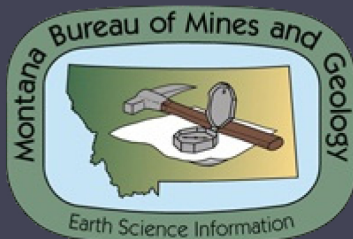


MBMG

Groundwater Investigations Program

Helena Area Projects

Stakeholders Meeting
June 17, 2010



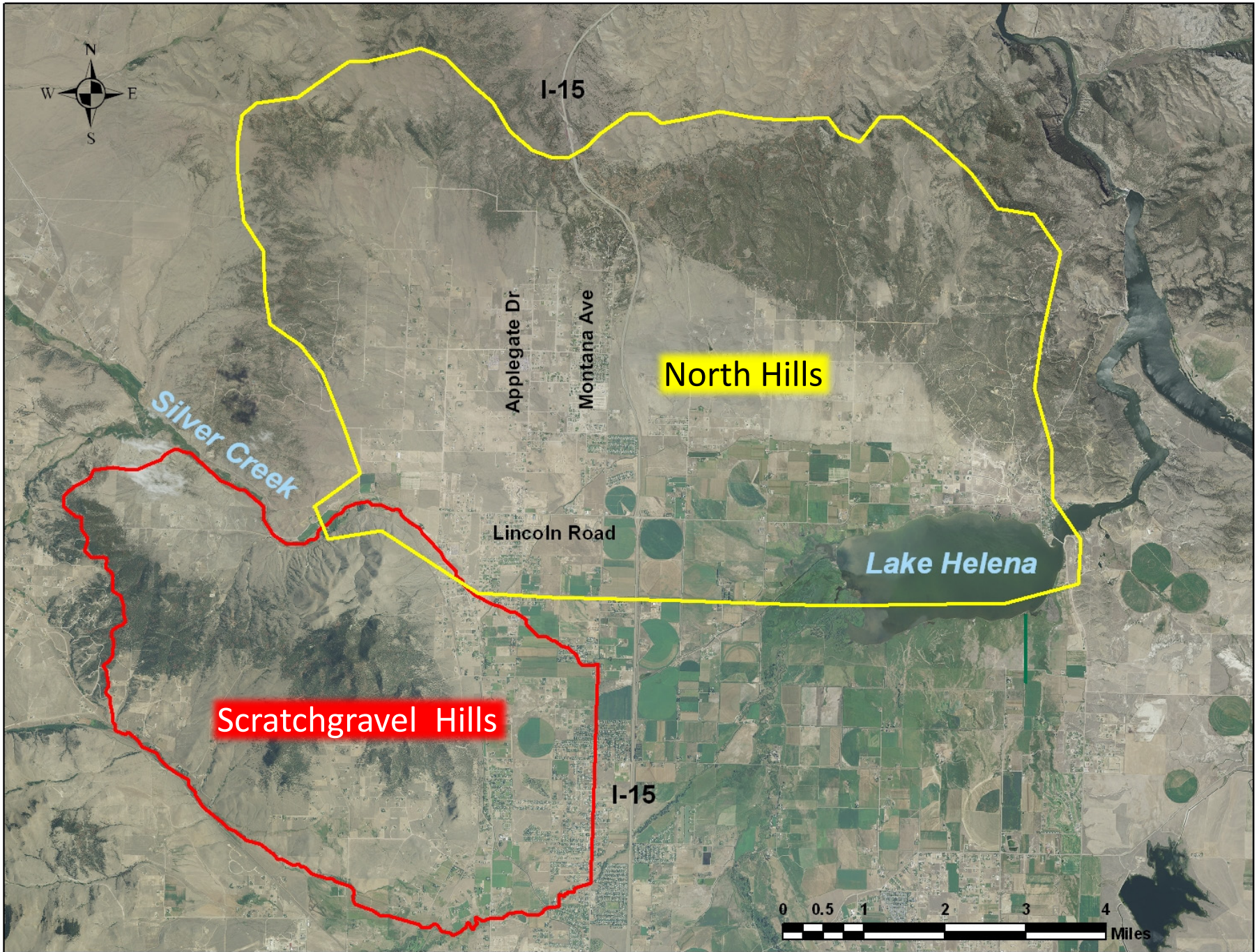
Kirk Waren
Andy Bobst
Julie Ahern
Jane Madison
Allie Brown

Helena Area Projects

North Hills

Scratchgravel Hills





North Hills

Scratchgravel Hills

Silver Creek

Lake Helena

I-15

Applegate Dr

Montana Ave

Lincoln Road

I-15



OUTLINE

For both the **North Hills** and **Scratchgravel Hills**
Study Areas:

- Key Questions
- Investigative Methods
- Work to date
- Upcoming work
- Summary

North Hills Area

Key Questions

- ***Can the North Hills aquifer system sustain current and projected groundwater withdrawals?***
 - Water budget (ET, surface water runoff)
 - Aquifer types & extents
- ***Is the North Hills aquifer system vulnerable to nitrate contamination?***
 - Water quality (historic & current)

North Hills Area

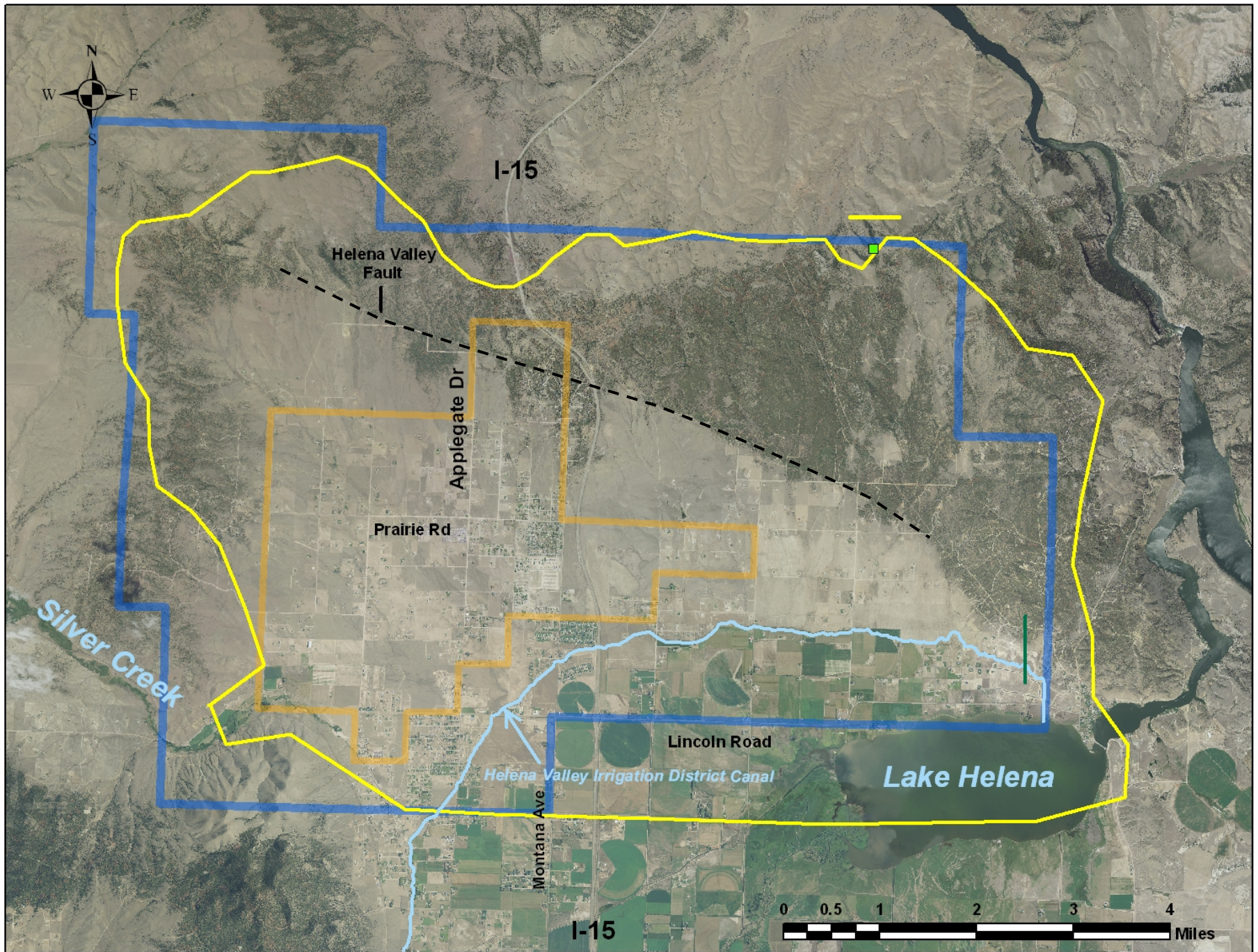
Finding Answers Via...

- Review of Existing Data
- Geophysical Surveys & Exploratory Drilling
- Aquifer Tests
- Monitoring Network
- Groundwater Flow Modeling

North Hills Area

Finding Answers Via...

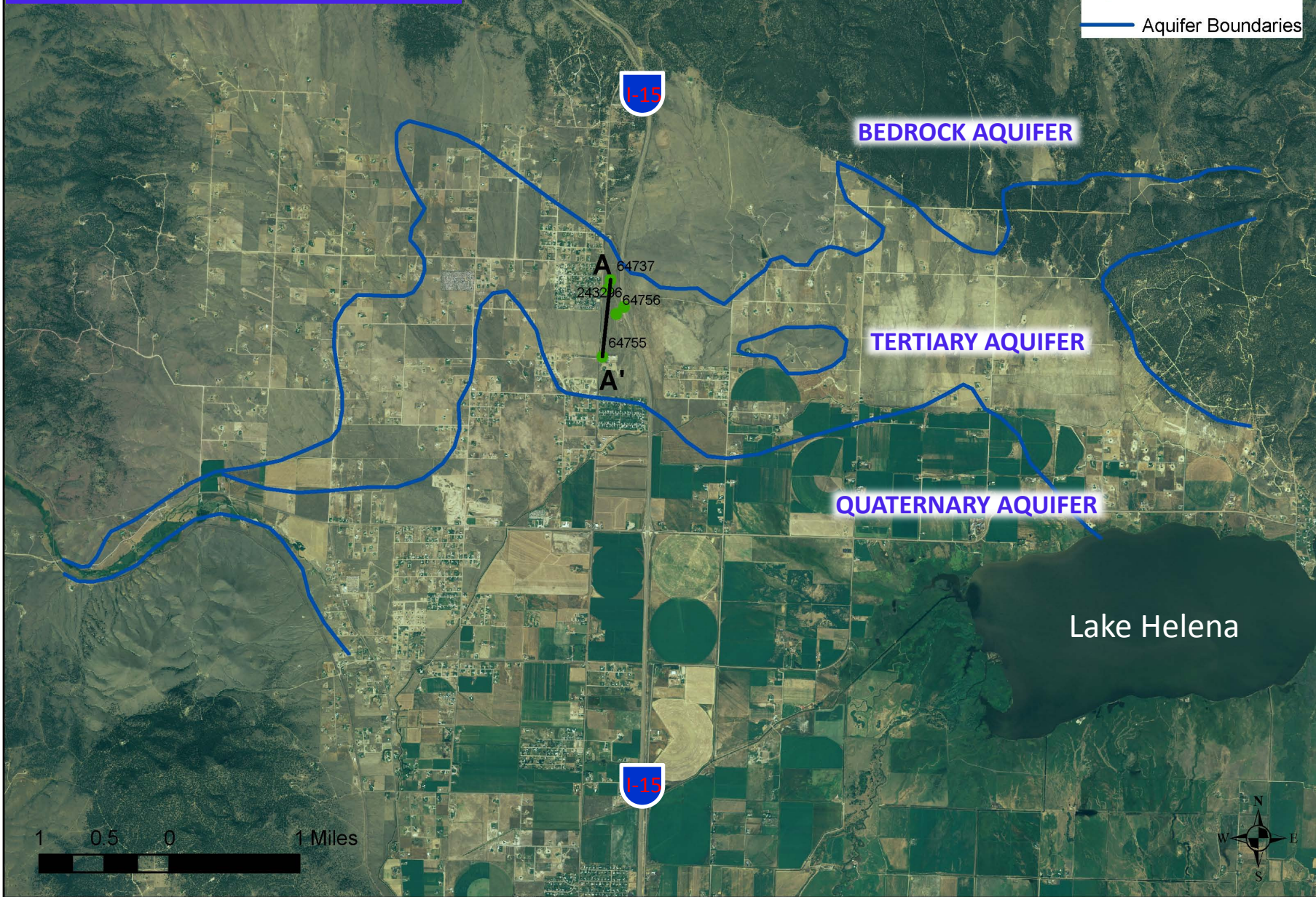
- **Review of Existing Data**
- Geophysical Surveys & Exploratory Drilling
- Aquifer Tests
- Monitoring Network
- Groundwater Flow Modeling



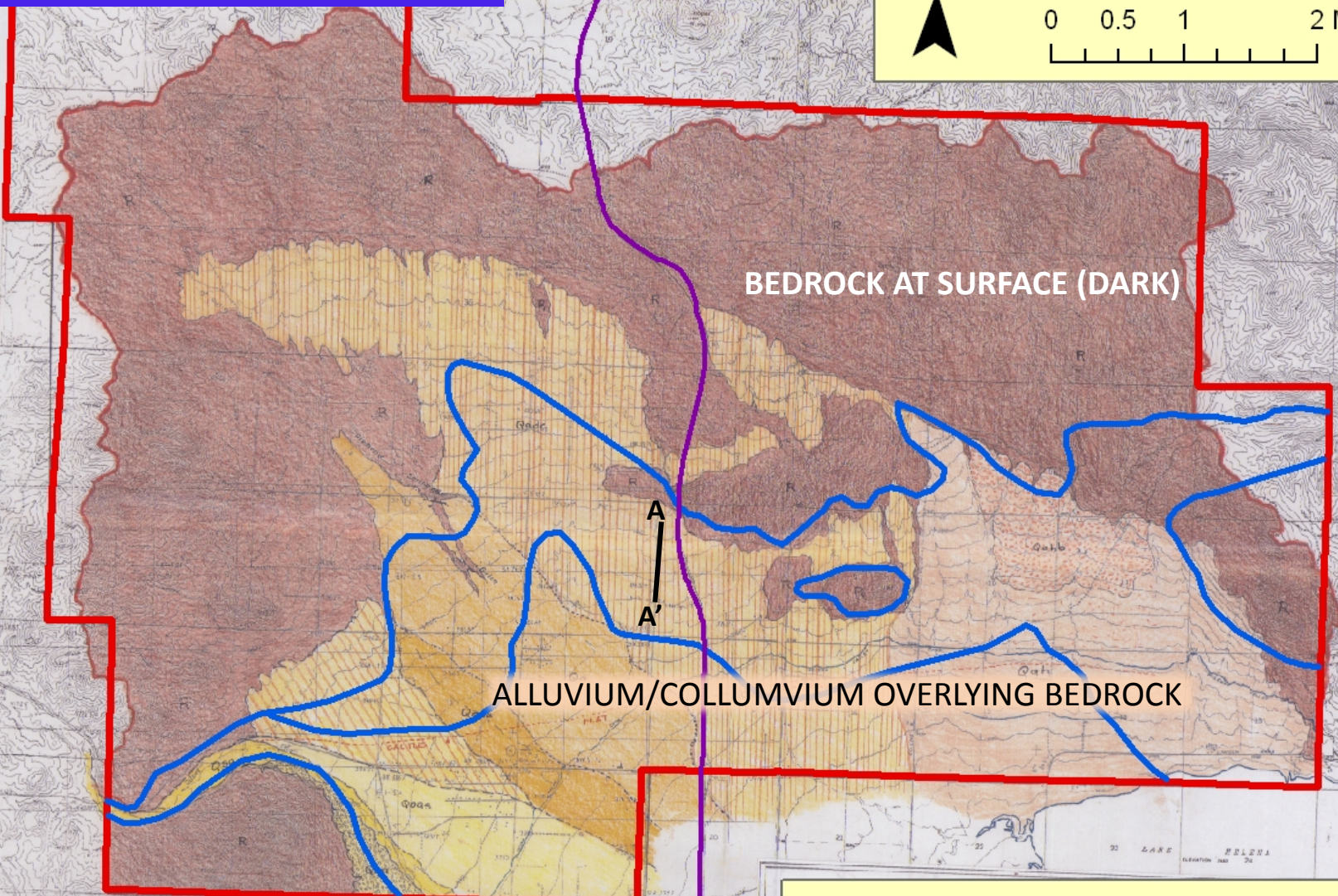
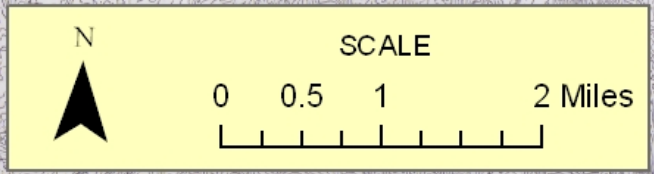
Aquifer Delineation in blue
(Madison, 2006)

Legend

- Xsec Line
- Wells
- Aquifer Boundaries



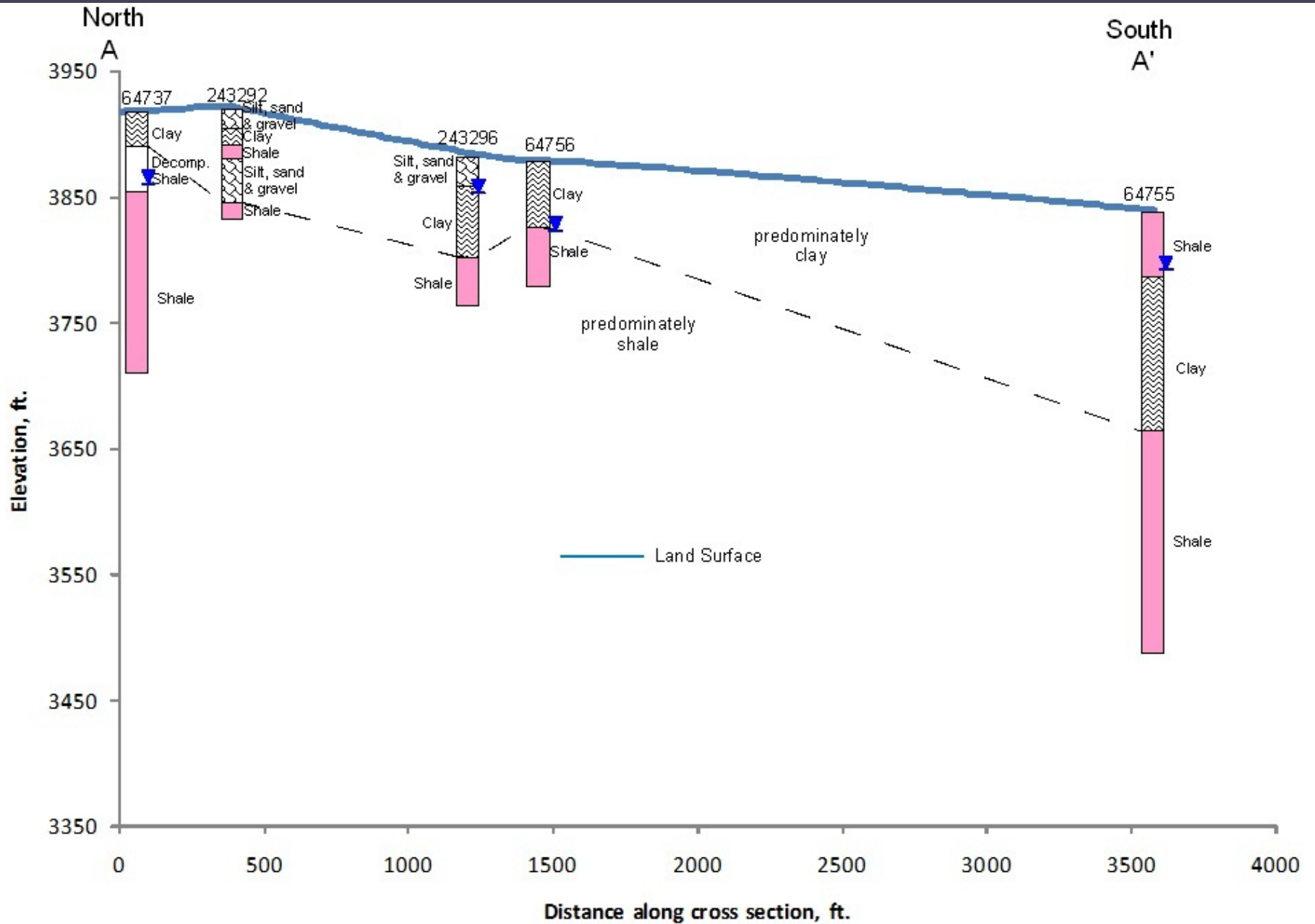
Aquifer Delineation in blue
(Madison, 2006)



Reynolds Surficial Geologic Map
2008, unpublished

0-40 feet; thickens locally to 90 feet south of Cactus Flat fault

outcrops 0-25 feet



North Hills Area

Finding Answers Via...

- Review of Existing Data
- **Geophysical Surveys & Exploratory Drilling**
- Aquifer Tests
- Monitoring Network
- Groundwater Flow Modeling

Objectives of Geophysical Testing

To create a geologic model to aid in determining the nature of the North Hills aquifer system

- Determine depth to bedrock and/or water table
- Interpret results in conjunction with existing drilling logs & geologic maps

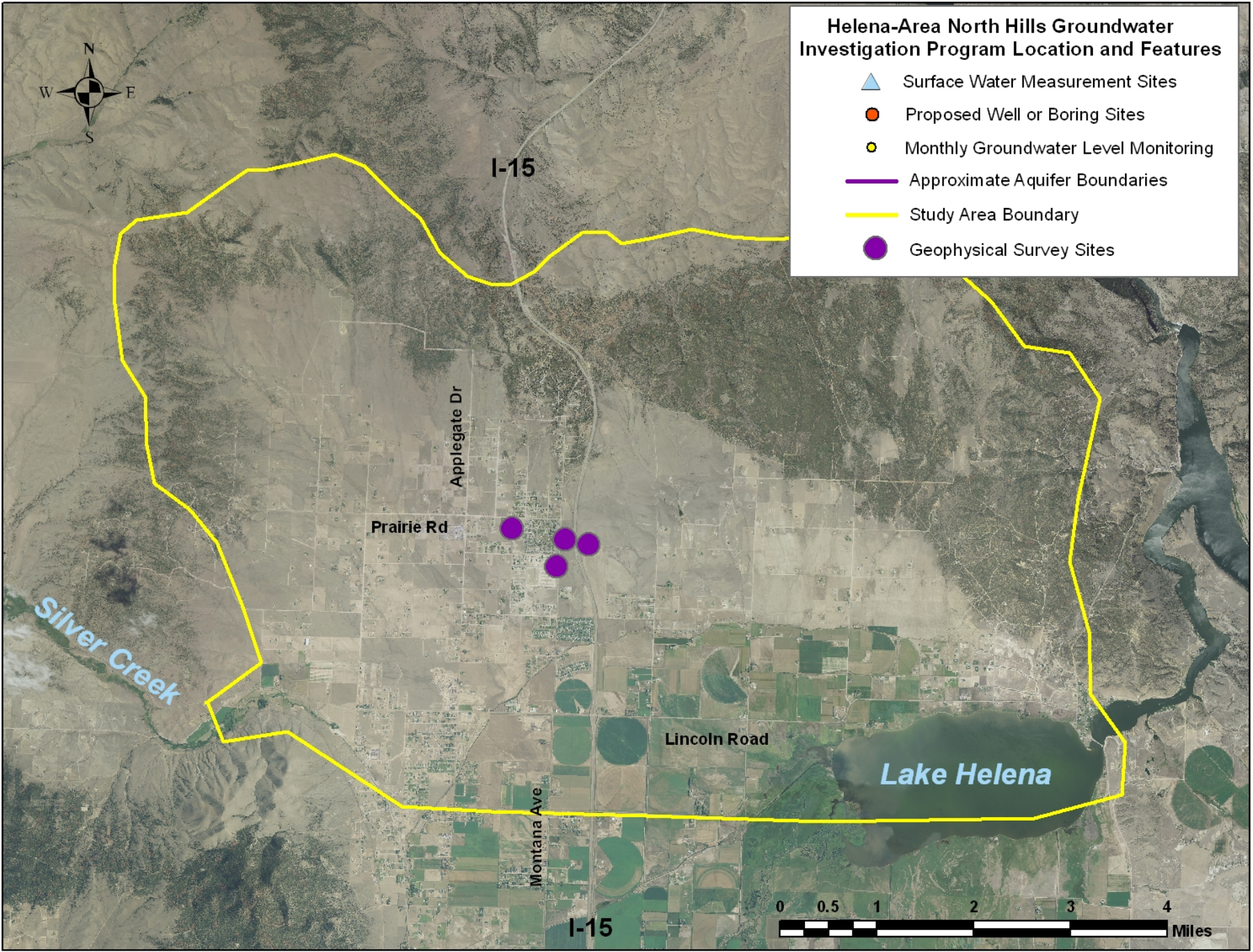
North Hills Area

Geophysical Surveying by MTech Students

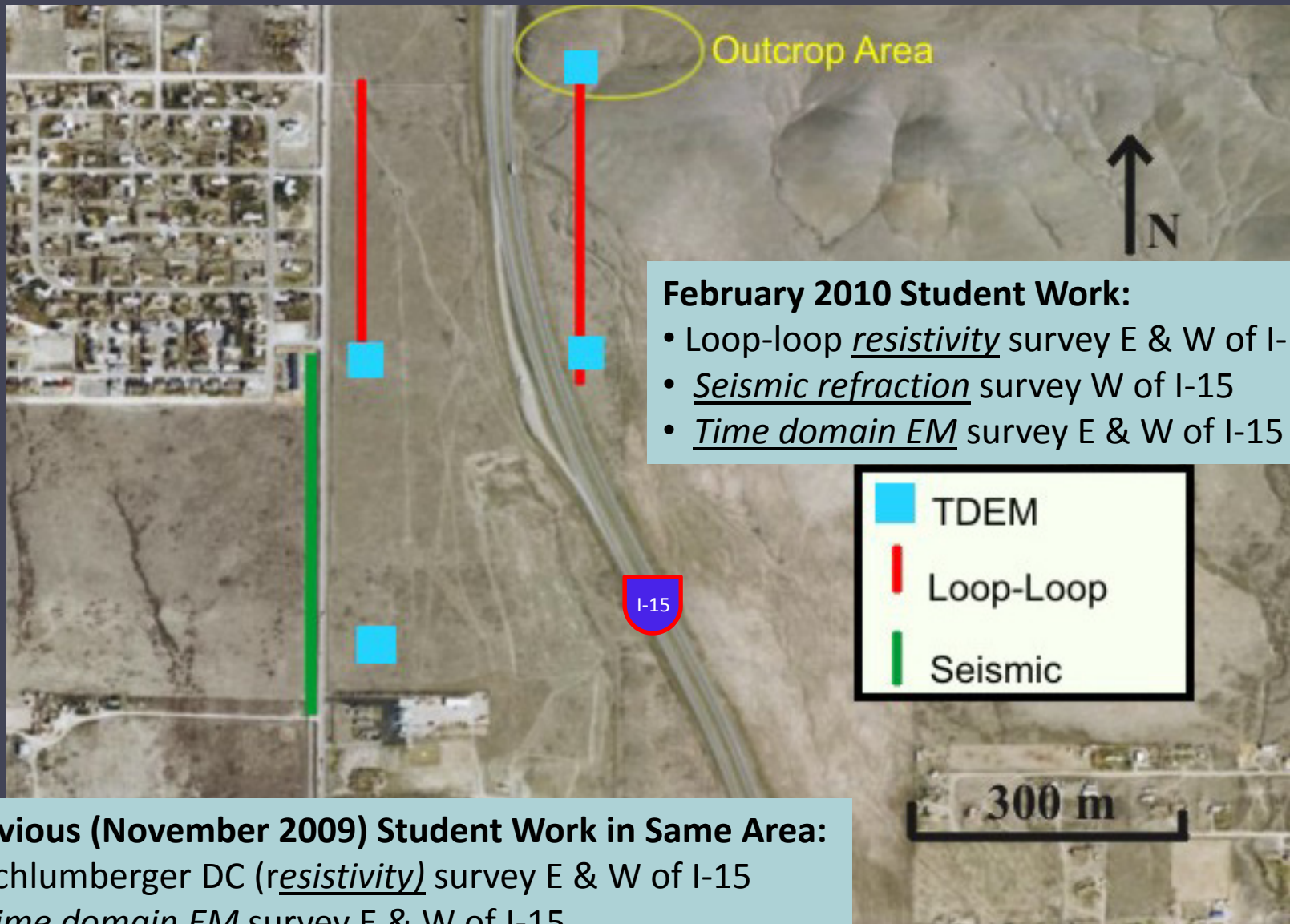
- Resistivity sounding conducted on shallow bedrock/possible fault zone – **October 2009**
- Resistivity, TDEM, and seismic surveys north of previous area - **February 2010**
- MTech field camp used gravity and resistivity methods – **May-June 2010**
- Combination of gravity and magnetic methods proposed – **Summer 2010**

Helena-Area North Hills Groundwater Investigation Program Location and Features

- ▲ Surface Water Measurement Sites
- Proposed Well or Boring Sites
- Monthly Groundwater Level Monitoring
- Approximate Aquifer Boundaries
- Study Area Boundary
- Geophysical Survey Sites



Geophysical Site: February 2010 Project



February 2010 Student Work:

- Loop-loop resistivity survey E & W of I-15
- Seismic refraction survey W of I-15
- Time domain EM survey E & W of I-15

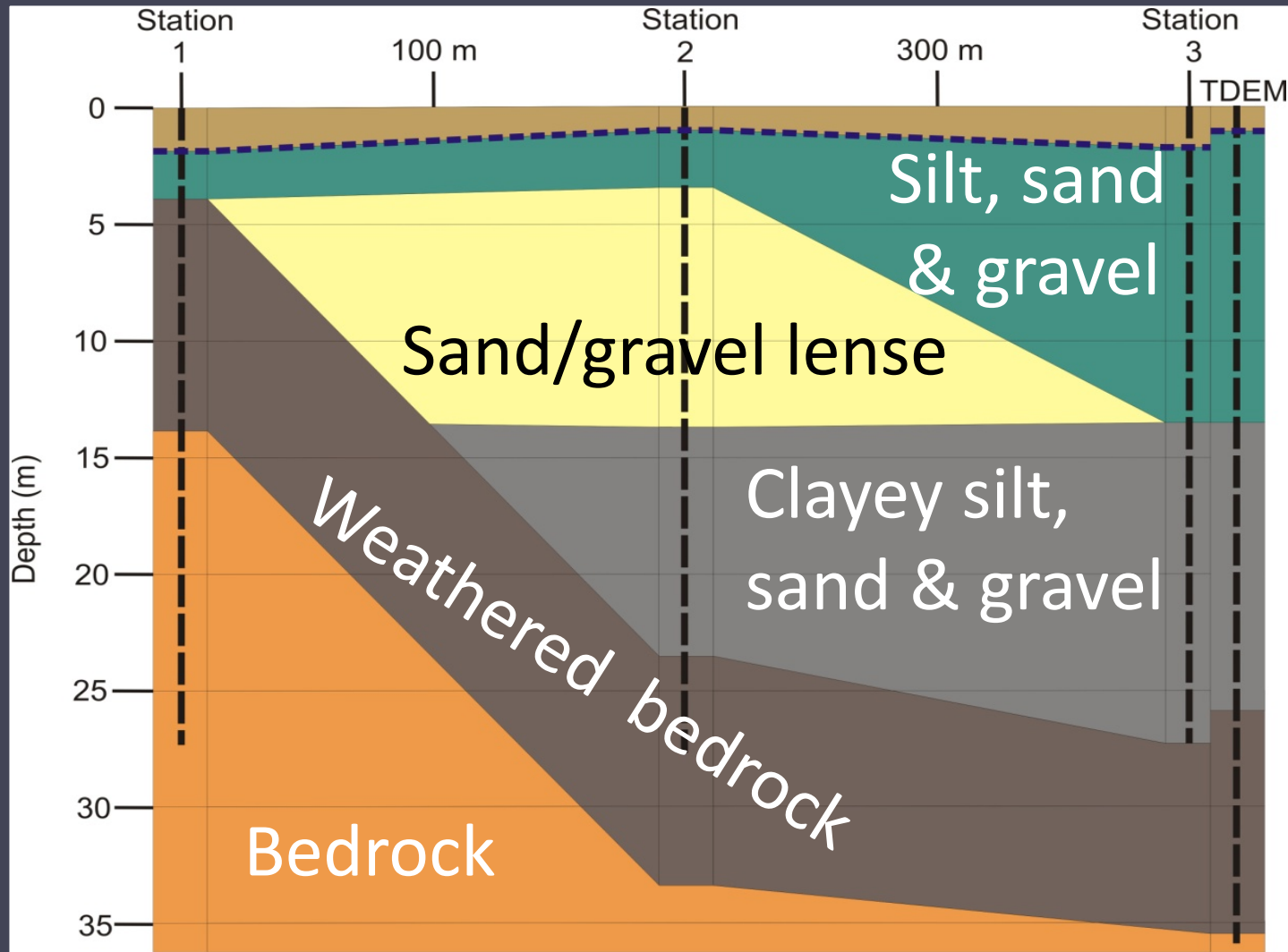
Previous (November 2009) Student Work in Same Area:

- Schlumberger DC (resistivity) survey E & W of I-15
- Time domain EM survey E & W of I-15

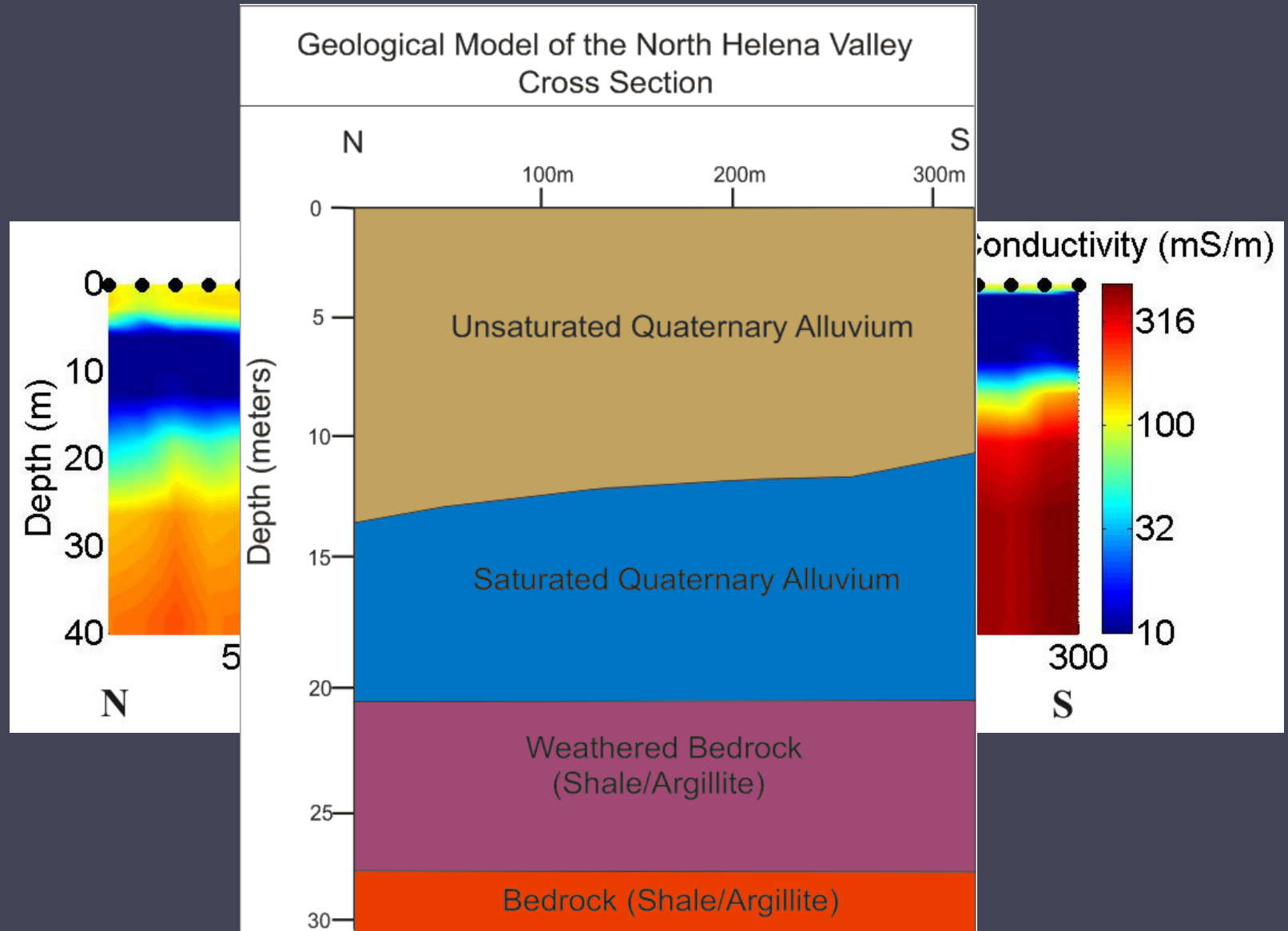
Interpretation of 2009 Geophysical Results

N

S



Interpretation of February 2010 Geophysical Results



DRILLING SITES Completed & Planned

Helena-Area North Hills Groundwater Investigation Program Location and Features

- ▲ Surface Water Measurement Sites
- Proposed Well or Boring Sites
- Monthly Groundwater Level Monitoring
- Approximate Aquifer Boundaries
- Study Area Boundary
- Completed Well Installations

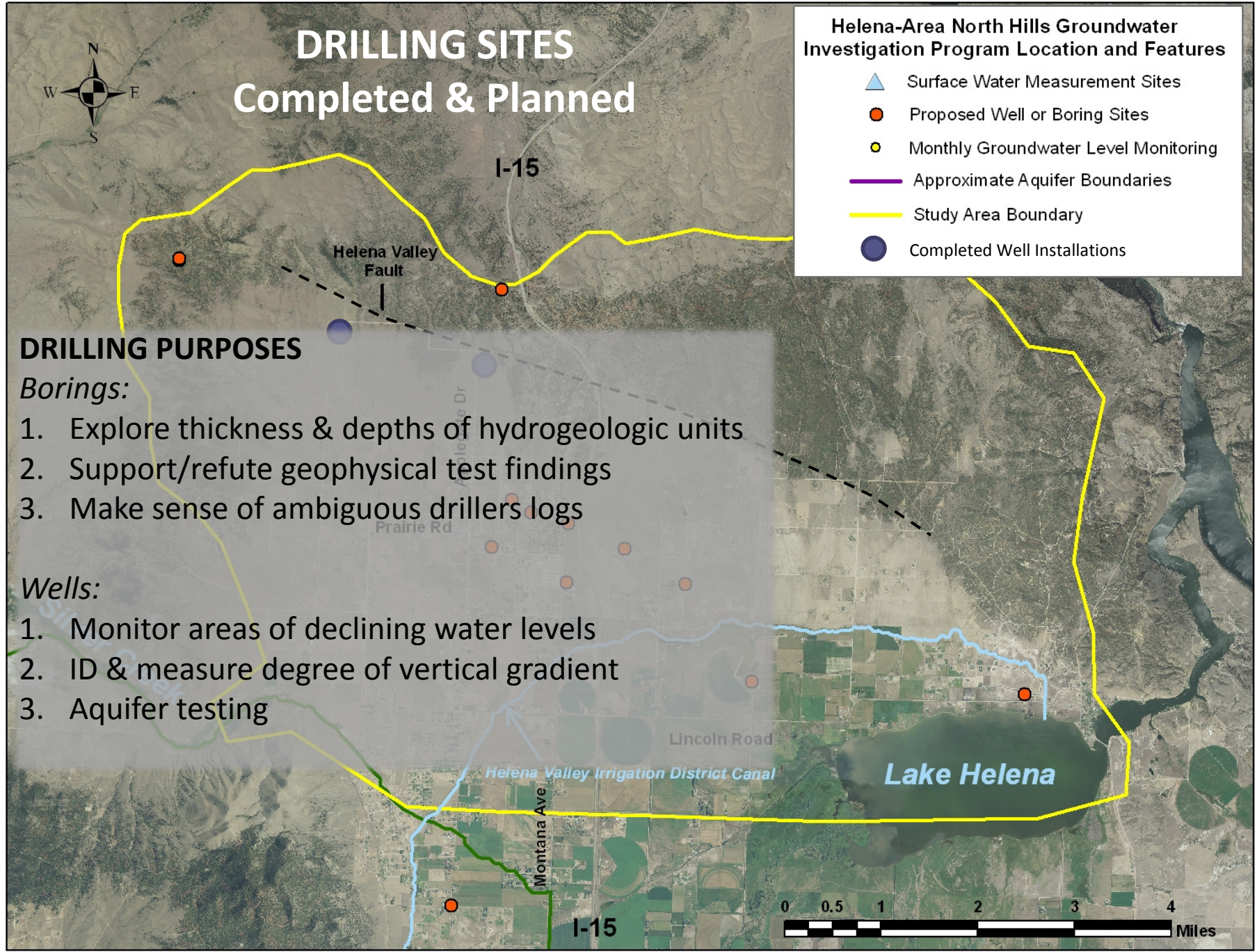
DRILLING PURPOSES

Borings:

1. Explore thickness & depths of hydrogeologic units
2. Support/refute geophysical test findings
3. Make sense of ambiguous drillers logs

Wells:

1. Monitor areas of declining water levels
2. ID & measure degree of vertical gradient
3. Aquifer testing



North Hills Area

Finding Answers Via...

- Review of Existing Data
- Geophysical Surveys & Exploratory Drilling
- **Aquifer Tests**
- Monitoring Network
- Groundwater Flow Modeling

Aquifer Test Objectives

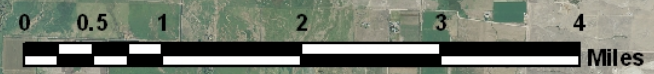
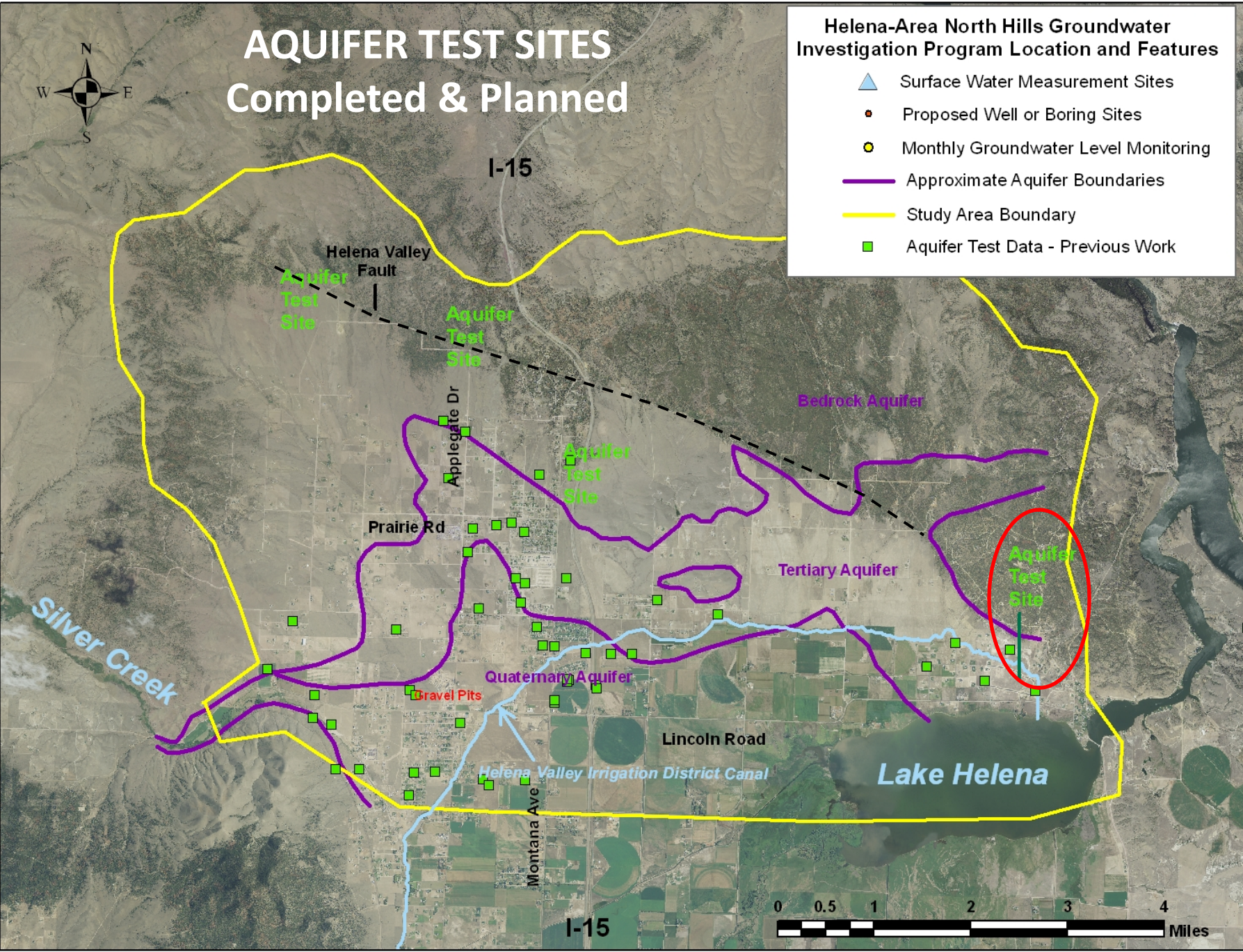
ESTIMATE AQUIFER PROPERTIES

- **Transmissivity** – How easily is water transmitted?
- **Storativity** – How much water can the aquifer store?
- **Anisotropy** – Does its ability to transmit or store water change with direction?

AQUIFER TEST SITES Completed & Planned

Helena-Area North Hills Groundwater Investigation Program Location and Features

- ▲ Surface Water Measurement Sites
- Proposed Well or Boring Sites
- Monthly Groundwater Level Monitoring
- Approximate Aquifer Boundaries
- Study Area Boundary
- Aquifer Test Data - Previous Work





Note: Air Photo is from 2005

◆ Panaramic_Meddows_Wells

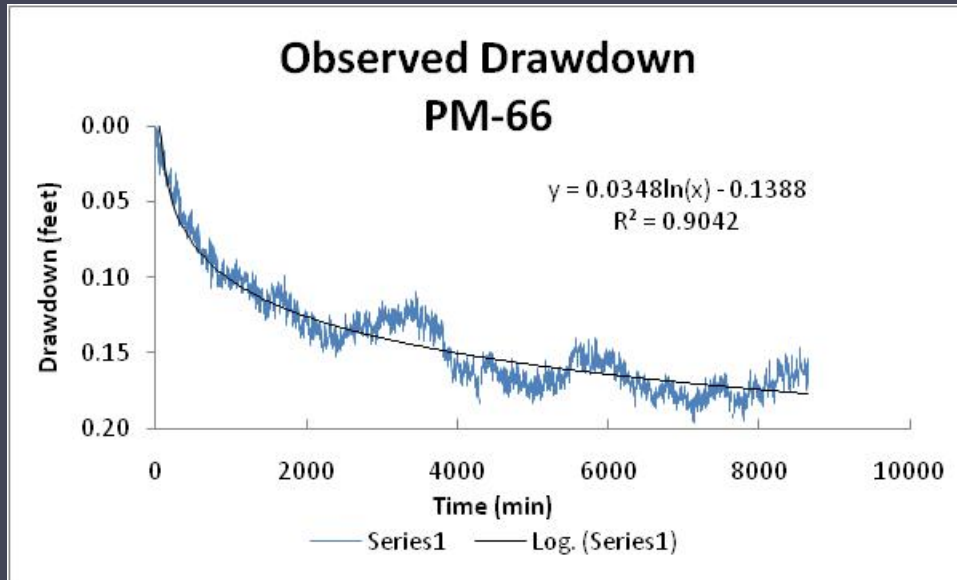
Panaramic Meadows Pump Test



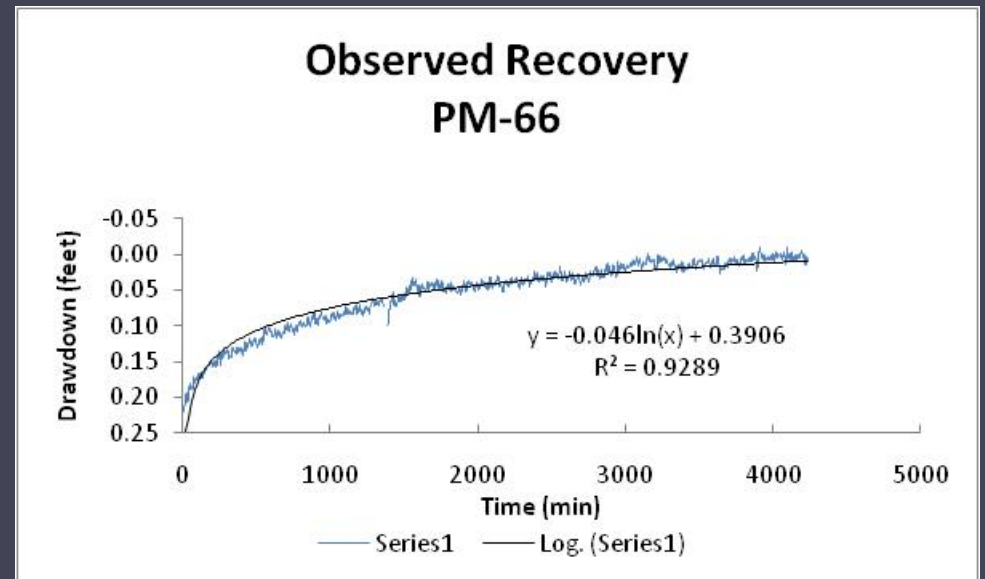
0 70 140 280 Feet

ALB; 12/31/09

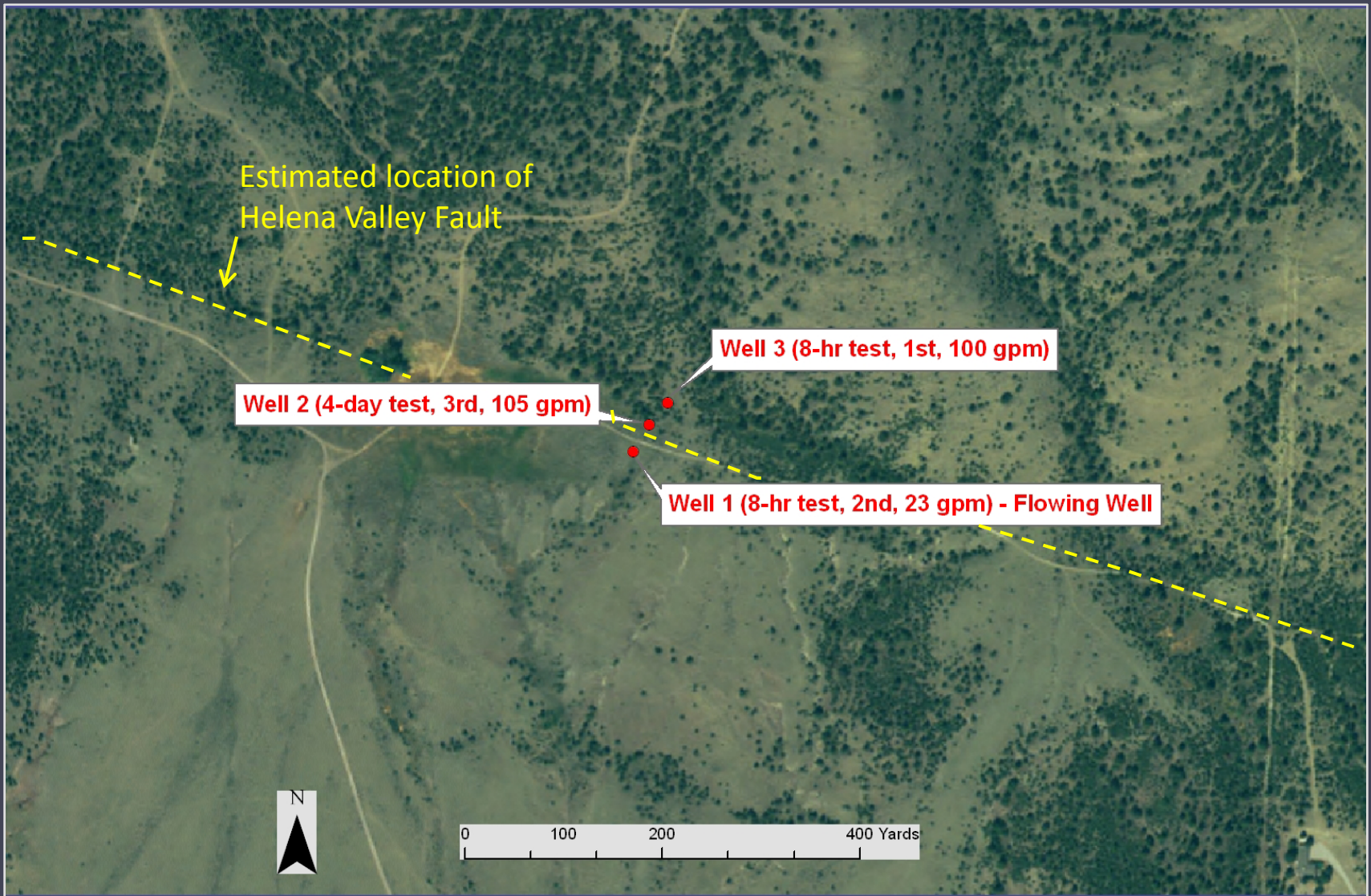
Drawdown in PM-66



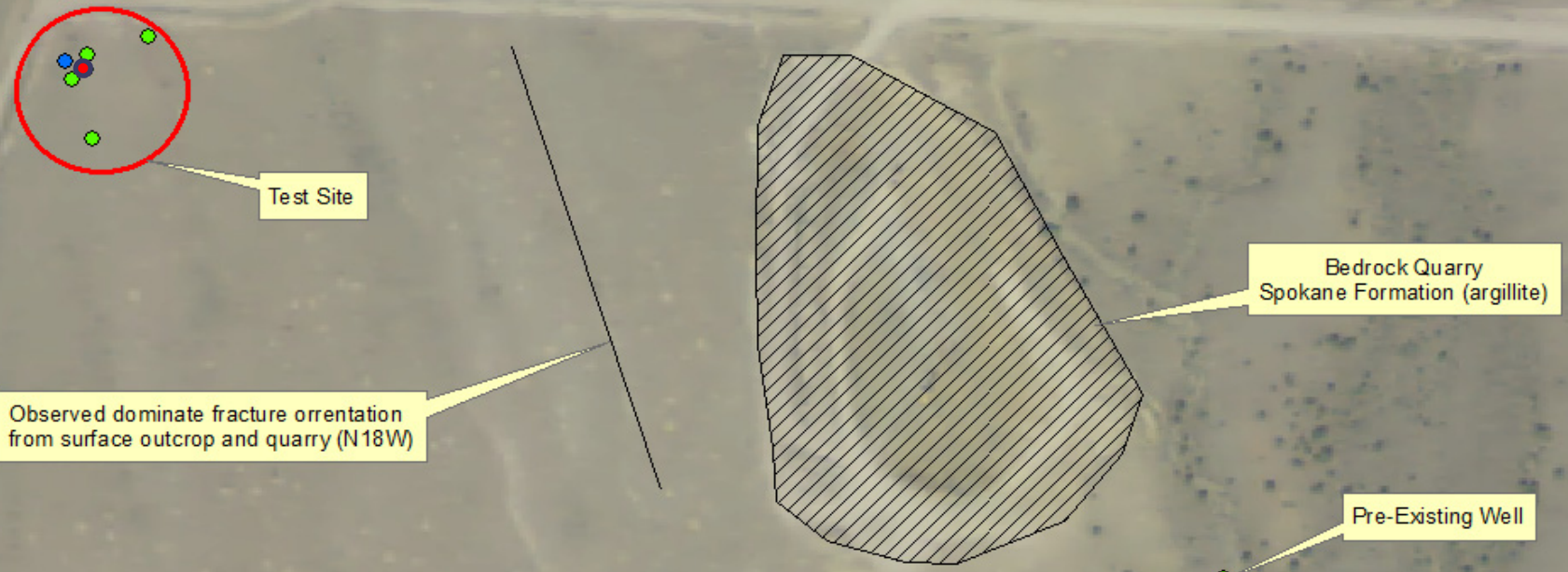
Recovery in PM-66



HELENA VALLEY FAULT AQUIFER TEST



Valley Excavating Aquifer Test



- GOAL:** Estimate aquifer properties of the Spokane Formation (bedrock)
- Fractured Precambrian Argillite
 - Primary aquifer, underlies most of the study area

North Hills Area

Finding Answers Via...

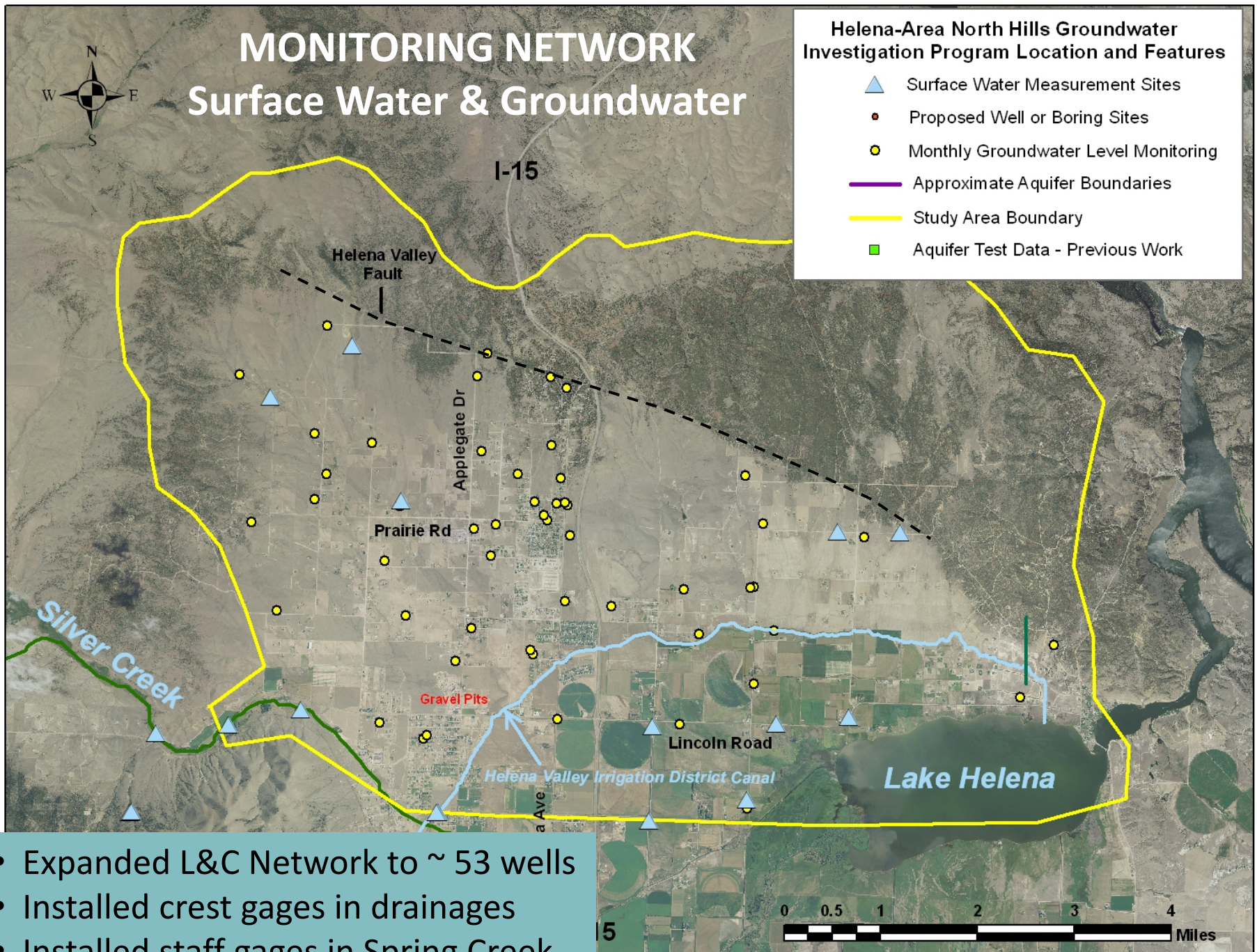
- Review of Existing Data
- Geophysical Surveys & Exploratory Drilling
- Aquifer Tests
- **Monitoring Network**
- Groundwater Flow Modeling

MONITORING NETWORK

Surface Water & Groundwater

Helena-Area North Hills Groundwater Investigation Program Location and Features

- ▲ Surface Water Measurement Sites
- Proposed Well or Boring Sites
- Monthly Groundwater Level Monitoring
- Approximate Aquifer Boundaries
- Study Area Boundary
- Aquifer Test Data - Previous Work



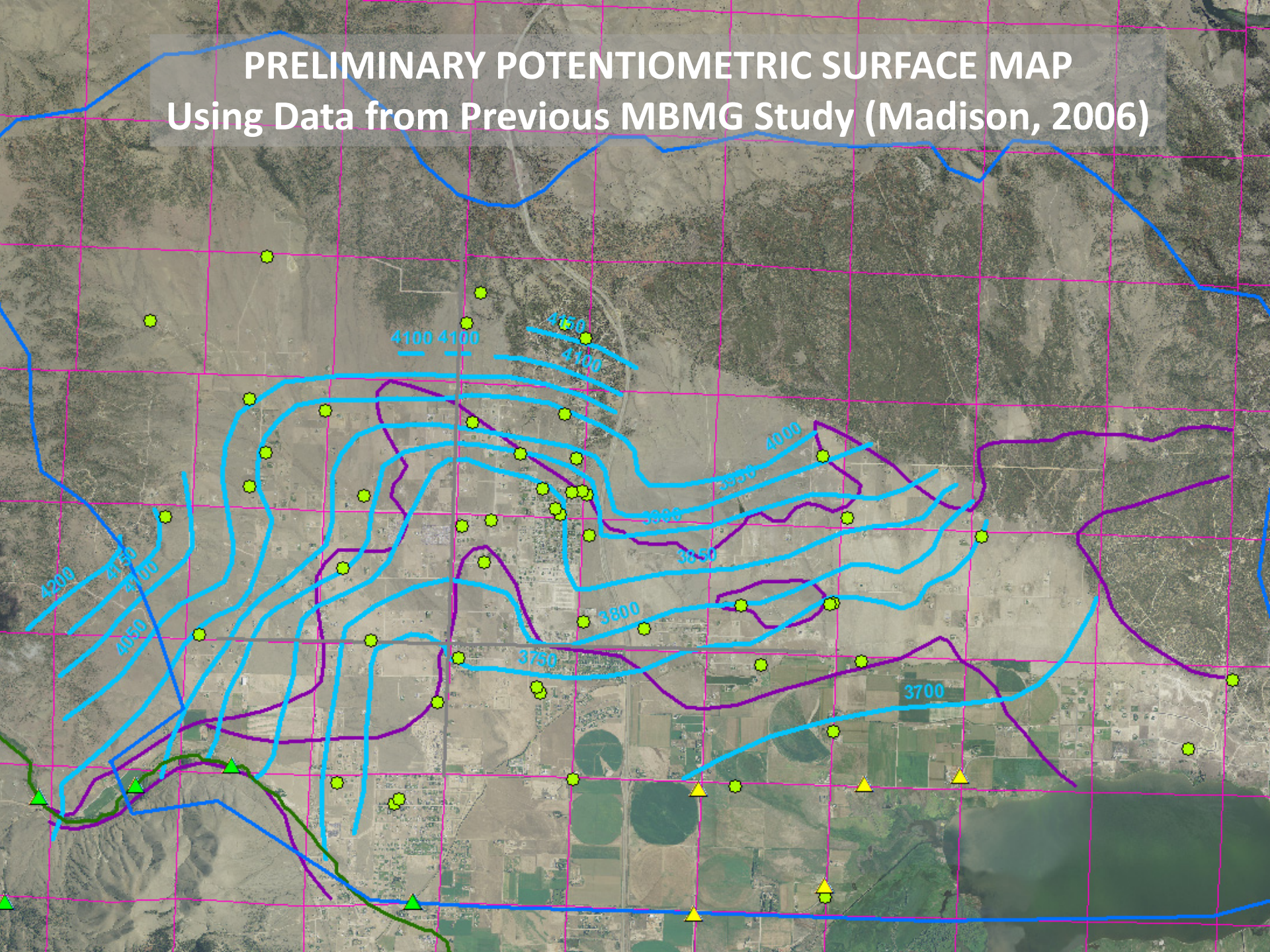
- Expanded L&C Network to ~ 53 wells
- Installed crest gages in drainages
- Installed staff gages in Spring Creek

Objectives of Monitoring Network

- Monitor changes over time & space
 - water levels
 - water quality
 - surface-water flow
- Determine factors driving such changes
 - climatic
 - human-induced
 - combination
- Generate analytical tools
 - potentiometric surface maps
 - stiff diagrams
 - hydrographs
 - rating curves

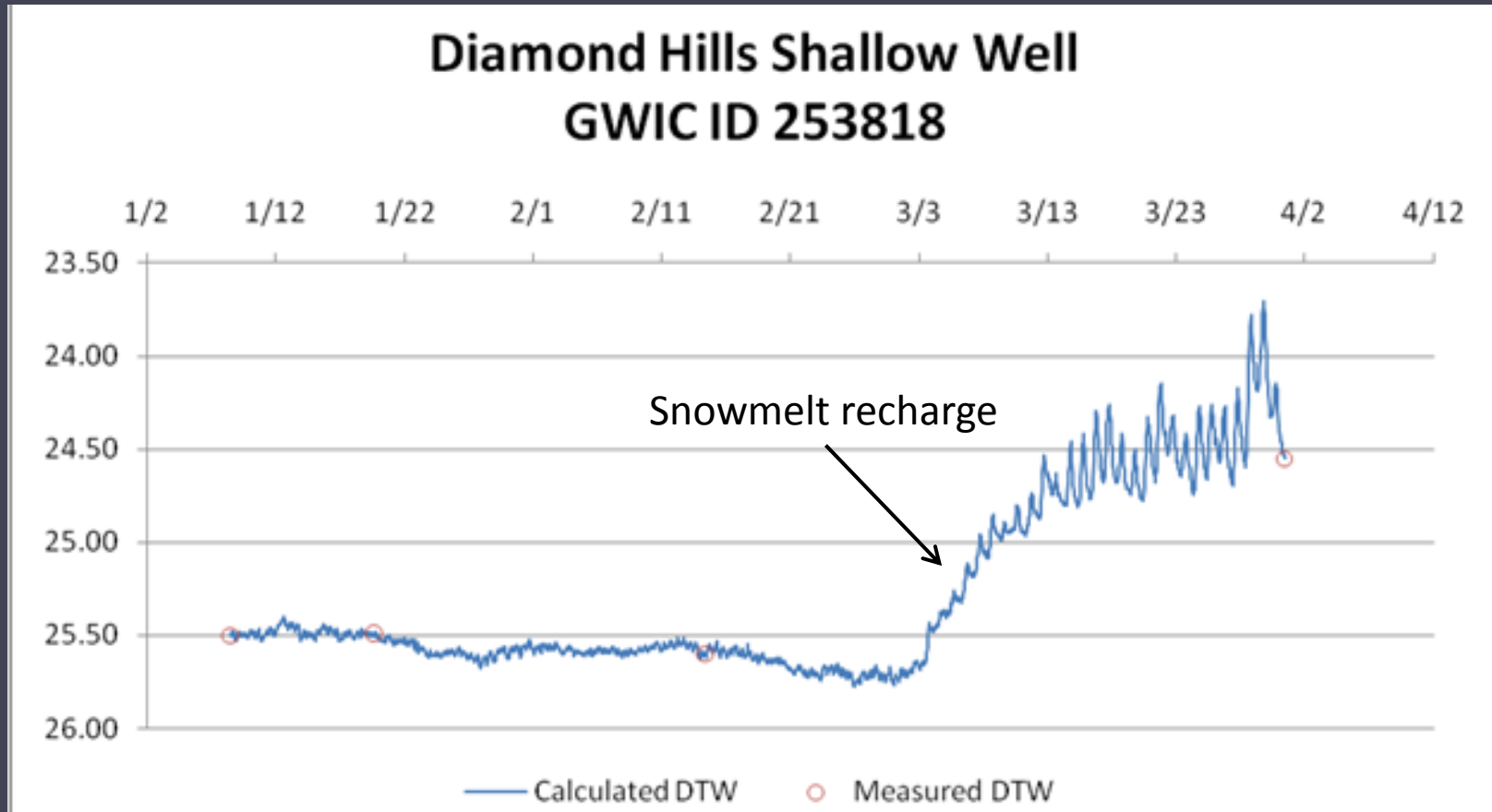
PRELIMINARY POTENTIOMETRIC SURFACE MAP

Using Data from Previous MBMG Study (Madison, 2006)



Monitoring Network Data Examples

Groundwater:



Surface Water:

No spring runoff observed, nor measured at crest gages

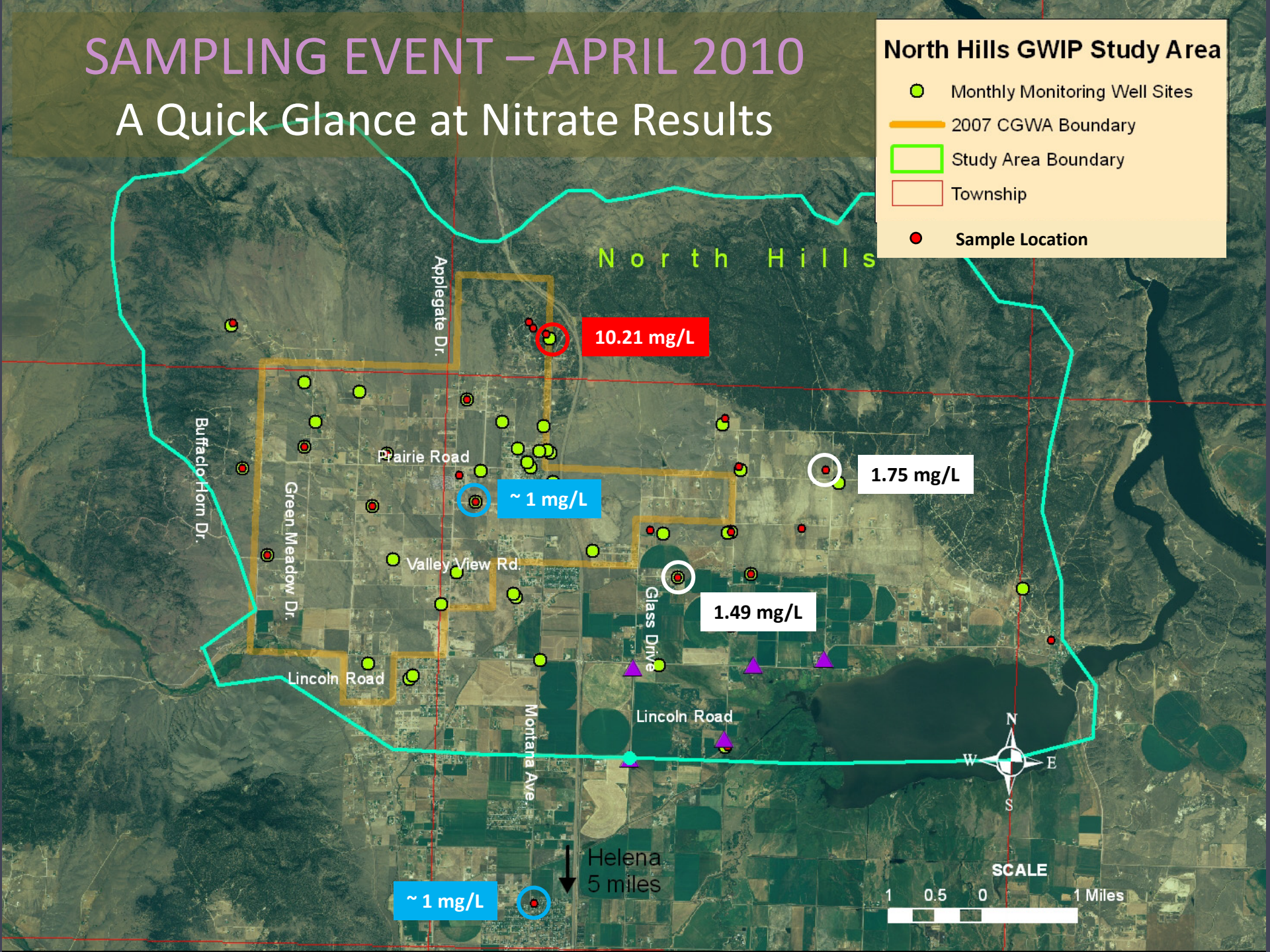
↳ Snowmelt evaporated and infiltrated

SAMPLING EVENT – APRIL 2010

A Quick Glance at Nitrate Results

North Hills GWIP Study Area

- Monthly Monitoring Well Sites
- 2007 CGWA Boundary
- ▭ Study Area Boundary
- ▭ Township
- Sample Location



North Hills Area

Finding Answers Via...

- Review of Existing Data
- Geophysical Surveys & Exploratory Drilling
- Aquifer Tests
- Monitoring Network
- **Groundwater Flow Modeling**

Groundwater Modeling

Objectives & Work to Date

Objectives:

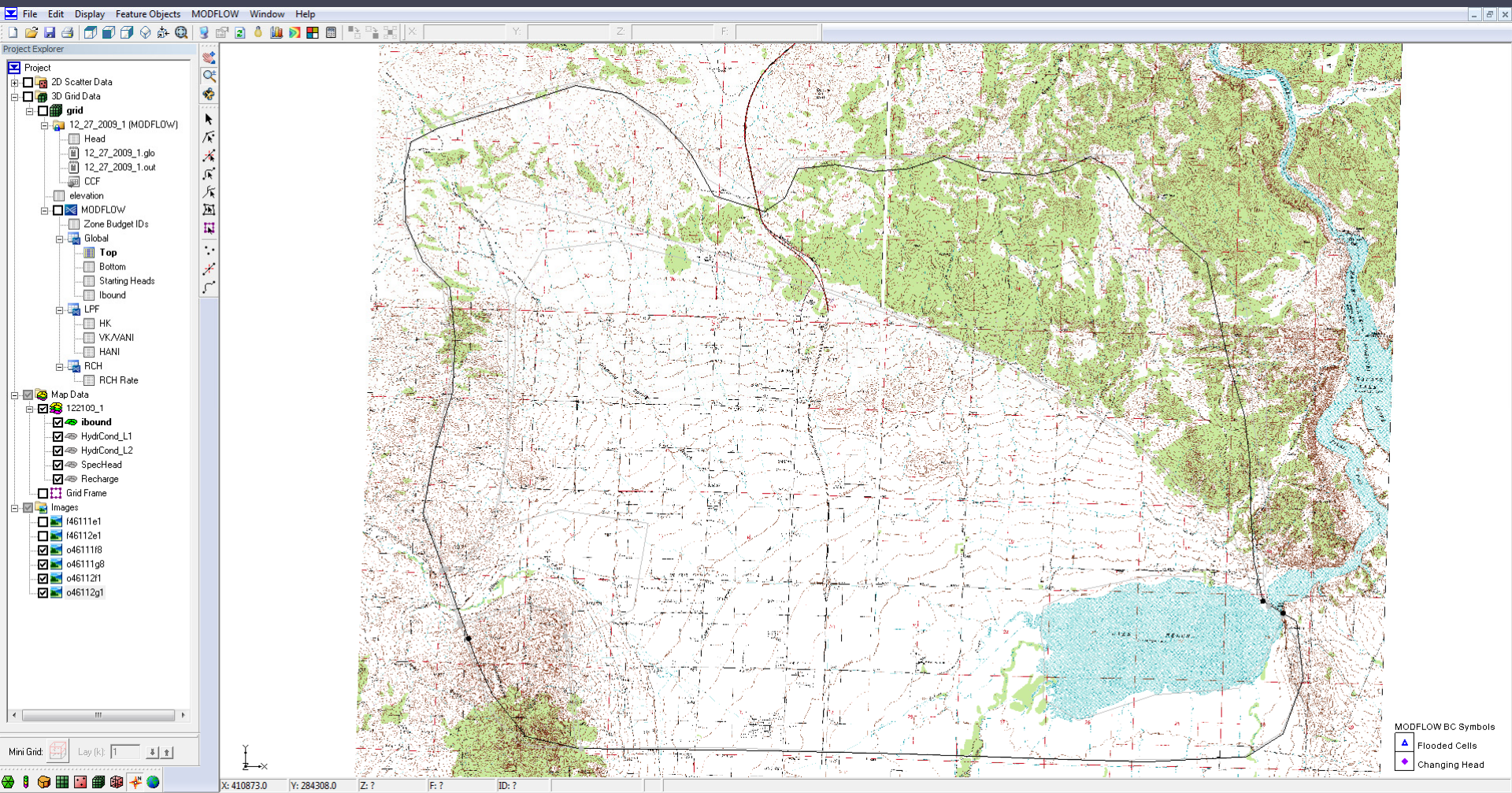
- Simulate past system conditions – Calibrate model to field data
- Predict future system conditions – Perform prediction-focused calibration and sensitivity analysis

Work to Date:

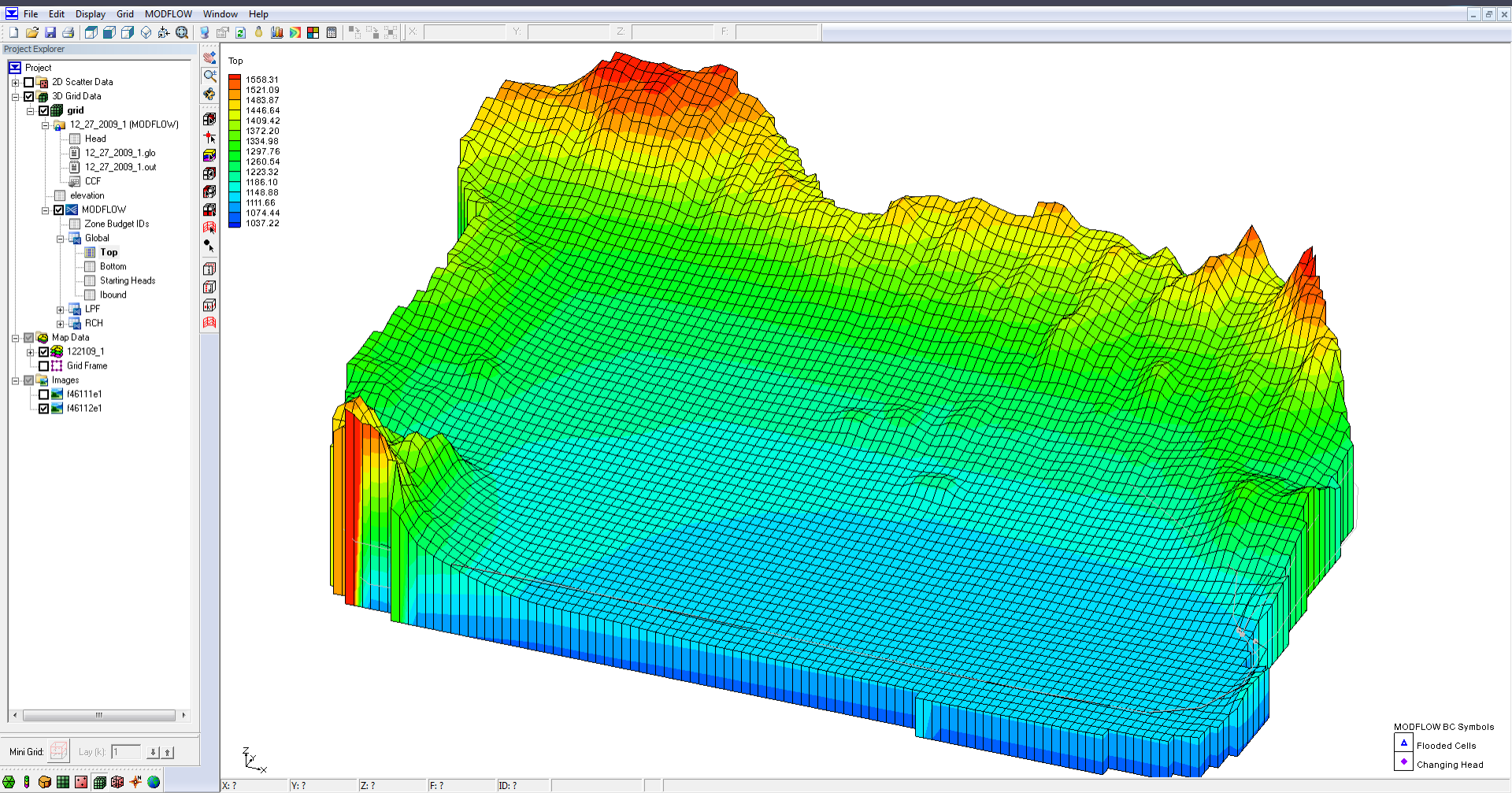
- Groundwater model framework underway
- Evaluating existing data to develop *conceptual* model
 - Aquifer tests, geophysical tests, drilling logs, water-level monitoring, etc
 - hydrogeologic units >> model layers
 - aquifer property estimates >> parameter values

Stage 1: Building the Model Framework

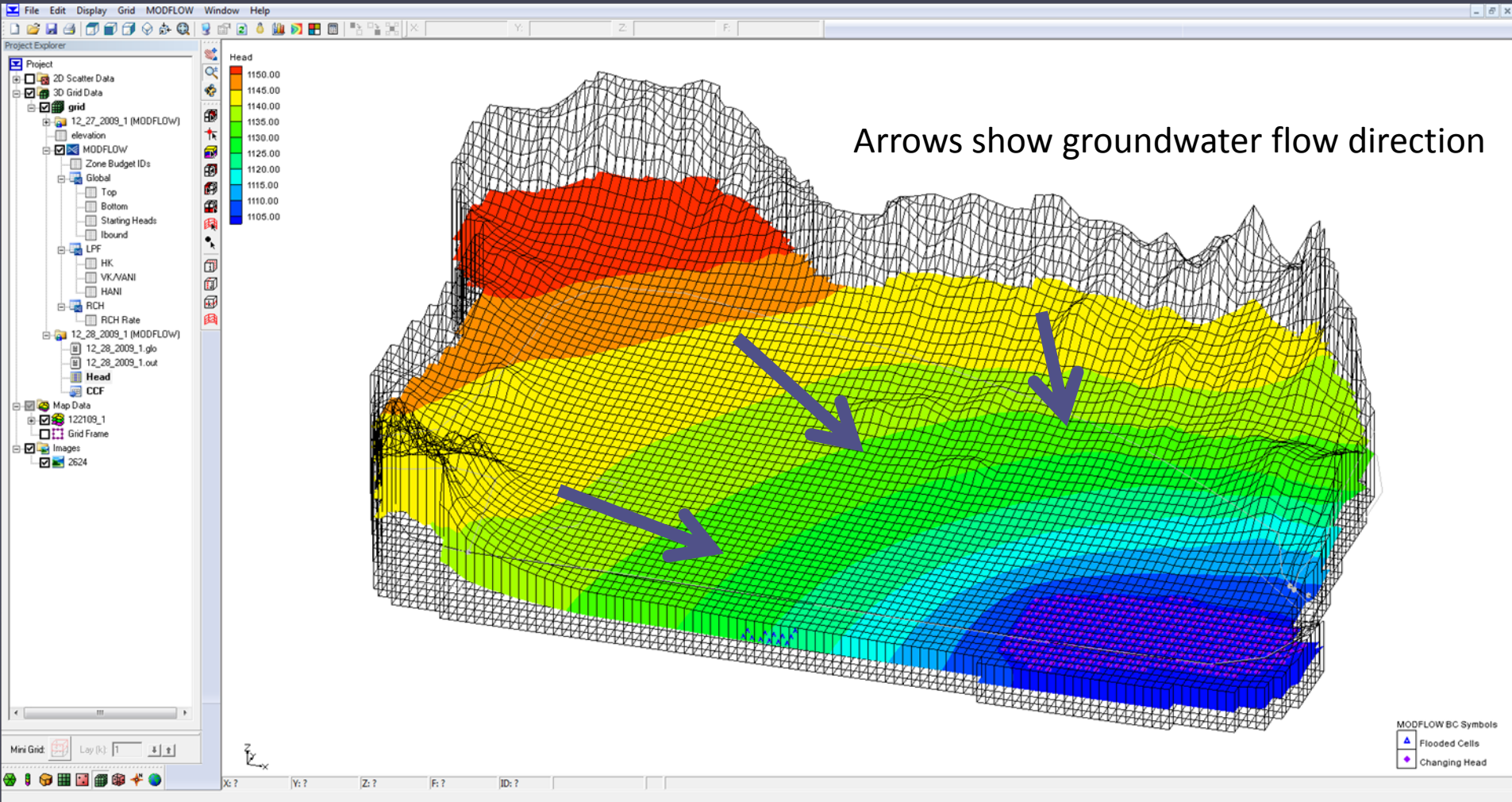
- Define area with maps



• Assign elevations using Digital Elevation Models (DEM's)



- Preliminary groundwater surface generated from areal recharge and known water elevations



North Hills Area

Other Upcoming Work

- Groundwater Sampling – Aug & Oct 2010
- Borehole & Well Drilling – Summer 2010
- ET Results (METRIC) – November 2010
- Field Data Analysis – Summer & Fall 2010

Examples and Photos

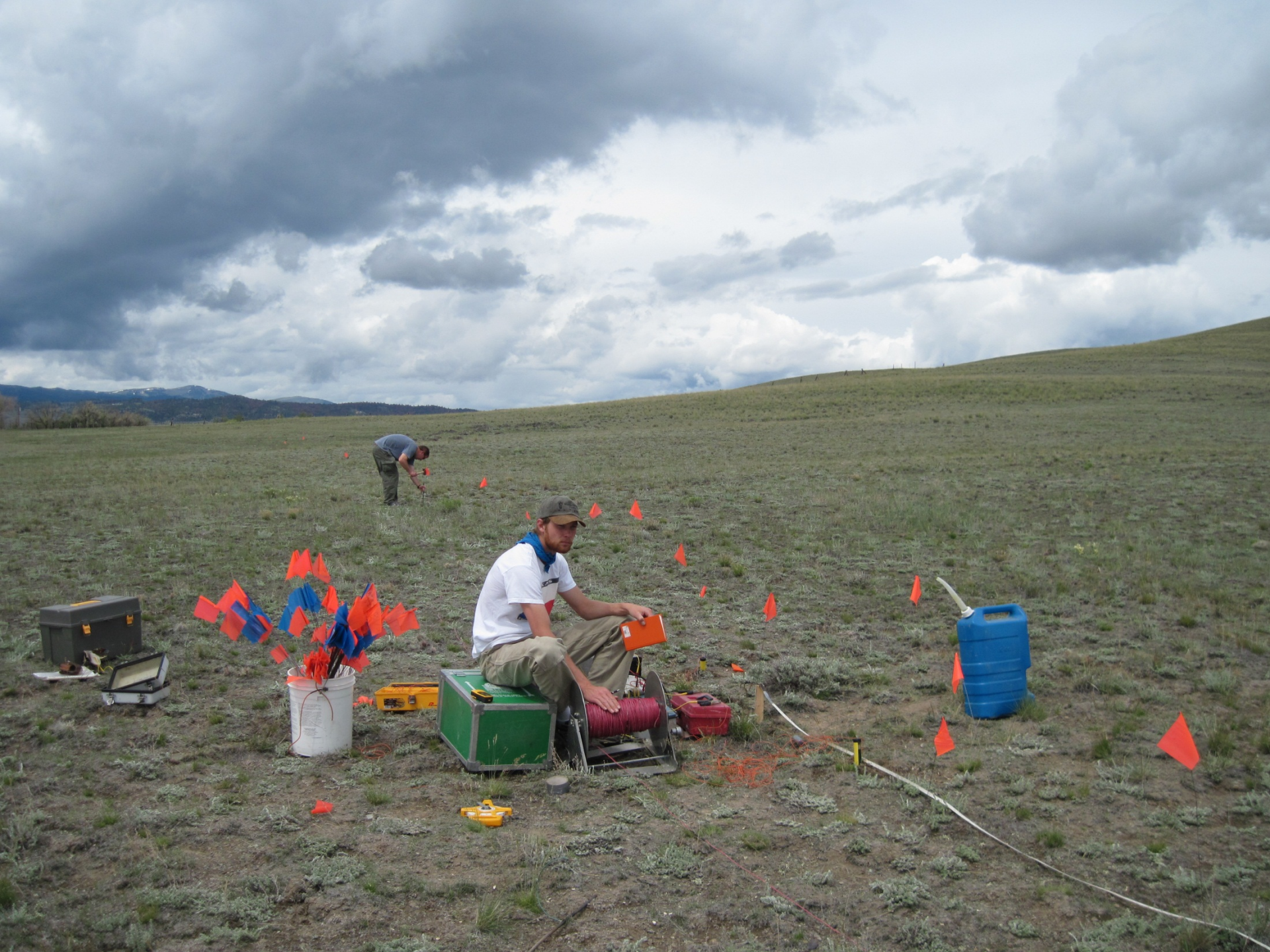
The following slides provide some examples
photographs of work conducted in the North
Hills groundwater investigation





Stilling well









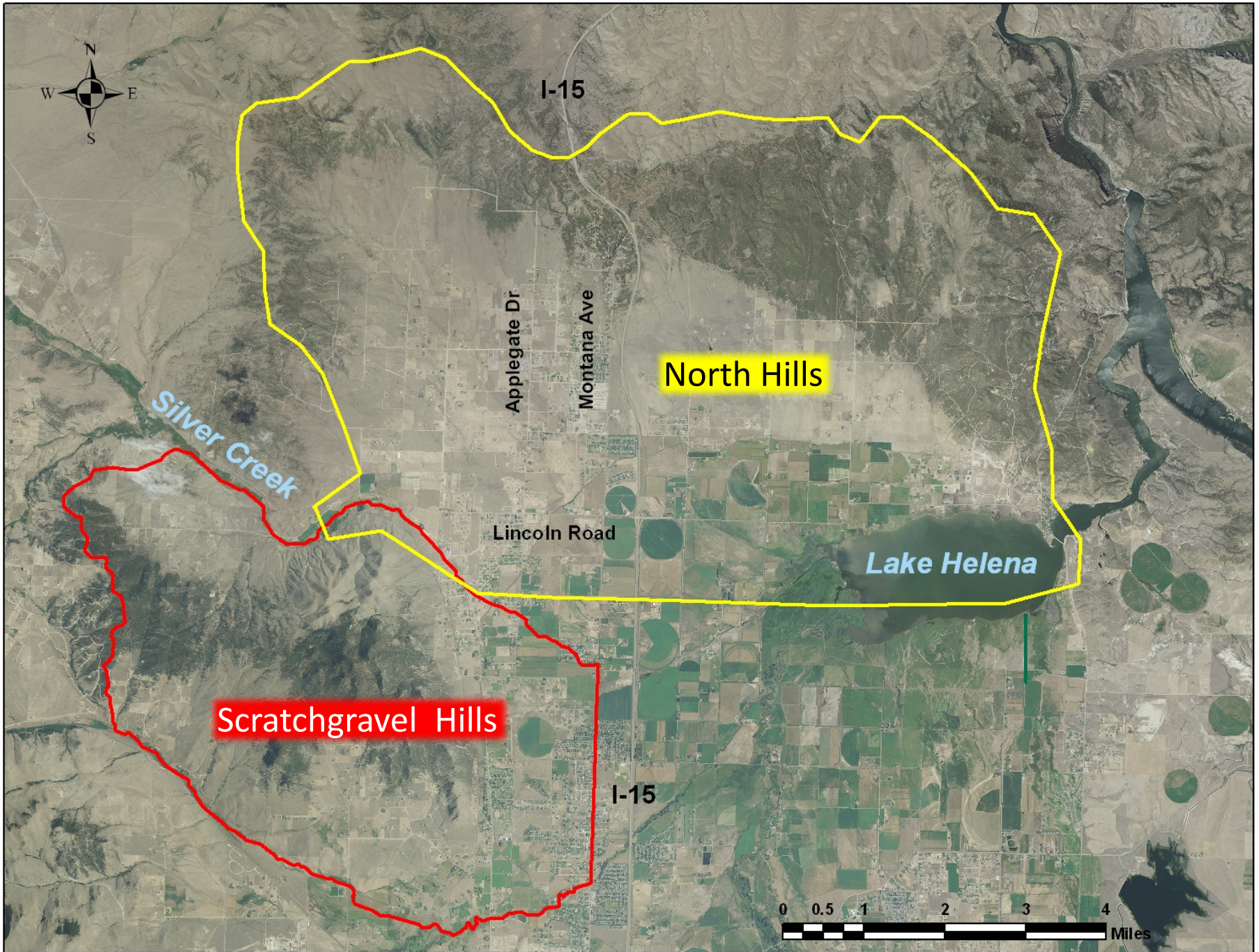




Scratchgravel Hills Area

Key Questions

- *Green Meadow Controlled Groundwater Area: Will withdrawals exceed recharge?*
 - *What level of development can be sustained*
- *Upper Missouri Closed Basin: Will groundwater pumping affect surface-water flows?*
- *Are wells in the Scratchgravel Hills vulnerable to nitrate contamination?*



North Hills

Silver Creek

Lake Helena

Scratchgravel Hills

I-15

Applegate Dr

Montana Ave

Lincoln Road

I-15

0 0.5 1 2 3 4 Miles

Scratchgravel Hills Area

Finding Answers Via...

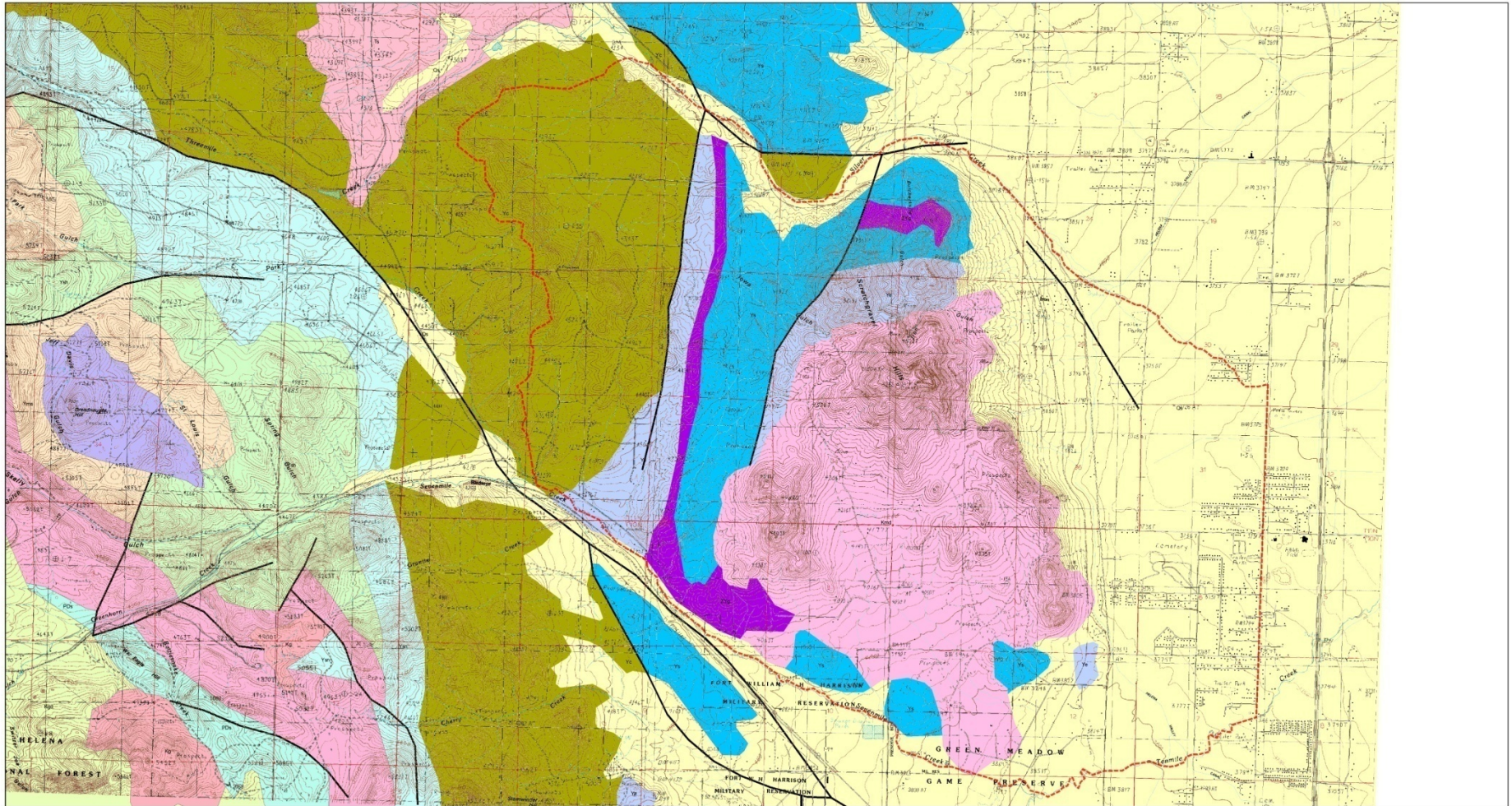
- Review of Existing Data
- Monitoring Network
- Water Quality Sampling
- Aquifer Tests
- Groundwater Flow Modeling

Scratchgravel Hills Area Update

June 2010

- Drilling and aquifer test contracts finalized
- Monitoring well network up and running (60 total sites)
- Contracted services with Lewis and Clark Co. Water Protection District – 38 Wells Monitored
- Stream monitoring sites with seasonal stage recorders and peizometers
 - Three along Silver Creek
 - Two along Sevenmile Creek
 - One on Sunny Vista Ditch
 - One on Threemile Creek
 - May install one on Tenmile Creek
- Investigation of faults planned

GWIP Project Area: Scratchgravel Hills, Lewis and Clark County

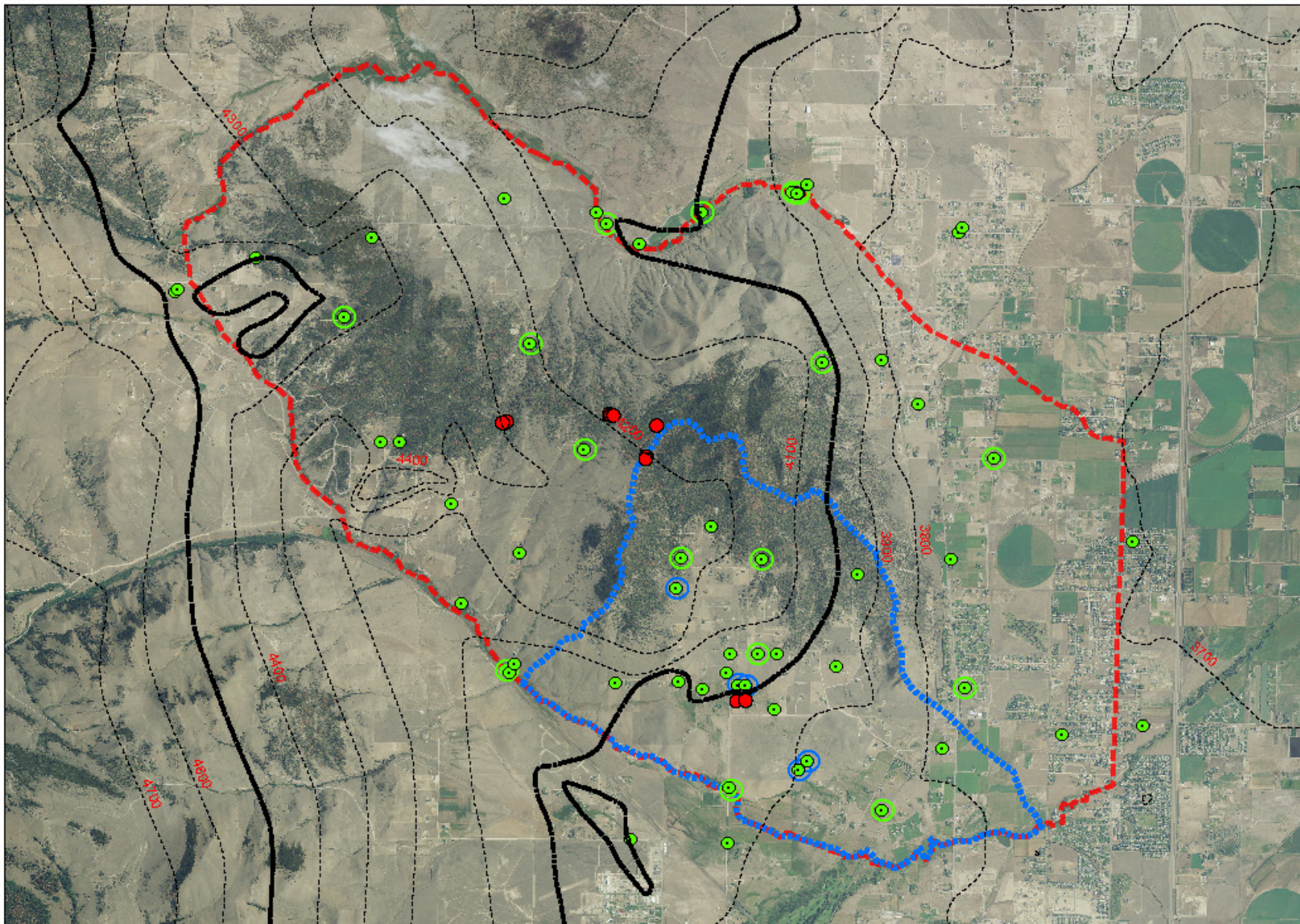


ALB; 10/6/09

Geology of the Scratchgravel Hills (Per OFR 363)

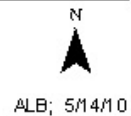
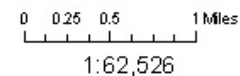
-  Project Area
-  Scratchgravel Hills Faults
- Geologic Units**
-  Qs
-  Kmd
-  ZYg
-  Yc
-  Ye
-  Ys



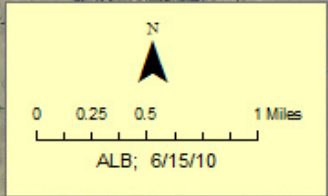
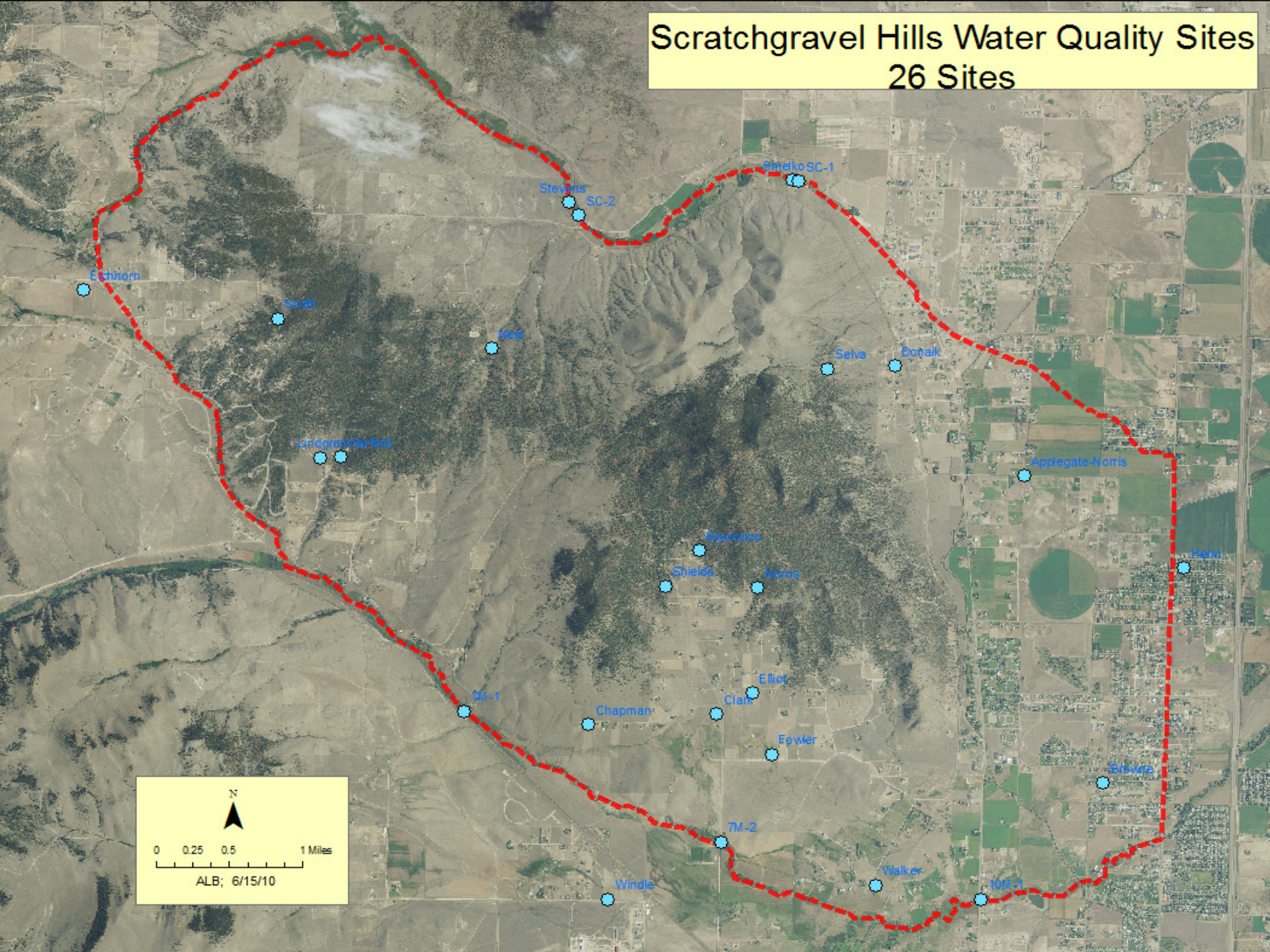


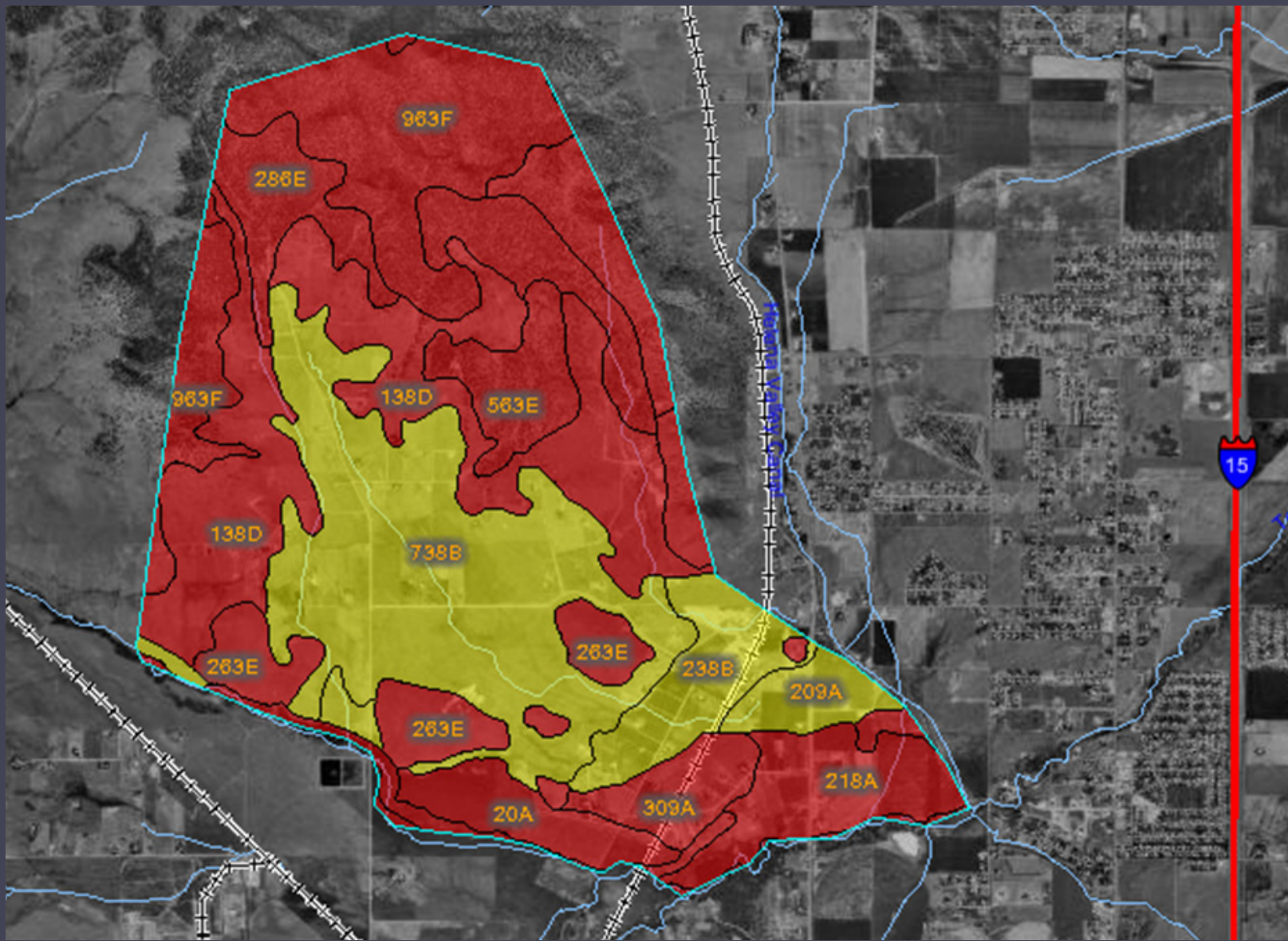
- MBMG Transducer Sites
- Monthly Mon Wells
- DNRC Transducer Sites
- MBMG Transducer Sites
- Proposed Drill Sites
- DNRC Transducer Sites

Groundwater Monitoring with Initial Potentiometric Surface



Scratchgravel Hills Water Quality Sites 26 Sites





NRCS Soils Map – Septic Tank Adsorption Fields

Red = Very Limited; Yellow = Somewhat Limited

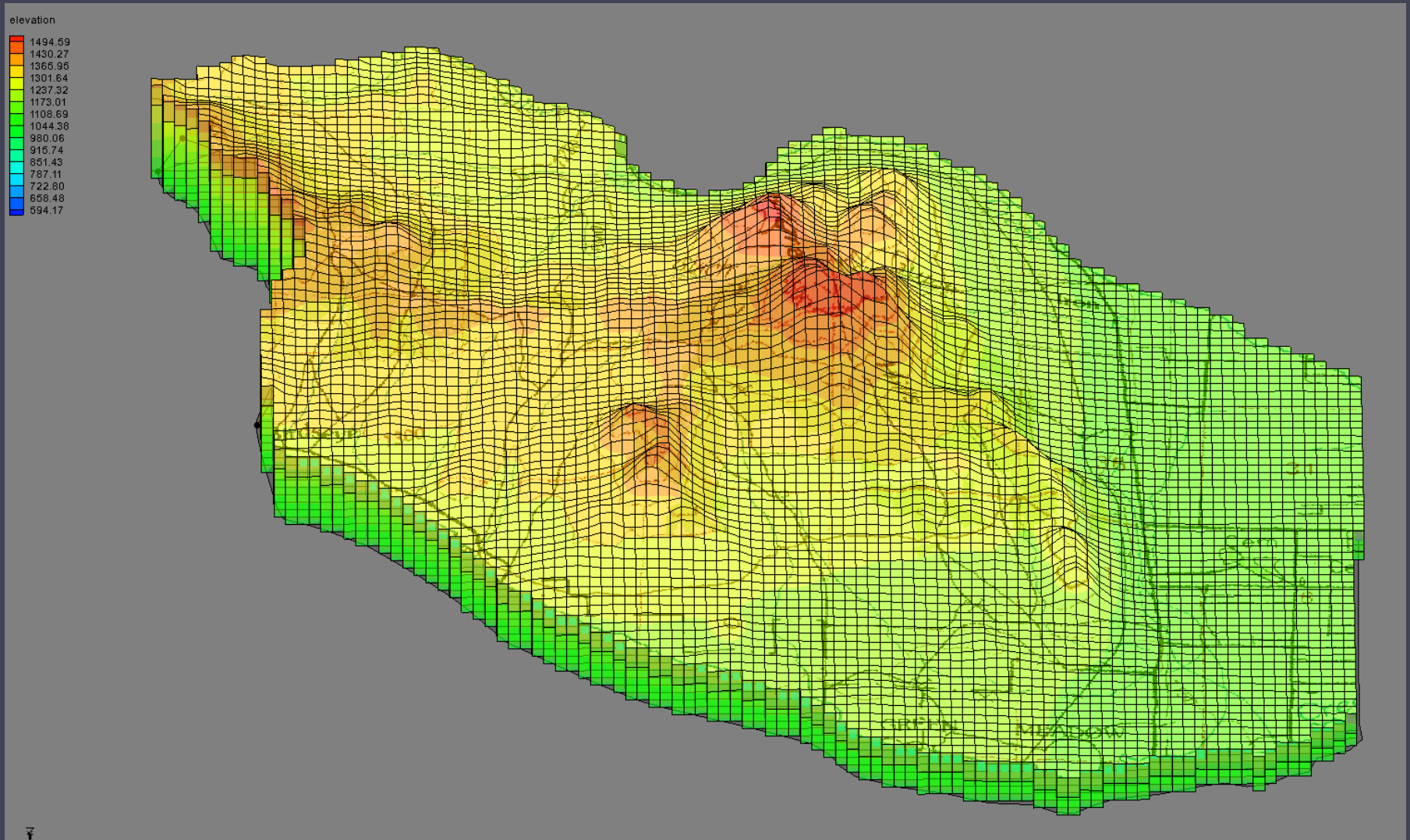
Awaiting Results from April Sampling Event for Nitrate

Scratchgravel Hills Area Update

June 2010

- Spring monitoring has been implemented (7 springs)
- Crest Gages have been installed at three sites
- Continuous recorders have been installed in dedicated monitoring wells, and in some domestic wells
- Flow in the Helena Valley Irrigation District Canal is measured where the canal enters and exits the study area

Early formulation and testing of the Scratchgravel groundwater model is underway



SUMMARY

Work To Date

- Data Review & Evaluation
- 3 Geophysical Student Projects
- Exploratory Drilling (10 wells)
- 3 Aquifer Tests
- Expansion of Monitoring Networks
- 1st Site-Wide Sampling Event
- Staff gage & Crest Gage Installation & Monitoring
- Development of Groundwater Model Framework

SUMMARY

Upcoming Work

- Monitoring – Ongoing into 2011
- 2 to 4 Aquifer Tests – Summer 2010
- Exploratory Drilling – Summer 2010
- Water Sampling Events – Summer & Fall 2010
- Geophysical Surveying Final Report – Summer 2010
- Groundwater Modeling – Ongoing

Agency and Group Coordination

FEDERAL:

- USGS
- EPA

STATE:

- DNRC Water Resources Division
- DEQ
- Montana Watershed Coordination Council
- University of Montana

LOCAL:

- Lewis & Clark County Water Quality Protection District
- Helena Valley Irrigation District
- Lewis & Clark County Conservation District
- Lake Helena Watershed Monitoring Committee
- Helena-area consultants, developers, and residents

Questions?

<http://www.mbmng.mtech.edu/gwip/gwip.asp>