# Groundwater in the Yellowstone Basin

## Aquifers, wells, and groundwater use

**John I. LaFave**
Montana Groundwater Assessment Program

**Presented to:**
**Yellowstone Basin Advisory Council**
**Billings, Dec. 13, 2013**

# Montana Bureau of Mines and Geology

*a department of Montana Tech*

- **Established in 1919 to provide reliable and unbiased earth science information**
- **Non regulatory, applied research**
  - **Geologic Mapping**
  - **Earthquake Studies**
  - **Small Miners**
  - **Environmental Assessment**
  - **Ground Water**
- **Web: http://www.mbmg.mtech.edu/**

# Montana Ground-Water Assessment Program

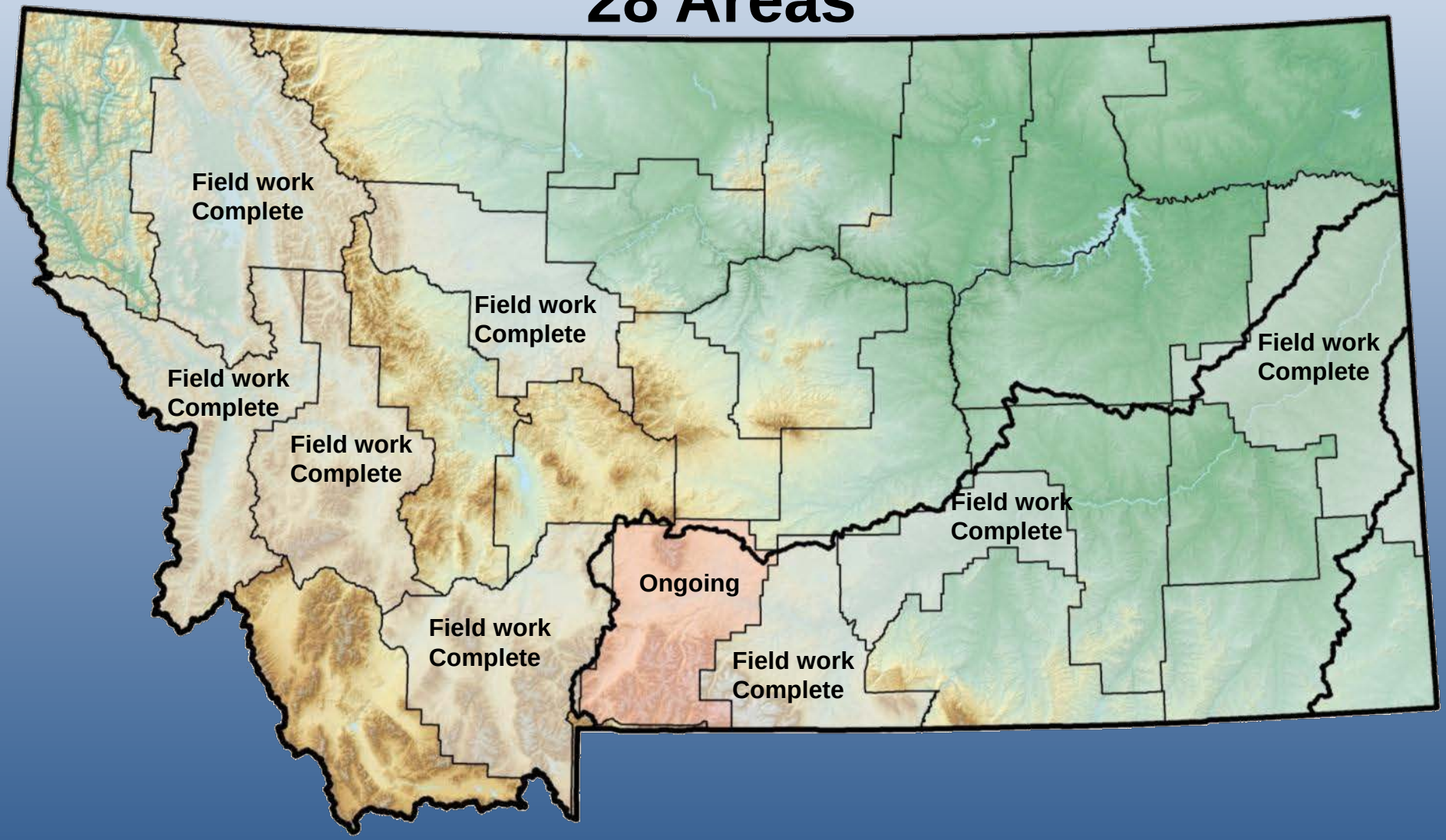
***"…systematically assess and monitor the state's ground water and to disseminate the information…"***

85-2-902(2) MCA

- **Ground-Water Characterization**
  - **systematic data collection and interpretation.**
- **Ground-Water Monitoring**
  - **long term records of water levels and quality.**
- **Ground-Water Information Center**
  - **data dissemination.**

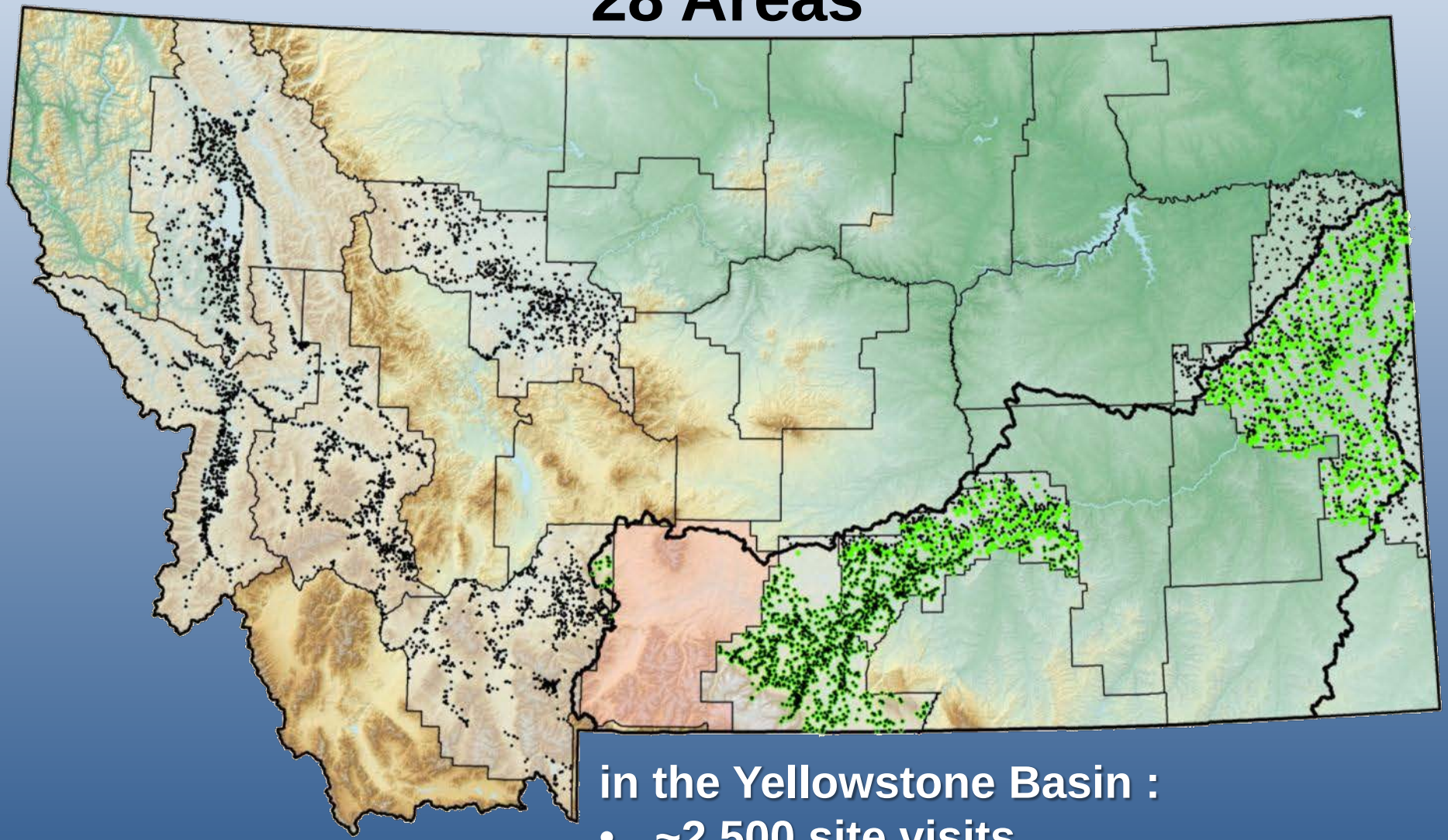
# Ground-Water Characterization

## 28 Areas



# Ground-Water Characterization

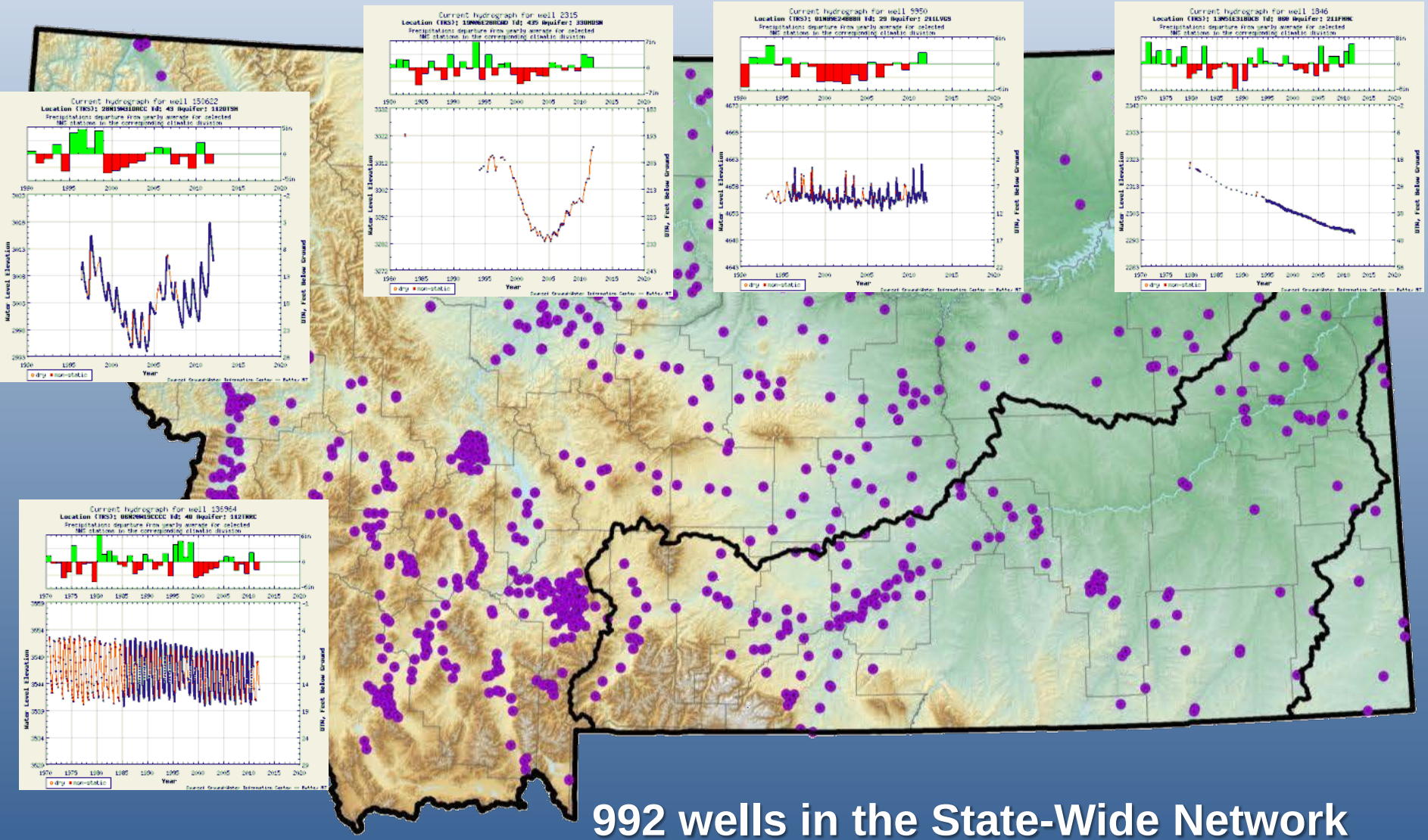
## 28 Areas



in the Yellowstone Basin :

- ~2,500 site visits
- ~500 water quality samples

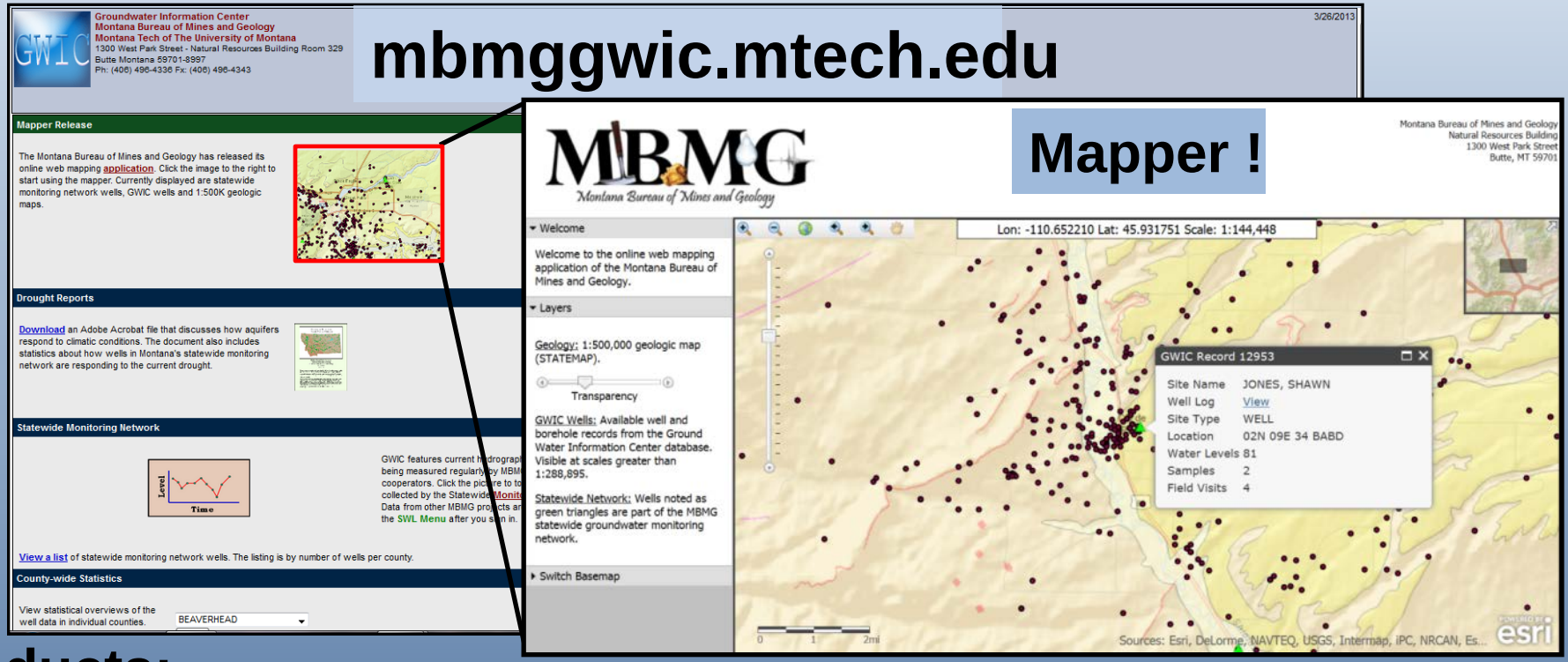
# Ground-Water Monitoring




**992 wells in the State-Wide Network**
**~200 in the Yellowstone Basin**

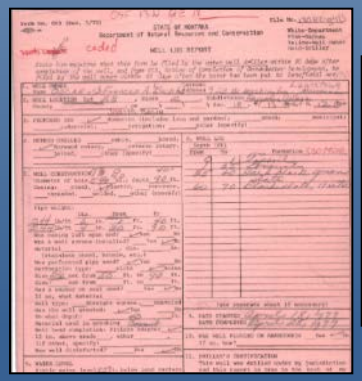
# Ground-Water Information Center

## mbmggwic.mtech.edu

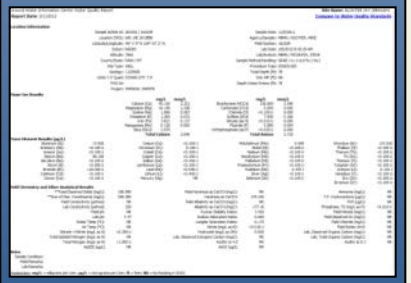



## Products:

### Well Logs

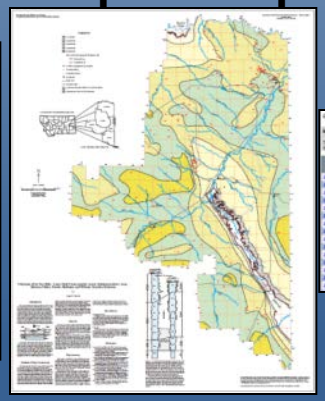


### Water Quality

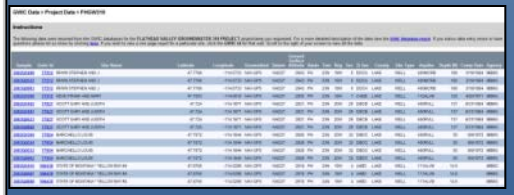


### Hydrographs

### Maps & Repts

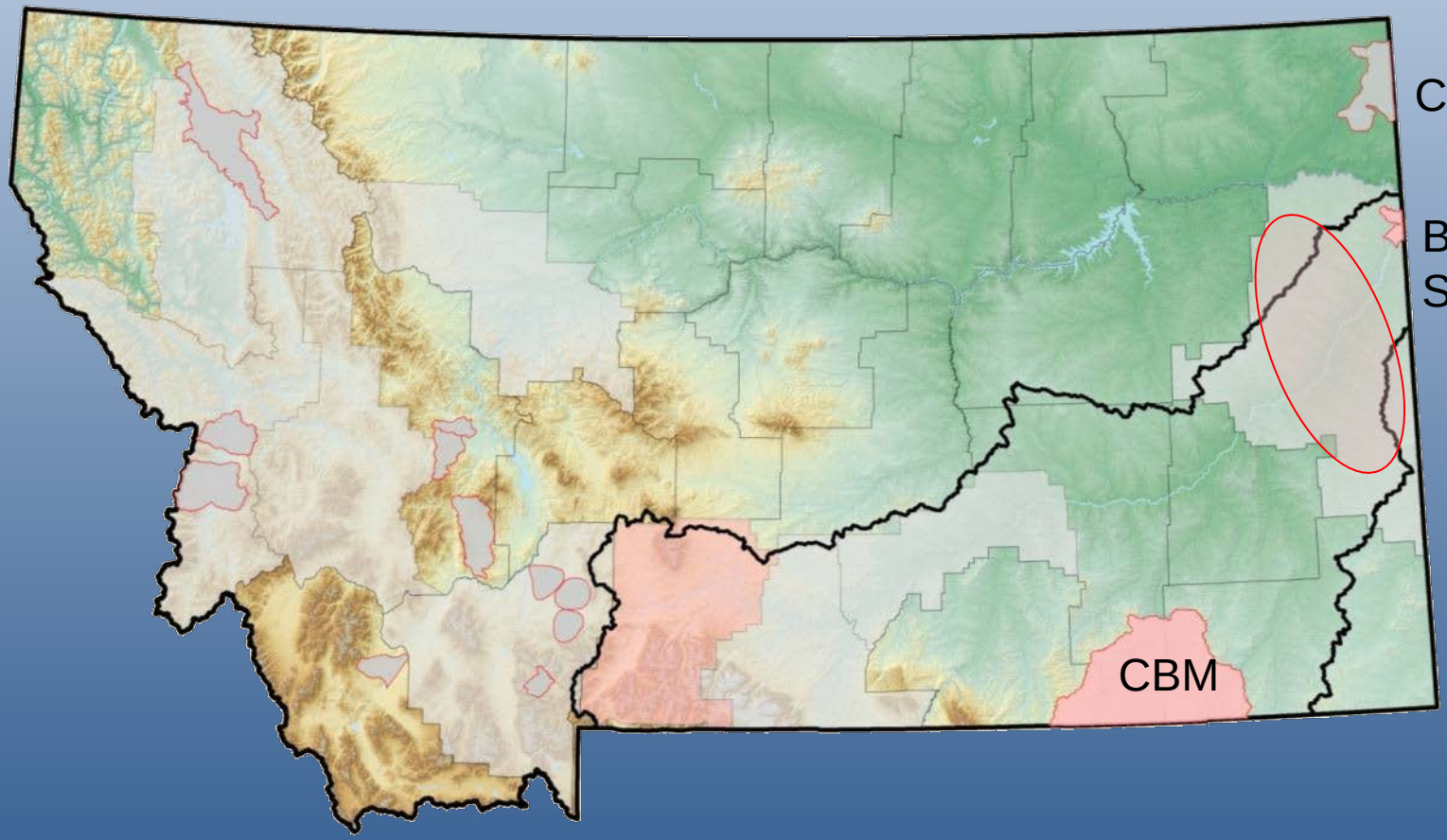


### Project data



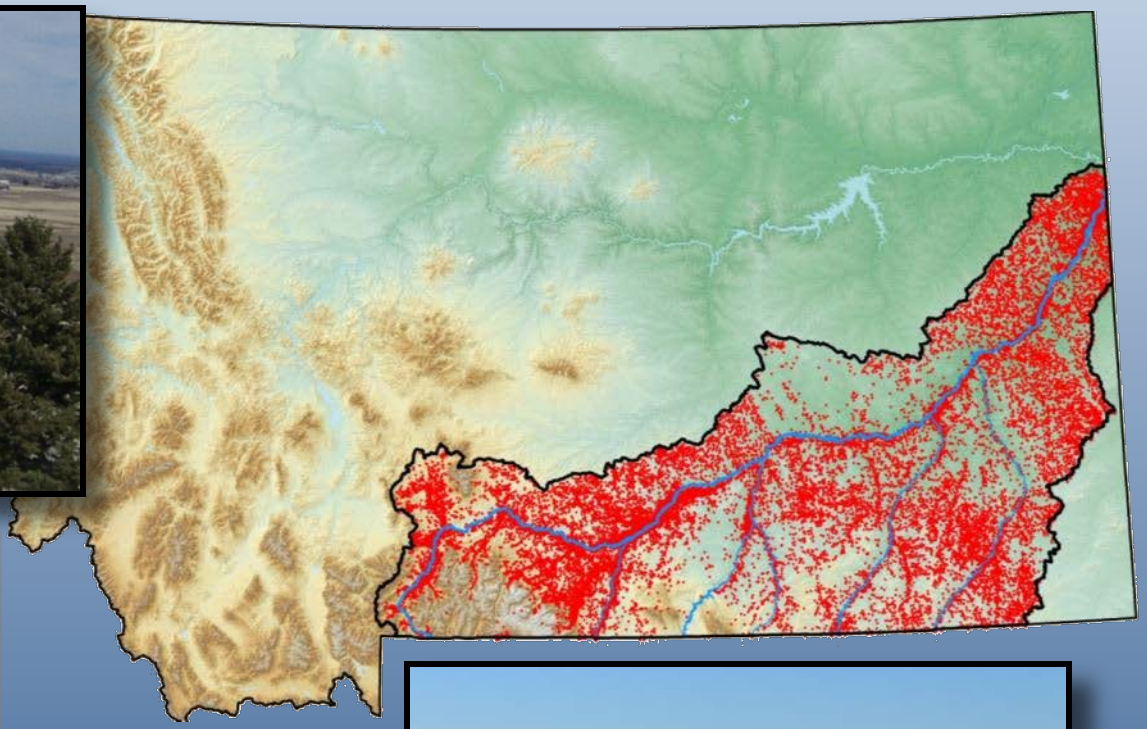
# Groundwater Investigation Program

In 2009, the Montana State Legislature established GWIP within the MBMG to conduct detailed groundwater investigations in areas with of concern



# Groundwater and Wells in the Yellowstone Basin

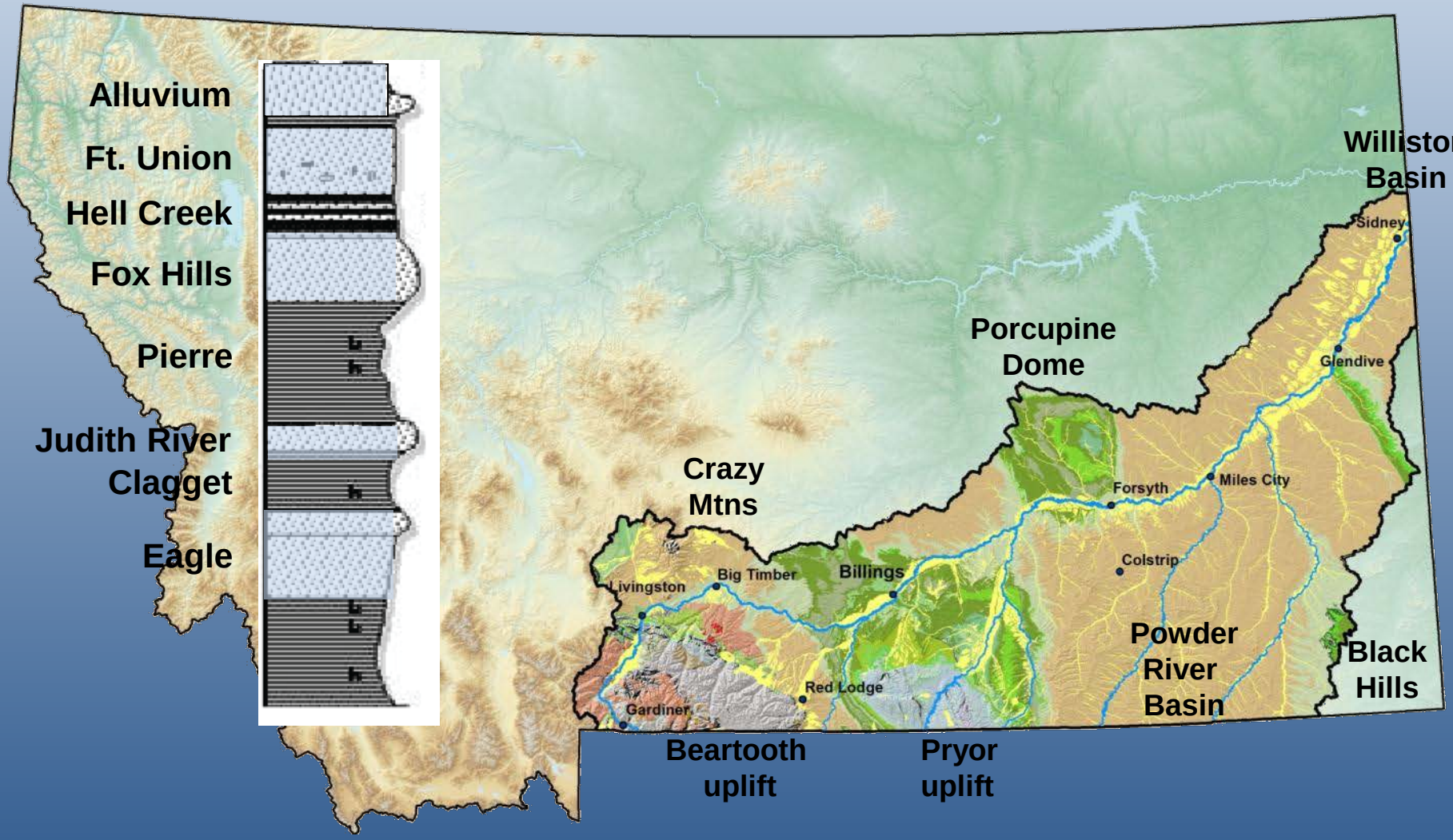
Alluvial terrace– Red Lodge



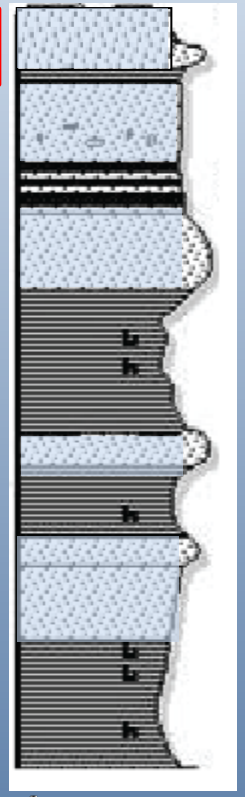
Fort Union Formation – eastern Montana

# Yellowstone Basin: Geology

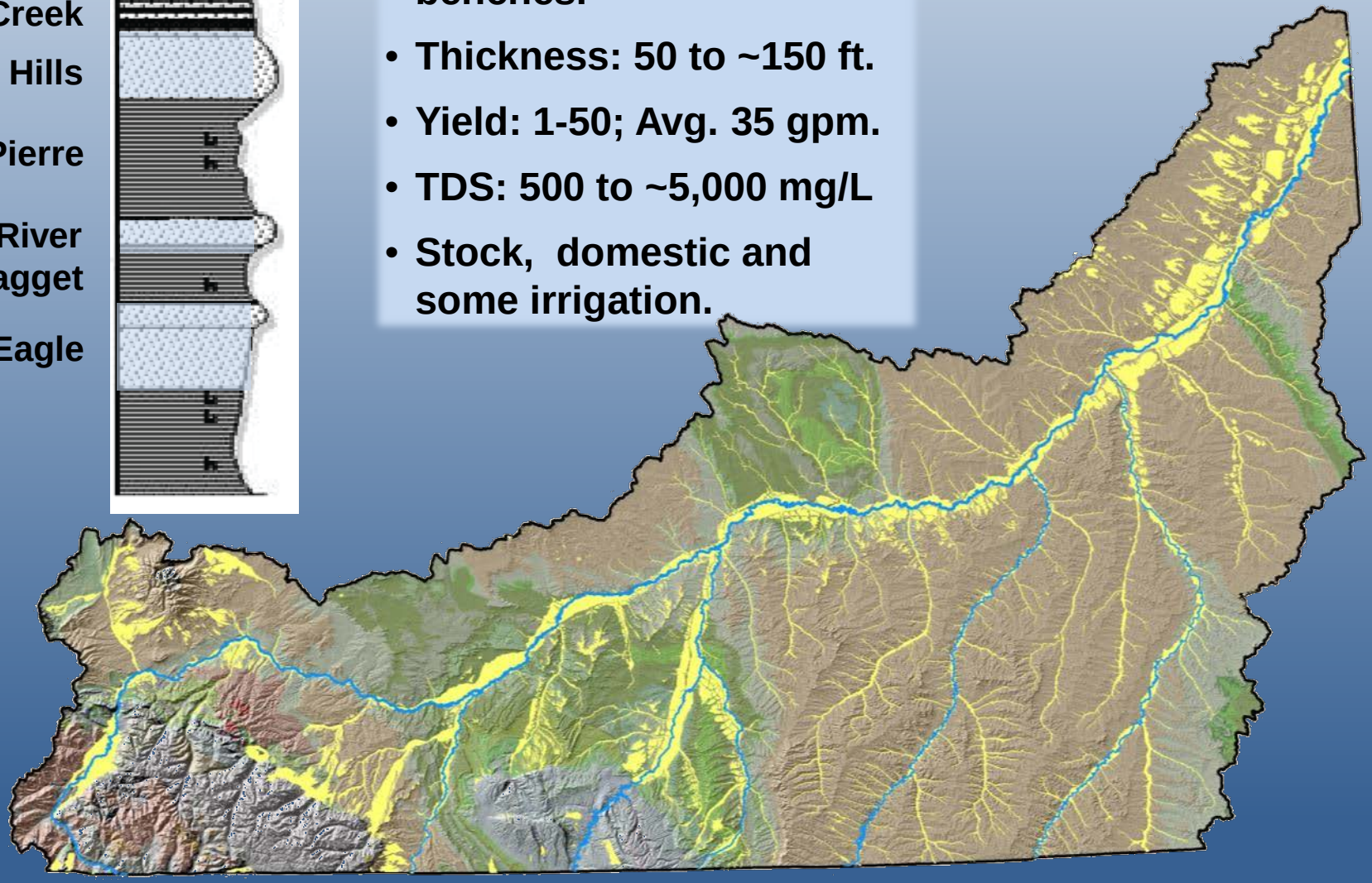
# Yellowstone Basin: Aquifers



# Alluvial aquifers




- Sand and gravel along major valleys – high level benches.
- Thickness: 50 to ~150 ft.
- Yield: 1-50; Avg. 35 gpm.
- TDS: 500 to ~5,000 mg/L
- Stock, domestic and some irrigation.



# Fort Union Formation

Alluvium

Ft. Union

Hell Creek

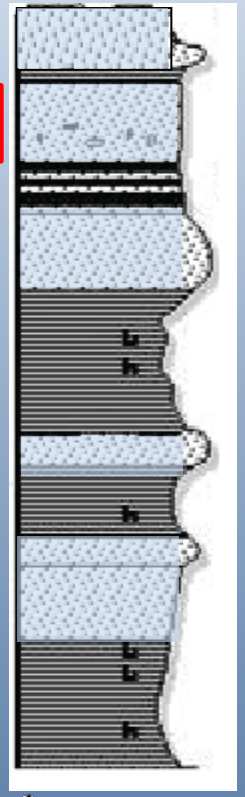
Fox Hills

Pierre

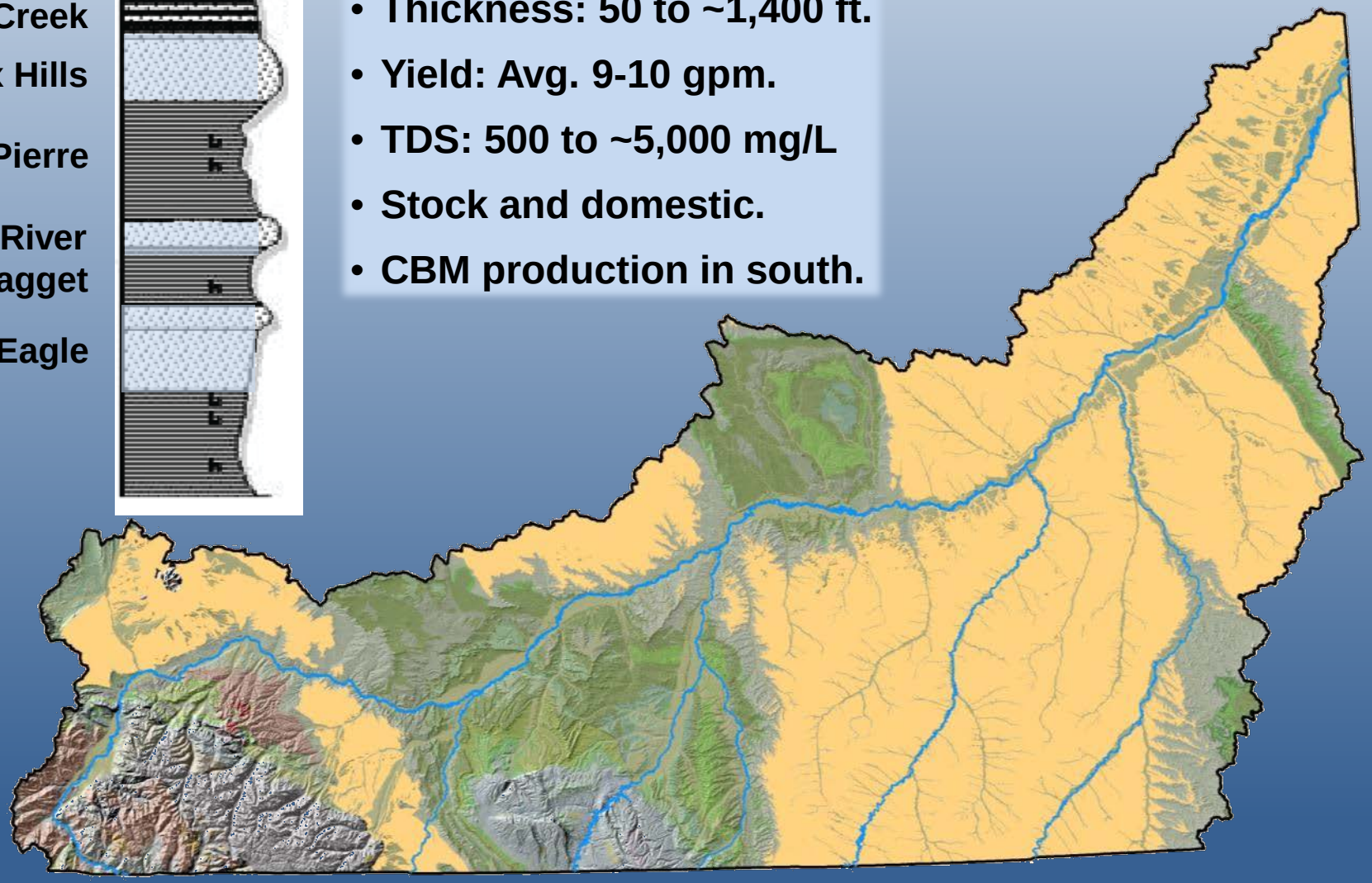
Judith River

Clagget

Eagle



- Interbedded sandstone and coal.
- Thickness: 50 to ~1,400 ft.
- Yield: Avg. 9-10 gpm.
- TDS: 500 to ~5,000 mg/L
- Stock and domestic.
- CBM production in south.



# Fox Hills – Hell Creek

Alluvium

Ft. Union

Hell Creek

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Pierre

Judith River

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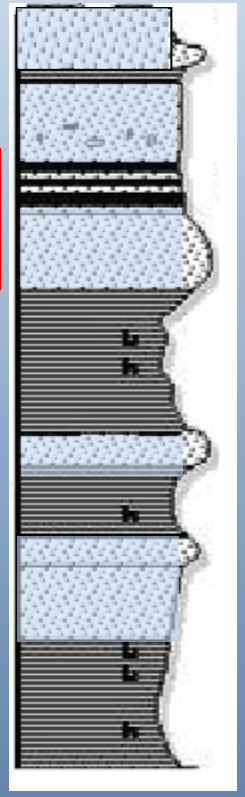
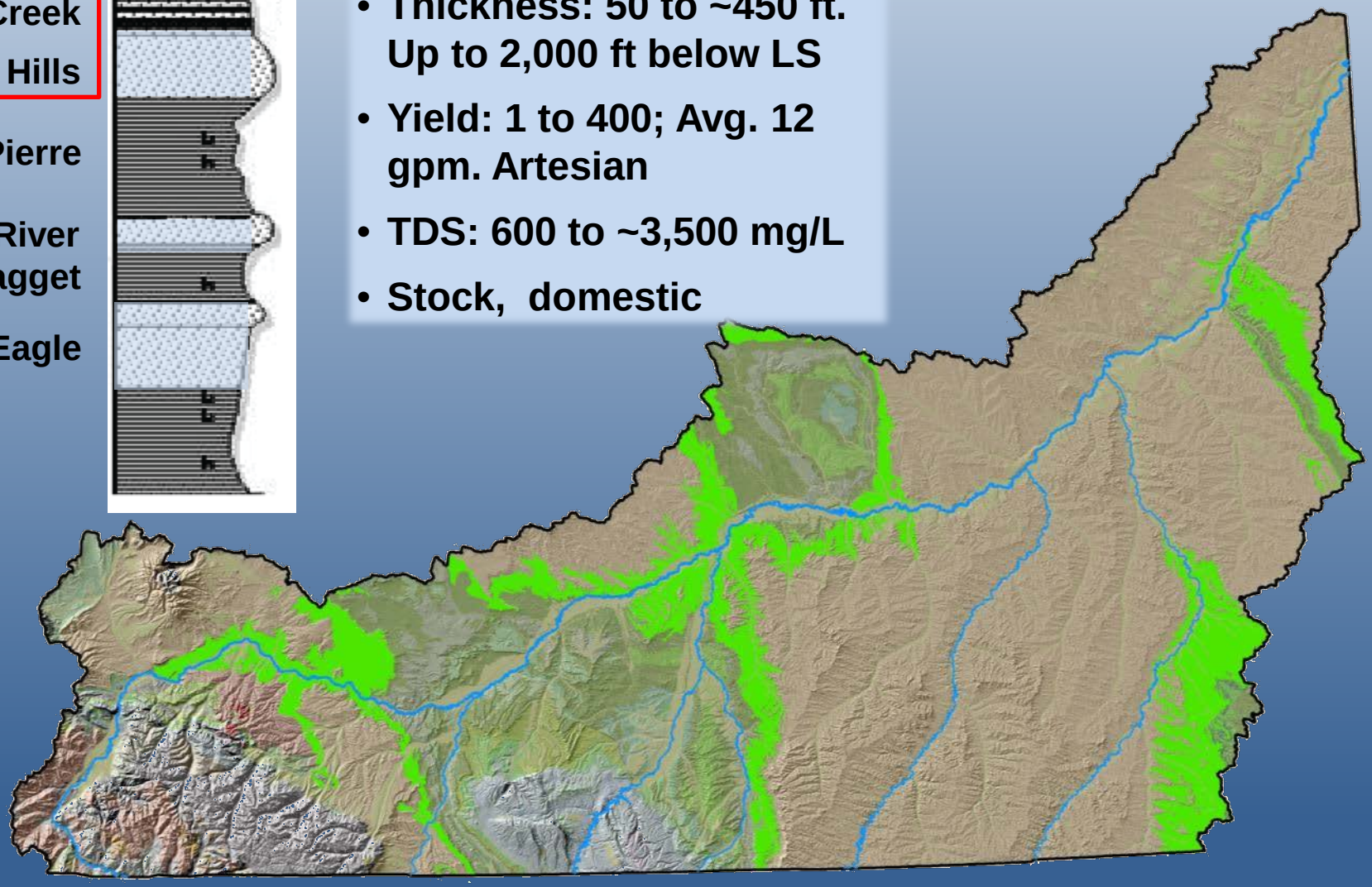
Eagle



- Regionally consistent permeable sandstone.
- Thickness: 50 to ~450 ft. Up to 2,000 ft below LS
- Yield: 1 to 400; Avg. 12 gpm. Artesian
- TDS: 600 to ~3,500 mg/L
- Stock, domestic



# Judith River Formation

Alluvium

Ft. Union

Hell Creek

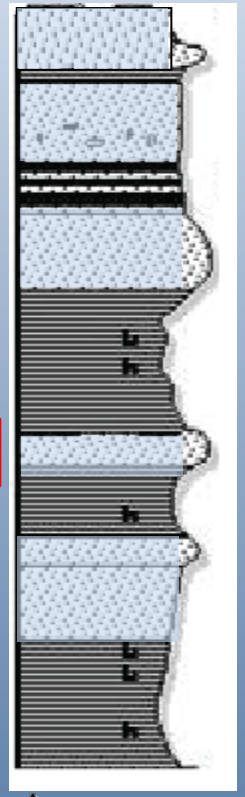
Fox Hills

Pierre

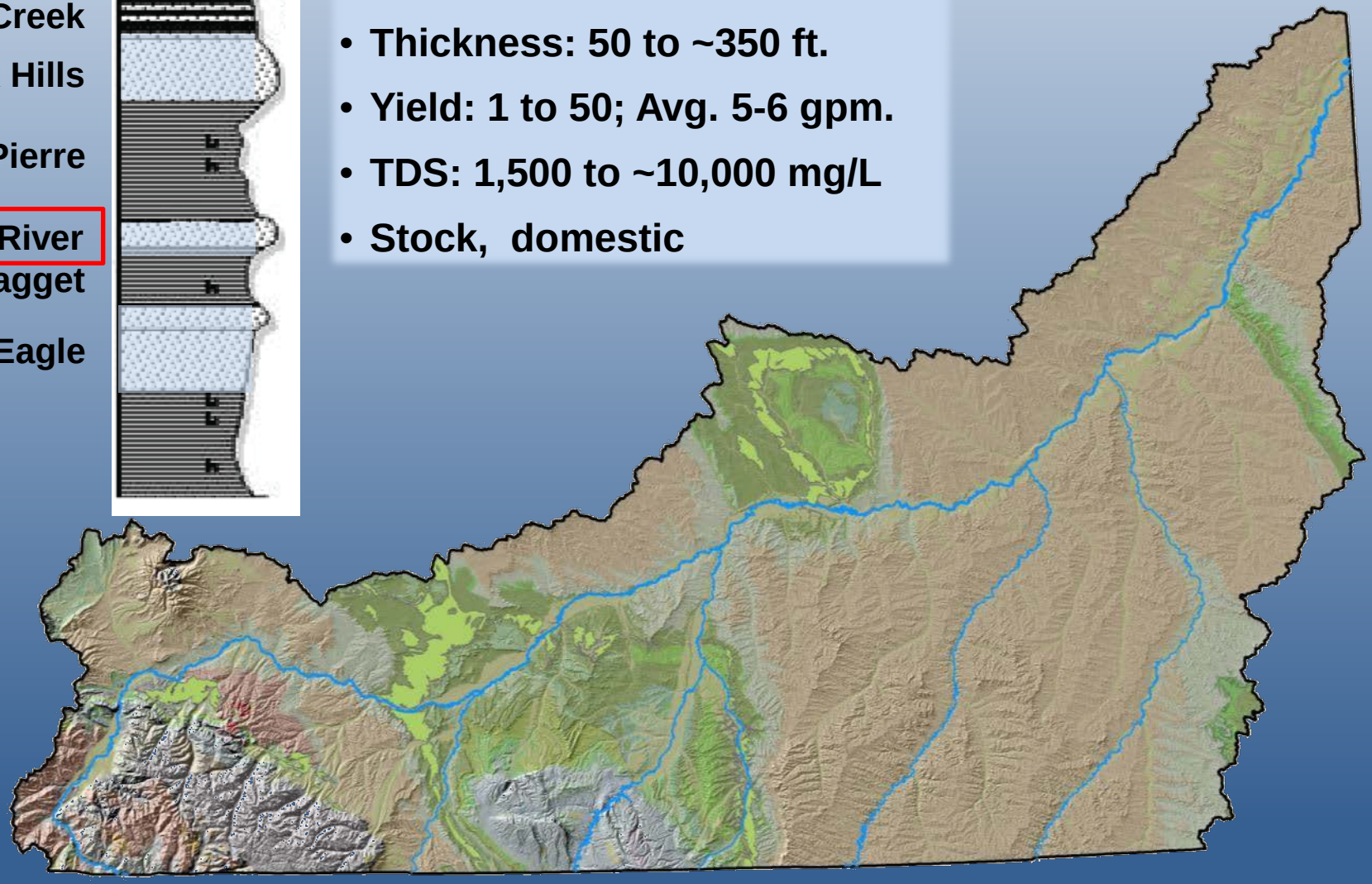
**Judith River**

Clagget

Eagle



- Interbedded sandstone and shale.
- Thickness: 50 to ~350 ft.
- Yield: 1 to 50; Avg. 5-6 gpm.
- TDS: 1,500 to ~10,000 mg/L
- Stock, domestic



# Eagle Sandstone

Alluvium

Ft. Union

Hell Creek

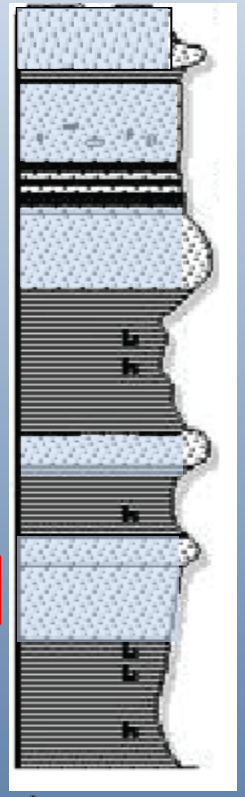
Fox Hills

Pierre

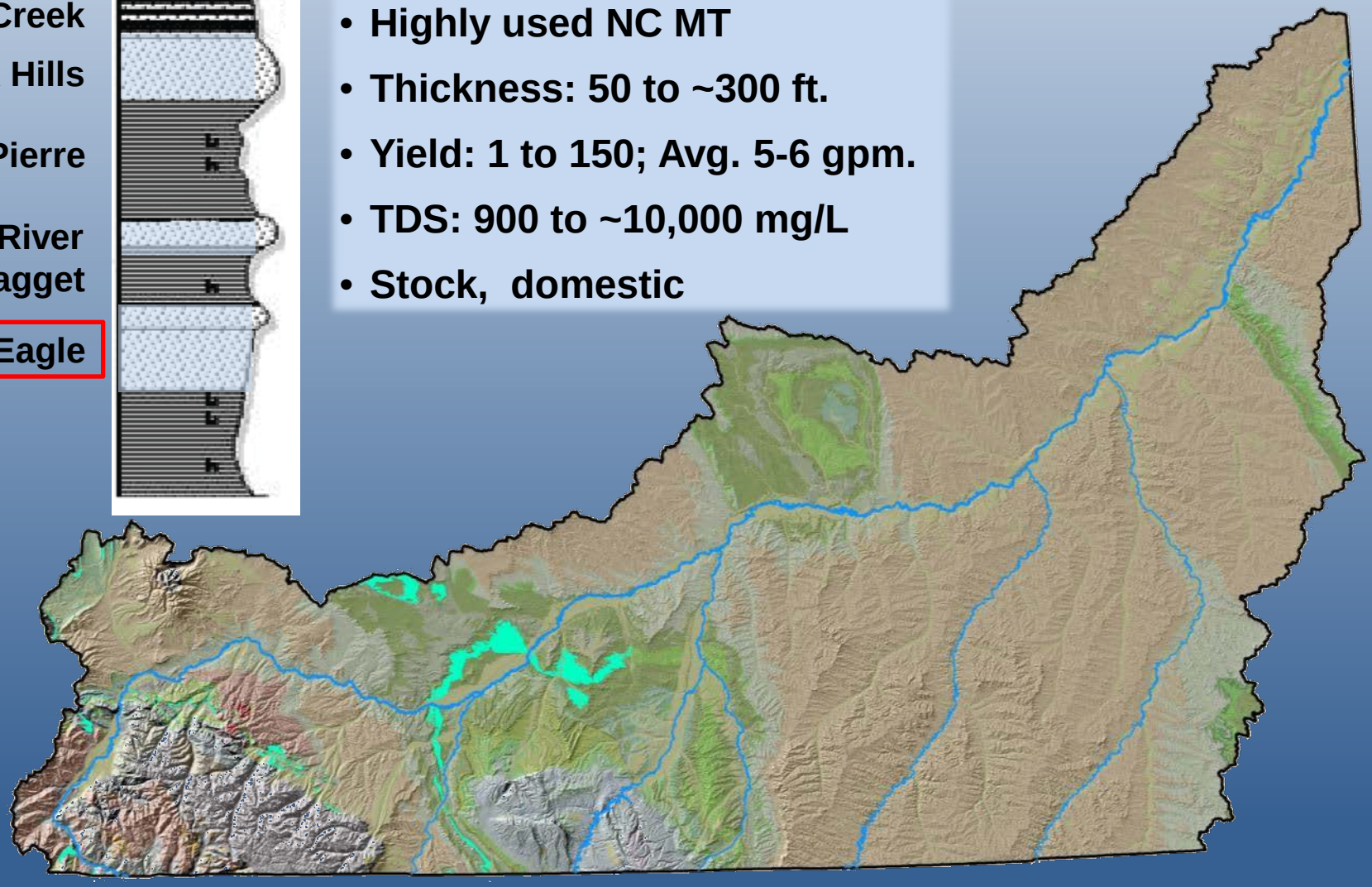
Judith River

Clagget

Eagle

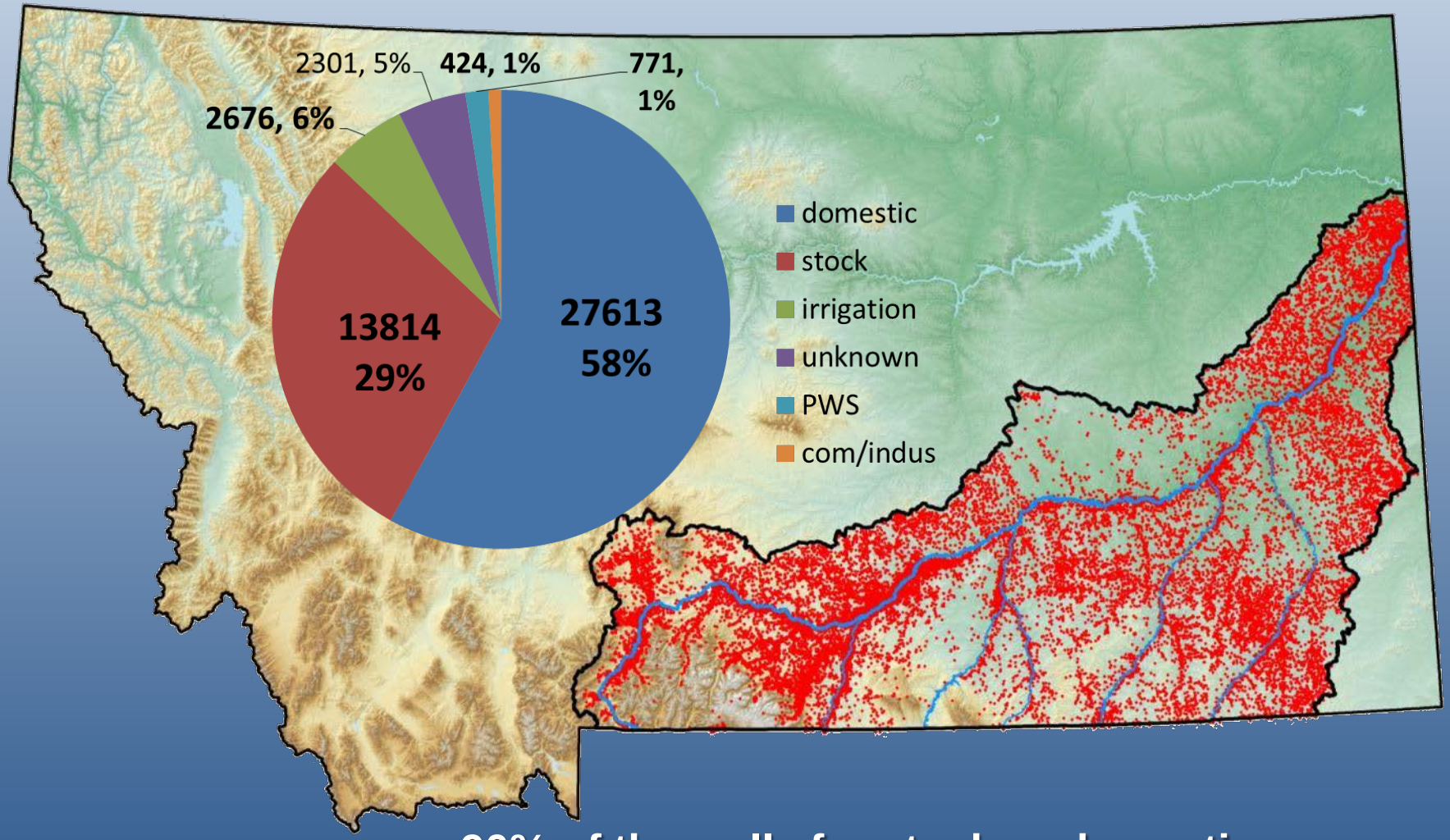


- Interbedded sandstone and shale.
- Highly used NC MT
- Thickness: 50 to ~300 ft.
- Yield: 1 to 150; Avg. 5-6 gpm.
- TDS: 900 to ~10,000 mg/L
- Stock, domestic



# Wells – Yellowstone Basin

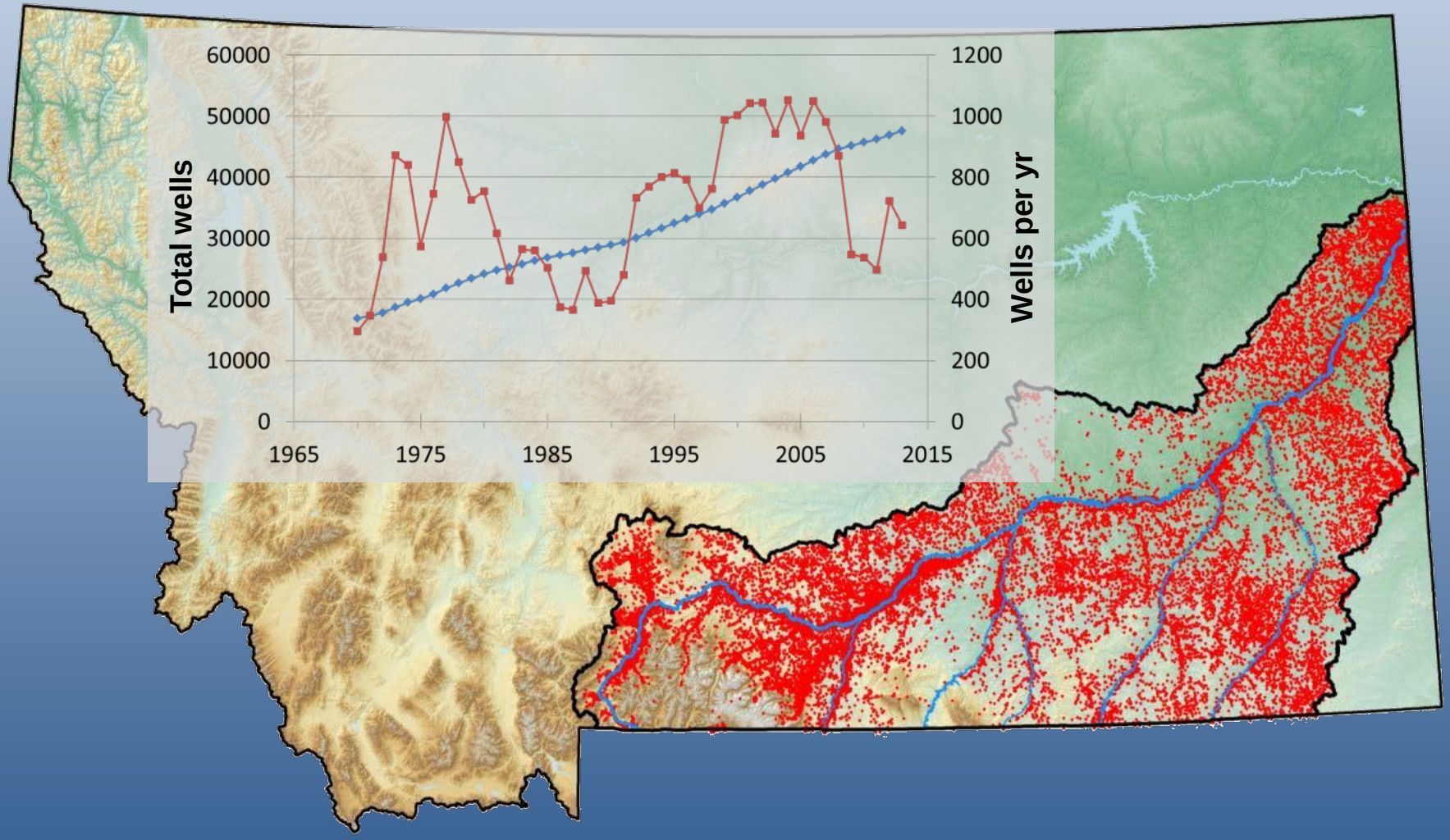
## ~48,000




- ~ 90% of the wells for stock or domestic use

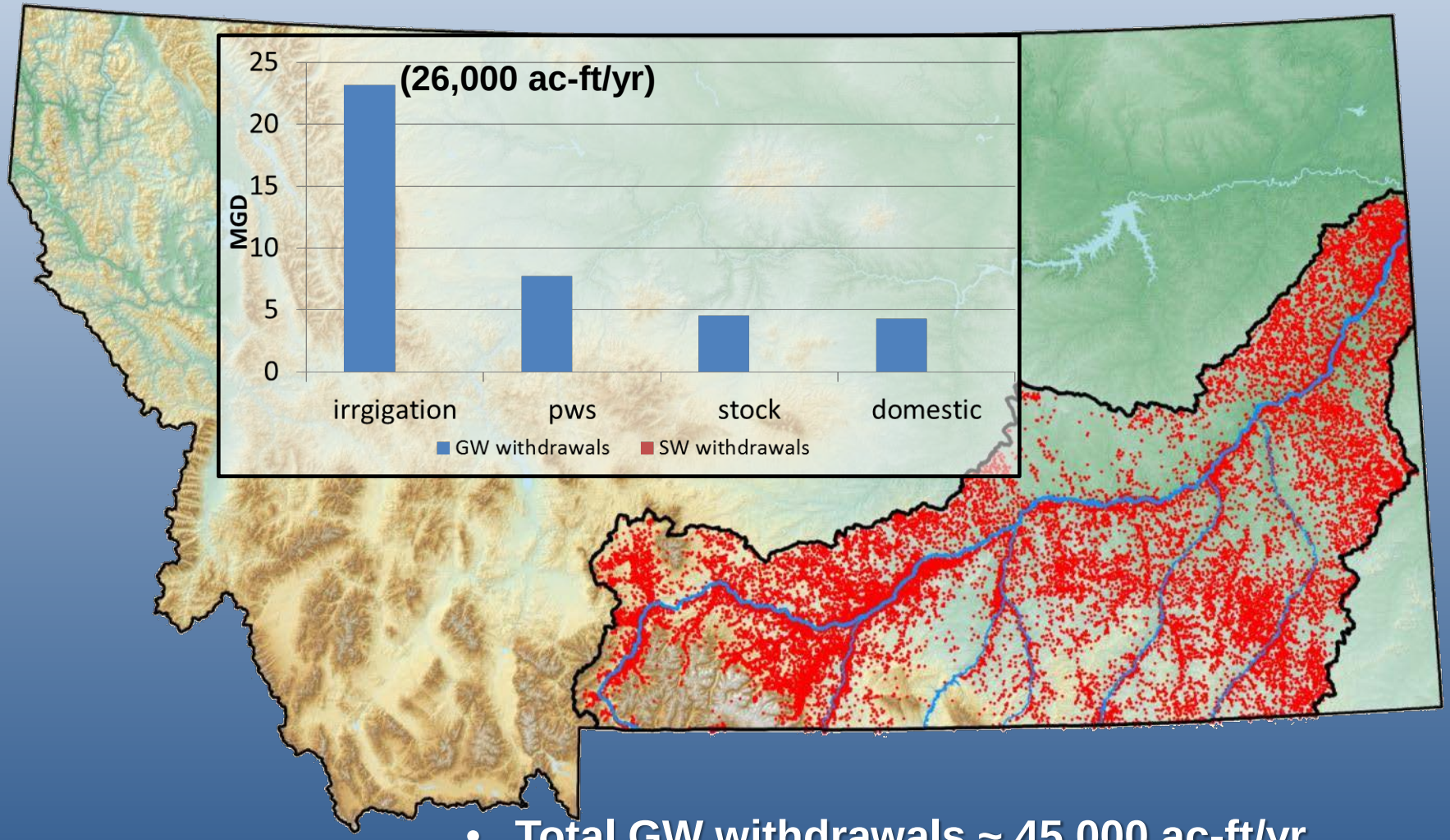
# Wells – Yellowstone Basin

## ~48,000



# Water Use – Yellowstone Basin

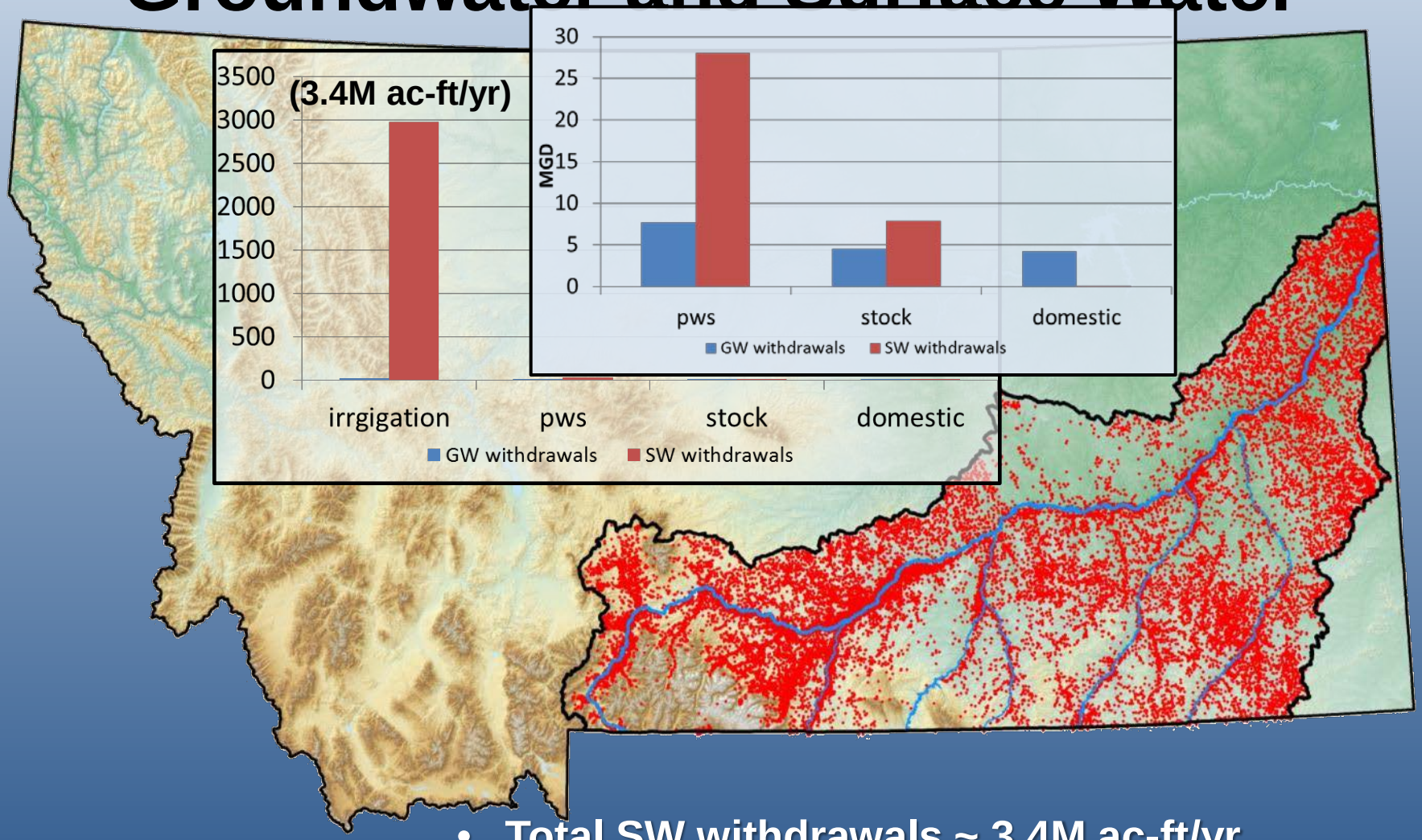
## Groundwater




- Total GW withdrawals ~ 45,000 ac-ft/yr
- Stock and domestic wells account for 22%

# Water Use – Yellowstone Basin

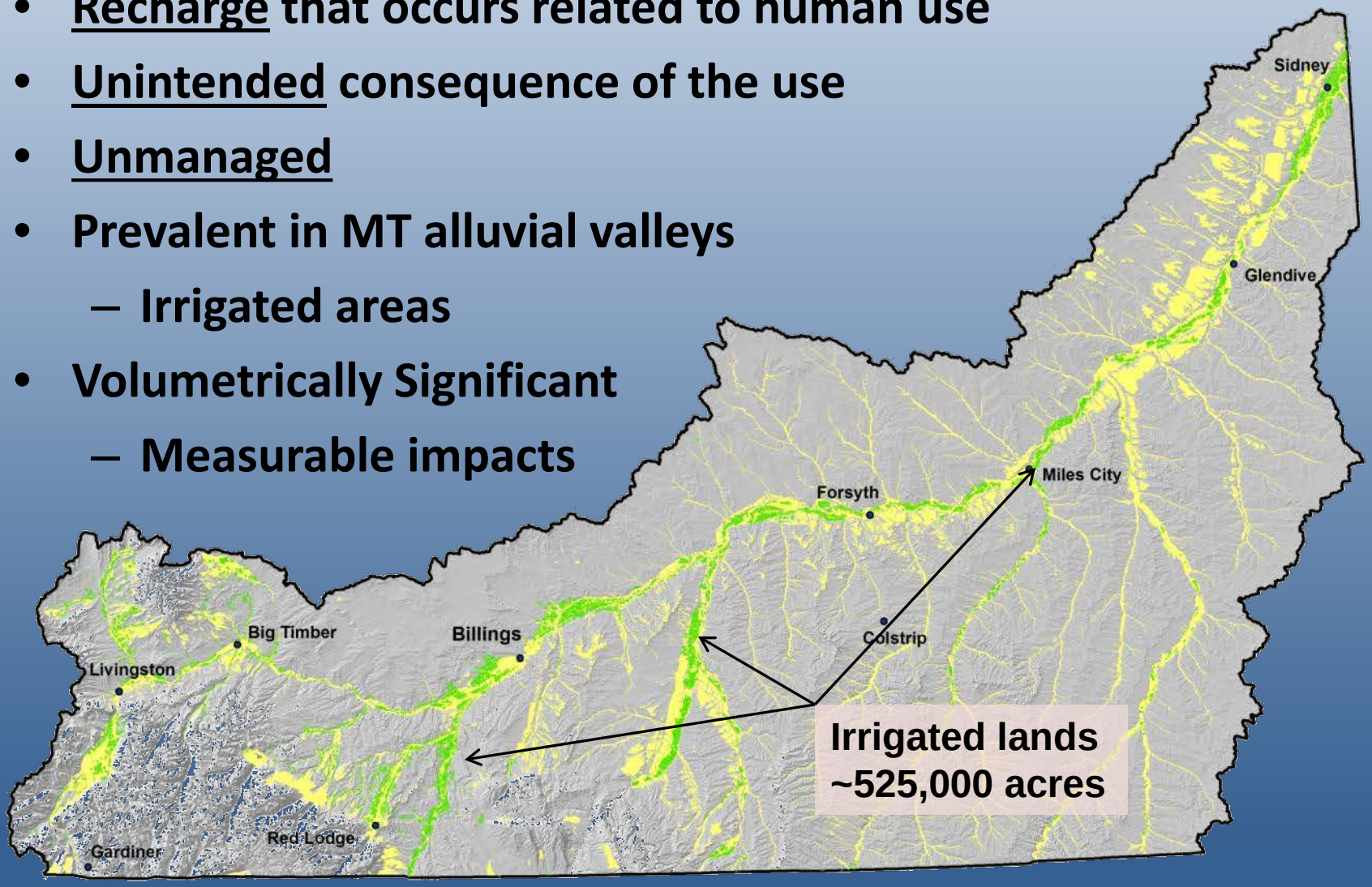
## Groundwater and Surface Water




- **Total SW withdrawals ~ 3.4M ac-ft/yr**
- **Irrigation withdrawals account for 99%**

# Yellowstone: Groundwater-Surface Water <u>Incidental Recharge</u>

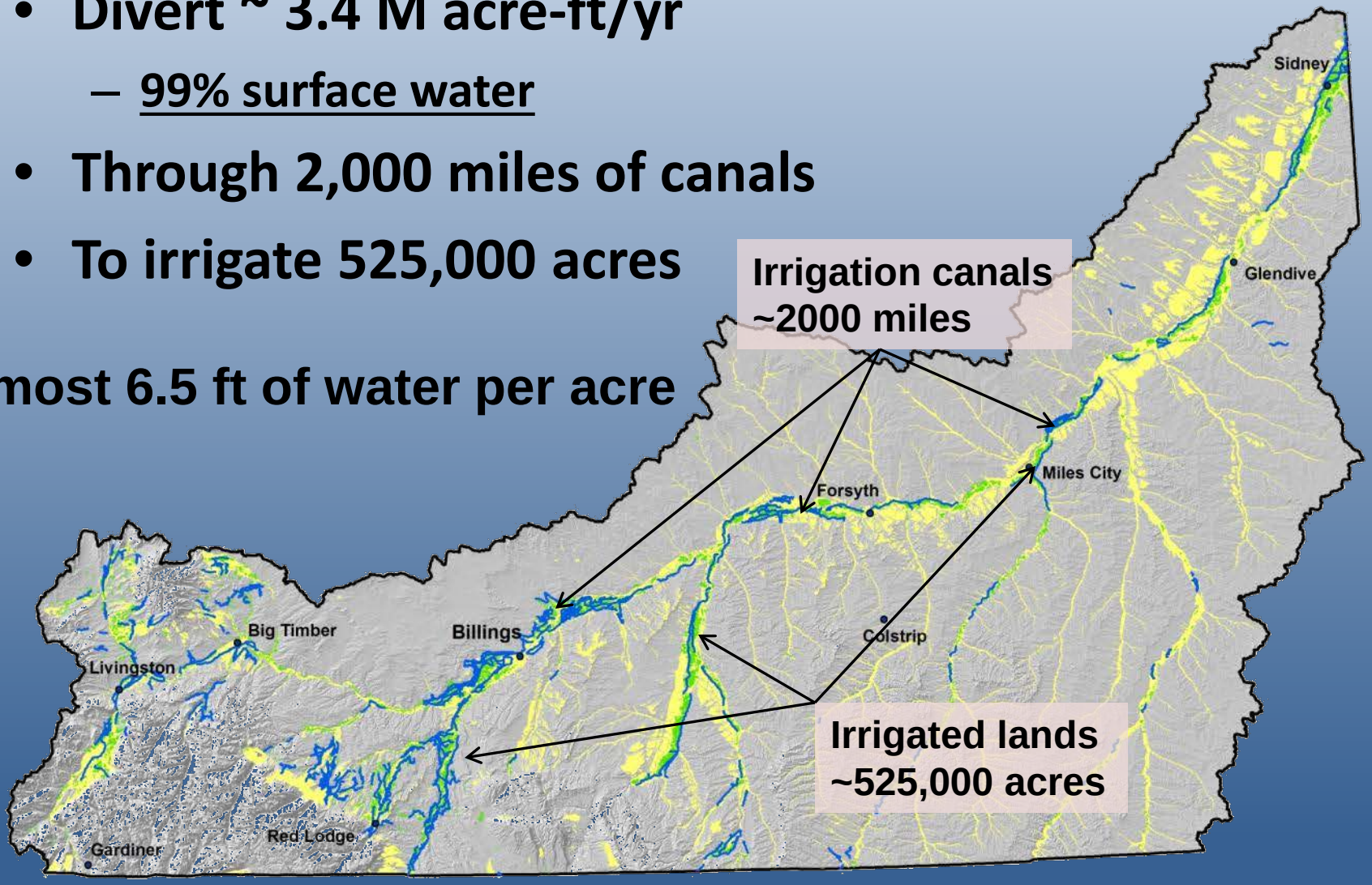
- <u>Recharge</u> that occurs related to human use
- <u>Unintended</u> consequence of the use
- <u>Unmanaged</u>
- Prevalent in MT alluvial valleys
  - Irrigated areas
- Volumetrically Significant
  - Measurable impacts



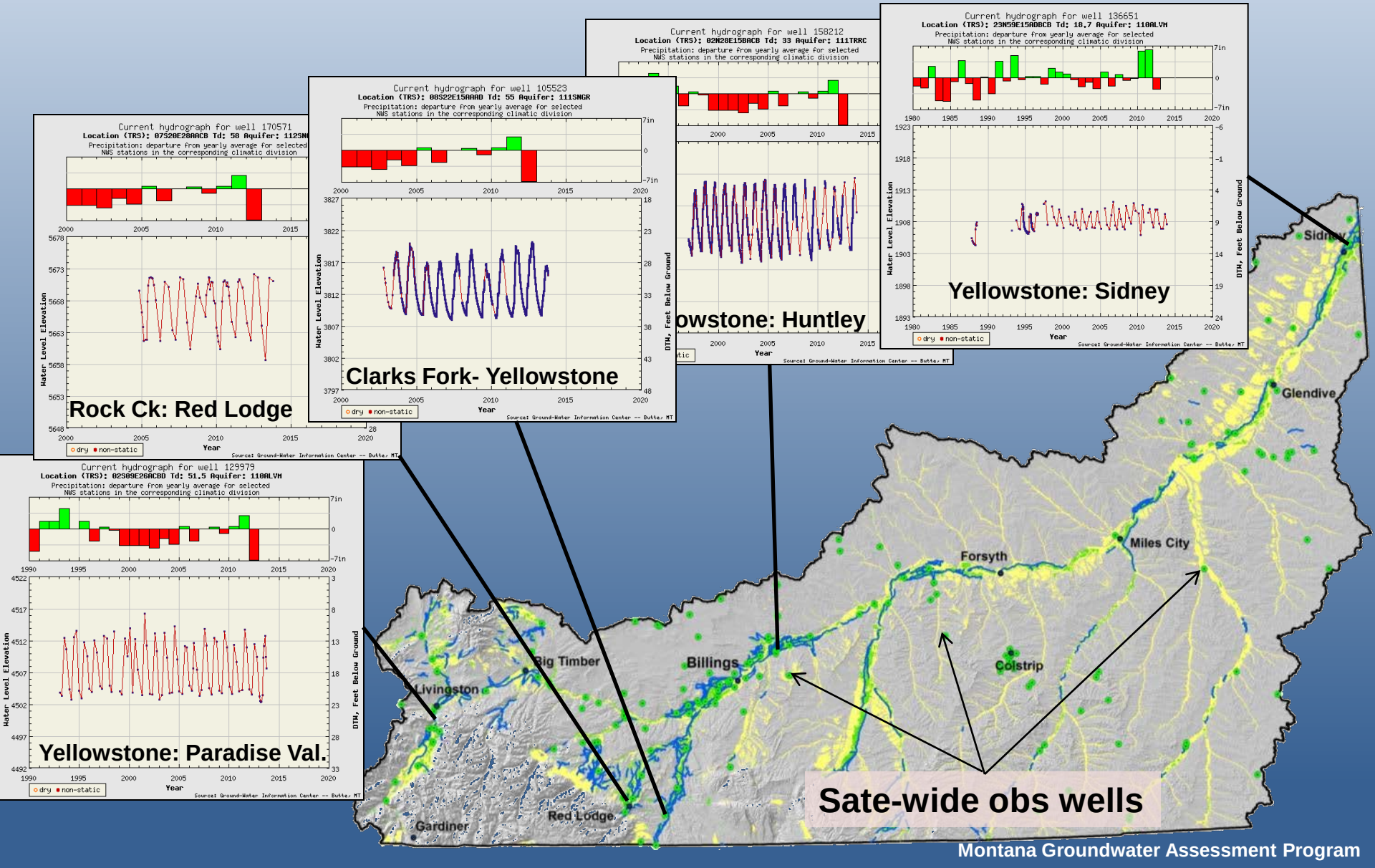
# Yellowstone: Groundwater-Surface Water <u>Incidental Recharge</u>

- **Divert ~ 3.4 M acre-ft/yr**
  - **<u>99% surface water</u>**
- **Through 2,000 miles of canals**
- **To irrigate 525,000 acres**

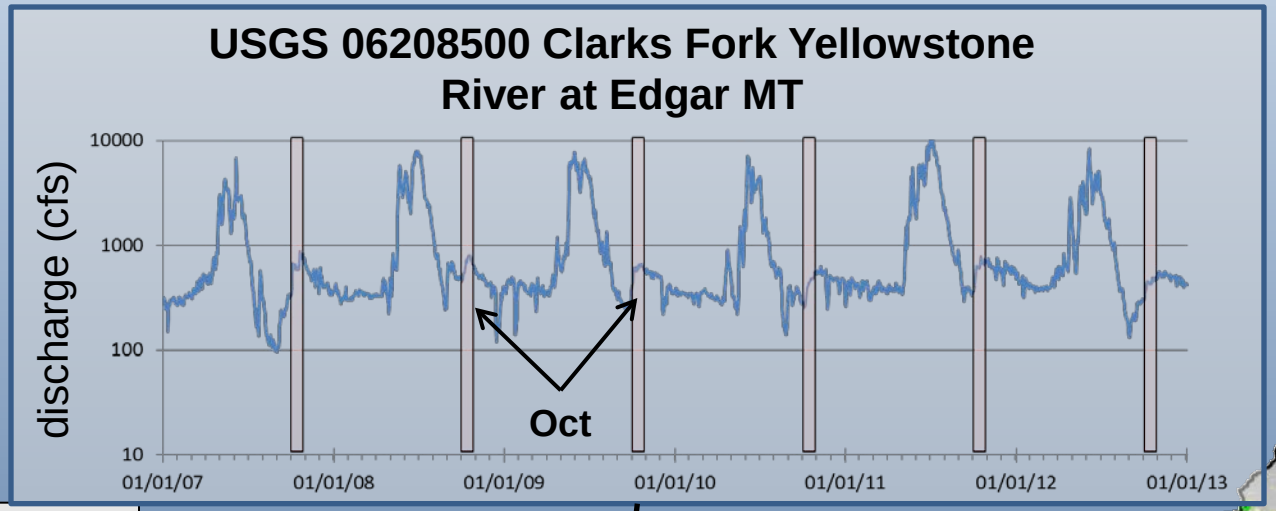
**Almost 6.5 ft of water per acre**

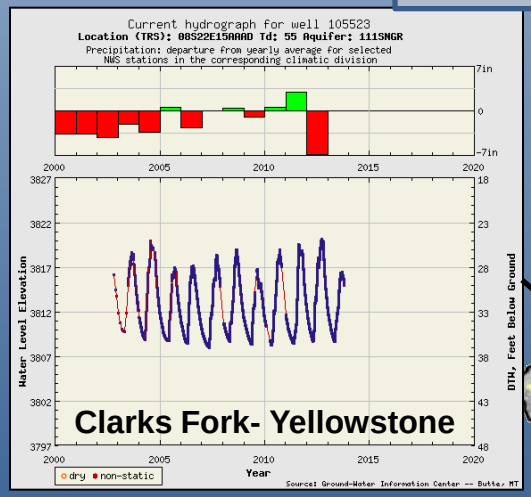


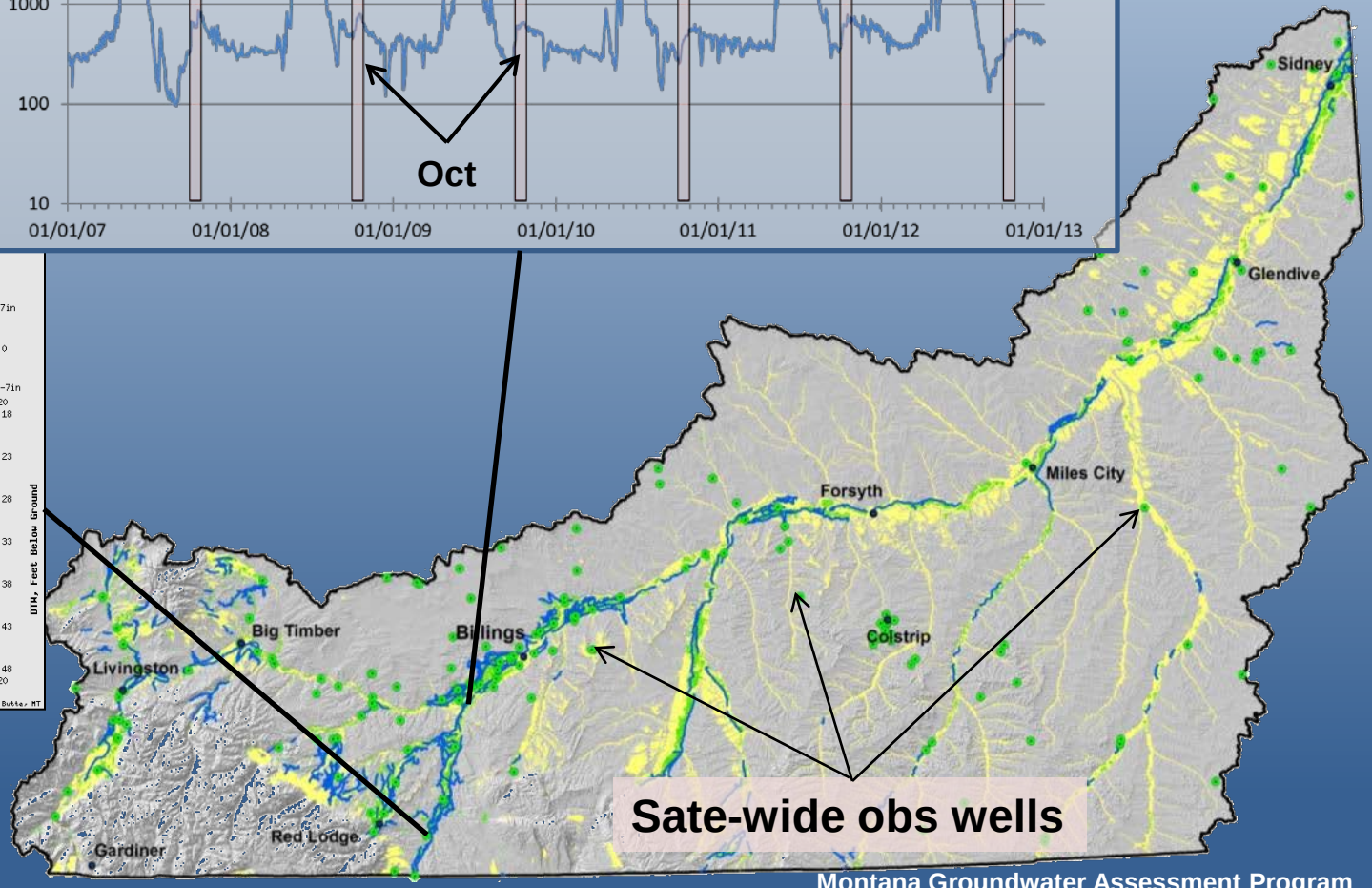
# Yellowstone: Groundwater-Surface Water Incidental Recharge



# Yellowstone: Groundwater-Surface Water
# Incidental Recharge



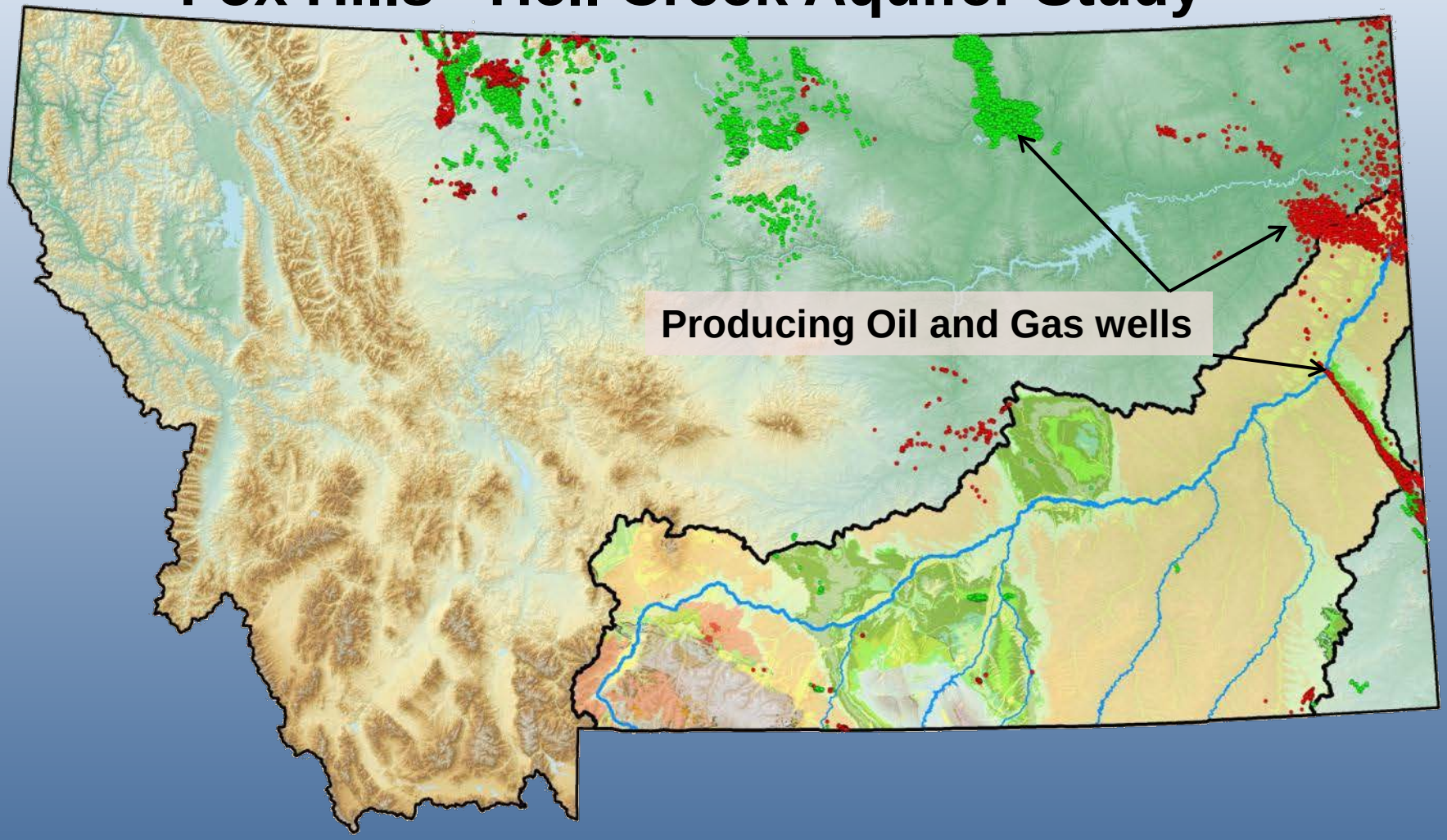



# *"The imperative need in groundwater development is to know what we are doing"*

**Harold E. Thomas, 1951**

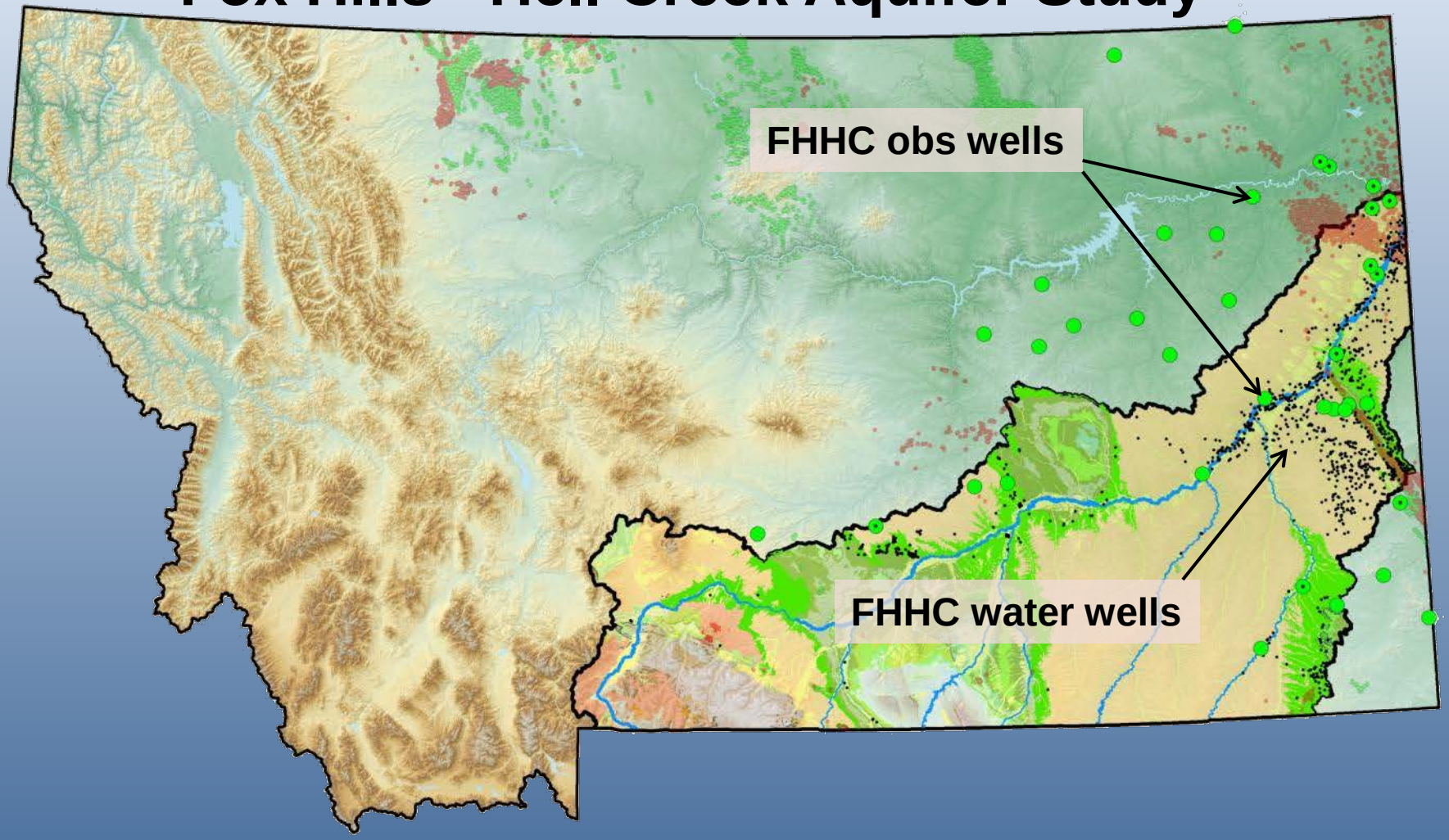
- **Significance of incidental recharge**
  - sustains aquifers, wetlands, riparian areas, alters flows
- **Factor into conceptual model GW/SW interaction**
  - Concern focused on pumping
  - Need to recognize land use controls recharge
- **Water policy, growth, land-use, climate changes**
  - Mitigate - Water transfers or water banking
  - Conversion of irrigated land
  - Snow to rain shift
- **Unintended consequences ?**

# Fox Hills - Hell Creek Aquifer Study



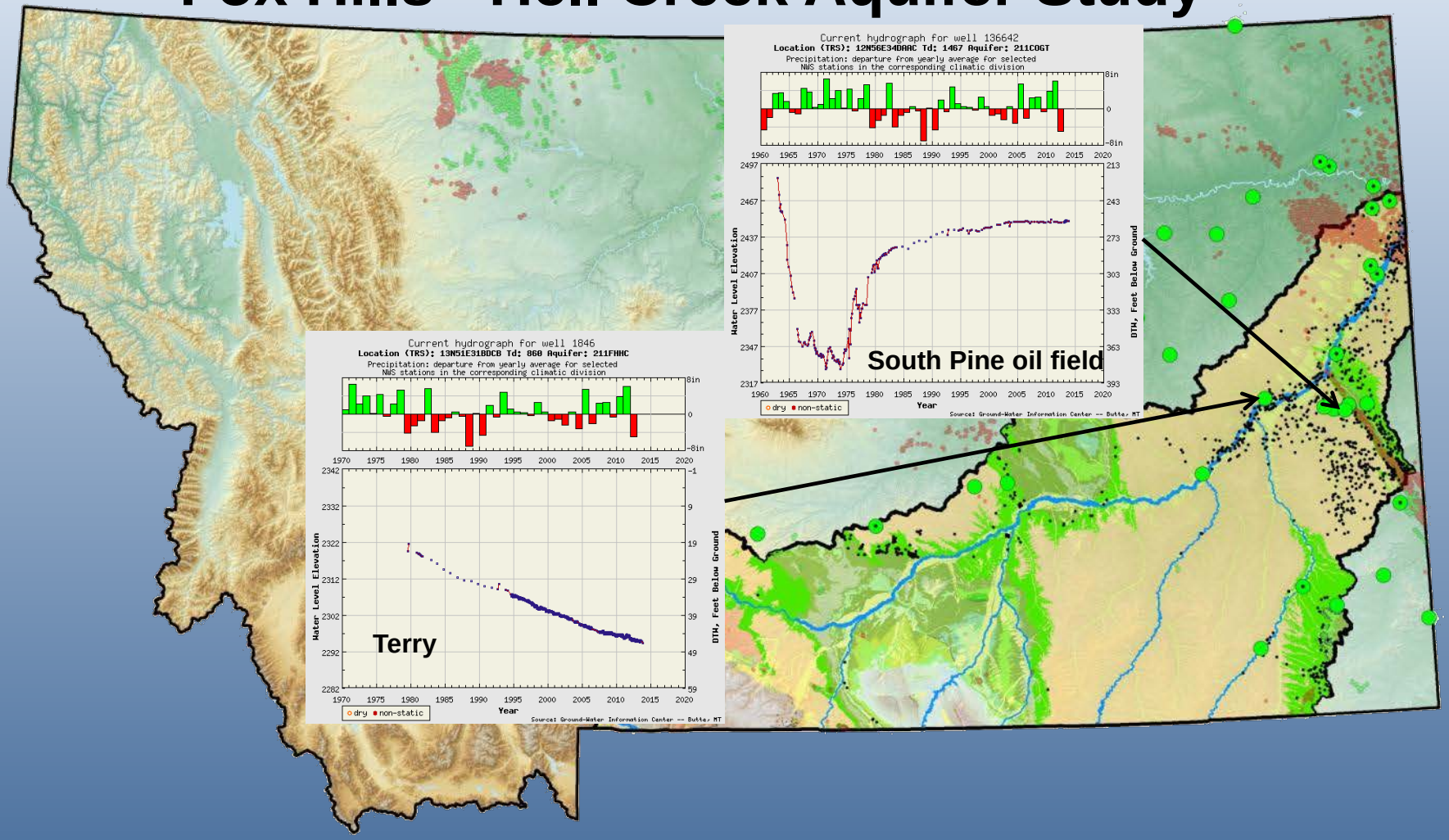

- 2011 – increased monitoring - GWIP.
- 2012 a joint project INL – MBMG project
- Data loggers in recharge and discharge areas
- Assess long-term trends

# Fox Hills - Hell Creek Aquifer Study



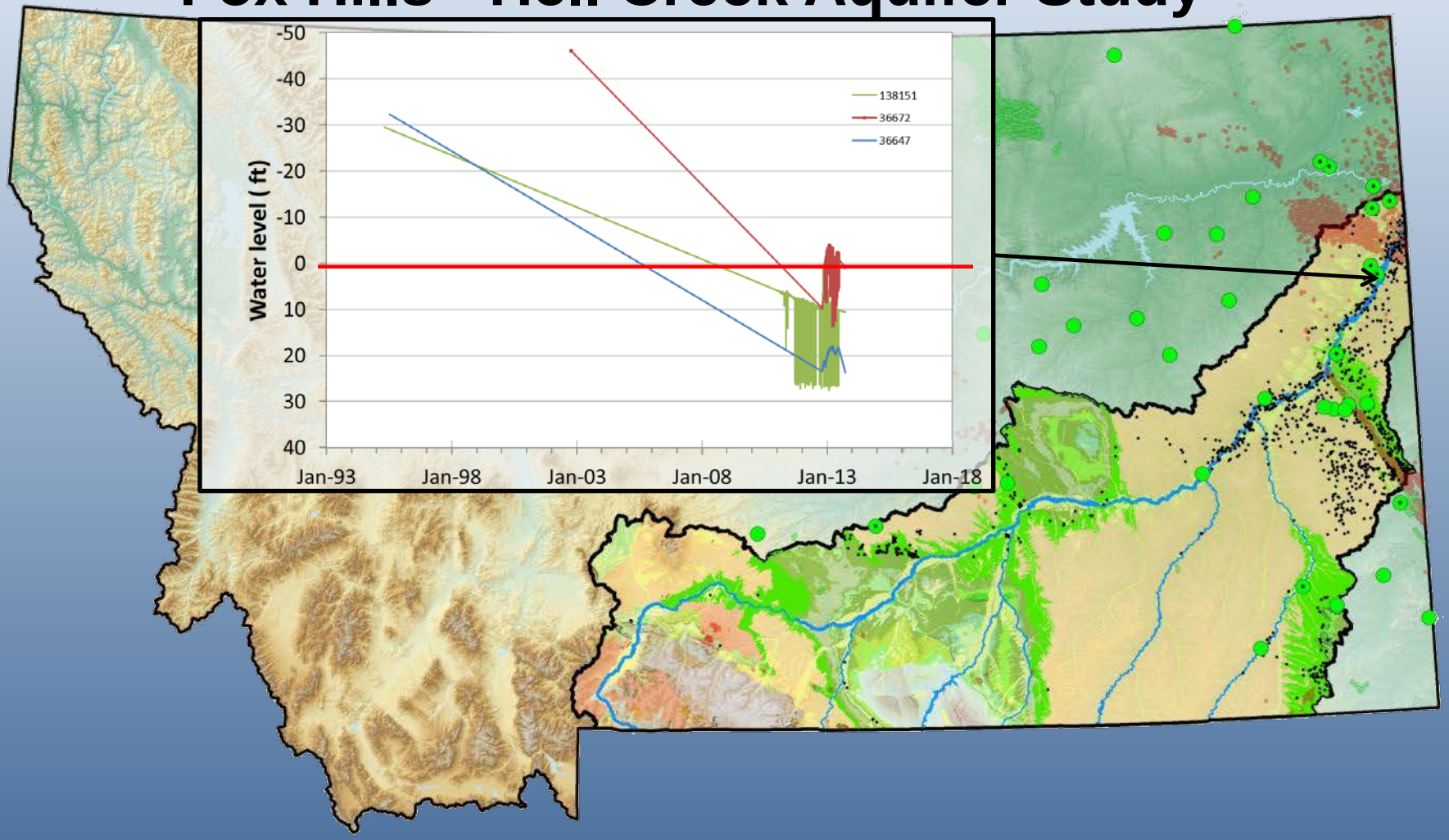

- Currently monitoring 40 wells in FHHC around the state – 20 in Yellowstone Basin

# Fox Hills - Hell Creek Aquifer Study



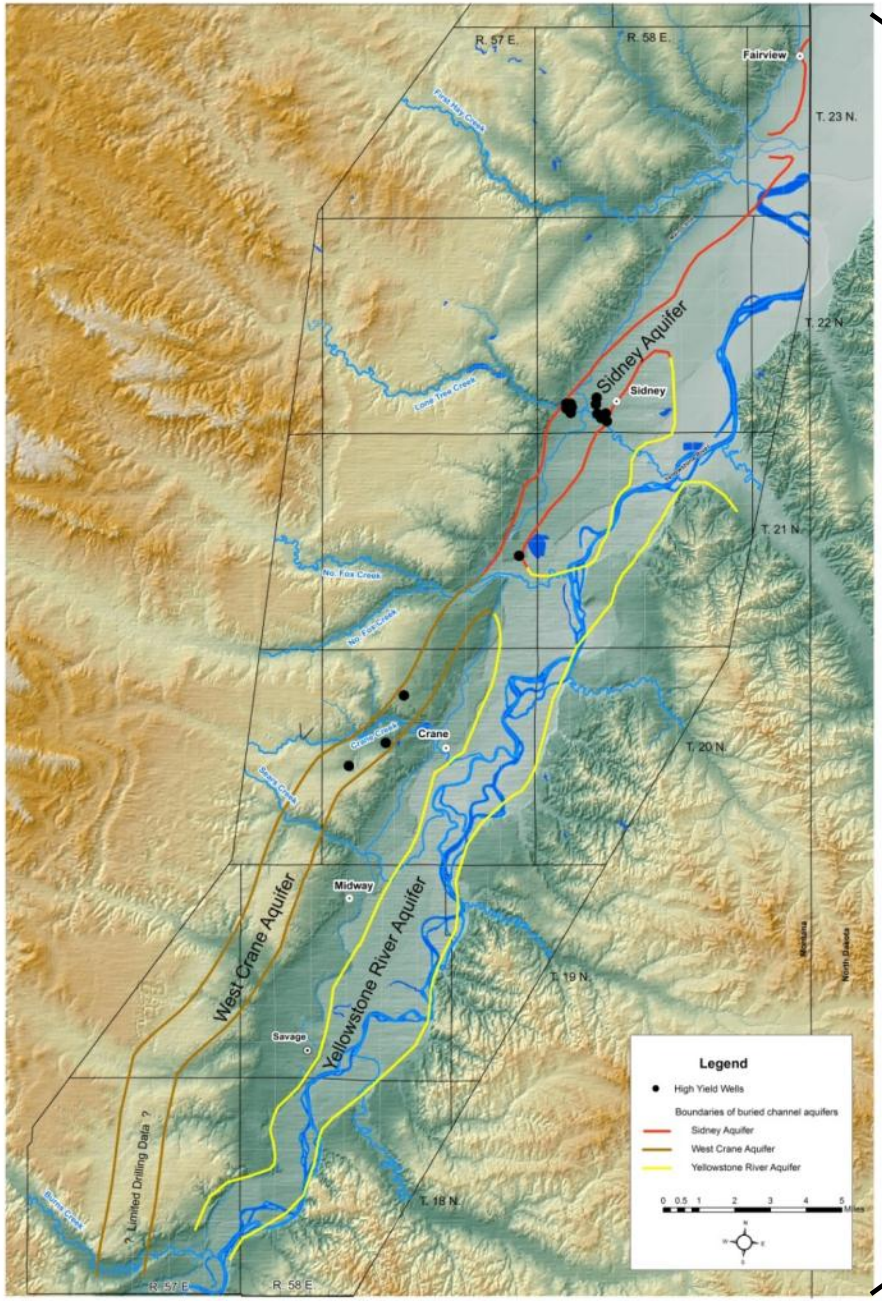

- **Some recovery… but**
- **Most long-term observations show downward trend**

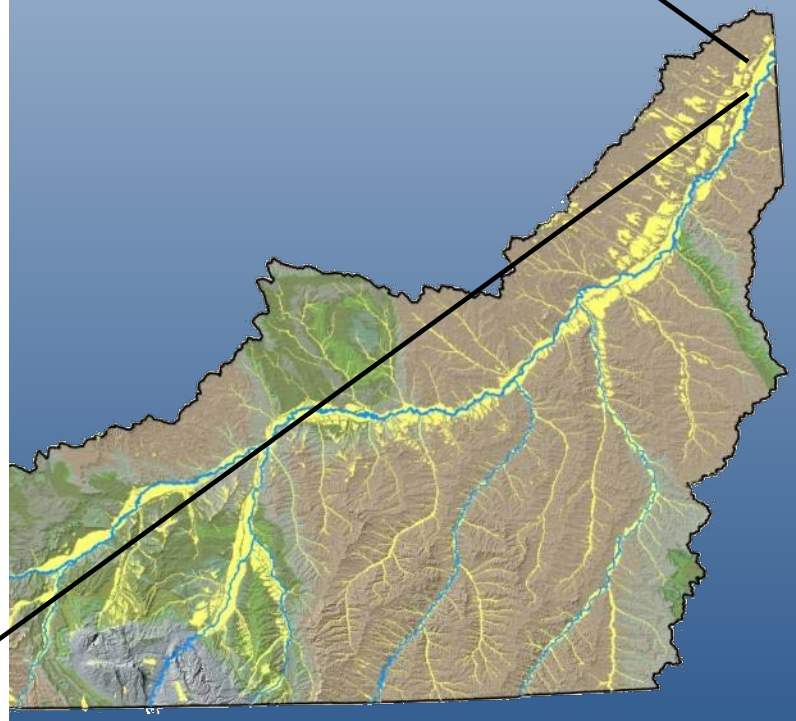
# Fox Hills - Hell Creek Aquifer Study




- In Sidney area rate of decline more than 2 ft /yr
  - More than 50 ft since 1990's
  - Some more than 100 ft since 1970's
- Wells no longer flow

# Sidney Buried Channels



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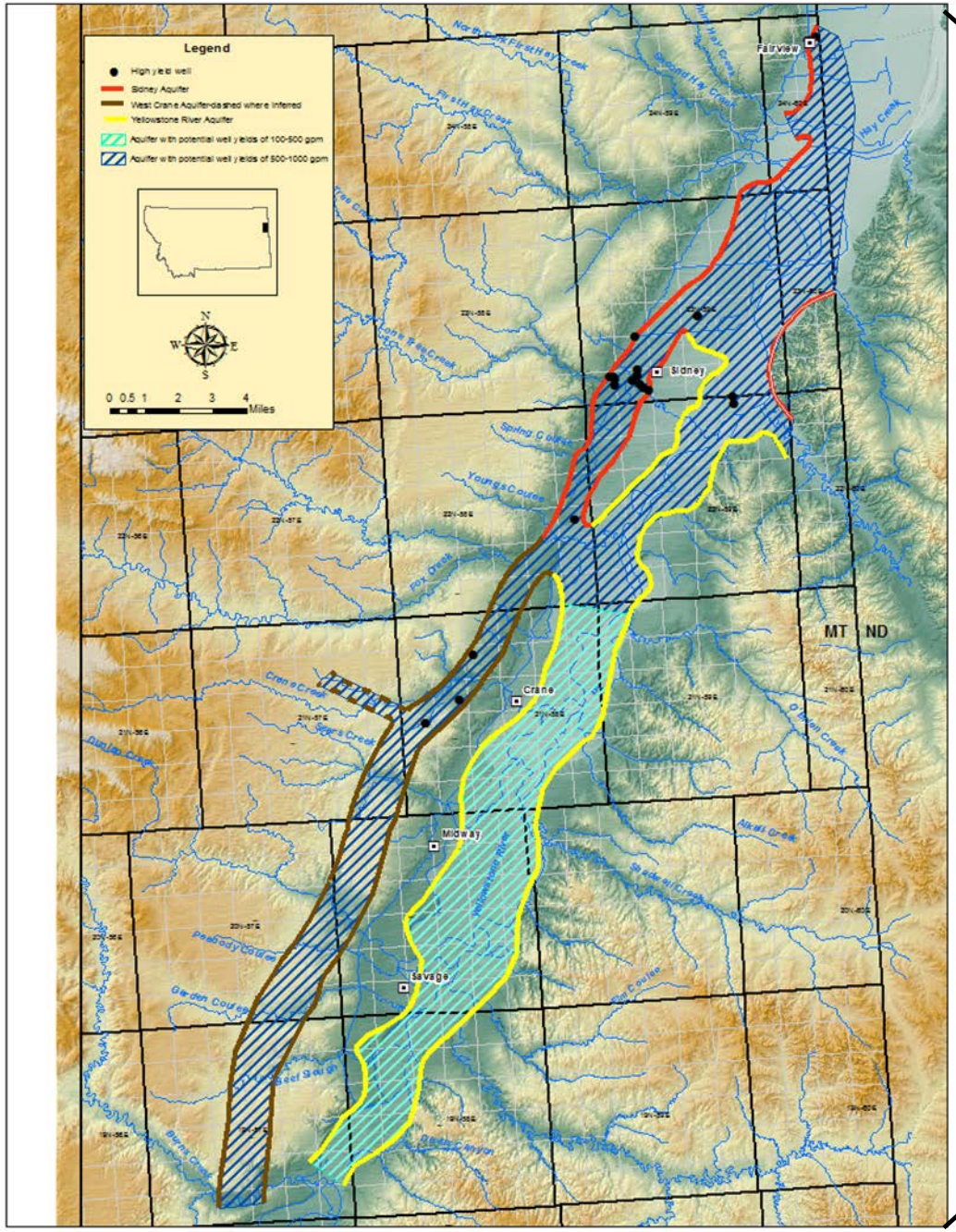


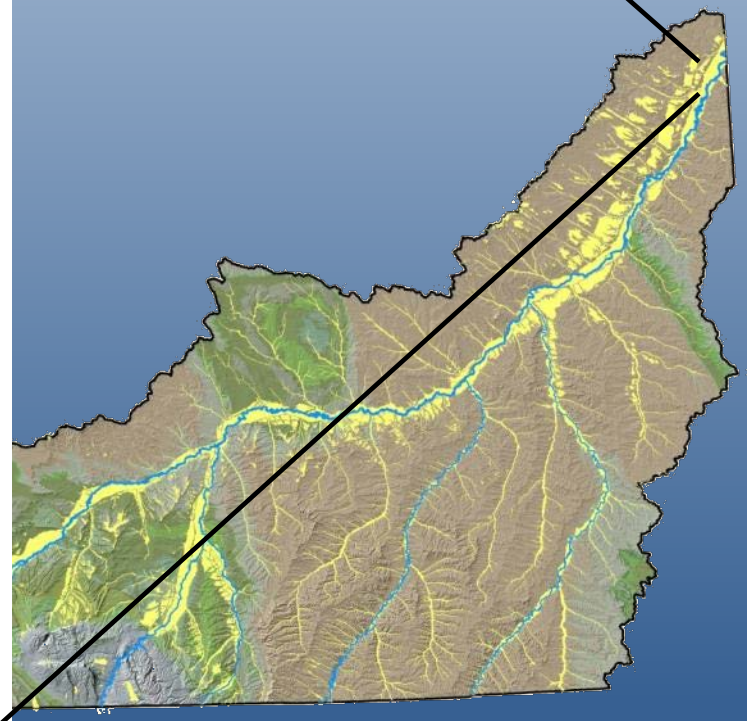

# Contact Information:

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