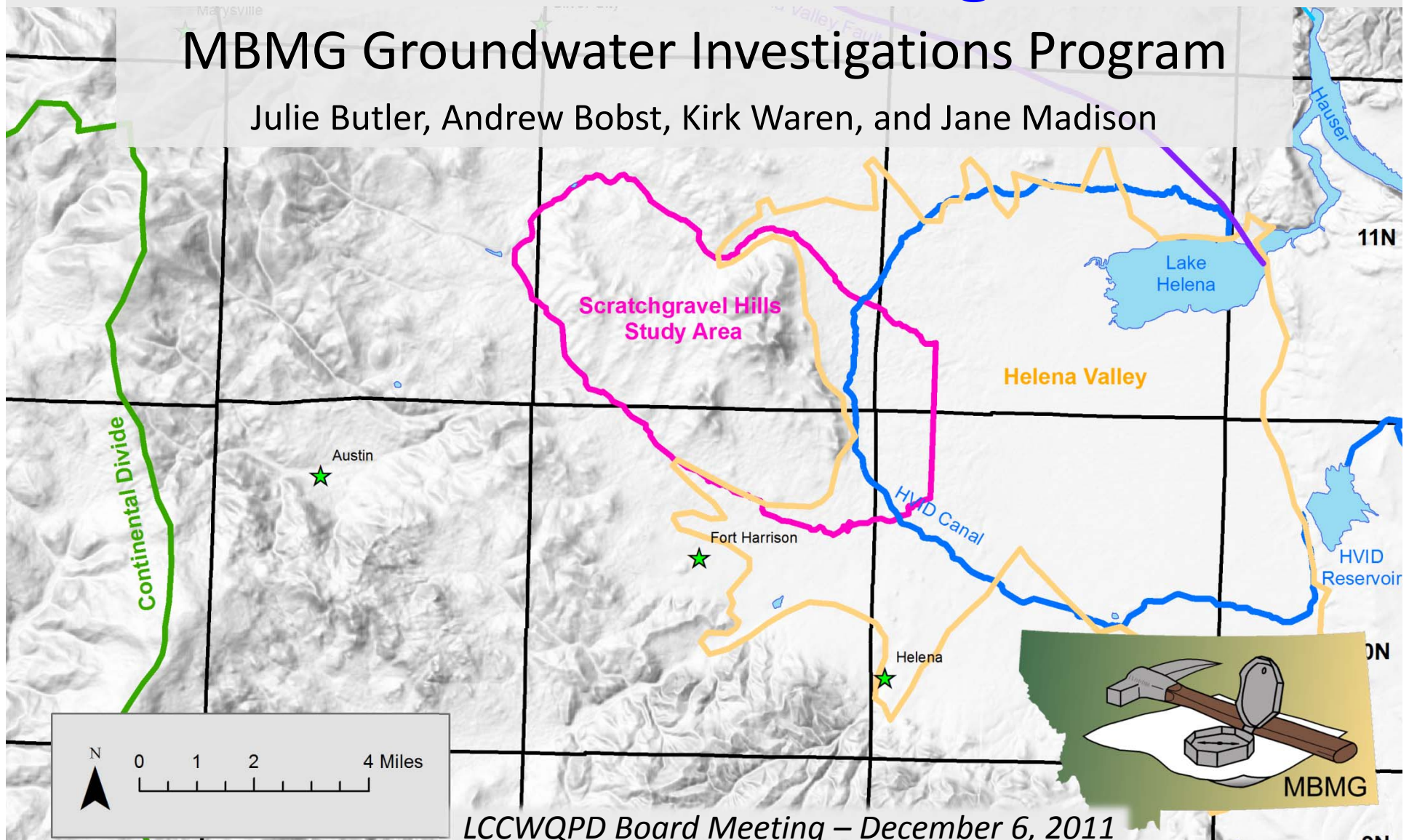# Scratchgravel Hills Groundwater Investigation

MBMG Groundwater Investigations Program

Julie Butler, Andrew Bobst, Kirk Waren, and Jane Madison
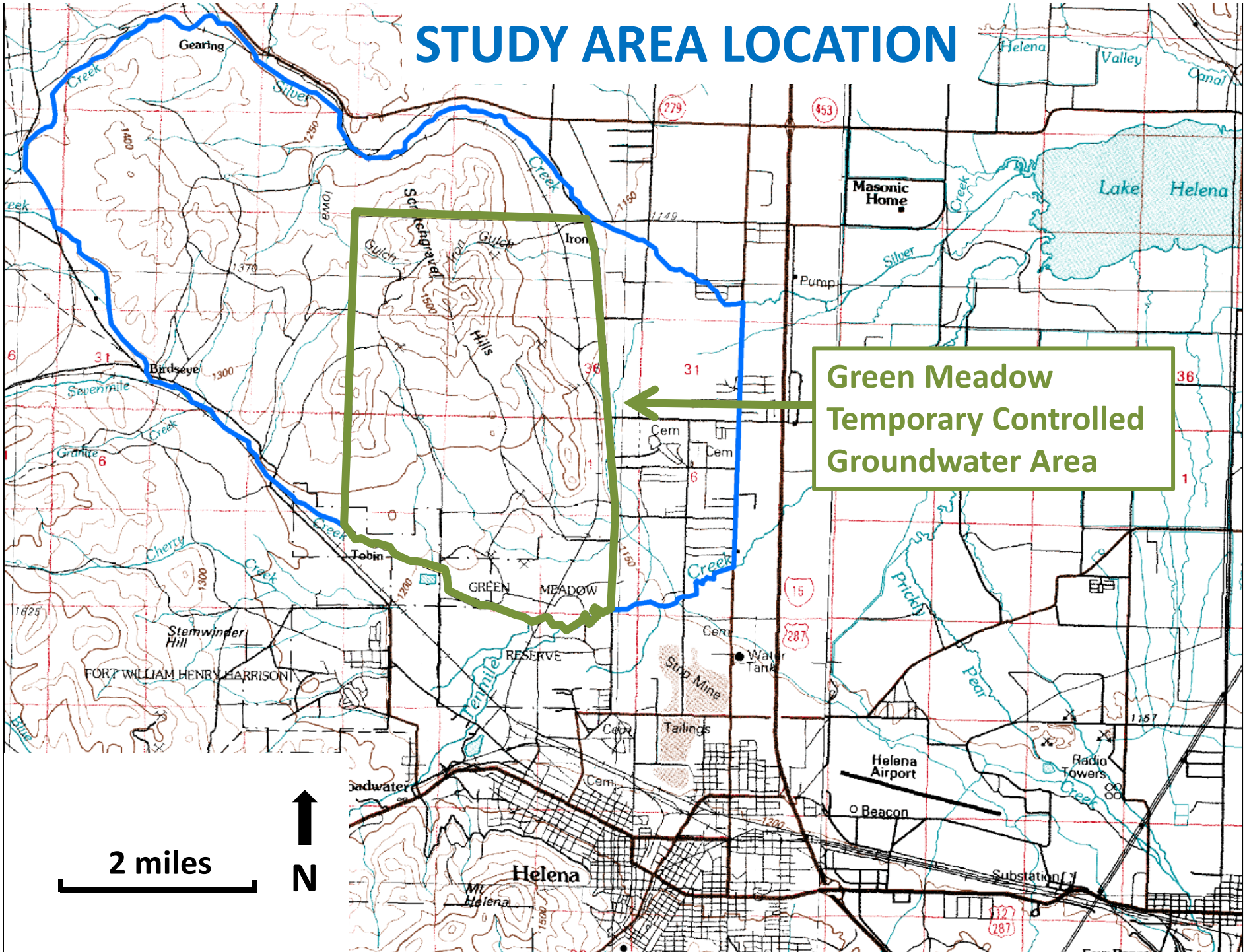
LCCWQPD Board Meeting – December 6, 2011

OUTLINE

- **Study Area Description**

- **Problem Statement**

- **Field Results**

  -- Groundwater Monitoring

  -- Aquifer Tests

  -- Water Quality Sampling

- **Groundwater Modeling**

- **Summary & Recommendations**

STUDY AREA LOCATION

Green Meadow Temporary Controlled Groundwater Area

2 miles

N

Problem Statement

- Increased subdivisions
  - Concerns regarding the amount of water available
- Some high nitrate levels
  - Concerns regarding the use of septic systems

- In 2008 DNRC designated the *Green Meadow Temporary Controlled Groundwater Area* (CGWA)

- MBMG was tasked with evaluating groundwater <u>availability</u> and <u>quality</u> in the Scratchgravel Hills
  - Baseline understanding of the hydrogeologic system
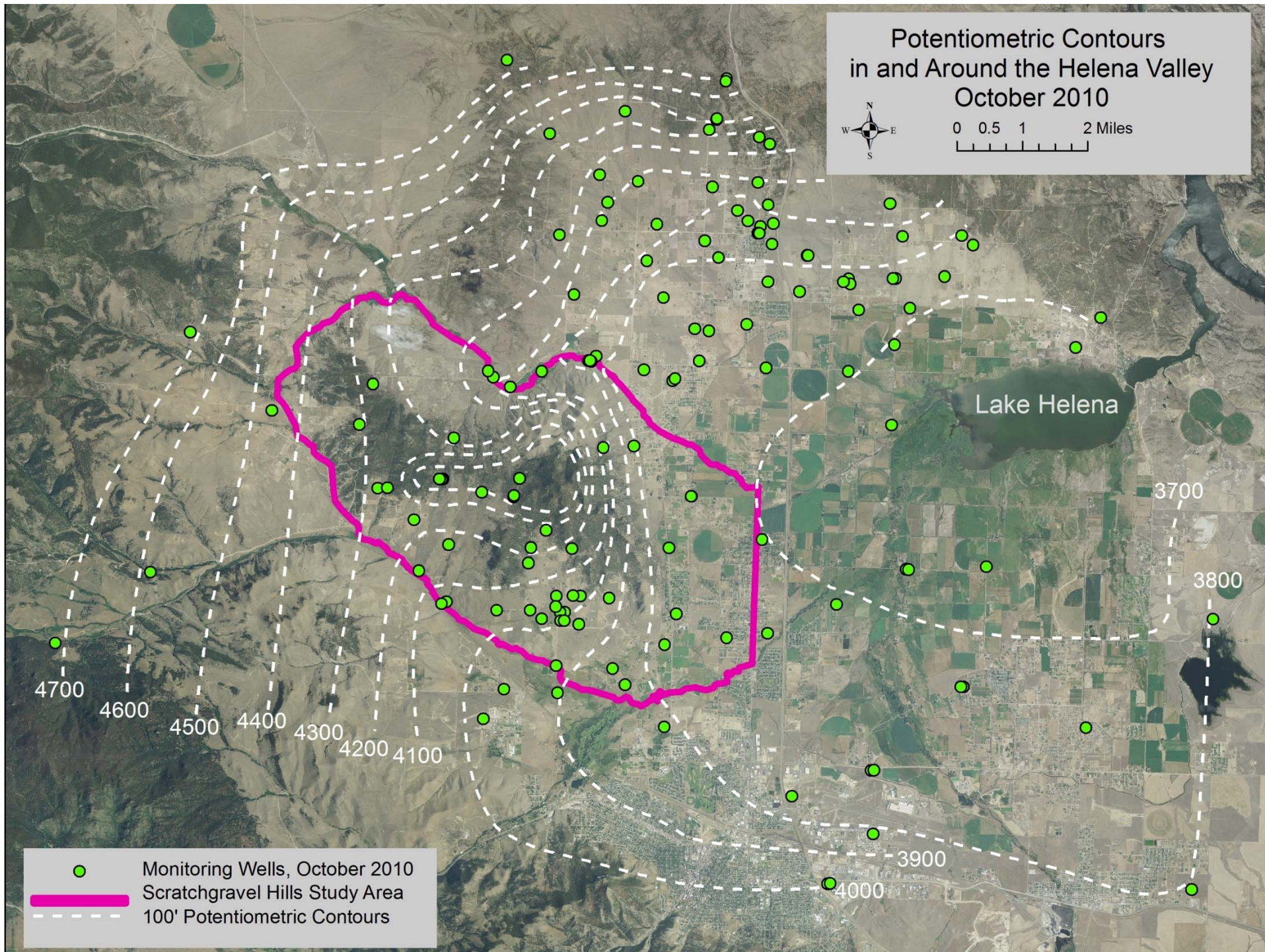 - Conceptual model
  - Groundwater flow model

Geologic Map of the
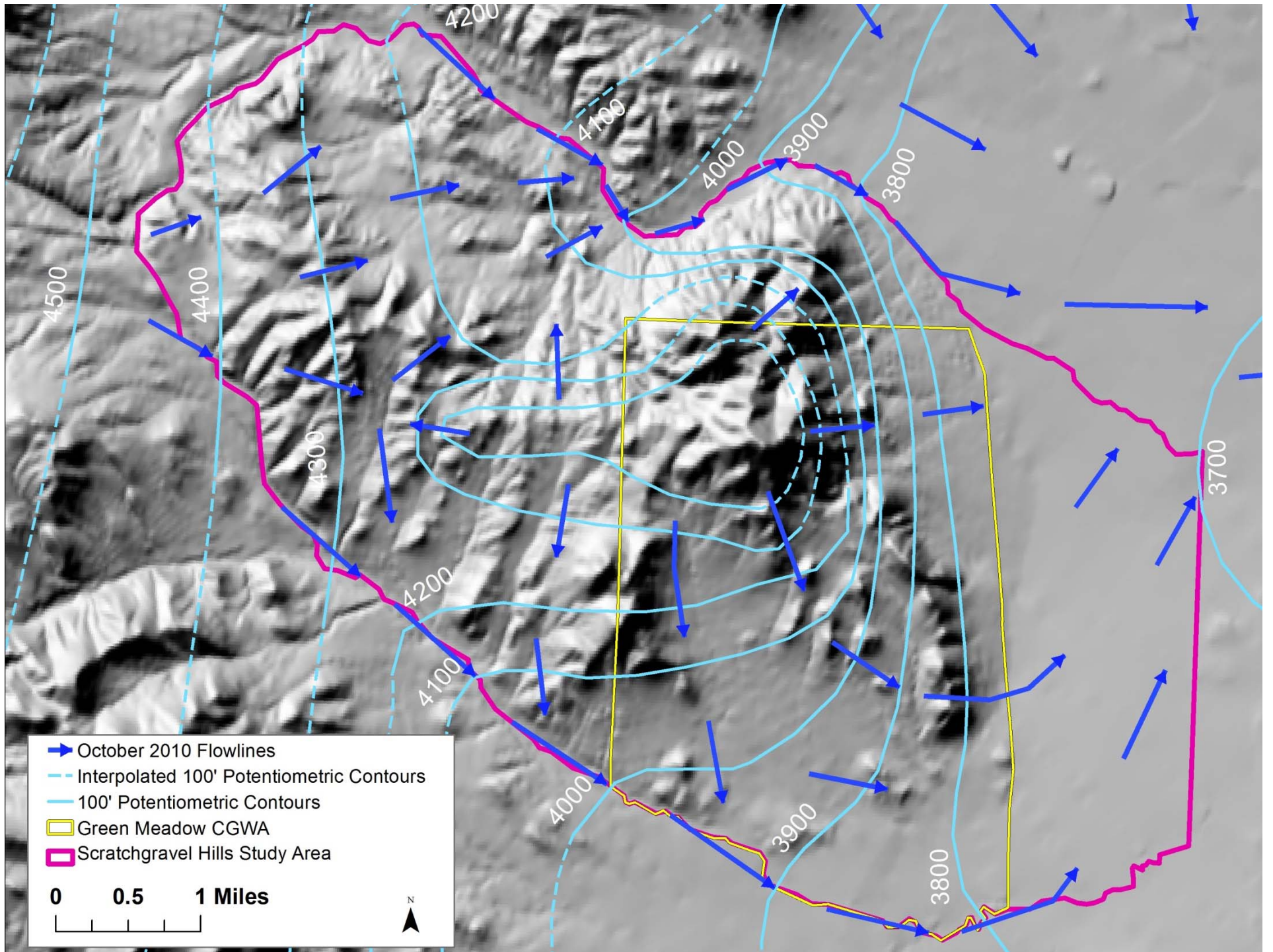Scratchgravel Hills
From Schmidt et al., 1994

Silver Creek Fault

Unnamed Fault

SCRATCH GRAVEL
HILLS STOCK
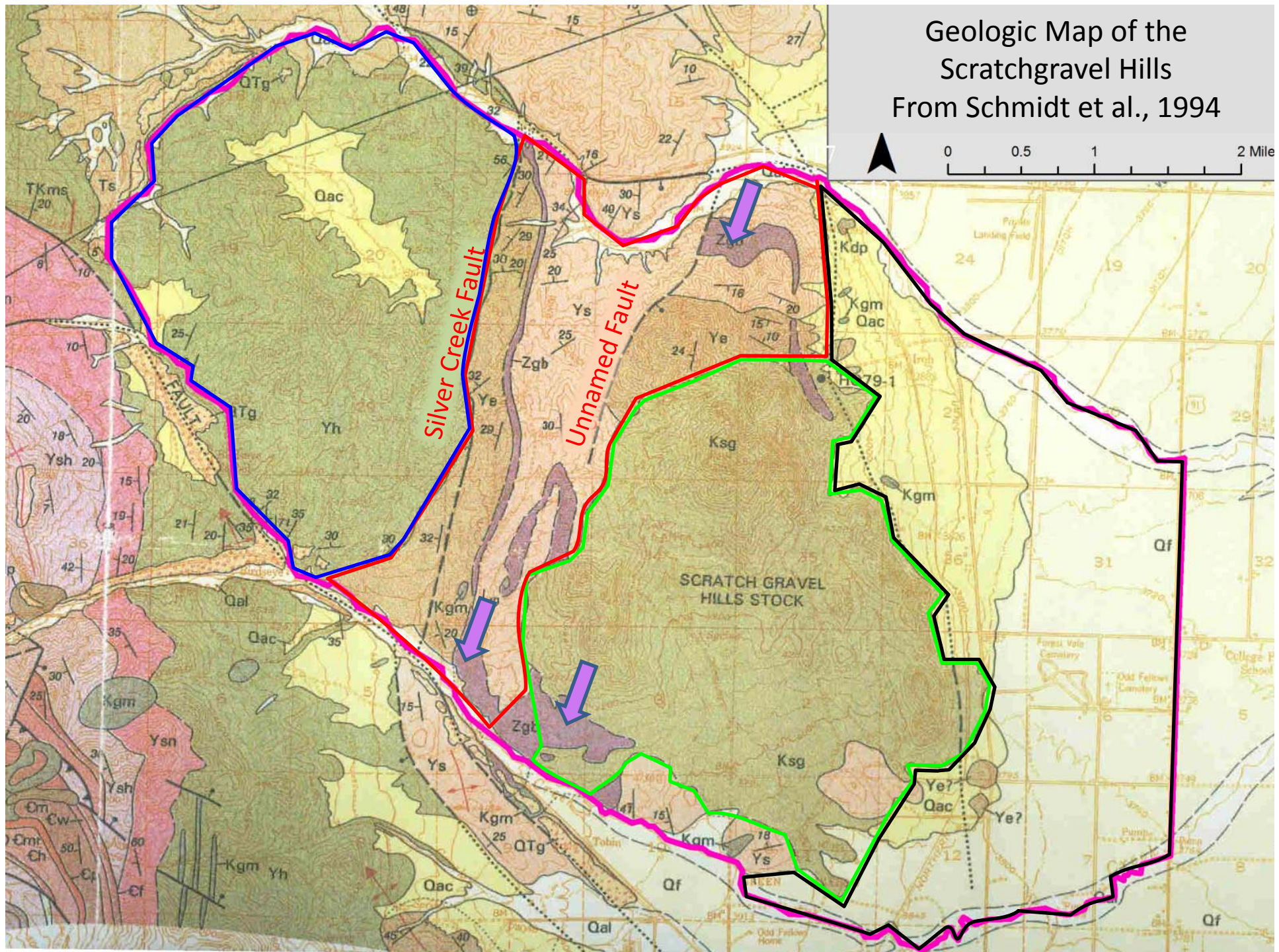
0   0.5   1   2 Miles

Potentiometric Contours
in and Around the Helena Valley
October 2010

0   0.5   1   2 Miles

Lake Helena

3700

3800

4700   4600   4500   4400   4300   4200   4100

3900

4000

● Monitoring Wells, October 2010
━ Scratchgravel Hills Study Area
╌╌ 100' Potentiometric Contours

October 2010 Flowlines

Interpolated 100' Potentiometric Contours

100' Potentiometric Contours

Green Meadow CGWA

Scratchgravel Hills Study Area

0   0.5   1 Miles

N

Hydrograph Slopes
1995 & 1996 vs. 2010

Hydrograph Slopes (ft/yr)
- 🔴 <-1.0
- 🟡 -1.0 to -0.5
- 🟠 -0.5 to 0.5
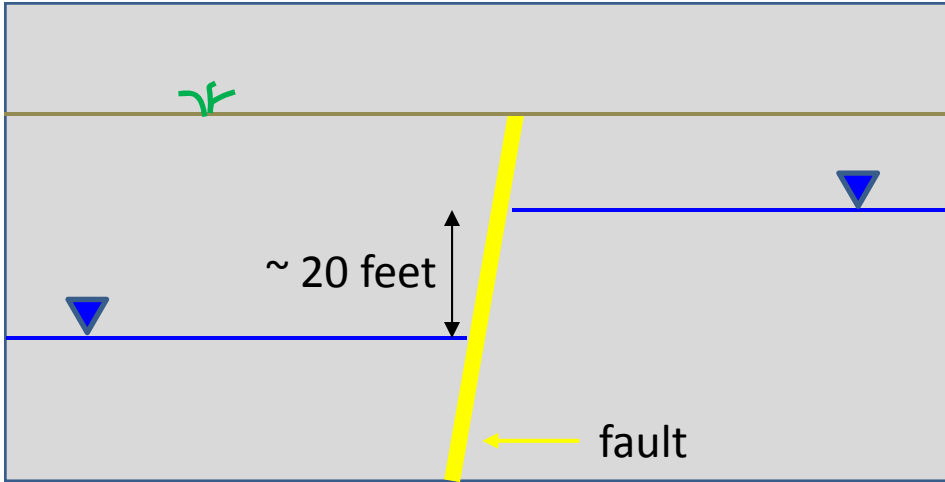- 🔵 0.5 to 1.0

N

0   0.4   0.8   1.6 Miles
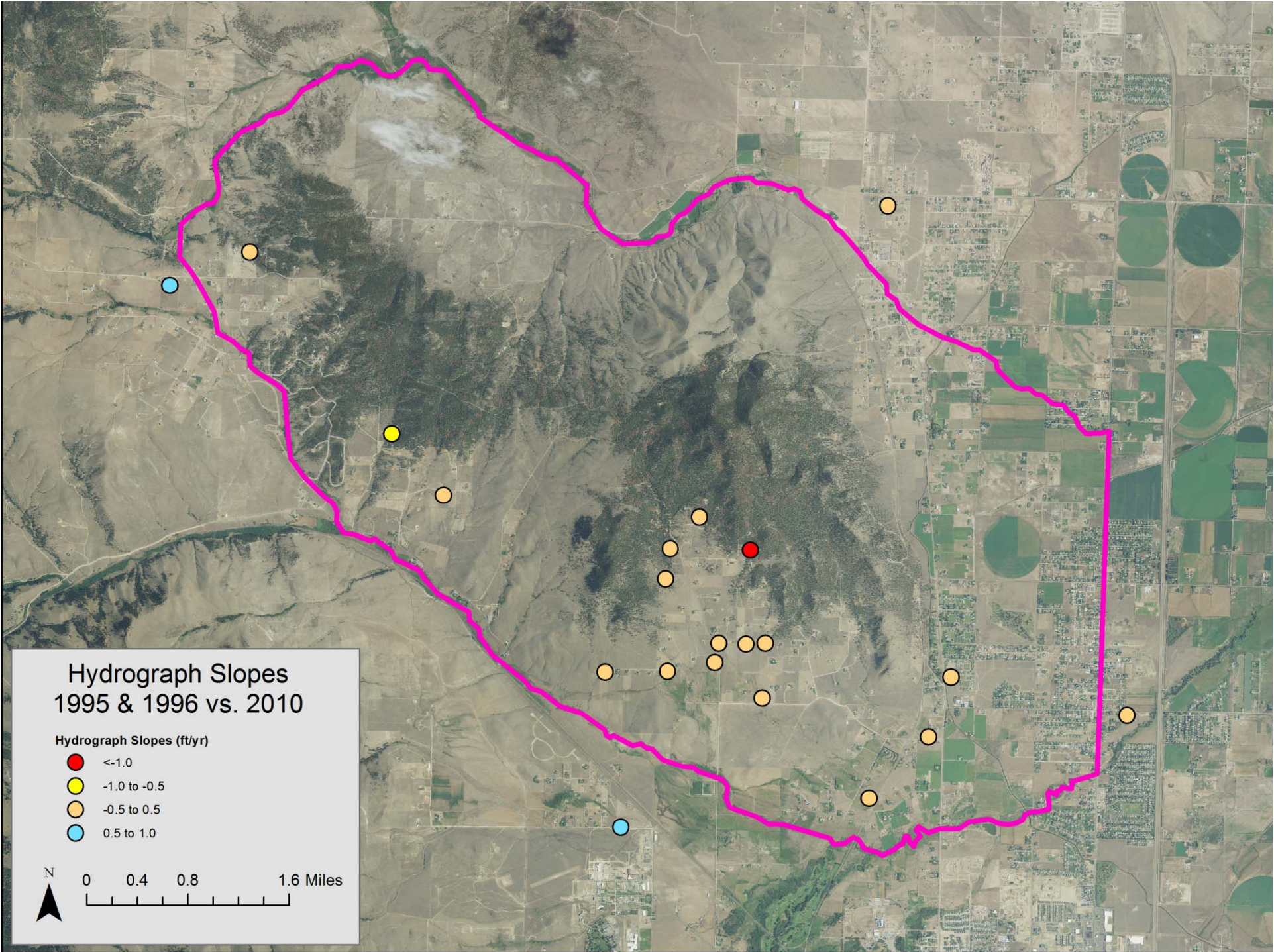
Well productivity is highly dependent on the
local fracture distribution

Aquifer Test Locations
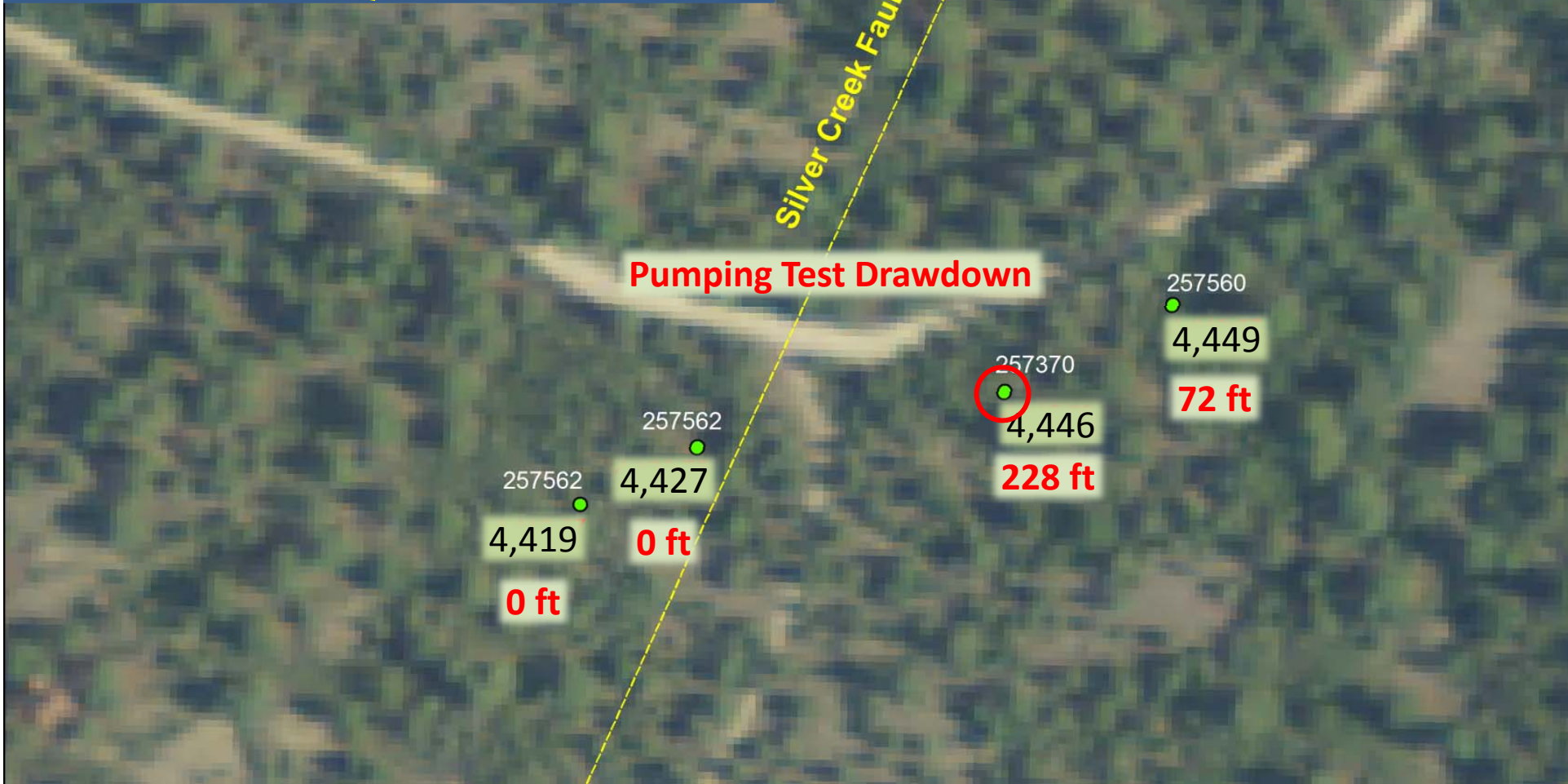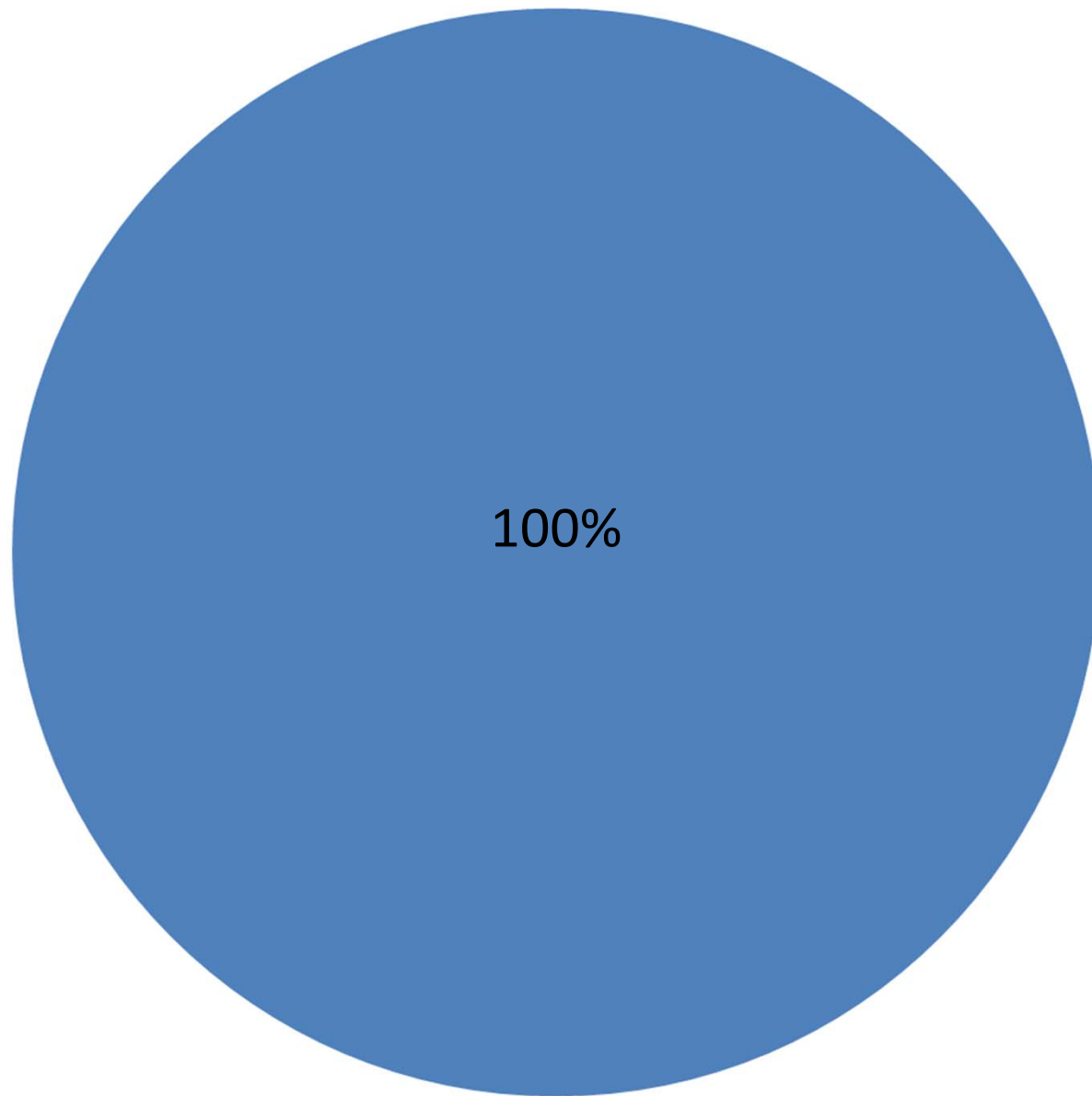And
Hydraulic Conductivity (K)
Estimates (feet/day)

Helena
Formation
0.005 – 1.2

Spokane/
Empire Fmt
1.6 – 18

Metagabbro
1.9 – 2.7

Granite
0.001 - 1.5

Quaternary
Sediments
1 - 920

SCRATCH GRAVEL
HILLS STOCK
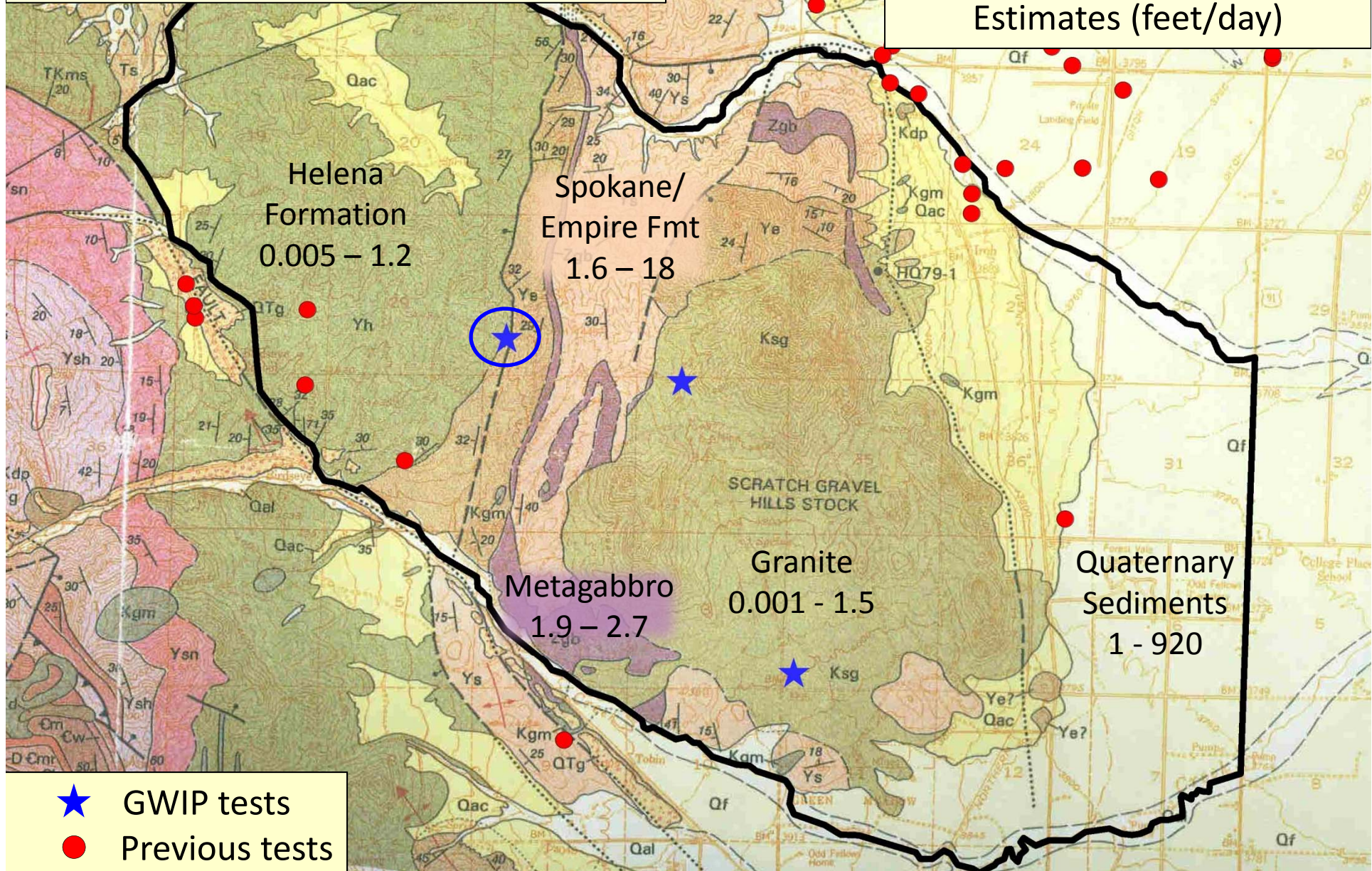
★ GWIP tests
● Previous tests

Silver Creek Fault Site Layout and Groundwater Elevations (11/9/10)

~ 20 feet

fault

Silver Creek Fault

Pumping Test Drawdown

257560
4,449
72 ft

257370
4,446
228 ft

257562
4,427
0 ft

257562
4,419
0 ft

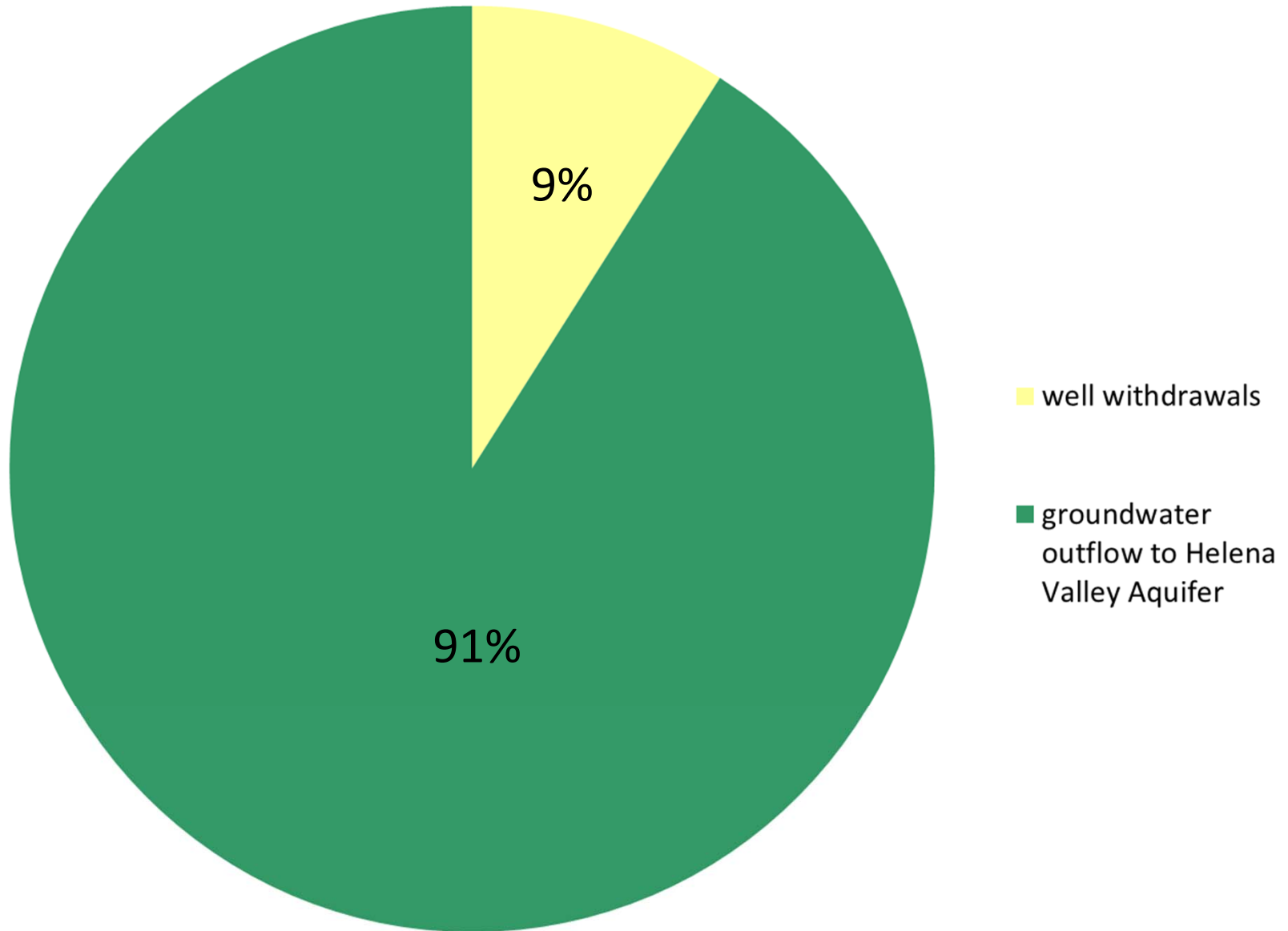**BEDROCK AQUIFER (GREEN MEADOW CGWA) RECHARGE SOURCES**

100%

■ local precipitation

STUDY AREA DISCHARGE SOURCES

9%

91%

well withdrawals

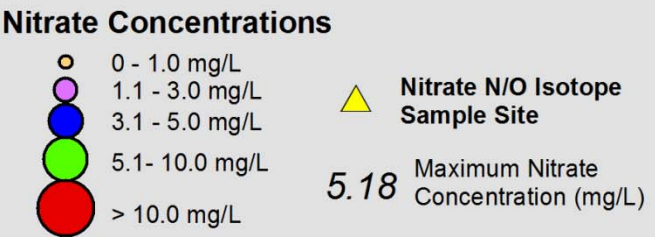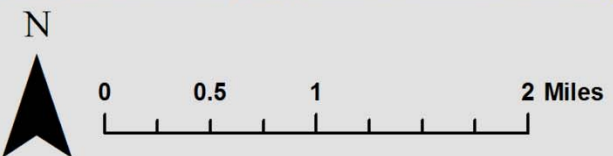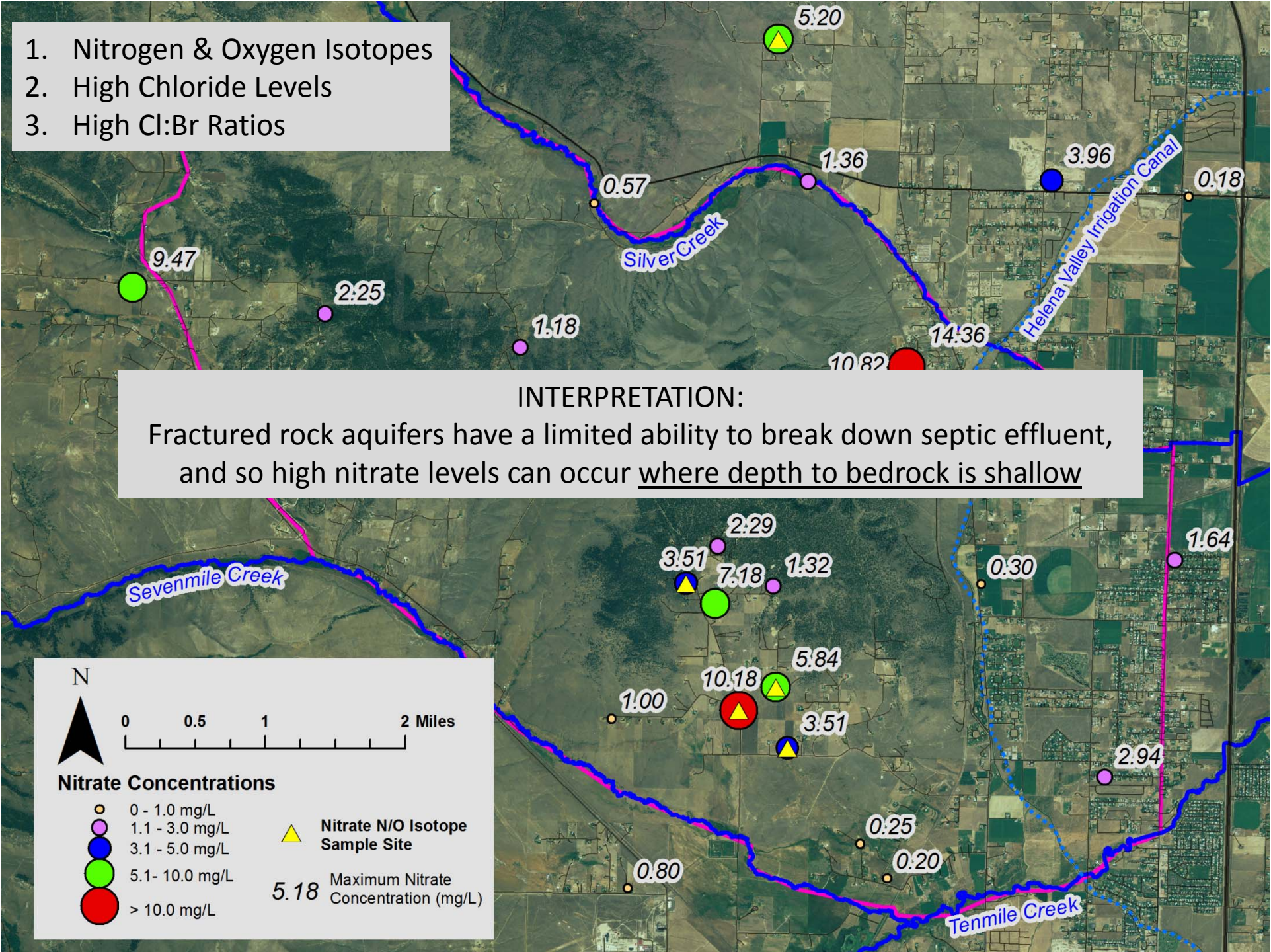groundwater outflow to Helena Valley Aquifer

Water Quality Sampling

- 3 Events in 2010: April, August, October
- Sampled for:
  - Major Ions
  - Nutrients (N & O isotopes for high nitrate samples (>3 mg/L))
  - Metals
  - Radon
  - Sulfate Isotopes
  - H & O stable Isotopes
  - Endocrine Disrupters
- Exceedance of drinking water standards
  - N, U, As, Mn
- Exceedance of aquatic life standard
  - N, As, Sr

1. Nitrogen & Oxygen Isotopes
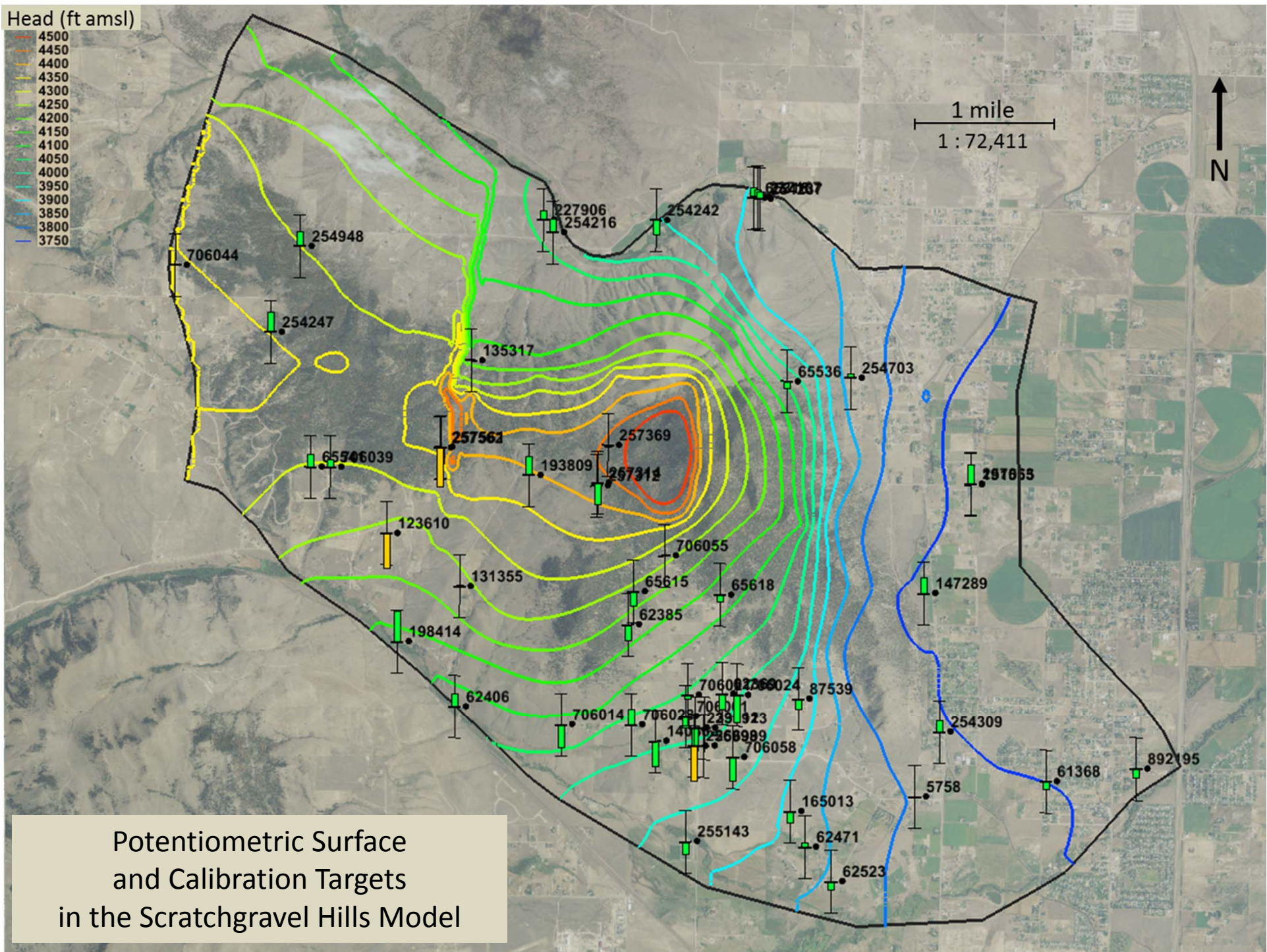2. High Chloride Levels
3. High Cl:Br Ratios

INTERPRETATION:
Fractured rock aquifers have a limited ability to break down septic effluent,
and so high nitrate levels can occur <u>where depth to bedrock is shallow</u>

5.20

1.36   3.96   0.18

0.57

9.47

2.25

1.18   14.36

10.82

Silver Creek

Helena Valley Irrigation Canal

2.29
3.51   7.18   1.32   0.30
1.00   10.18   5.84
3.51   1.64

Sevenmile Creek

2.94

0.25
0.80   0.20

Tenmile Creek

N

0   0.5   1   2 Miles

Nitrate Concentrations

○ 0 - 1.0 mg/L
● 1.1 - 3.0 mg/L   △ Nitrate N/O Isotope
● 3.1 - 5.0 mg/L   Sample Site
● 5.1- 10.0 mg/L
● > 10.0 mg/L   5.18 Maximum Nitrate
                              Concentration (mg/L)

Potentiometric Surface
and Calibration Targets
in the Scratchgravel Hills Model
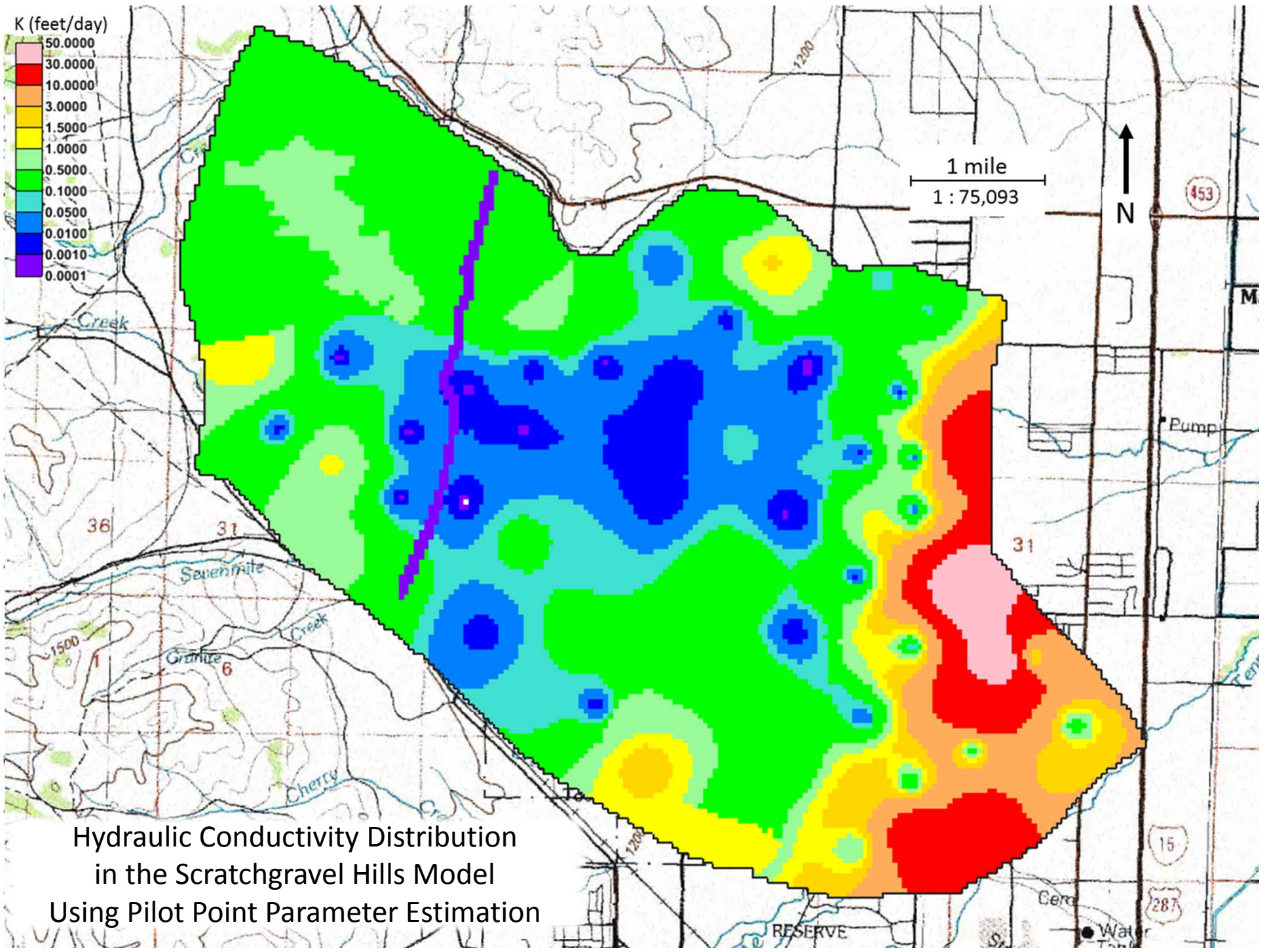
Hydraulic Conductivity Distribution
in the Scratchgravel Hills Model
Using Pilot Point Parameter Estimation

K (feet/day)
50.0000
30.0000
10.0000
3.0000
1.5000
1.0000
0.5000
0.1000
0.0500
0.0100
0.0010
0.0001
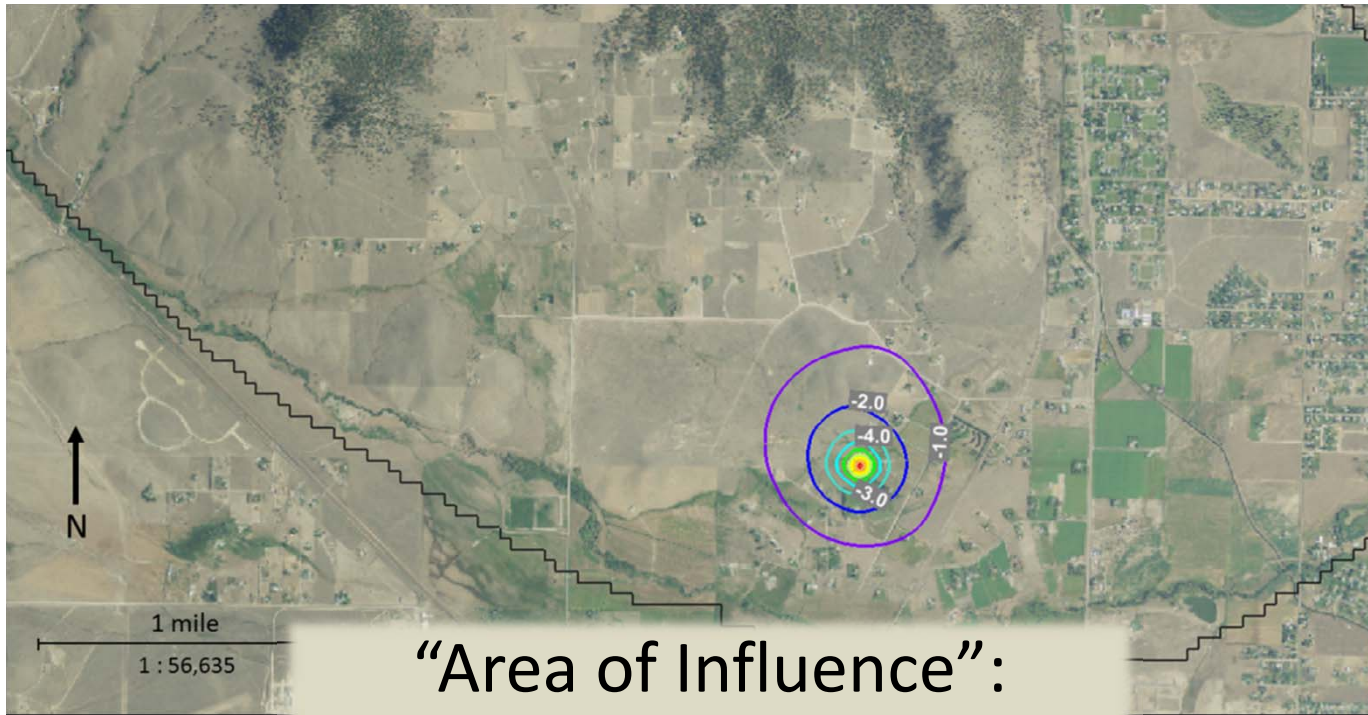
"Area of Influence": extent of 1-ft of drawdown

Scenario 1:

o 1 PWS Well

o Supply for **10-acre** lots

o 10 years of pumping
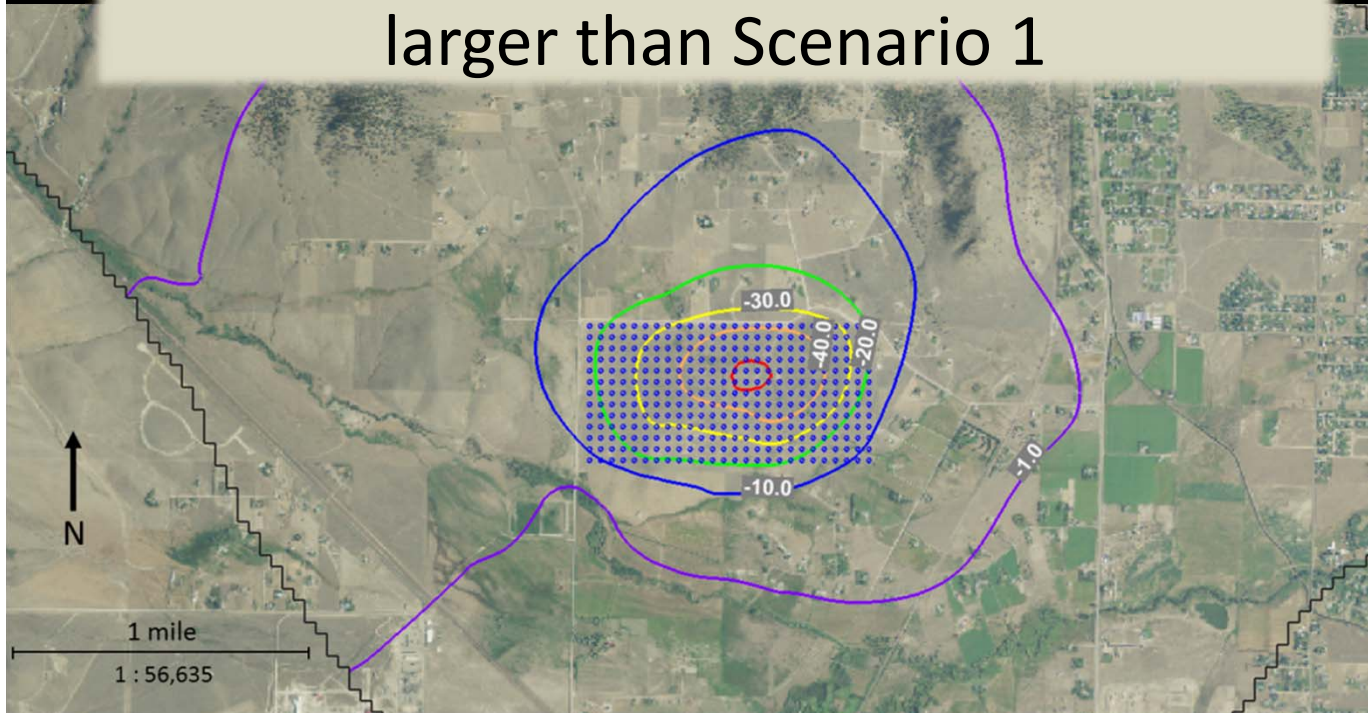
o 1-ft area of influence extended **0.47 miles**
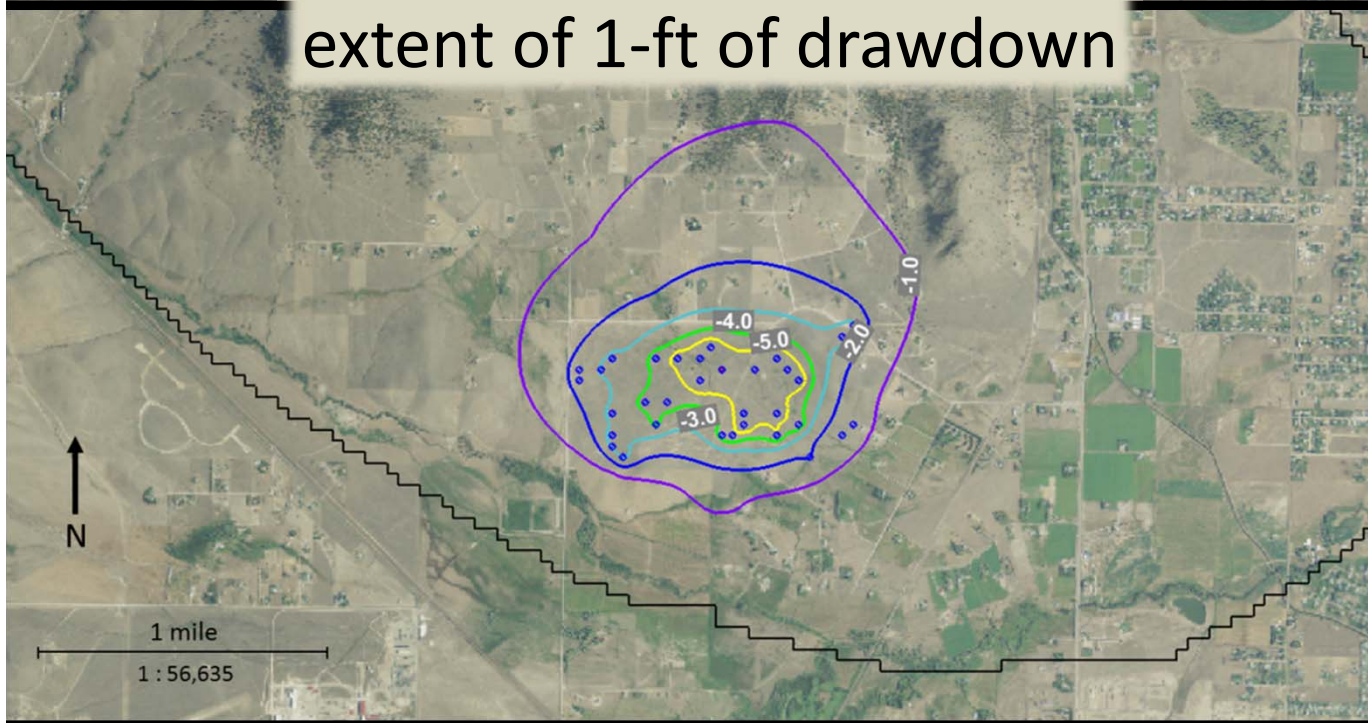
Scenario 2:

o 33 exempt wells

o Supply for **10-acre** lots

o 10 years of pumping

o 1-ft area of influence extended **0.87 miles**
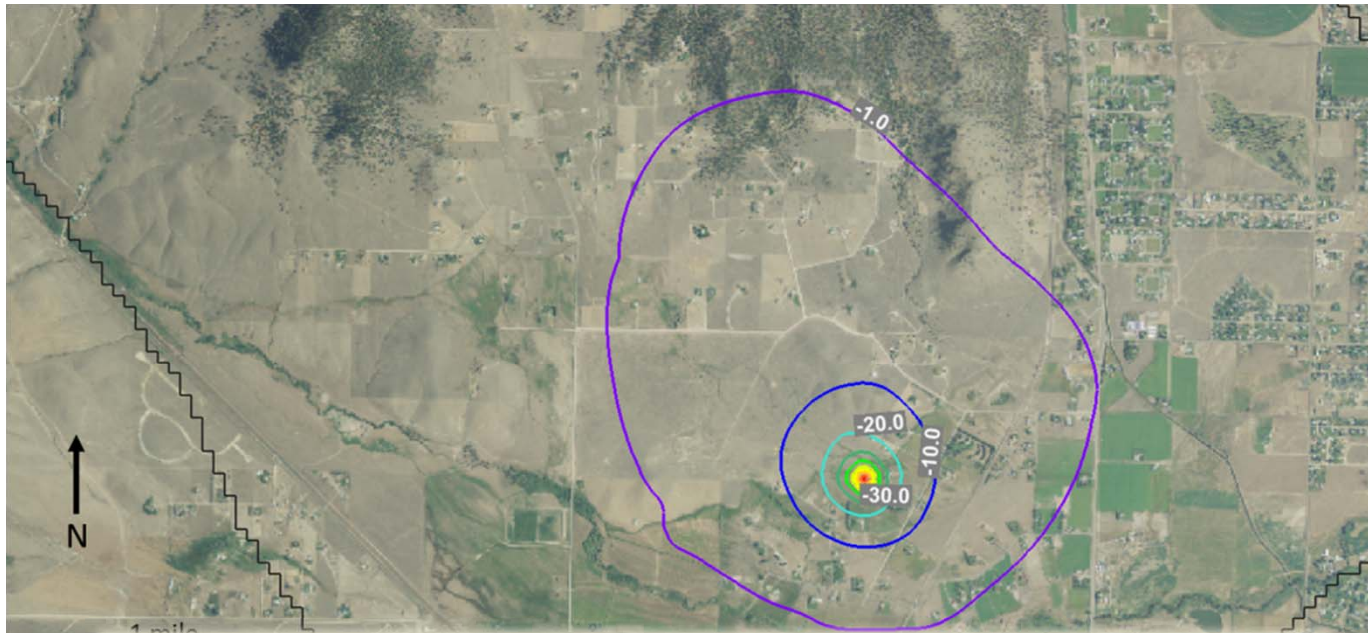
Areas of Influence are 3 to 4 times larger than Scenario 1

Scenario 3:

o 1 PWS Well

o Supply for **1.4-acre** lots

o 10 years of pumping

o 1-ft area of influence extended **1.33 miles**

Scenario 4:

o 338 exempt wells

o Supply for **1.4-acre** lots

o 10 years of pumping

o 1-ft area of influence extended **2.0 miles**

Scratchgravel Hills Bedrock Aquifer System: Summary

- Well yields vary locally and are highly dependent on:
  - *Degree of fracturing*
  - *Proximity to impermeable faults*
  - *Most variable in the granite and Helena Formation*

- Recharge to the Green Meadow CGWA is local

- Septic effluent could be problematic where depth to bedrock is shallow

Future subdivision developments:

- PWS well preferable to exempt wells
  - *Ability to selectively locate (high-K zone, away from septic effluent)*
  - *Easier management*
  - *Smaller area of influence*

Scratchgravel Hills Bedrock Aquifer System: Recommendations

- Conduct long-term monitoring to better establish groundwater level trends

- Consider depth to bedrock in design of future septic systems

- Conduct monitoring in new developments with a lot density < 10 acres
  - *Water levels and water use*

- Incorporate site-specific data into models to predict impacts of development
  - *Particularly consider local variation in fractures and faults*

THANK YOU

QUESTIONS???