Fox Hills-Hell Creek Aquifer (HB935)
And
Buried Channel Aquifers (GWAP 11)

MBMG Project Updates

Alan English, Manager
Ground Water Assessment Program

House Bill 935 Updates

The Directive **"Complete a feasibility study on ground water availability from the Fox Hills-Hell Creek Aquifer"**

Including…

a) **The compilation and update of new geologic and hydrogeologic data**

b) **A limited field collection of water levels and pressure for wells with historical data**

c) **A preliminary water budget for the Fox Hills-Hell Creek aquifer**

d) **A preliminary model to evaluate the effects of pumping on water levels and pressure**

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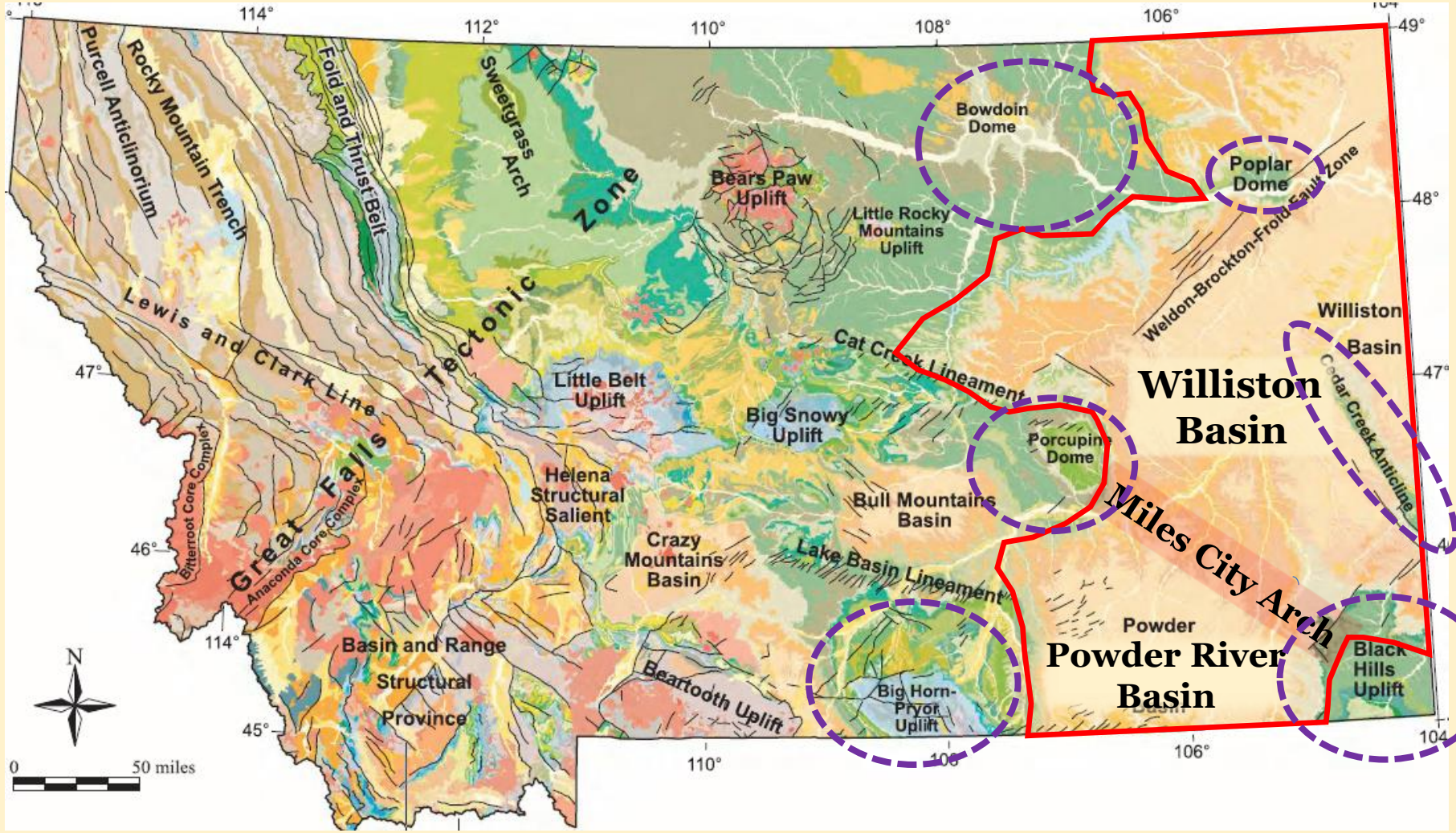
THE STUDY AREA

FOCUS ON WHERE THE FOX HILLS AND HELL CREEK FORMATIONS OUTCROP AND UNDERLIE THE POWDER RIVER AND WILLISON BASINS IN EASTERN MONTANA



FORMATIONS FOLDED, FAULTED, AND INTRUDED DURING FORMATION OF THE ROCKY MOUNTAINS.

LARGE GEOLOGIC STRUCTURES IMPACT WHERE WATER RECHARGES THE FHHC AQUIFER AND WHERE IT FLOWS

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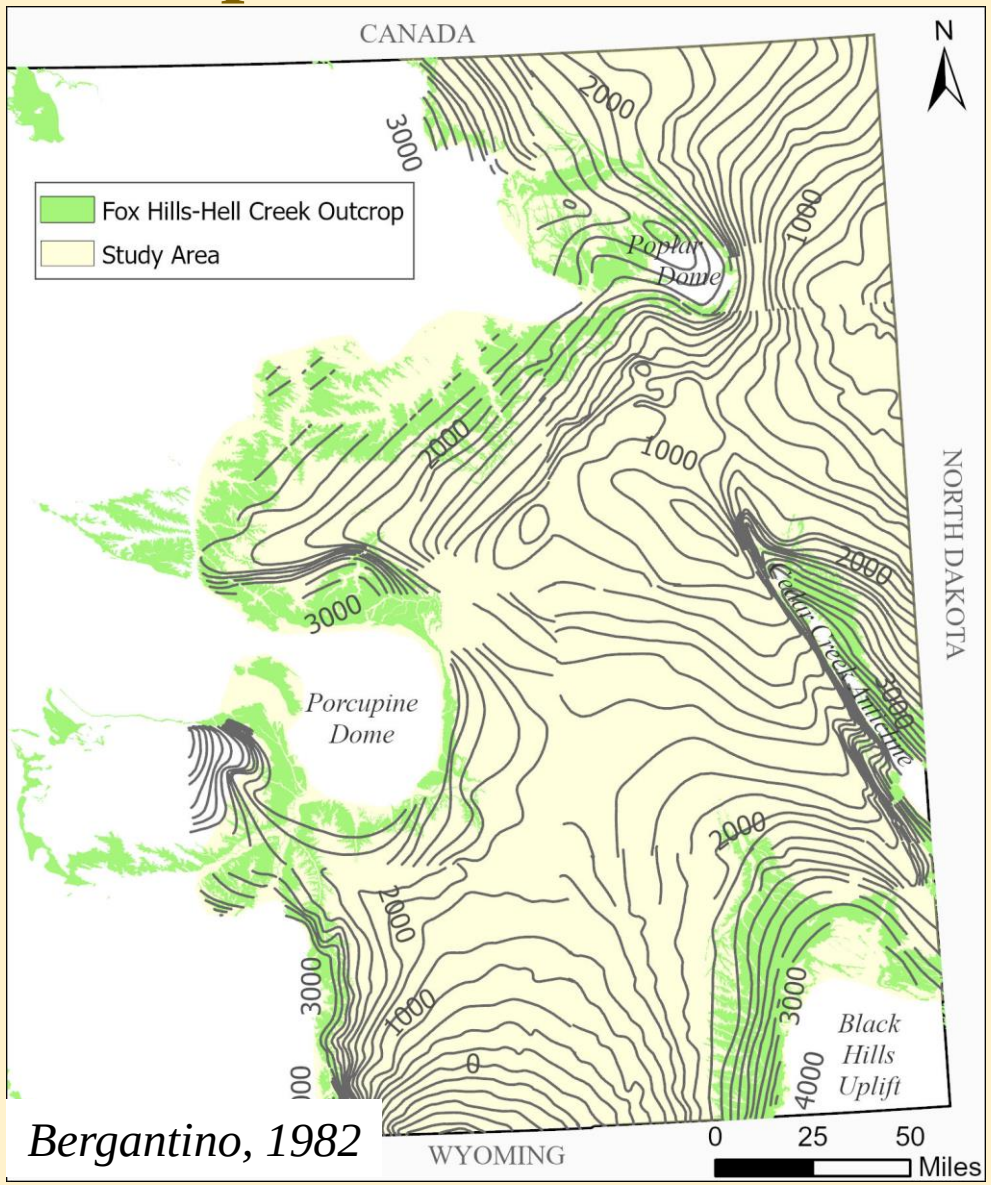
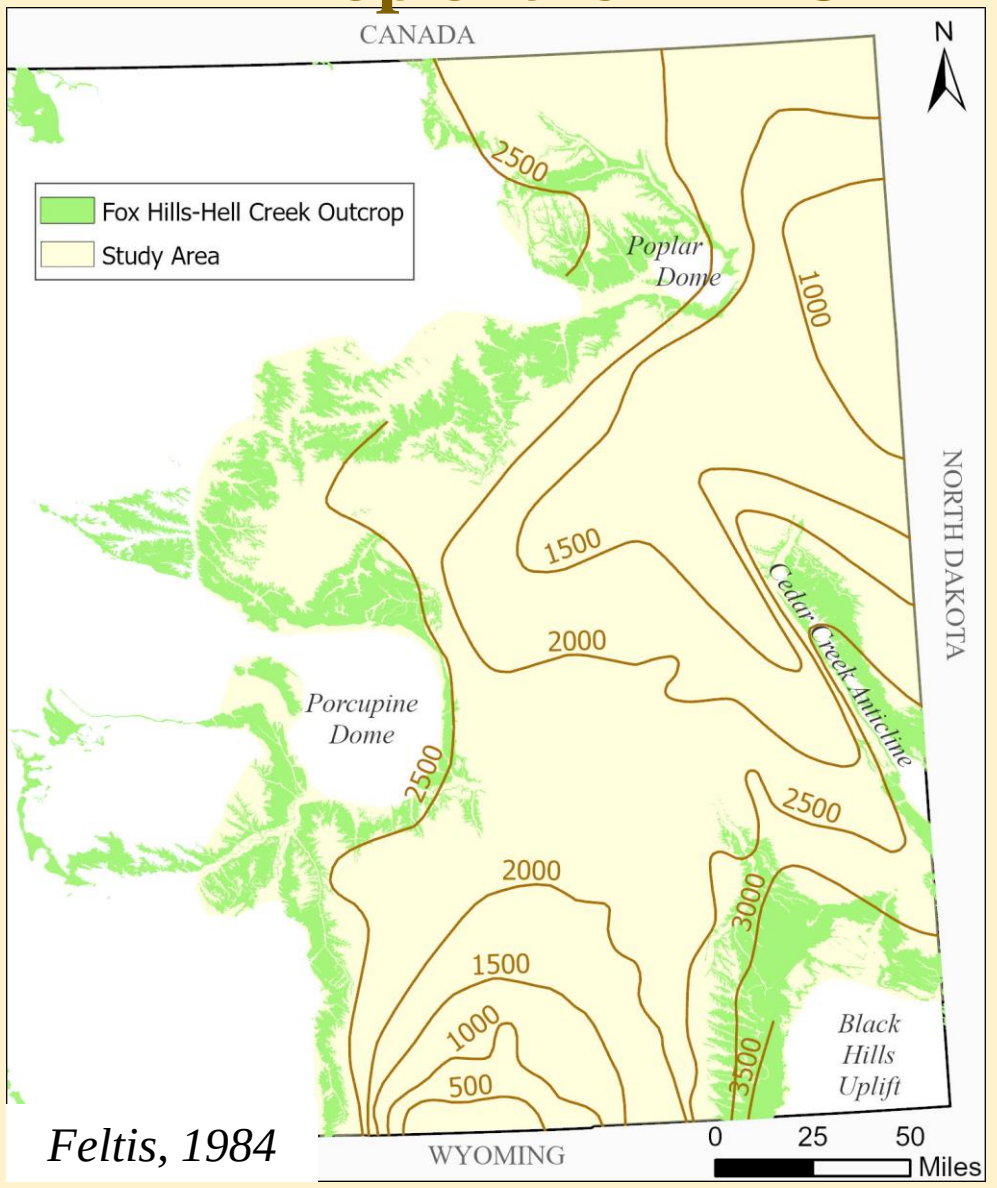
The Shape (Structure) of the FHHC Aquifer System

Top of Bearpaw Shale-Bottom FHHC



Bergantino, 1982

Top of the FHHC



Feltis, 1984

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Progress Report-Compilation and update of new geologic and hydrogeologic data

- ✓ **PETROLEUM WELL RECORDS**
  - ✓ **Top of FHHC Aquifer**
  - ✓ **Percent Sand in the FHHC Aquifer**
  - ✓ **Bottom of the Fox Hills Formation**

- ✓ **PREVIOUS WORK**
  - ✓ **MBMG-Montana GWAA 1 (**Dawson, Fallon, Prairie, Wibaux Co**)**
  - ✓ **USGS Reports and Groundwater Modeling**

- ✓ **BOTTOM LINE…**
  - ✓ **Lots of geologic information available**
  - ✓ **FHHC aquifer is a large, multistate system**
  - ✓ **The bottom of the FHHC aquifer is easy, the top is "*Fuzzy*"**
  - ✓ **Identifying the top of the FHHC aquifer is important for modeling**

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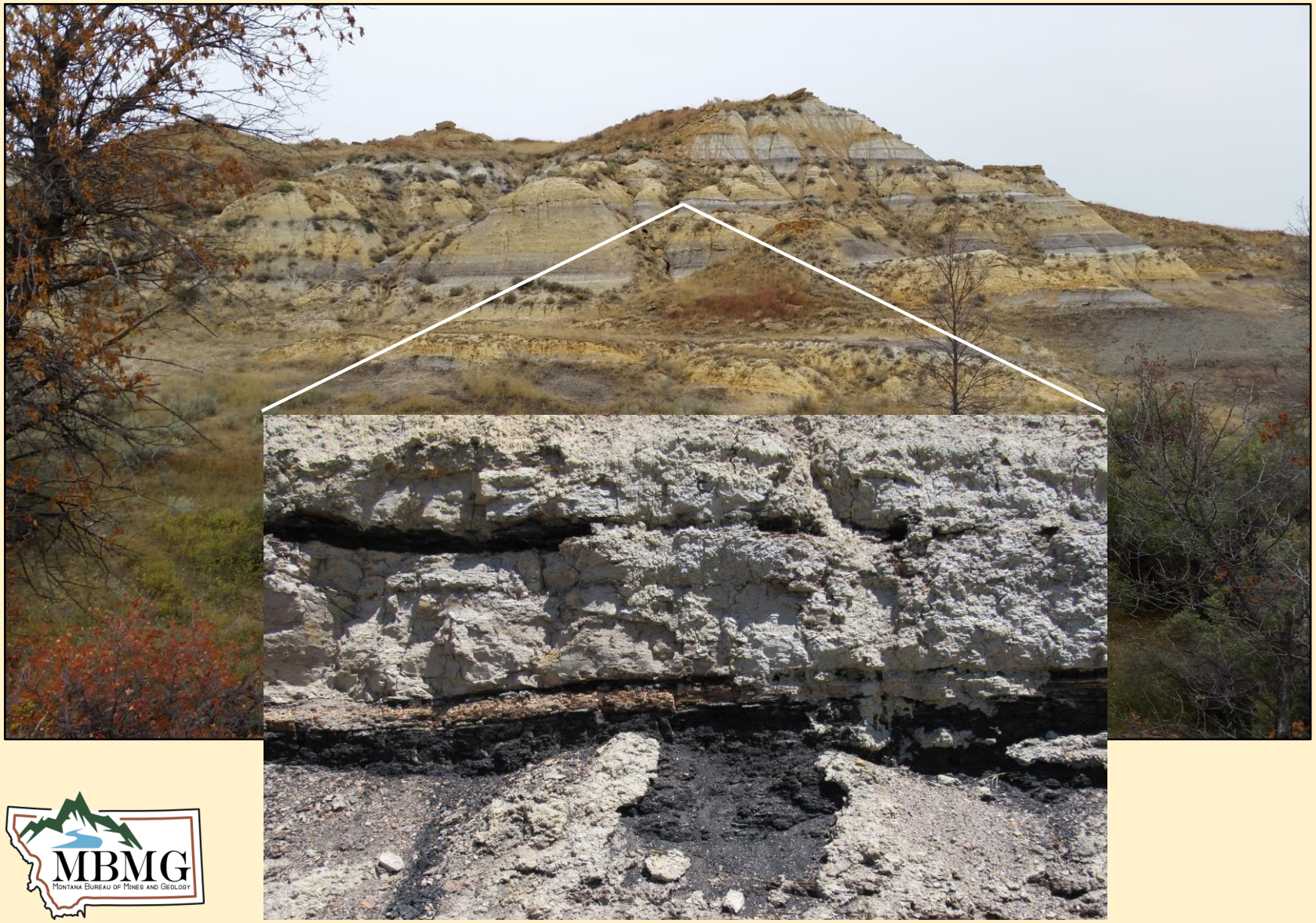
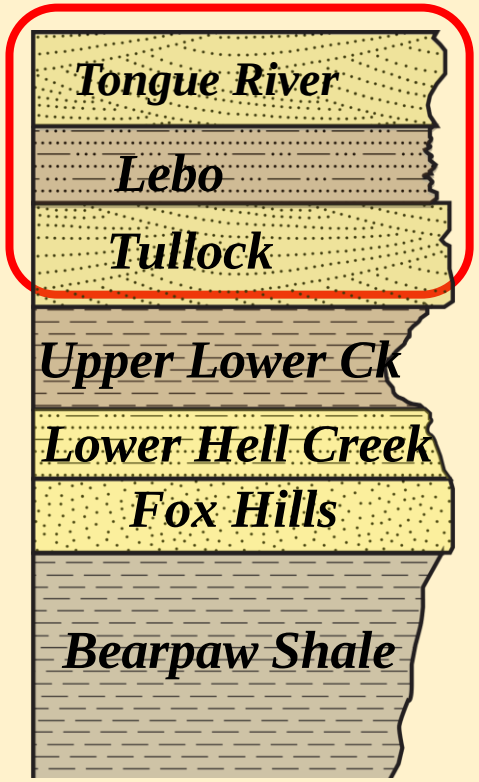
GEOLOGIC OVERVIEW-Fort Union Formation

A Regional Unconfined Aquifer





- Streams & Swamps draining the ancestral Rocky Mtns
- Fine sandstones, siltstone, mudstones, clay and coal.
- Sandstones form unconfined aquifers

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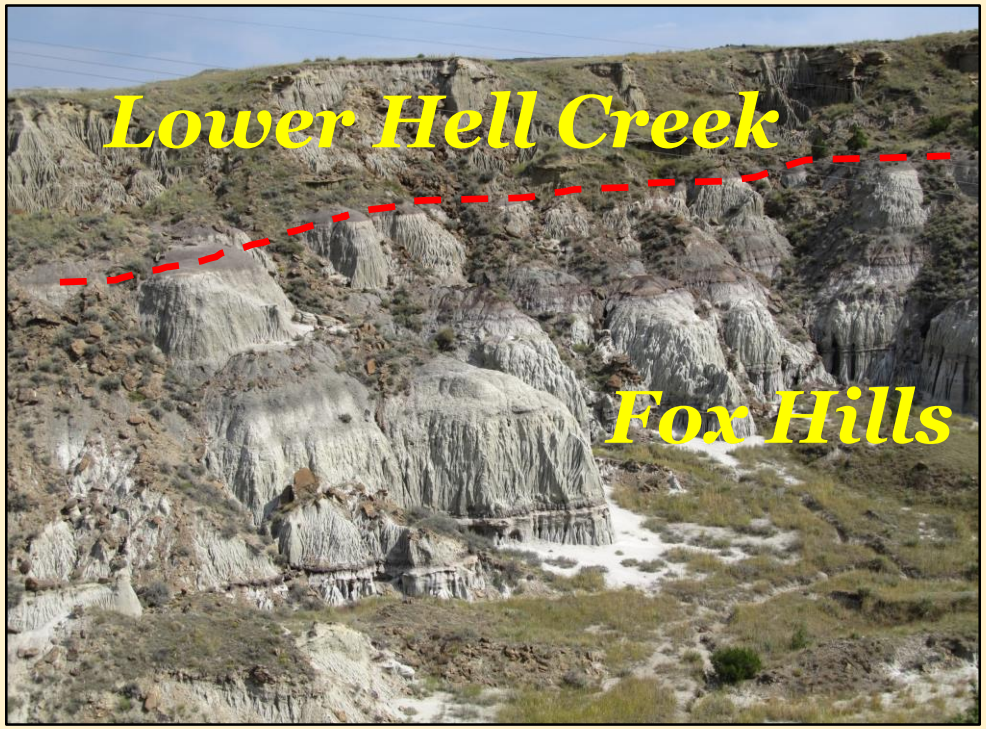
GEOLOGIC OVERVIEW-Hell Creek, Fox Hills Formations

A regional confined and unconfined aquifer



- Deposited as Cretaceous Western Interior Sea retreated.
- Upper Hell Creek - Mainly Siltstone and Mudstone
- Lower Hell Creek - Fine Sandstone
- Fox Hills - Medium to Fine Sandstone

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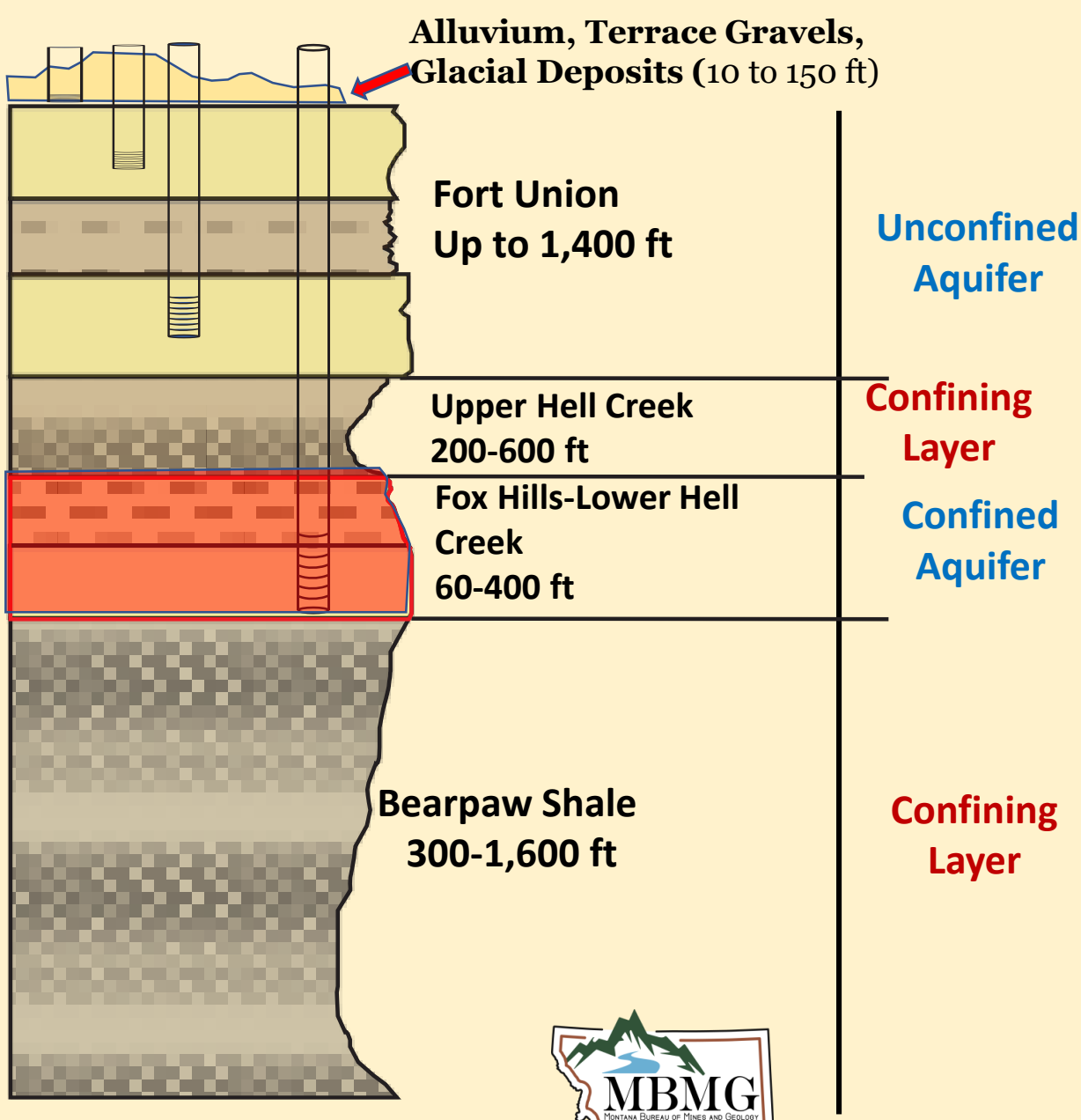
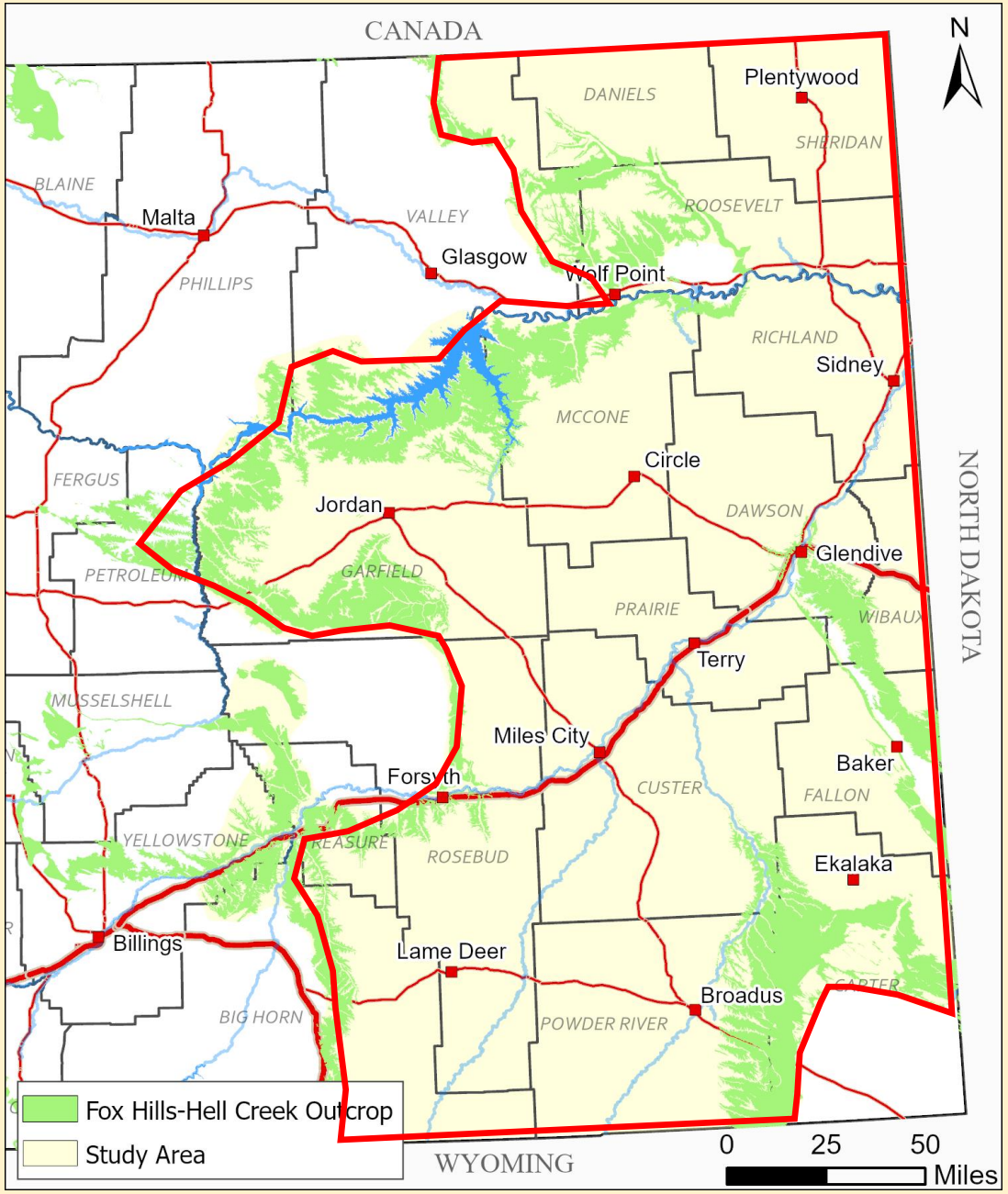
HYDROGEOLOGIC UNITS-Primary Aquifers





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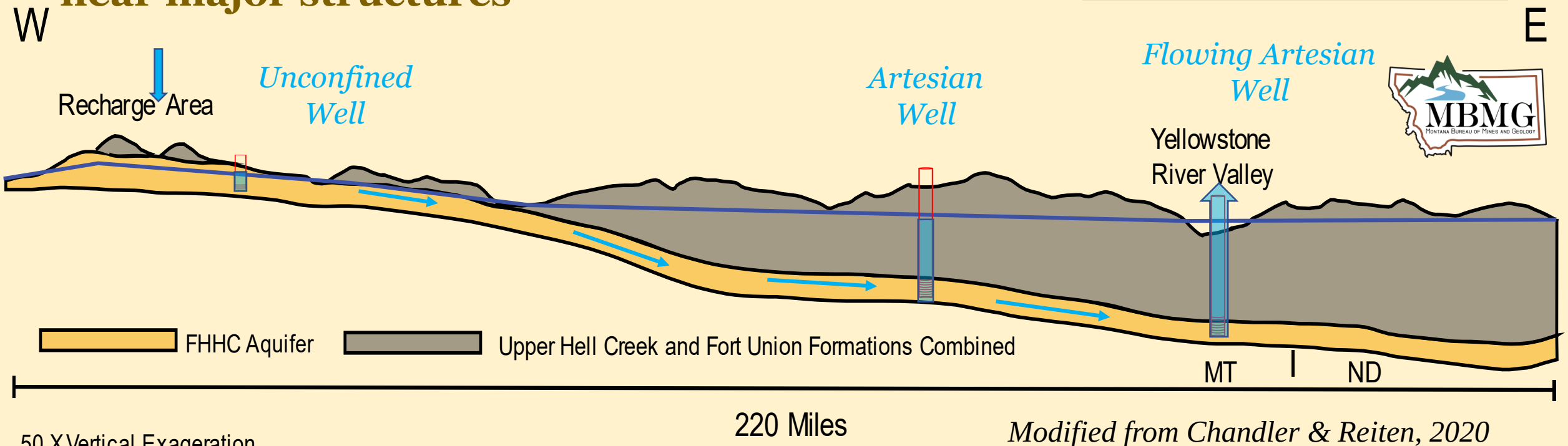
WELL BEHAVIOR IN THE FHHC AQUIFER

- ✓ **Wells near recharge zones - unconfined**
- ✓ **Wells above major river and stream valleys artesian but don't usually flow**
- ✓ **Most flowing wells in river/stream valleys or near major structures**



Modified from Chandler & Reiten, 2020

a)Progress Report-A limited field collection of water levels and pressure from wells with historical data & A preliminary water budget

- ✓ Visiting FHHC wells to get **updated water-level/pressure data**
- ✓ Reviewing GWIC database - **updated inventory of FHHC wells**

- ✓ **Bottom Line…**
  - ✓ Over 100 well visits
  - ✓ Currently in SE counties (Rosebud, Powder River, Carter, Custer, Fallon) **Contacts???**
  - ✓ Over 17,000 well records reviewed
  - ✓ About 7,600 wells preliminarily identified as FHHC wells
  - ✓ Water-level trends vary depending on location in aquifer

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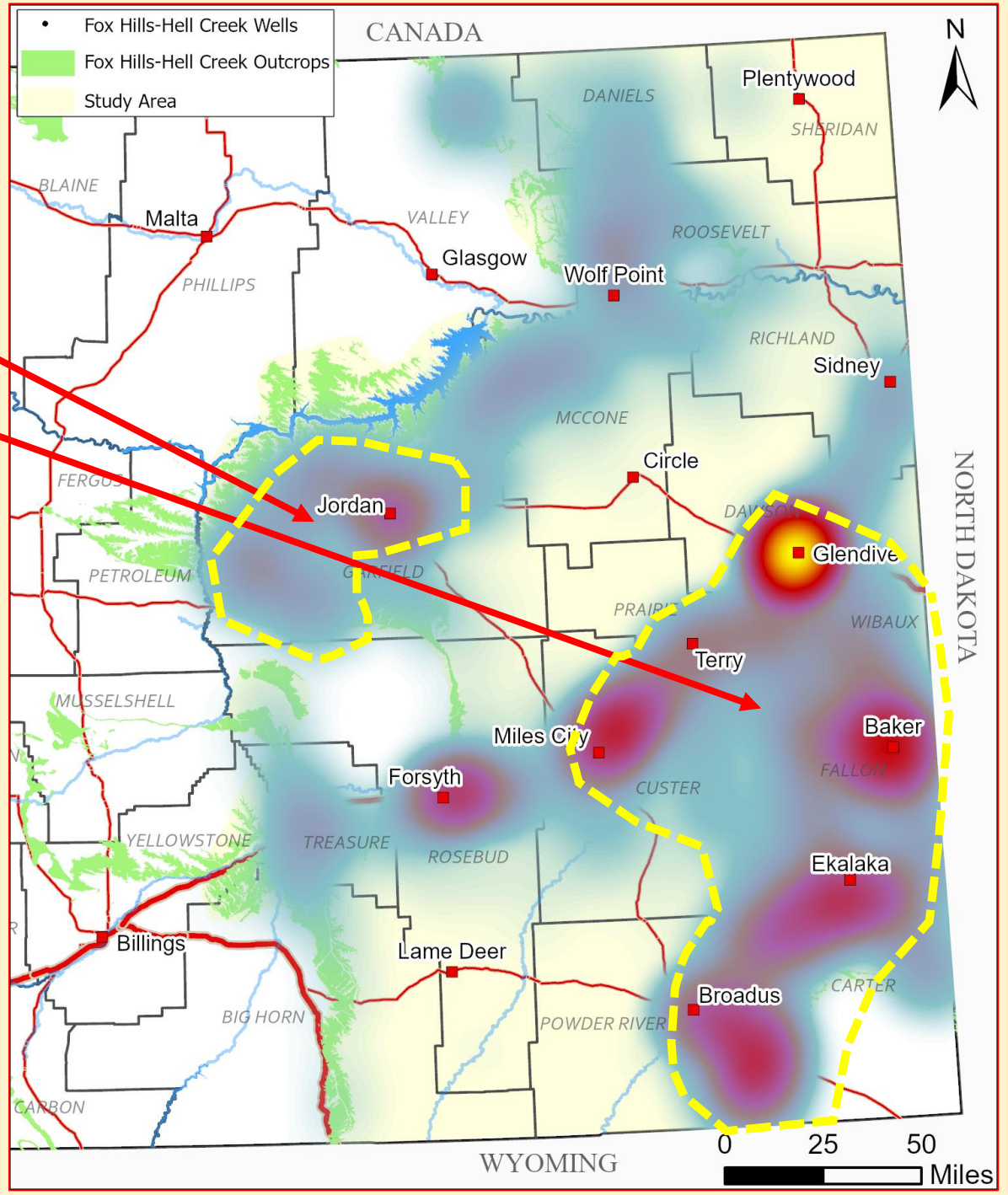
FHHC WELL INVENTORY

County	Number of Wells
GARFIELD	961
CARTER	918
FALLON	894
CUSTER	844
DAWSON	841
POWDER RIVER	717
ROSEBUD	483
PRAIRIE	348
ROOSEVELT	322
MCCONE	297
RICHLAND	248
TREASURE	179
WIBAUX	178
DANIELS	147
BIG HORN	114
VALLEY	114
SHERIDAN	26
TOTAL	7631

5175 Wells (68%)



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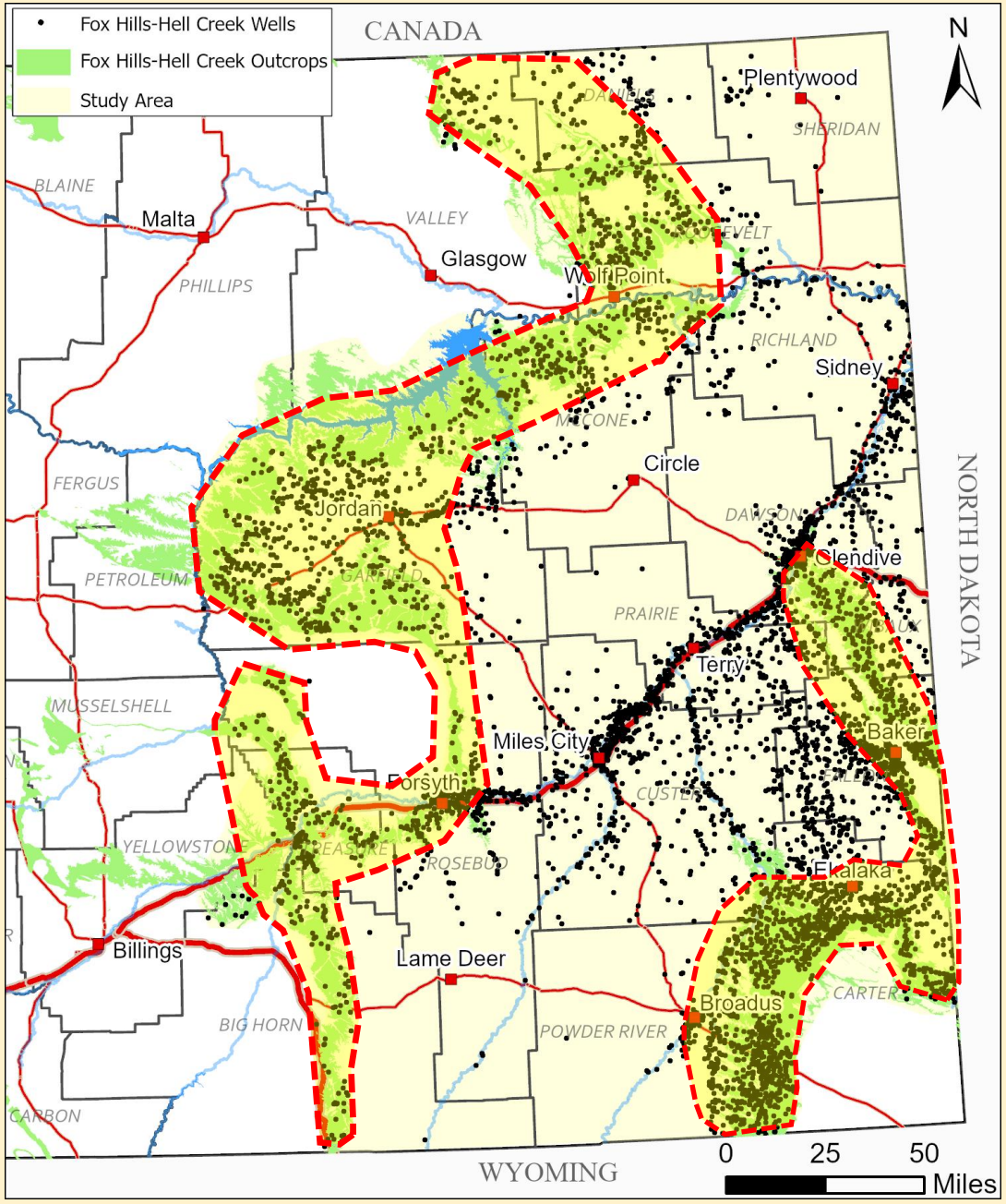
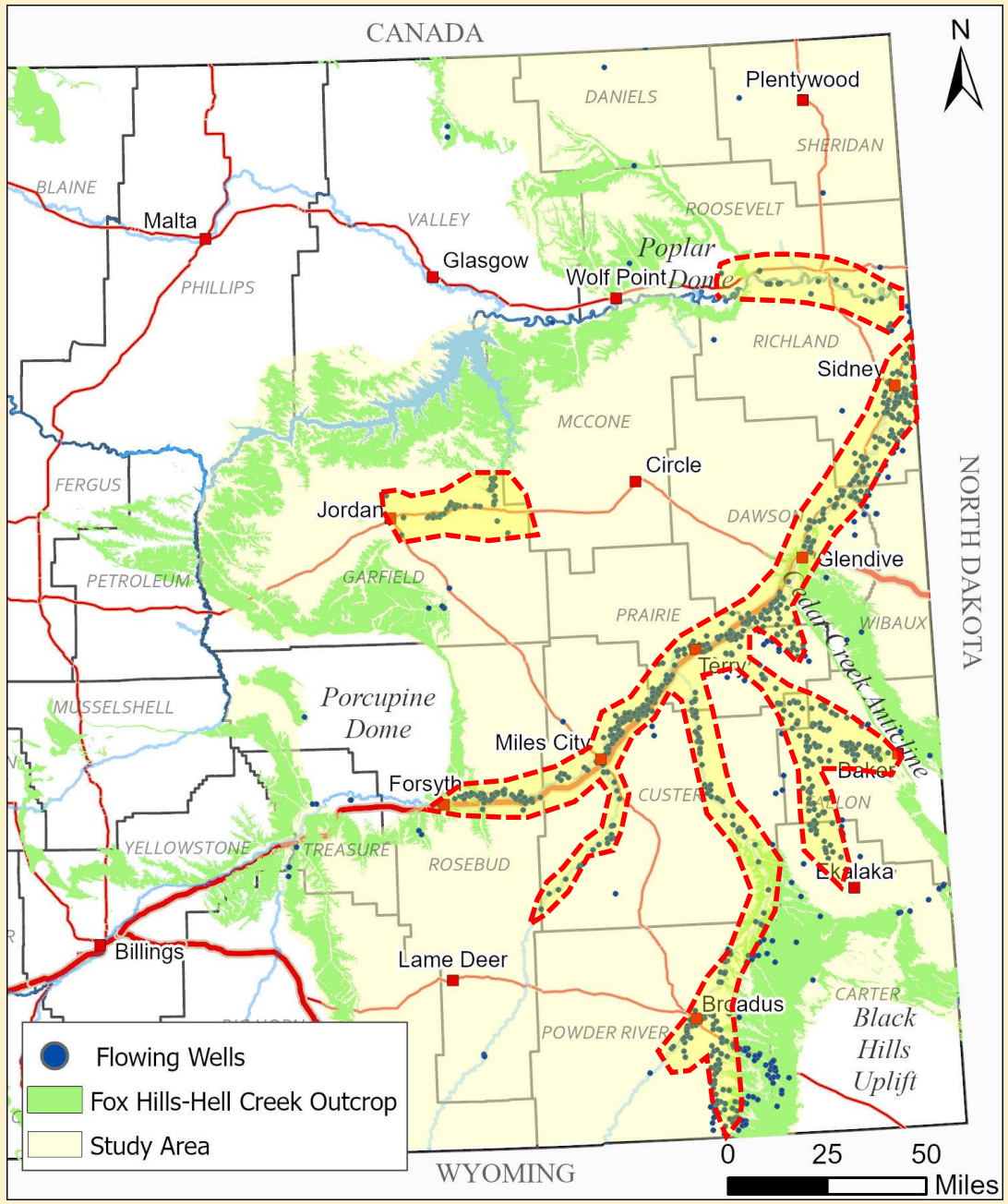
All FHHC WELLS vs FLOWING FHHC WELLS





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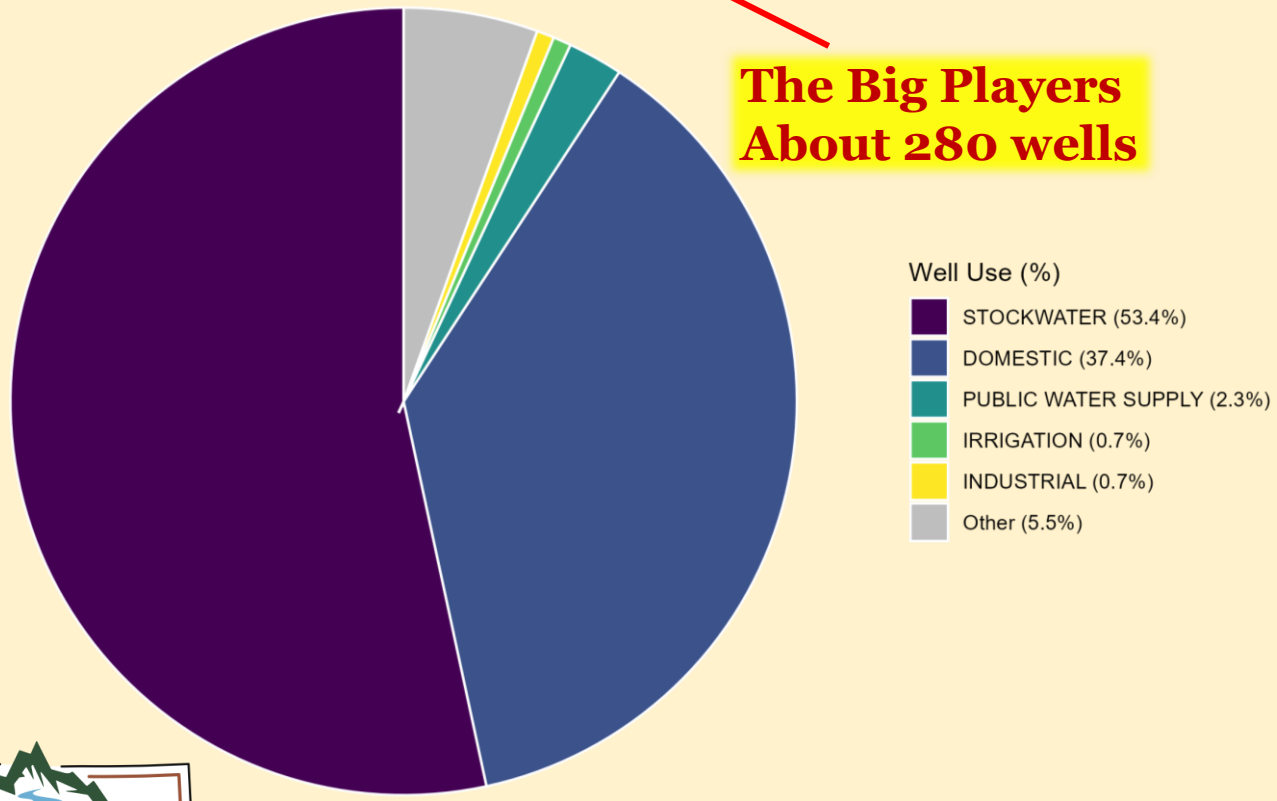
FHHC WELL USE

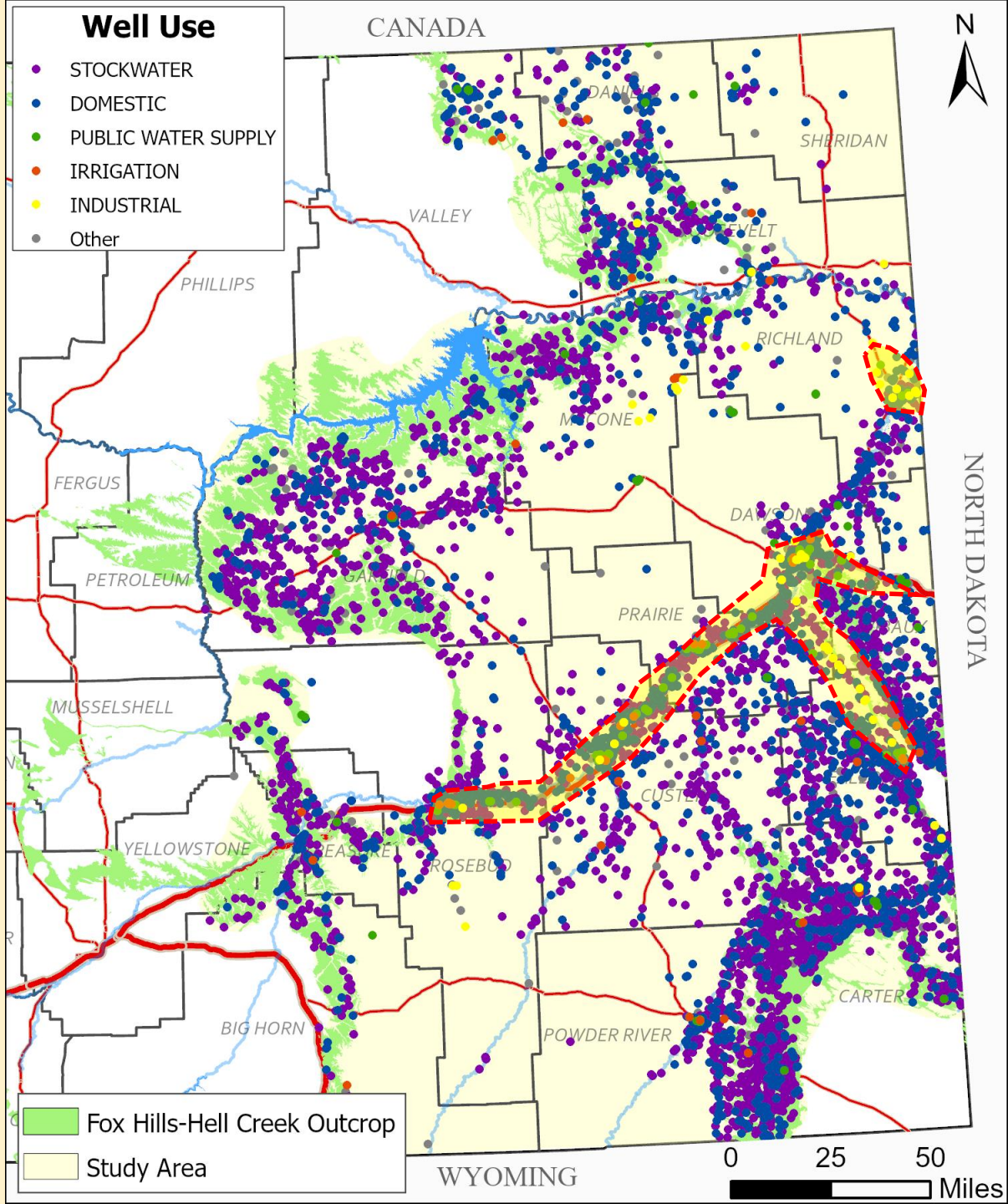
91% (6944) domestic & livestock use-Low

2.3% are public water supply

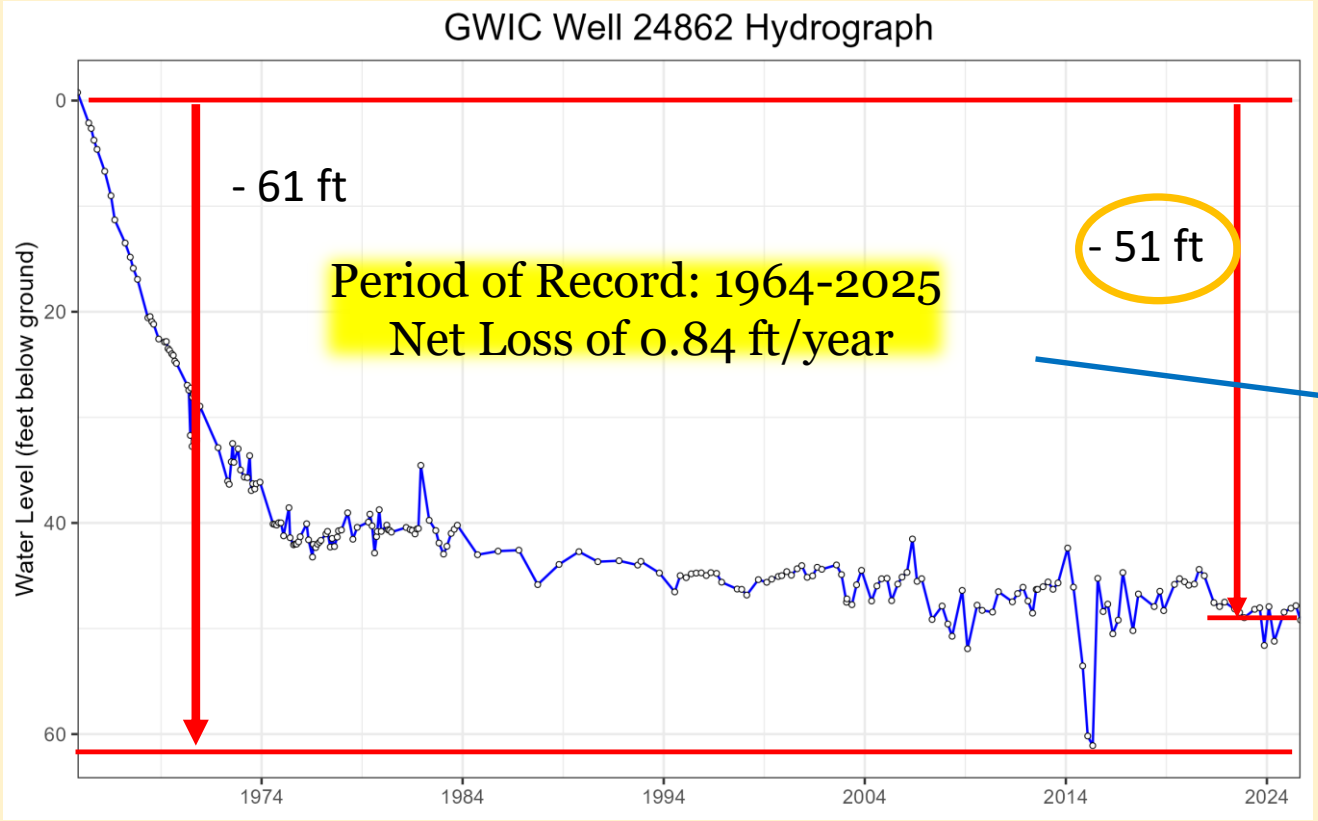
1.4% are for irrigation and industrial use

The Big Players
About 280 wells



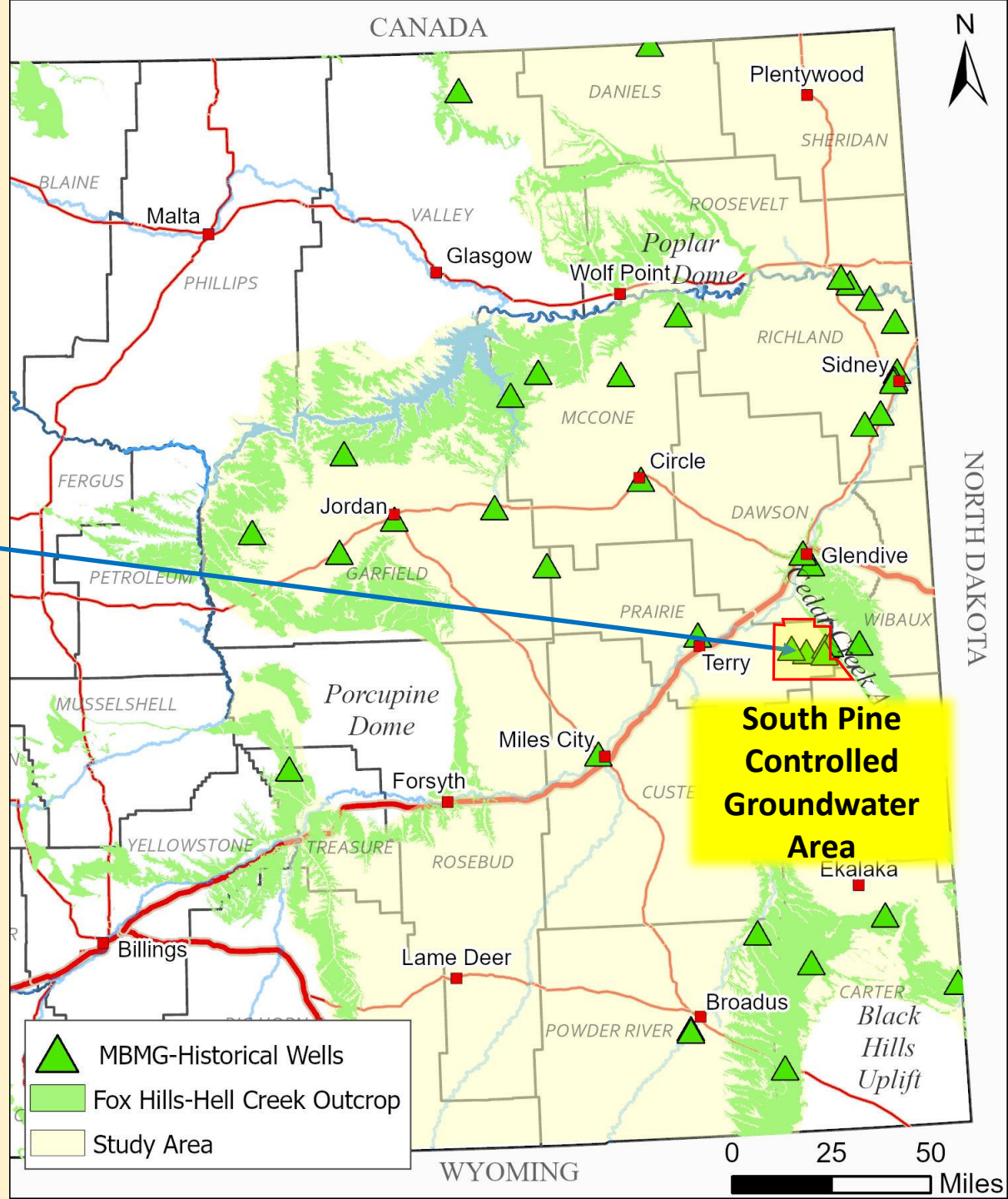


FHHC WATER-LEVEL TRENDS
Example of Declining Levels
West Flank Cedar Creek Anticline

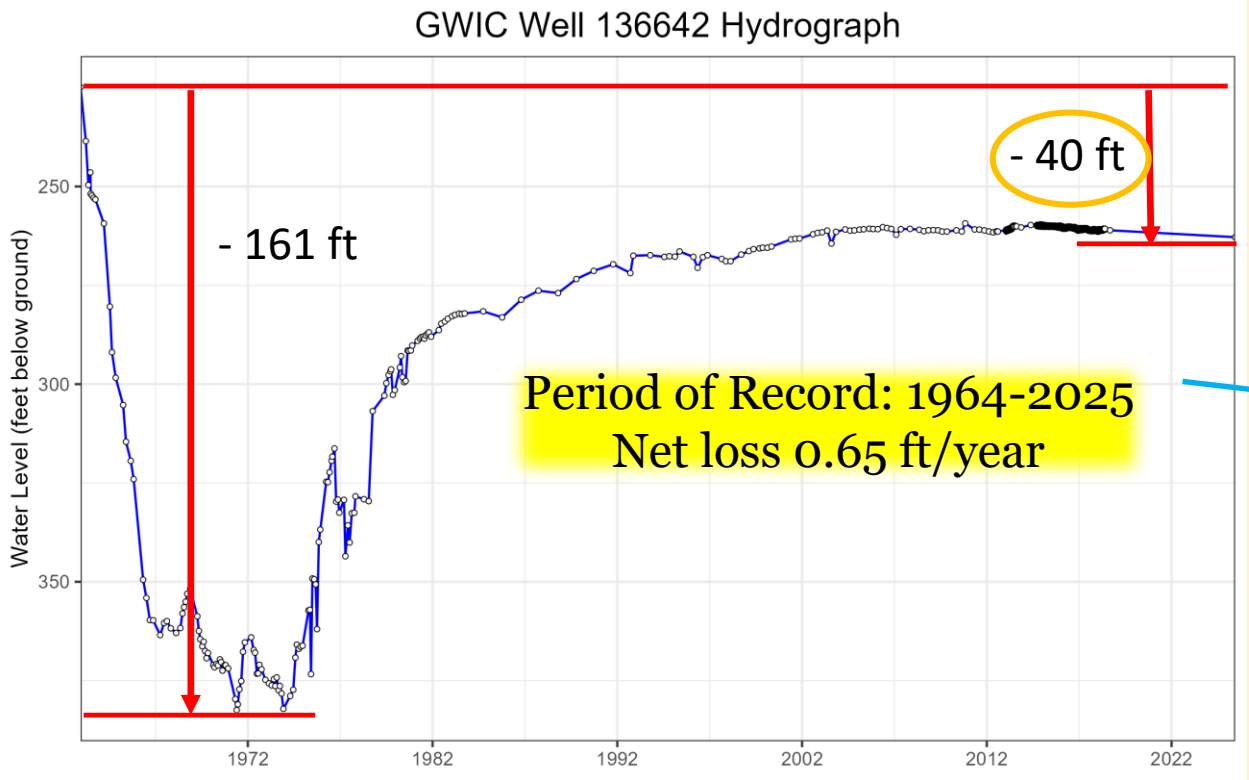


Total Depth-1275 ft
Drilled in 1943
Reported Yield 9 gpm

Industrial Pumping Restricted in 1967



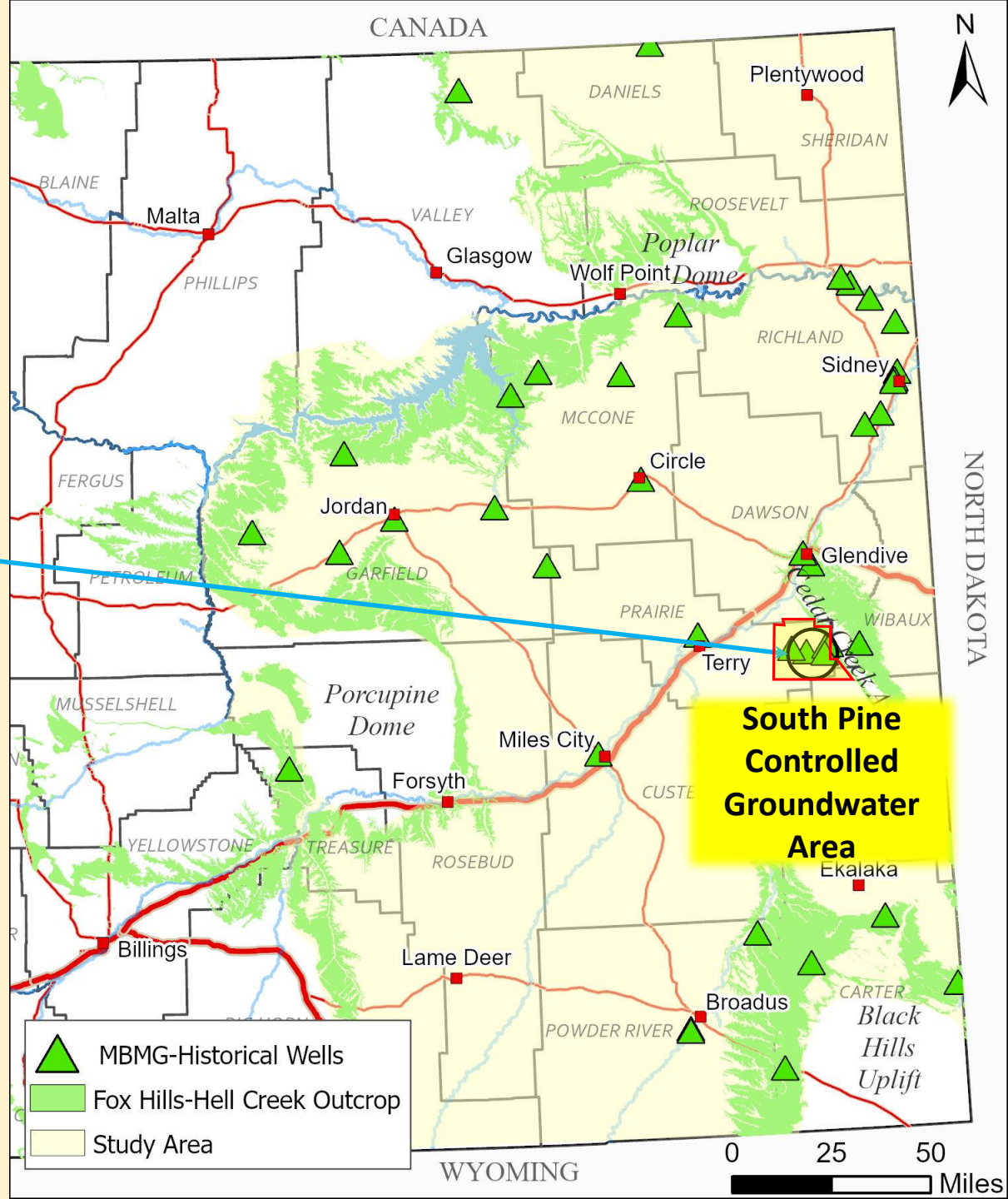
FHHC WATER-LEVEL TRENDS
Example of Declining Levels
West Flank of Cedar Creek Anticline



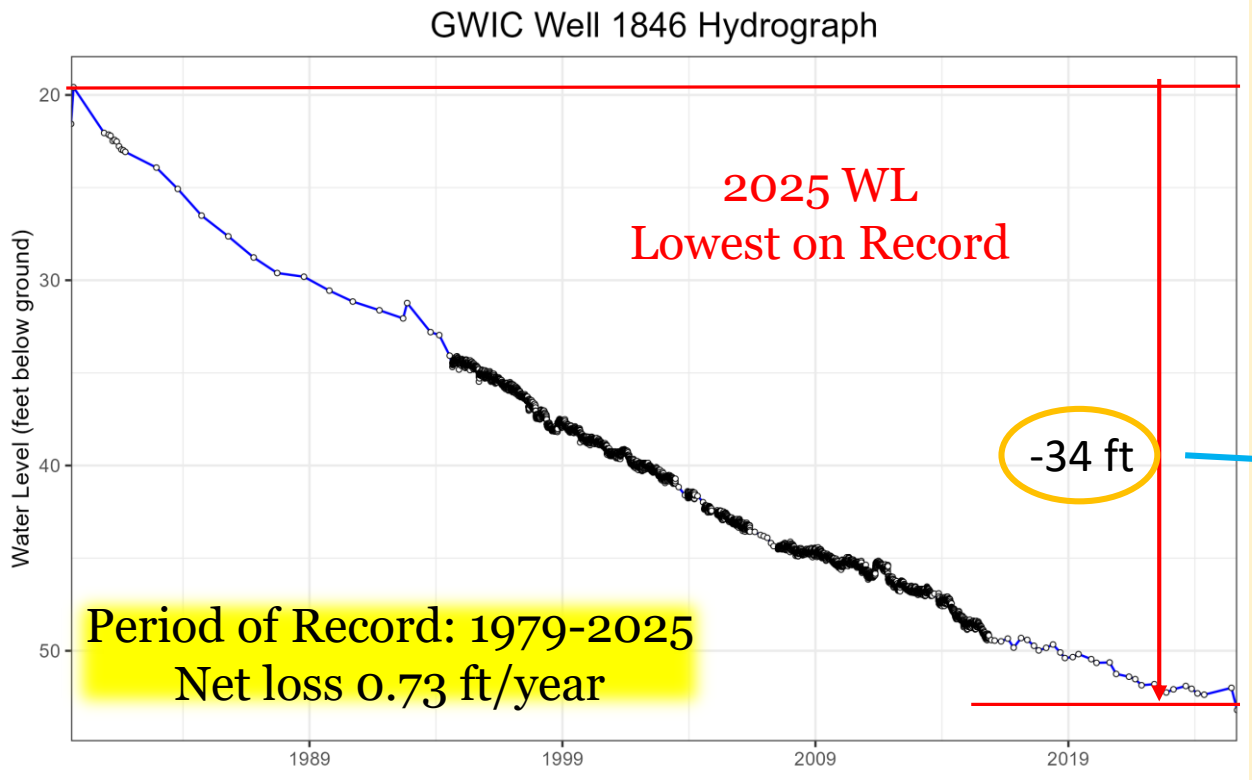
Period of Record: 1964-2025
Net loss 0.65 ft/year

Total Depth-1467 ft
Drilled in 1962
No Yield Reported

Industrial Pumping Restricted in 1967

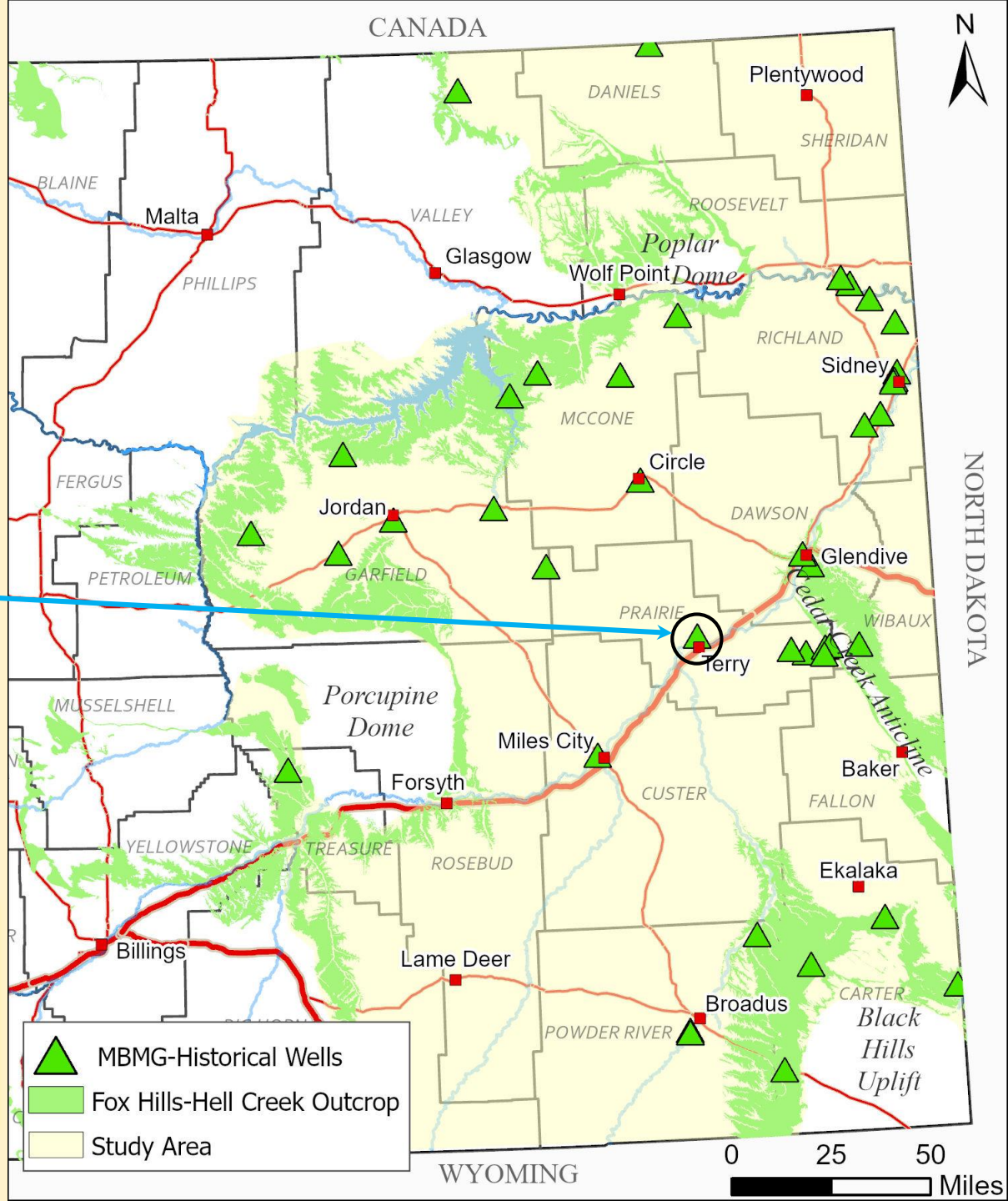


FHHC WATER-LEVEL TRENDS
Example of Declining Levels
Yellowstone River Valley by Terry

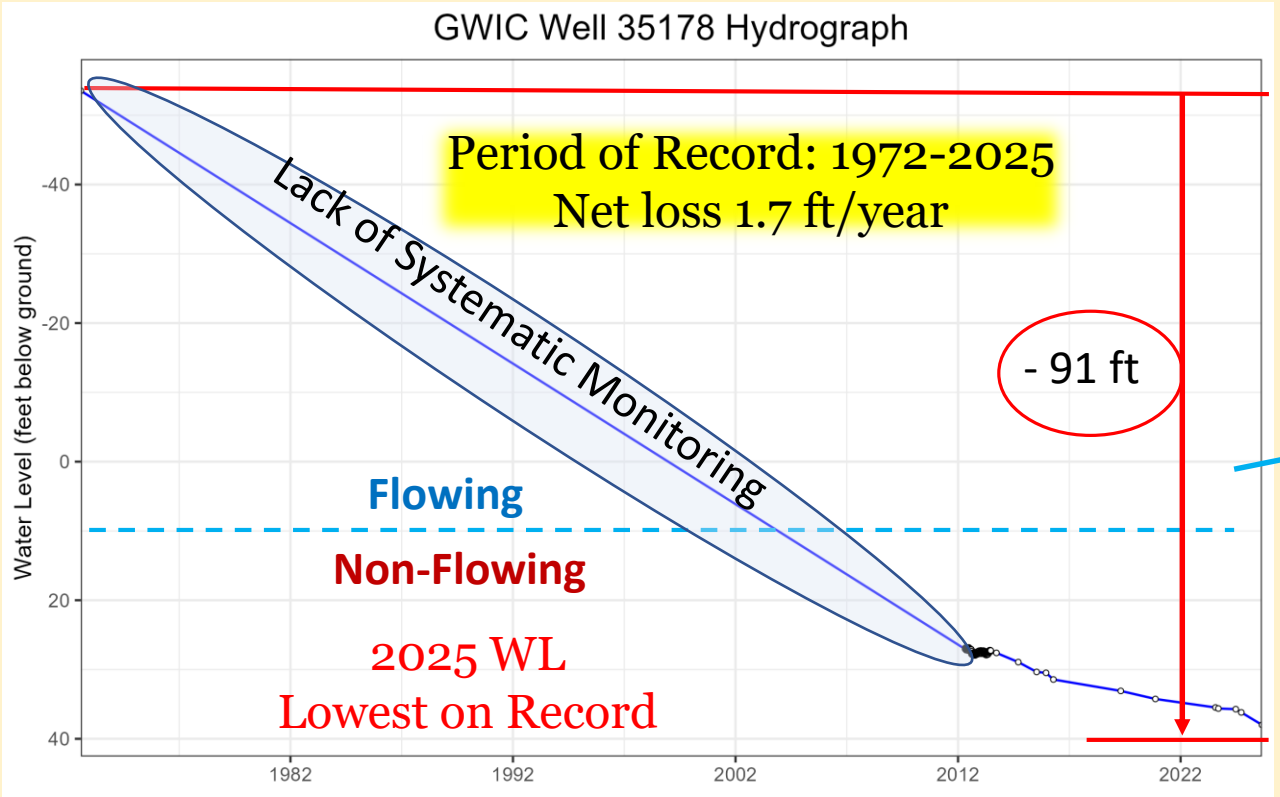


Total Depth-860 ft
Drilled in 1979
Yield Reported 37.5 gpm

Long-Term Steady Decline
- Unregulated Flowing Wells?
- Increasing Number of Wells?
- Decreasing Rechaerge?

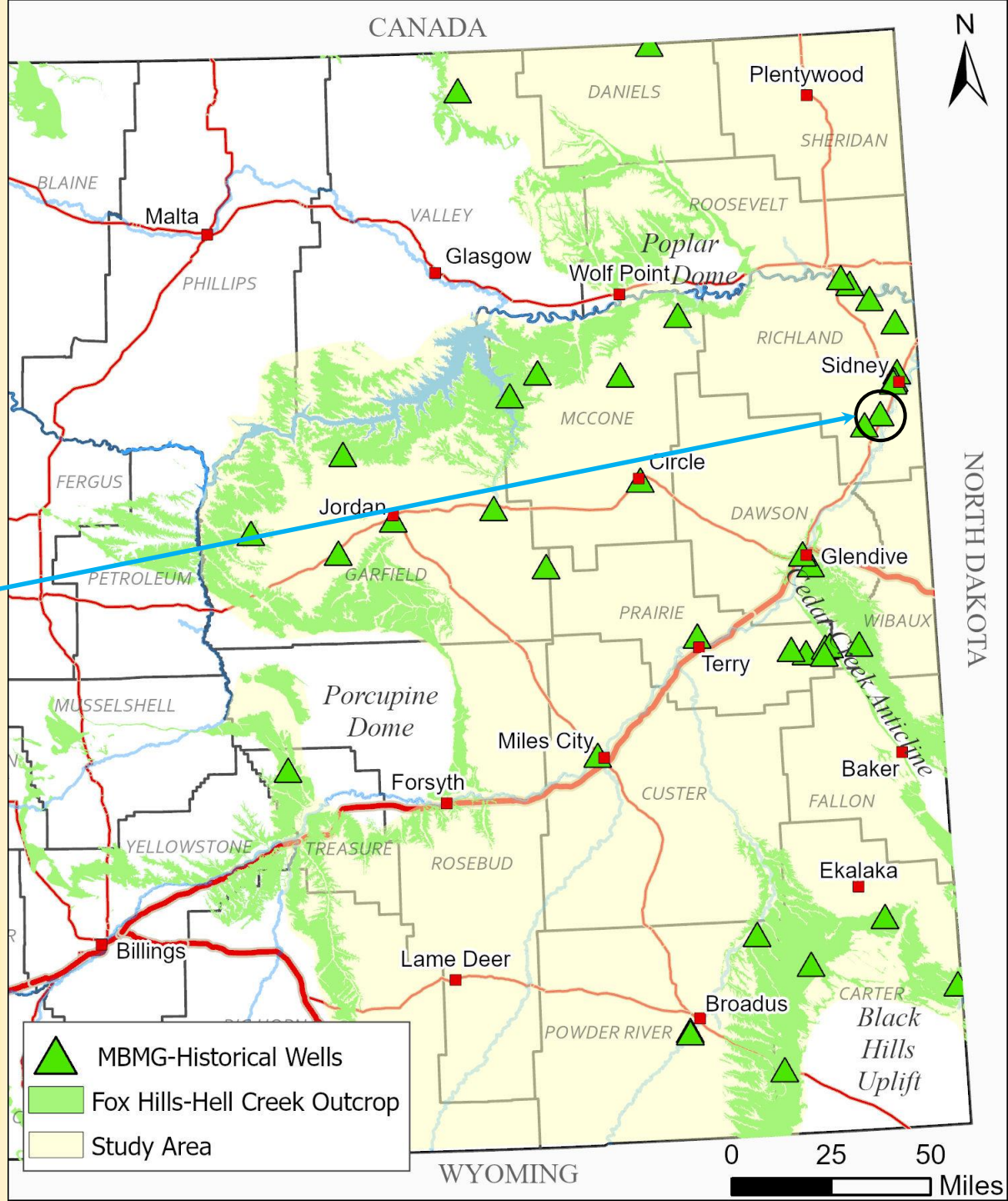


FHHC WATER-LEVEL TRENDS
Example of Declining Levels
Yellowstone River Valley by Sidney

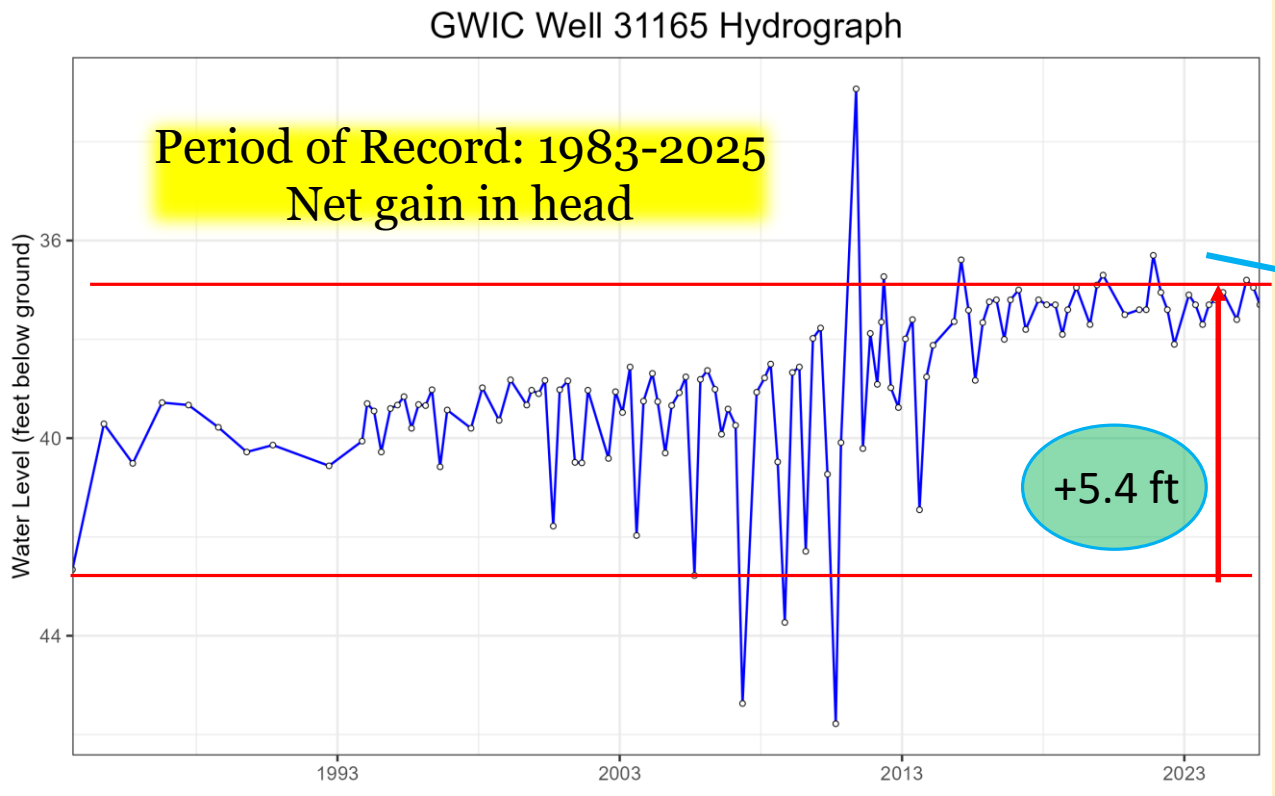


Total Depth-1325 ft
Drilled in 1972
Yield Reported-8 gpm

Long-Term Steady Decline
- Unregulated Flowing Wells?
- Increasing Number of Wells?
- Decreasing Recharge?

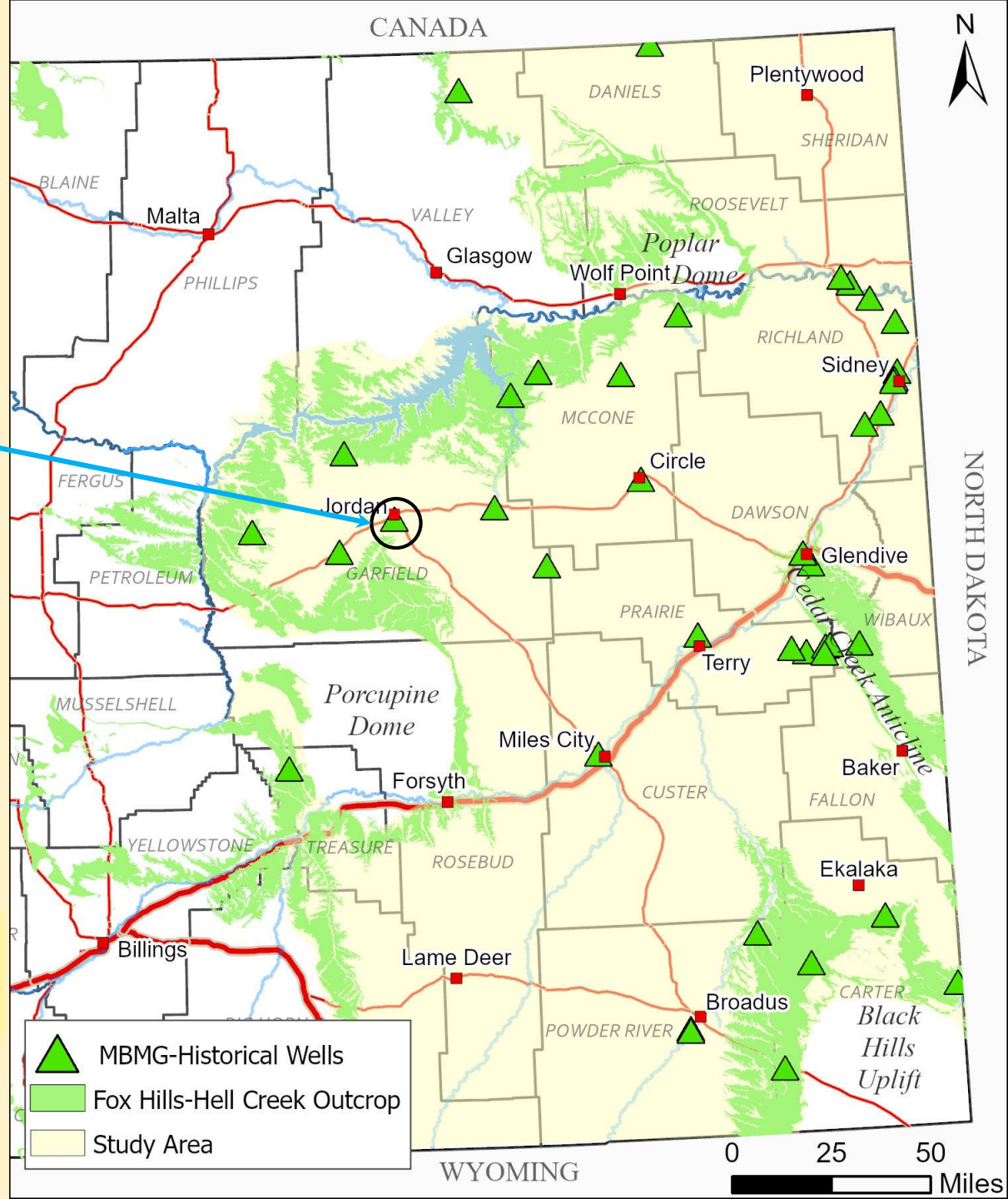


FHHC WATER-LEVEL TRENDS
Example of Increasing Levels
Jordon-Big Dry Creek Valley



Total Depth-520 ft
Drilled in 1981
Yield Reported 20 gpm

Why Are Levels Increasing
- Decrease in pumping?
- Local recharge events?



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Progress Report- Preliminary model to evaluate the effects of pumping on water levels & pressure

- ✓ The extent of the model area and the initial model layers created
- ✓ Based on data from 2017 USGS Model (Davis and Long)
- ✓ Evaluating petroleum well data compiled by the MBMG Billings
- ✓ Bottom Line…
  - ✓ Focused on updated water-level data for the preliminary model
  - ✓ FHHC aquifer is a large, multistate system
  - ✓ Identifying the top of the FHHC aquifer is important for modeling
  - ✓ Important to consider the 3-Dimentional shape & thickness of aquifer

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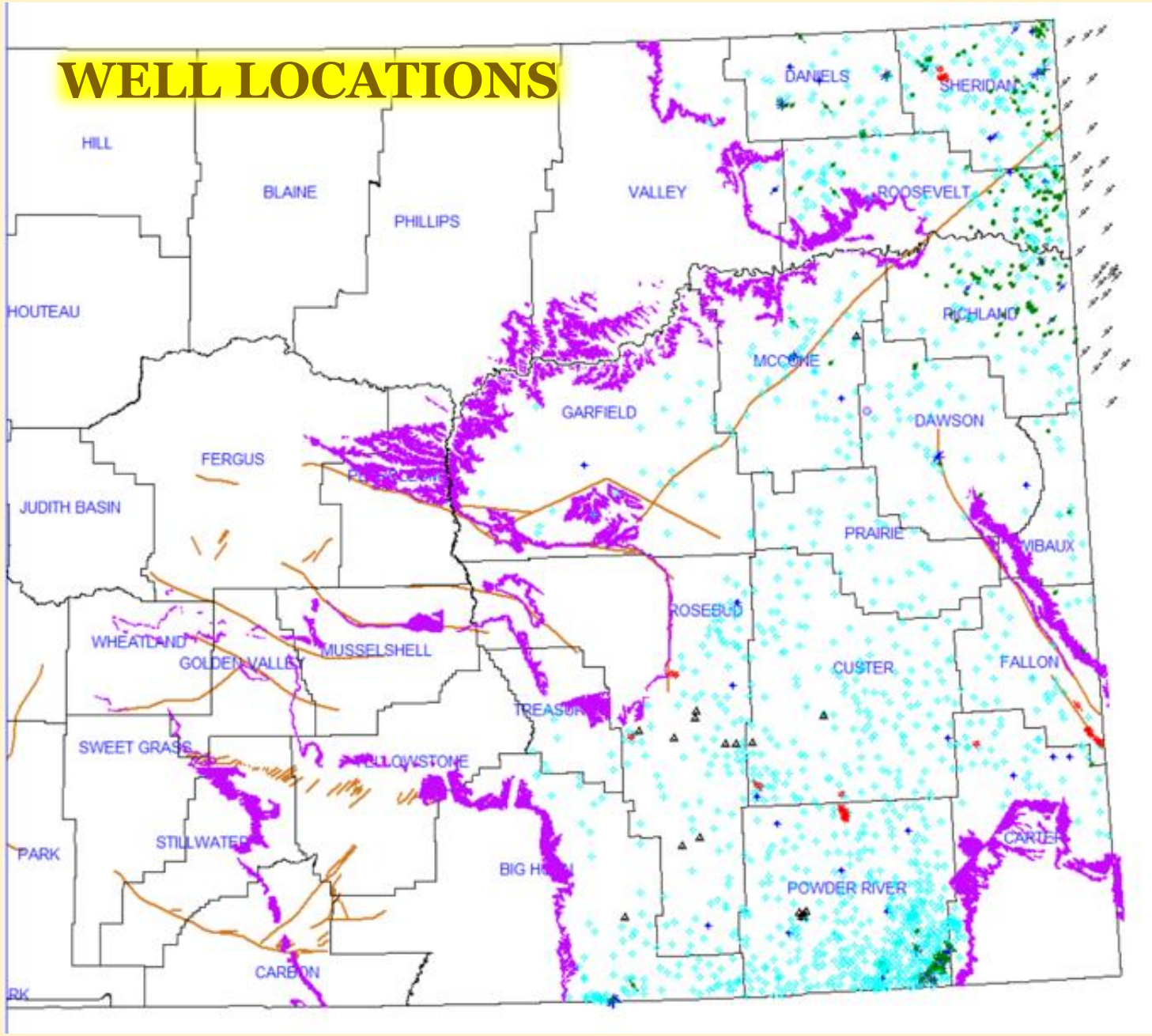
COMPILATION OF FHHC DATA FROM PETROLEUM WELL RECORDS

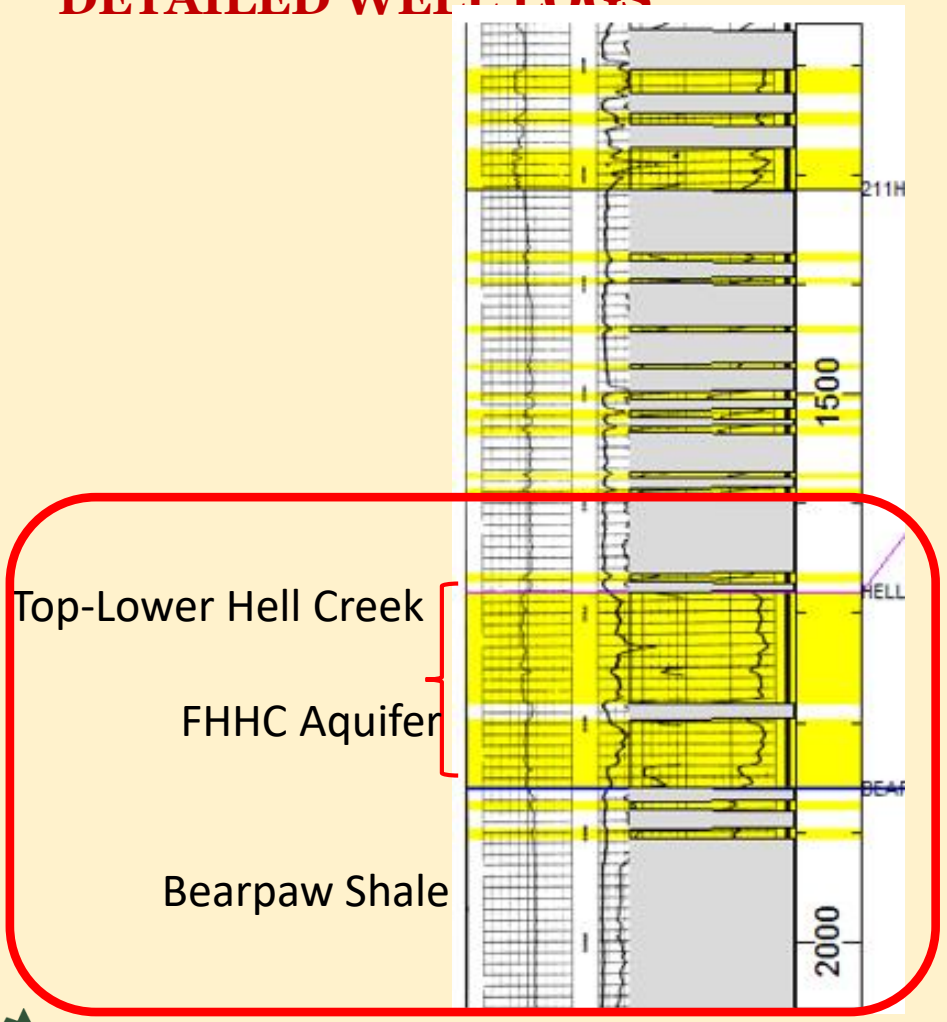
DETAILED REVIEW BY MBMG BILLINGS OFFICE

1650 PETROLEUM WELLS WITH LOGS THAT INCLUDE THE FOX HILLS AND HELL CREEK FORMATIONS

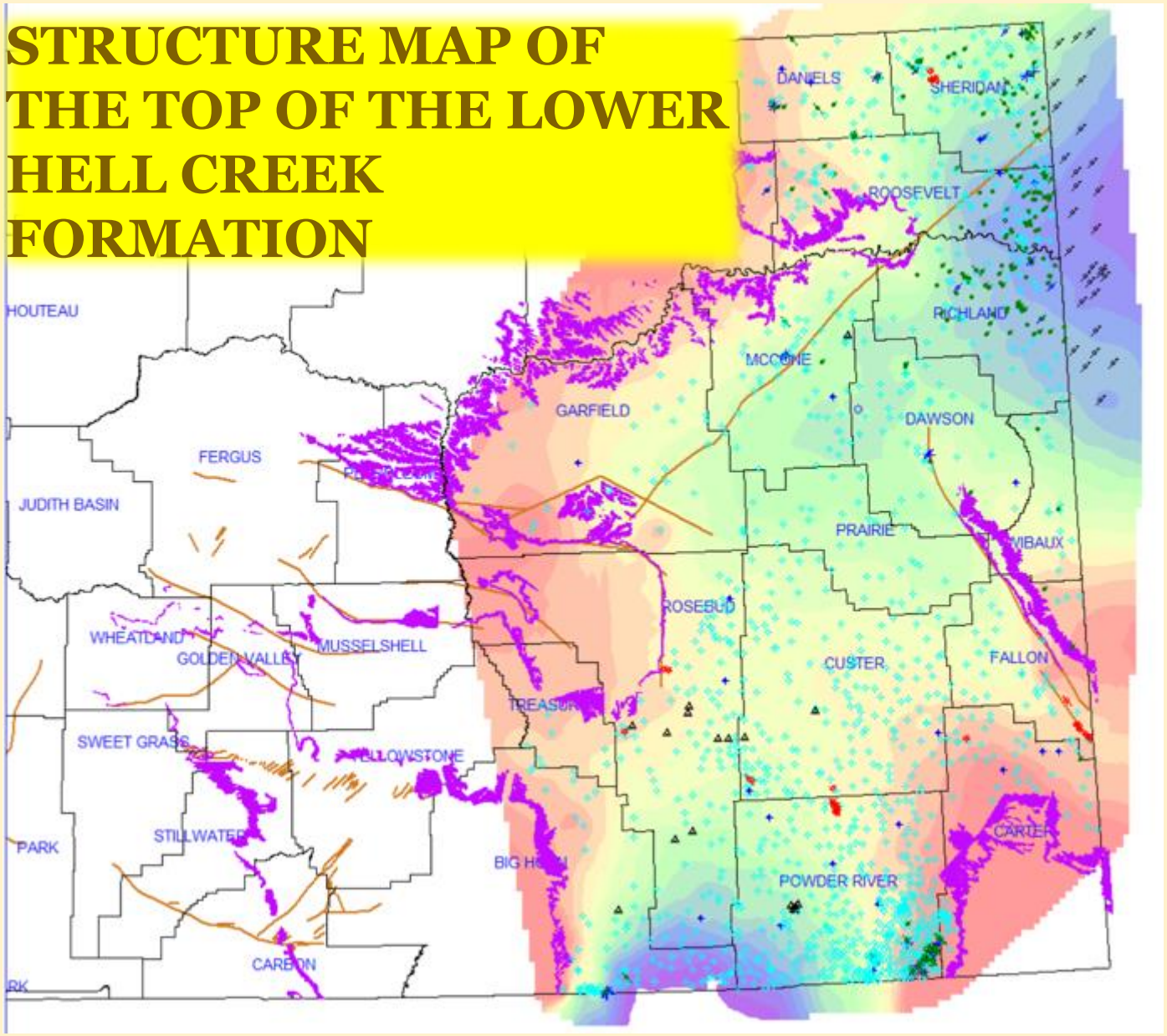


COMPILATION OF FHHC DATA FROM PETROLEUM WELL RECORDS

TOP DEFINED USING DETAILED WELL LOGS



STRUCTURE MAP OF THE TOP OF THE LOWER HELL CREEK FORMATION



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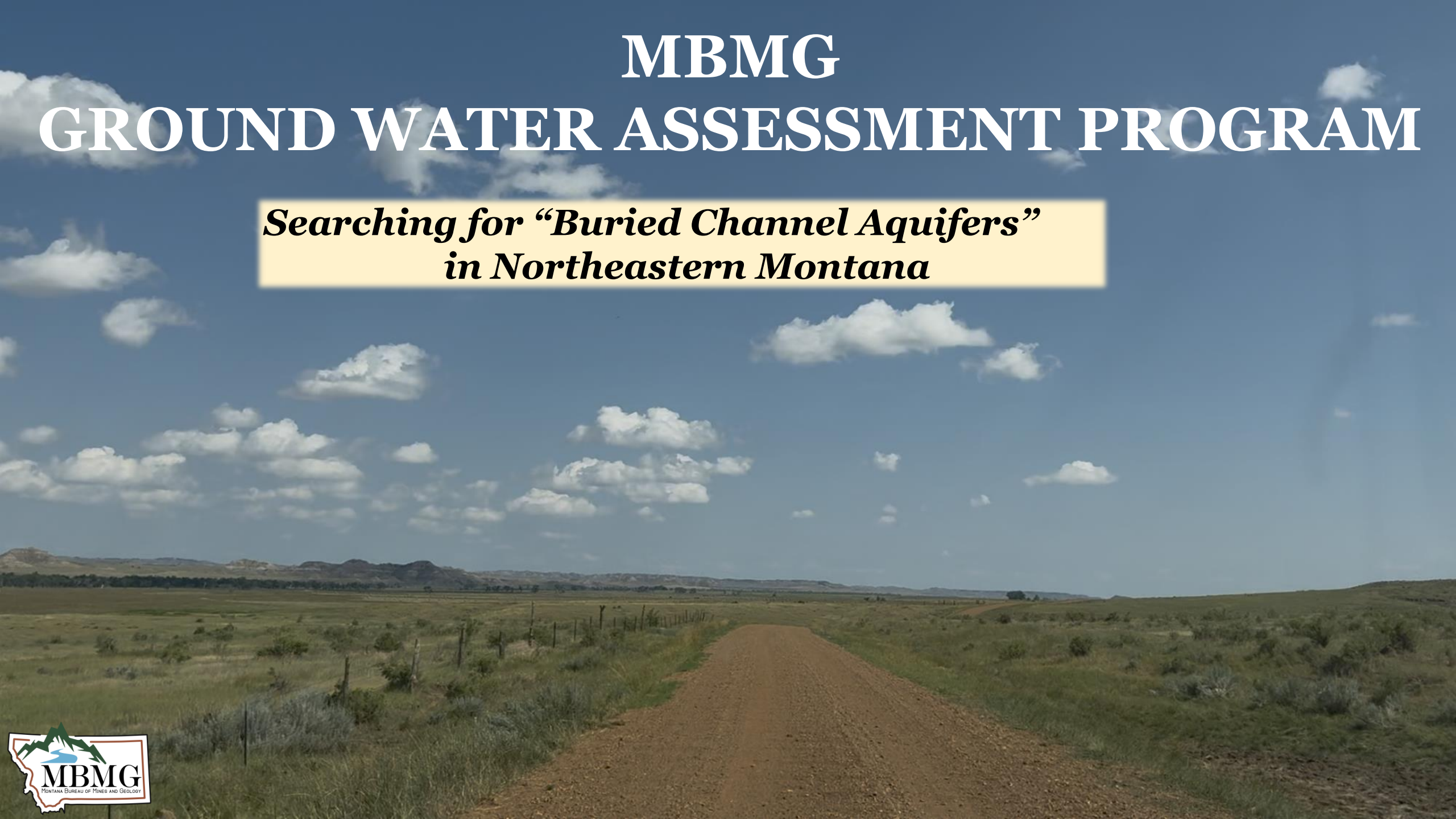
GROUND WATER ASSESSMENT PROGRAM

Searching for "Buried Channel Aquifers" in Northeastern Montana



- **Ice sheets flowed into Montana several times**
- **Overran ancestral Missouri River, streams, lower Yellowstone River**
- **Buried channel deposits under till (no surface expression)**
- **As ice retreated, sand & gravel deposits were also left behind, and in places covered by younger glacial till**

GWAP Study Area

Hand drawn map showing thickness of alluvial deposits in northeastern Montana-(Bob Bergantino-MBMG)

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Progress Report-2024 Activities

- ✓ **FOCUS** on Clear Lake-Medicine Lake area between Westby and Poplar Montana

- ✓ **TESTING** effectiveness of shallow geophysical methods
  - ✓ Electrical Resistivity Tomography (ERT)-(Find Gravels)
  - ✓ High Resolution Gravity (Find Bedrock Channels)
  - ✓ Work Completed with assistance from UoM Western

- ✓ **PURPOSE**: Evaluate use of if aerial surveys over much larger area
- ✓ (Aerial Electromagnetic Surveys)

- ✓ **APPROACH**: Although aerial surveys would required significant funding, it would be much cheaper than widespread exploratory drilling

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Progress Report-2025 Activities

- ✓ **Renewable Resource Planning Grant**
  - ✓ 2025 GWAP funding, expand testing shallow geophysical methods
  - ✓ Purchase additional cables to look deeper (300 ft)
  - ✓ Expanded ERT and Gravity Surveys
  - ✓ Test TEM Equipment (Transient Electromagnetics)

- ✓ **Monitoring Well** was installed near Medicine Lake and used to compare with 2024 and 2025 ERT surveys

- ✓ **Bottom Line**
  - ✓ Buried channel deposits are potential source of good water in an area of limited water resources
  - ✓ Aerial geophysical methods along with focused on-the-ground geophysical methods and test drilling is probably the most cost effective way to continue to explore this resource

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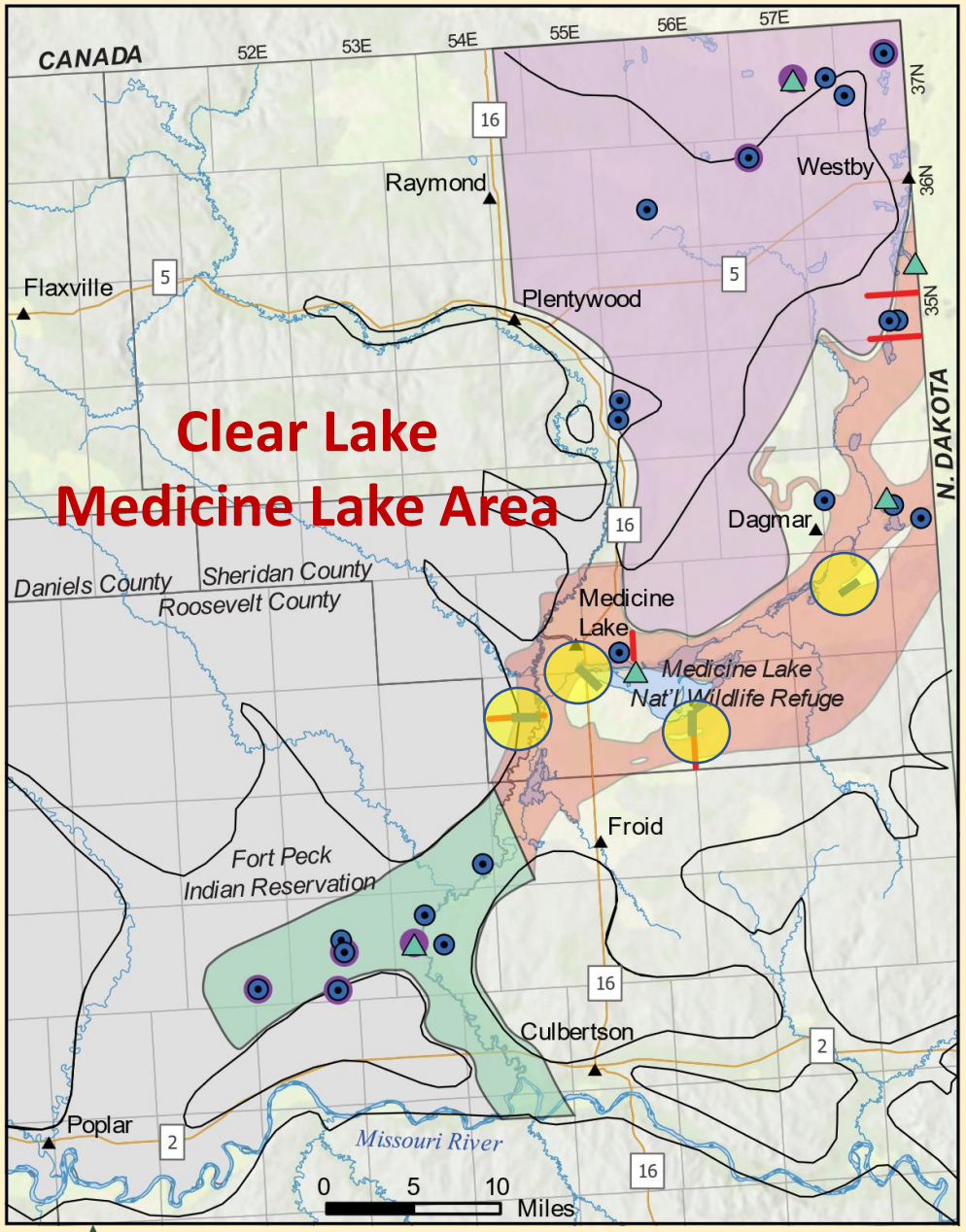
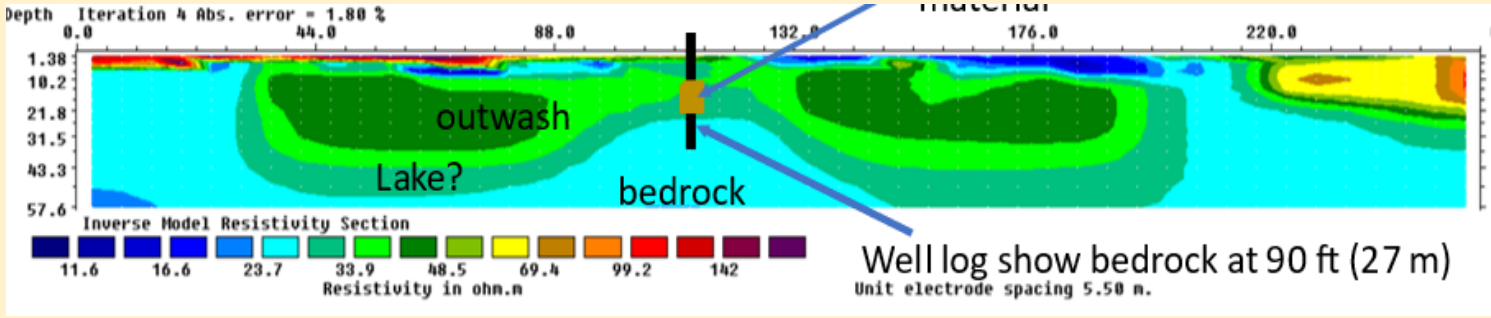
2024
Geophysical Surveys
- ✓ 4 ERT lines-800 ft (150 ft depth)
- ✓ 4 High Resolution Gravity Lines





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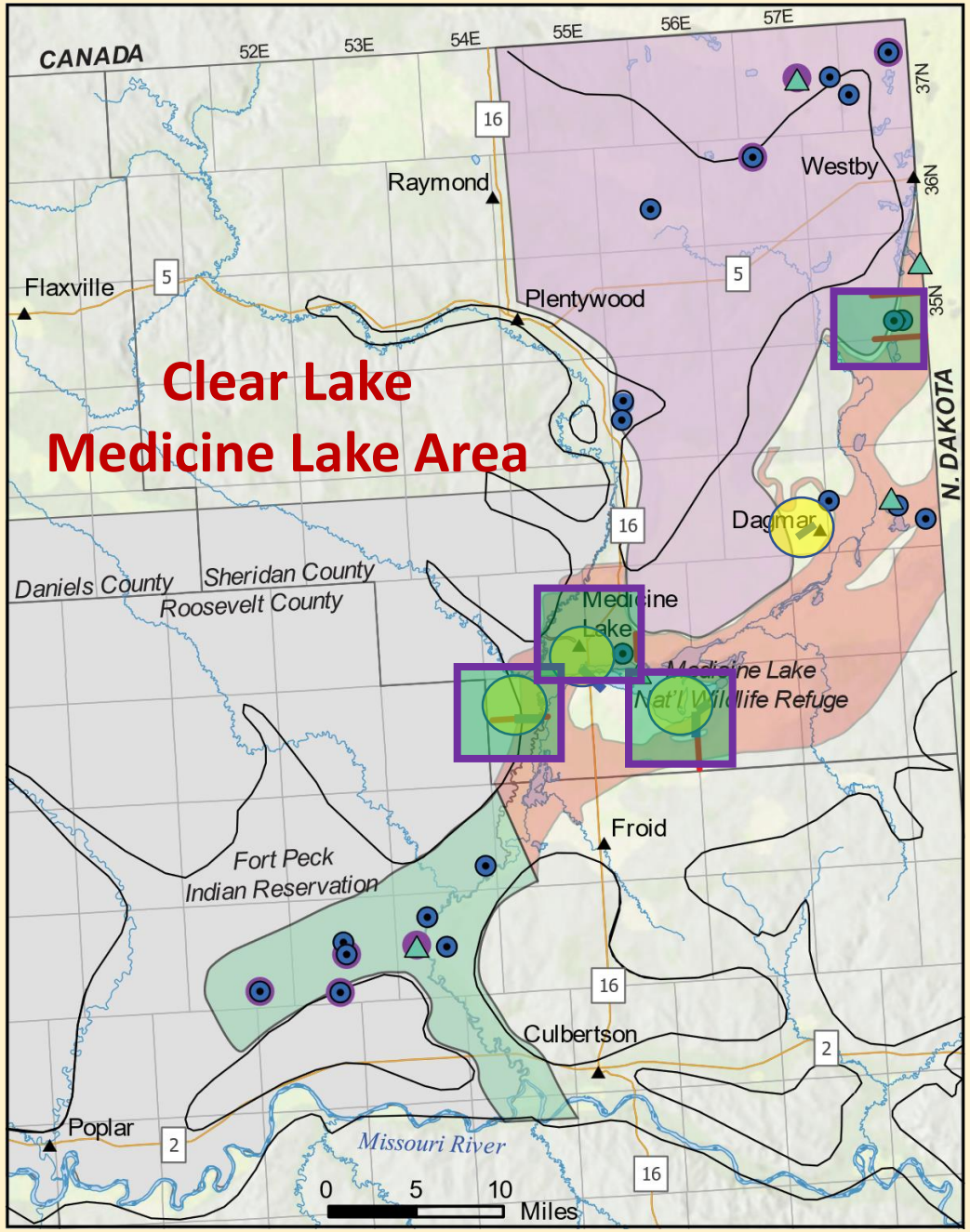

2025
Geophysical Surveys

- ✓ 5 ERT lines-1640 ft *300 ft depth
- ✓ 5 High Resolution Gravity Lines
- ✓ 30 Water Quality Samples
  - ✓ Wells and Lakes
- ✓ Deployed 5 water-level data loggers

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Thank You

Questions ?

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