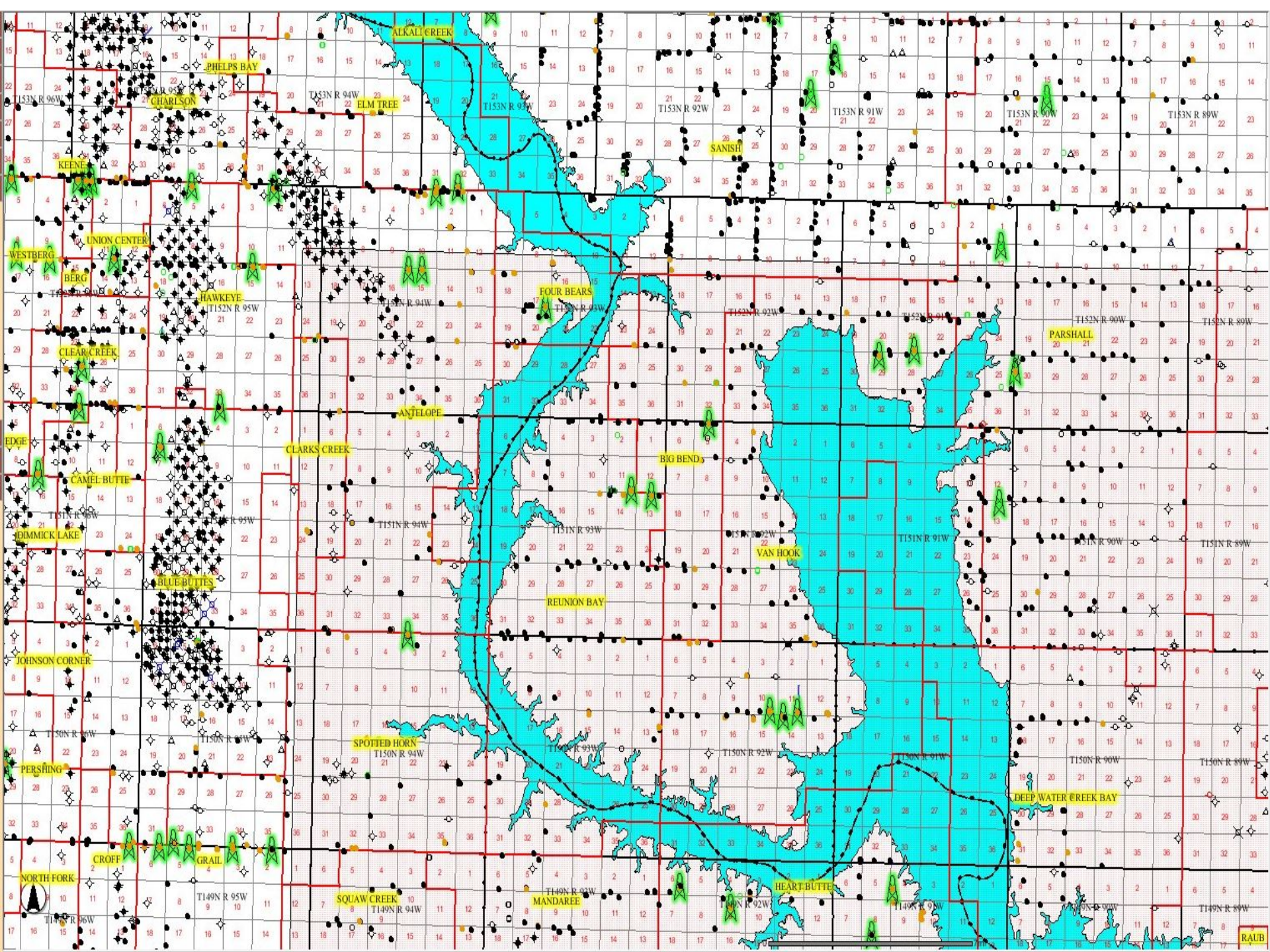
ALKALI CREEK
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N
Map
Photos
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Google earth
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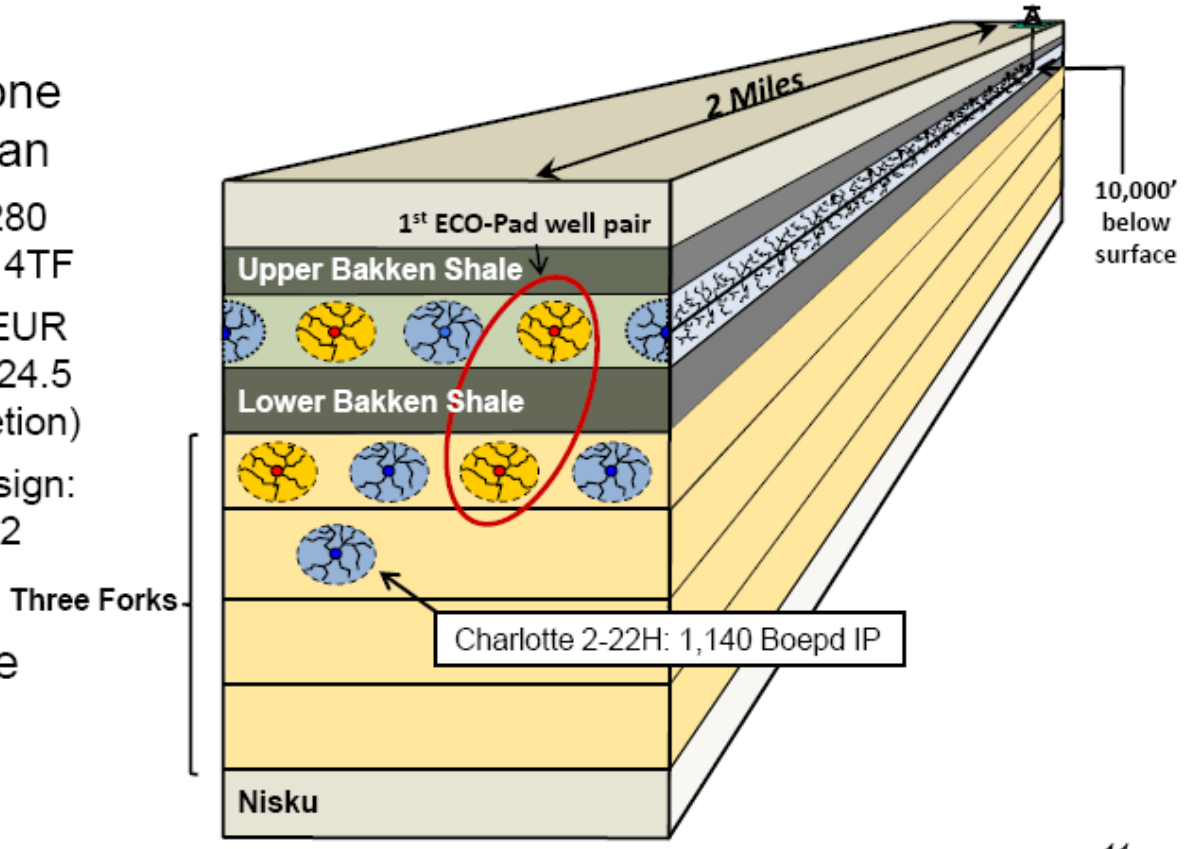
Vern Whitten Photography

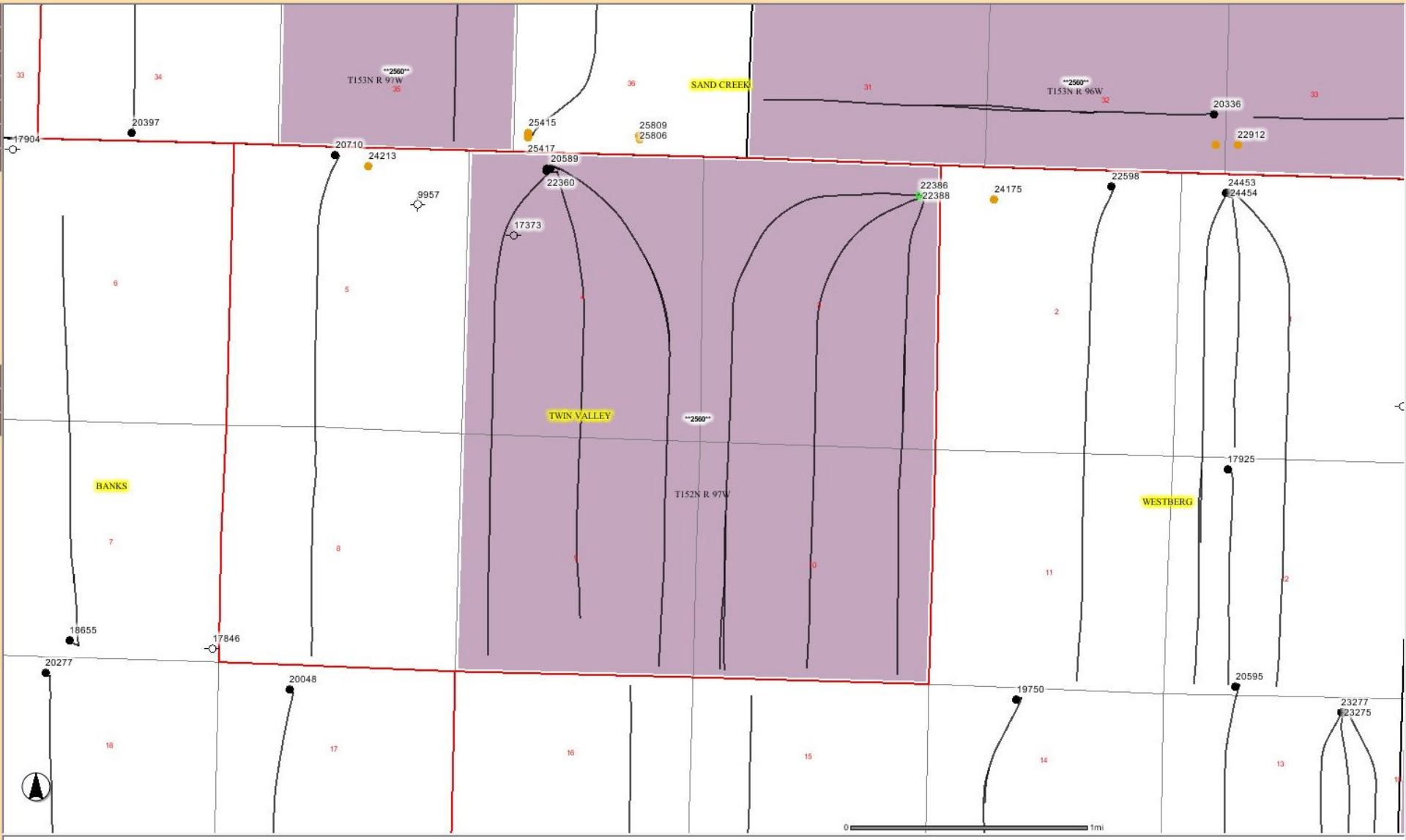
Bakken Development Plan

- Original dual-zone development plan
  - 8 wells per 1,280 acres – 4 MB, 4TF
  - 603,000 Boe EUR per well (avg. 24.5 stages/completion)
  - ECO-Pad® design: 2 wells south, 2 wells north
- Additional Three Forks potential



Six Wells on a Single Pad

Vern Whitten Photography


T153N R 97W
SAND CREEK
T153N R 96W
20397
17904
20710
24213
25415
25417
25809
25806
20589
22360
9957
17373
22386
22388
24175
22598
20336
22912
24453
24454
TWIN VALLEY
T152N R 97W
BANKS
WESTBERG
17925
18655
17846
20277
20048
19750
20595
23277
23275
0
1mi


19858
24838
24804
24844
8106
22244
22245
21128
T152N R 99W
19918
23664
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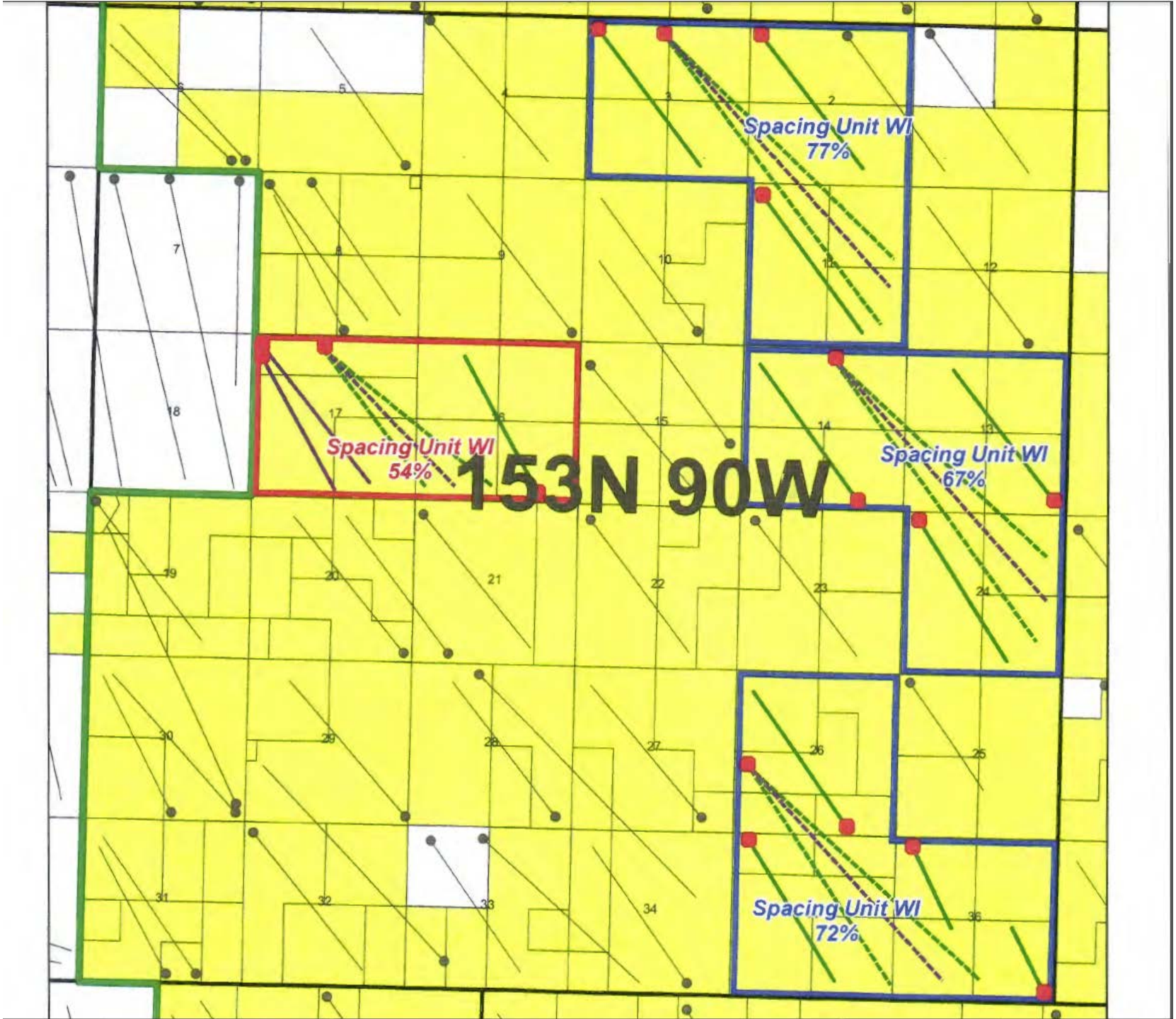
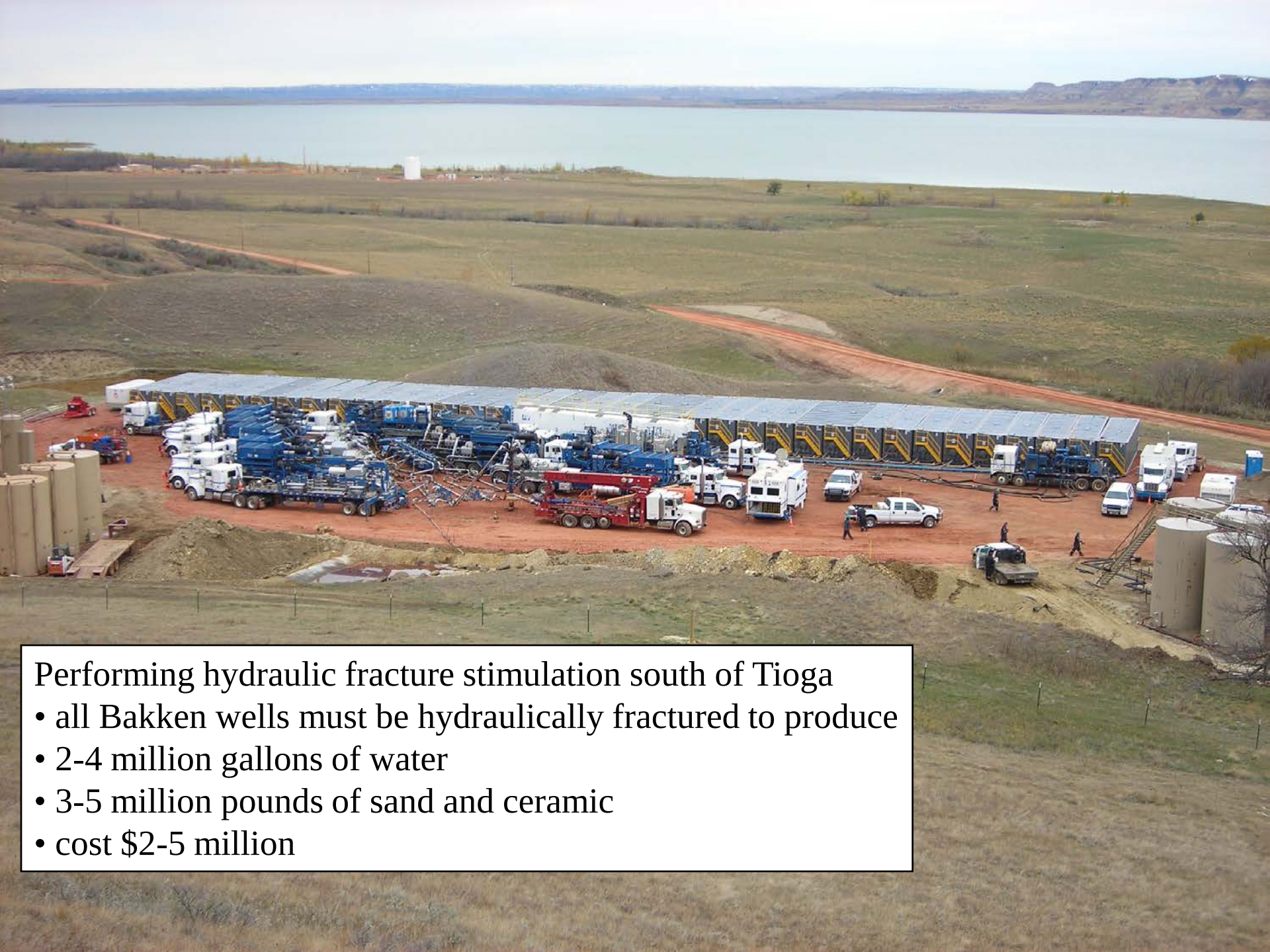
19637
23612
19740
19590
BANKS
22375
23051
23048
22273
19915
19126
22155
24333
24335
8678
23385
T152N R 98W
19956
19350
23993
20715
21814
22322
22808
22806
17755
8626
16252
17763
17856
POE
C19817
21309
24155
22850
25827
25826
20973
24490
T151N R 99W
NORTH TOBACCO GARDEN
24507
20676
23086
20731
20732
20689
SIVERSTON
T151N R 98W
GARDEN
0
1mi


Spacing Unit WI
77%
Spacing Unit WI
54%
153N 90W
Spacing Unit WI
67%
Spacing Unit WI
72%

To see the drilling video, please visit
http://www.emeraldoil.com/drilling



Performing hydraulic fracture stimulation south of Tioga

- all Bakken wells must be hydraulically fractured to produce
- 2-4 million gallons of water
- 3-5 million pounds of sand and ceramic
- cost $2-5 million

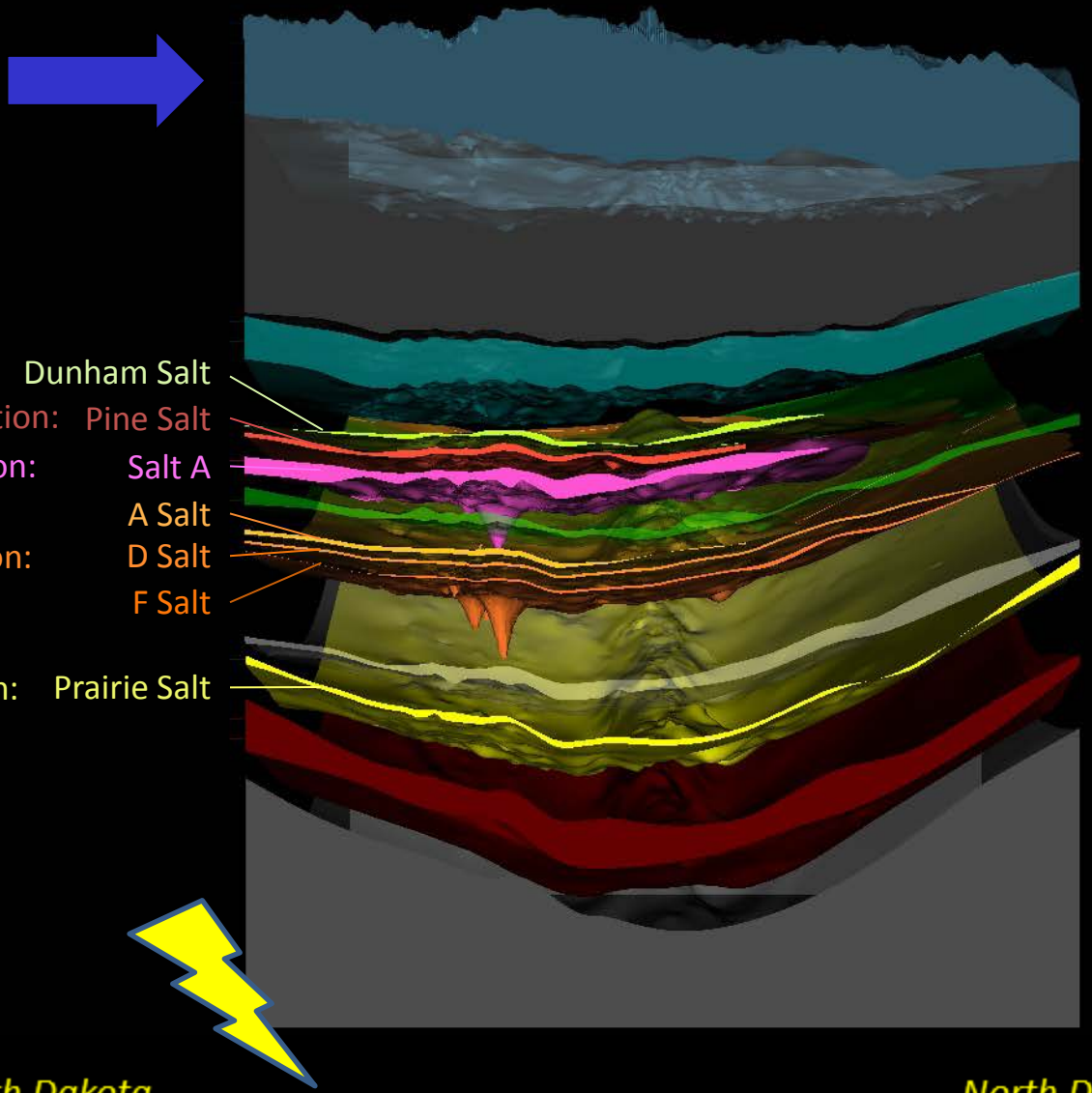
Thirsty Horizontal Wells

- 2,000 - 3,000 wells / year
- 15 - 25 years duration
- 20 - 30 million gallons water / day

FRAC WATER NEEDS

- Lake Sakakawea (Missouri River) is the best water resource
  - one inch contains 10 billion gal water
    - 30 million gallons per day for 1 year

Significant Salt Intervals of Northwestern North Dakota



Piper Formation: Dunham Salt
Spearfish Formation: Pine Salt
Opeche Formation: Salt A
A Salt
Charles Formation: D Salt
F Salt
Prairie Formation: Prairie Salt

Fresh Water Zone
Shallow Gas Zone
Dakota Group
Spearfish Formation
Tyler Formation
Madison Group
Bakken-Three Forks
Prairie Formation
Red River Formation
Precambrian Basement

North Dakota Geological Survey

North Dakota Depart. of Mineral Resources

- **Compound**
  - **Purpose**
    - **Common application**

- Fresh **Water** – 80.5%
- Proppant – 19.0%
  - Allows the fractures to remain open so the oil and gas can escape
    - Drinking water filtration, **play ground sand**
- Acids - 0.12%
  - Help dissolve minerals and initiate fractures in rock (pre-fracture)
    - **Swimming pool cleaner**
- Petroleum distillates – 0.088%
  - Dissolve polymers and minimize friction
    - **Make-up remover**, laxatives, and candy
- Isopropanol – 0.081%
  - Increases the viscosity of the fracture fluid
    - **Glass cleaner**, antiperspirant, and hair color
- Potassium chloride – 0.06%
  - Creates a brine carrier fluid
    - Low-sodium **table salt substitute**
- Guar gum – 0.056%
  - Thickens the water to suspend the sand
    - **Thickener used in cosmetics**, baked goods, ice cream, toothpaste, sauces, and salad dressing
- Ethylene glycol – 0.043%
  - Prevents scale deposits in the pipe
    - Automotive **antifreeze**, household cleansers, deicing, and caulk

- Sodium or potassium carbonate – 0.011%
  - Improves the effectiveness of other components, such as cross-linkers
    - Washing soda, detergents, **soap**, water softeners, glass and ceramics
- Sodium Chloride – 0.01%
  - Delays break down of the gel polymer chains
    - **Table Salt**
- Polyacrylamide – 0.009%
  - Minimizes friction between fluid and pipe
    - **Water treatment**, soil conditioner
- Ammonium bisulfite – 0.008%
  - Removes oxygen from the water to protect the pipe from corrosion
    - Cosmetics, **food and beverage processing**, water treatment
- Borate salts – 0.007%
  - Maintain fluid viscosity as temperature increases
    - Used in laundry **detergents**, hand soaps and cosmetics
- Citric Acid – 0.004%
  - Prevents precipitation of metal oxides
    - **Food additive**; food and beverages; lemon juice
- N, n-Dimethyl formamide – 0.002%
  - Prevents the corrosion of the pipe
    - Used in **pharmaceuticals**, acrylic fibers and plastics
- Glutaraldehyde – 0.001%
  - Eliminates bacteria in the water
    - **Disinfectant**; Sterilizer for medical and dental equipment

Find a Well

Back To Search

Next Page

Page 1 of 5 Go

API No.	Job Date	State	County	Operator	WellName	Well Type	Latitude	Longitude	Datum
33-025-01132	4/13/2011	North Dakota	Dunn	XTO Energy/ExxonMobil	Alwin Federal 12X-19	Oil	47.627564	-102.967017	NAD83
33-105-01913	4/18/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Lonnie 31X-3	Oil	48.196639	-102.880264	NAD83
33-105-01824	5/14/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Allen 21X-17	Oil	48.254792	-103.058819	NAD83
33-105-01825	4/28/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Woodrow 34X-32	Oil	48.198603	-103.053617	NAD83
33-053-03113	3/22/2011	North Dakota	Mc Kenzie	XTO Energy/ExxonMobil	101 Federal 21X-24	Oil	47.546178	-104.000694	NAD83
33-105-01948	2/26/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Normark 24X-31	Oil	48.460233	-103.008811	NAD83
33-105-01899	2/17/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Michael State 31X-16	Oil	48.167464	-103.031950	NAD83
33-025-01165	5/9/2011	North Dakota	Dunn	Marathon Oil	Lucky Fleckenstien #34-20H	Oil	47.264306	-102.330608	NAD83
33-025-01173	5/3/2011	North Dakota	Dunn	Marathon Oil	Wardner #24-35H	Oil	47.245872	-102.445641	NAD83

NORTH DAKOTA UPDATE

- Spotlight on the Bakken: Media Coverage
  - National Geographic
  - New York Times
  - The Globe and Mail (Canada)
  - BBC
  - Daily: California, Florida, New York, Washington, D.C., Colorado, Alaska.
  - Inquiries from Australia, France, Germany, Japan, United Kingdom, Poland, Austria.

QUESTIONS?

- **Alison Ritter**
- **Department of Mineral Resources**
- **Public Information Officer**
- **amritter@nd.gov**
- **701-328-8036**