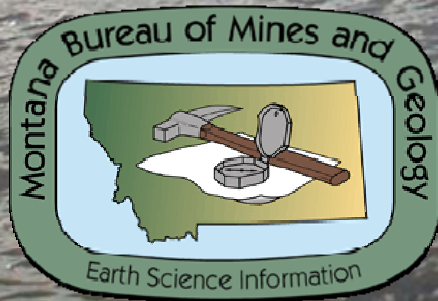


MBMG

Groundwater Investigations Program

Helena Area Projects

Lake Helena Watershed Group
January 21, 2010

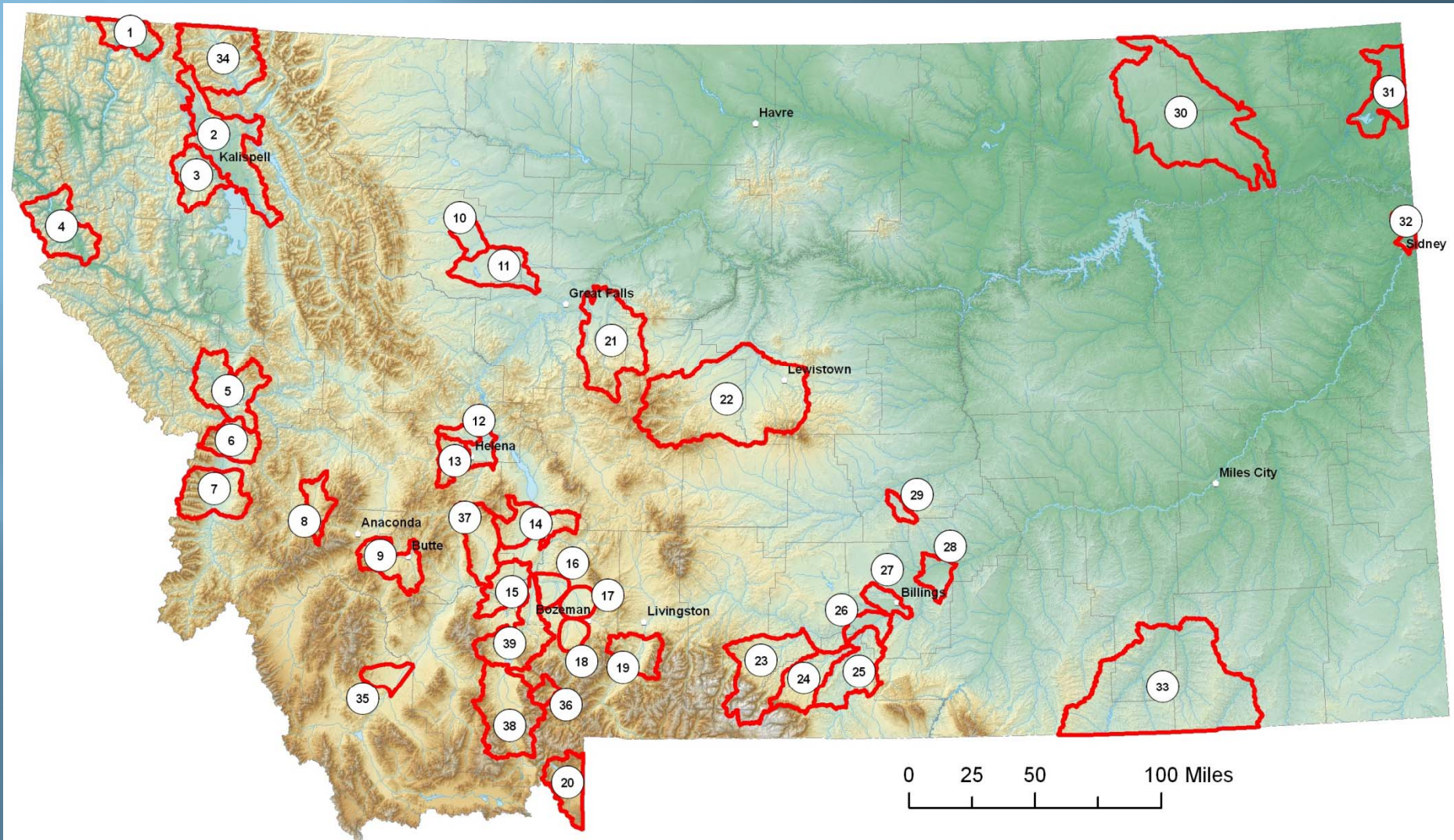


Kirk Waren
Andy Bobst
Julie Ahern

Groundwater Investigations Program (GWIP) What is it???

- ▣ House Bill 52 – Passed in April, funded in July '09
- ▣ MBMG directed to investigate groundwater resource issues state-wide
- ▣ All sites at a sub-basin scale
- ▣ Variety of issues related to human-induced change
 - stream depletion
 - declining groundwater levels
 - declining groundwater quality

Groundwater Investigation Program Areas



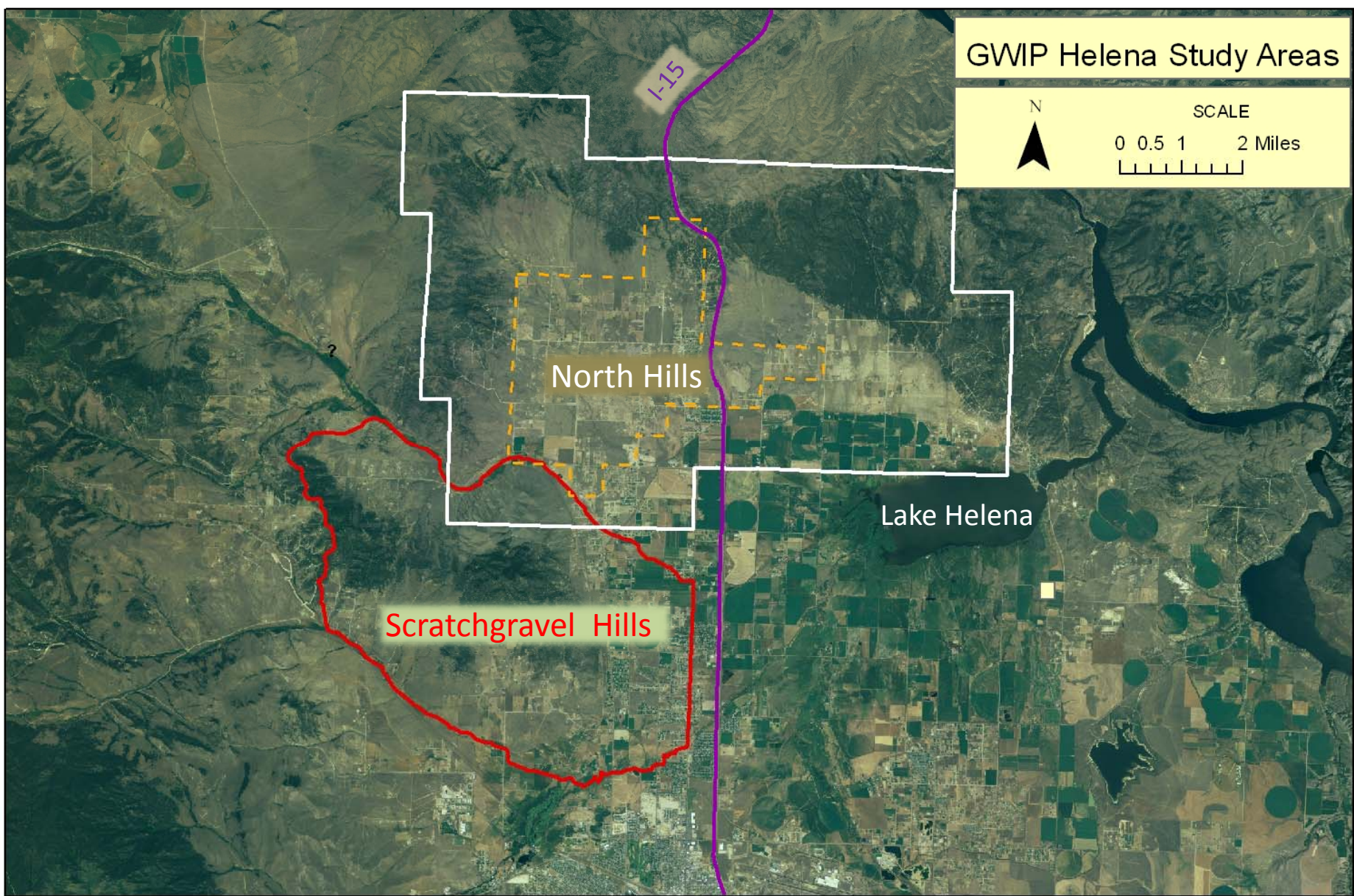
Helena Area Projects




- ▣ North Hills
- ▣ Scratchgravel Hills

GWIP Helena Study Areas



SCALE
0 0.5 1 2 Miles
[Scale bar with tick marks]



-  Scratchgravel Hills Study Area
-  Former North Hills Controlled Groundwater Area and Approximate GWIP Study Area
-  Current North Hills Controlled Groundwater Area

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

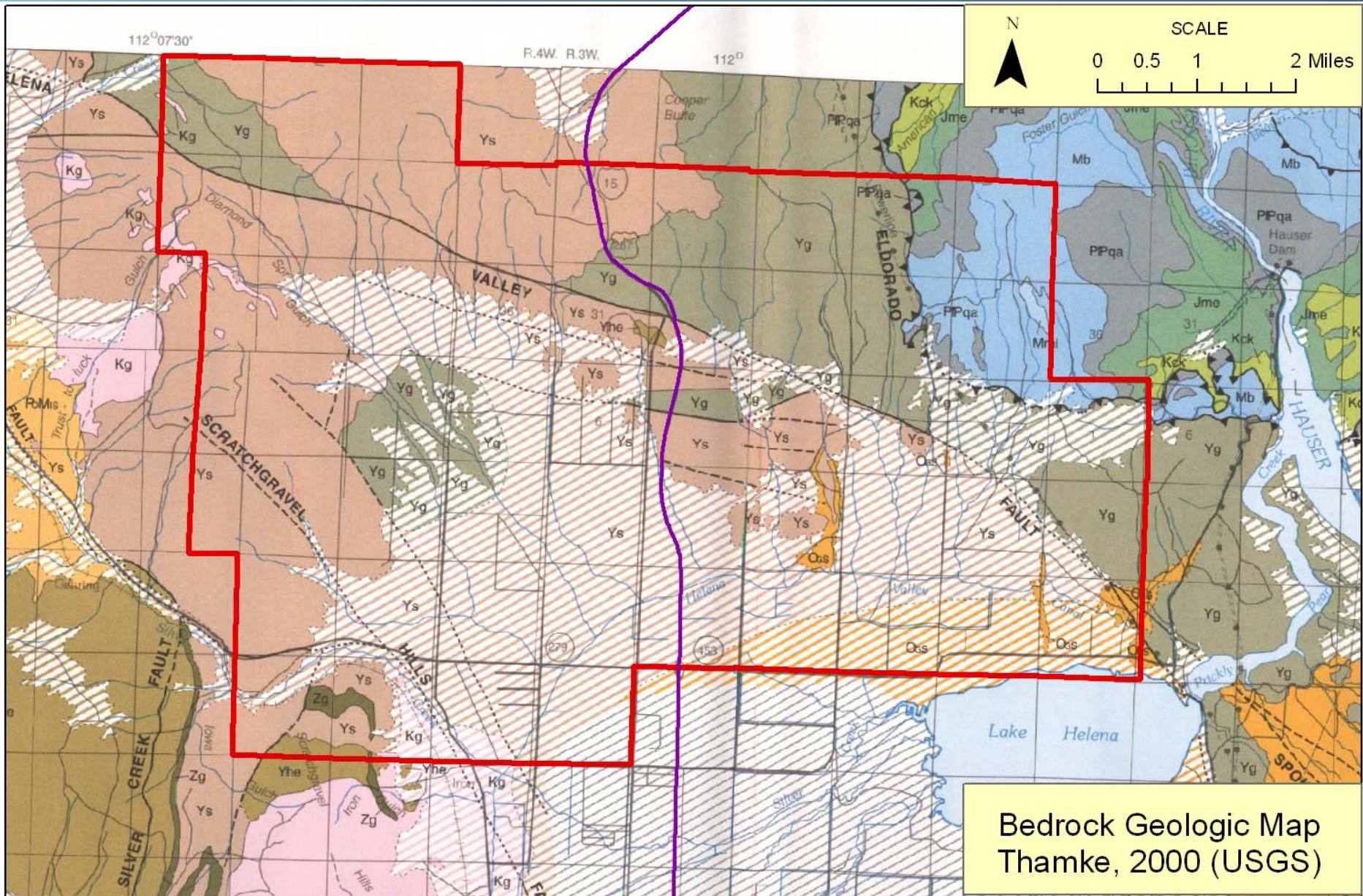
Finding Answers Via...

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

North Hills Area

Finding Answers Via...

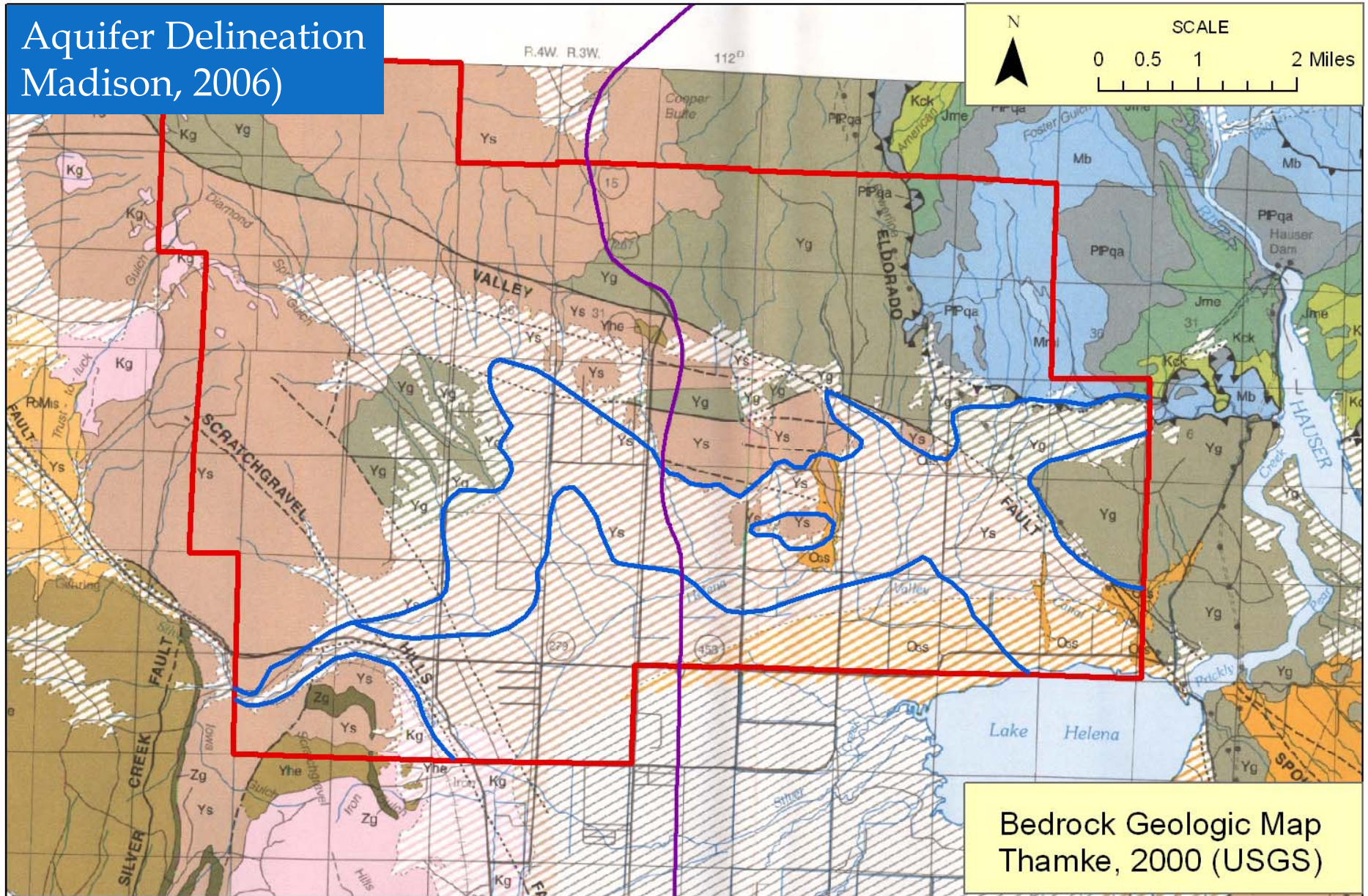
- ▣ **Review of Existing Data**
- ▣ Geophysical Surveys & Exploratory Drilling
- ▣ Monitoring Network
- ▣ Aquifer Tests
- ▣ Groundwater Flow Modeling



- Spokane Formation - argillite and siltite
- Greyson Formation - siltite and argillite
- Oligocene Sedimentary Rock - sandstone, volcanic tuff, conglomerate

Stripes denote bedrock overlain by quaternary deposits

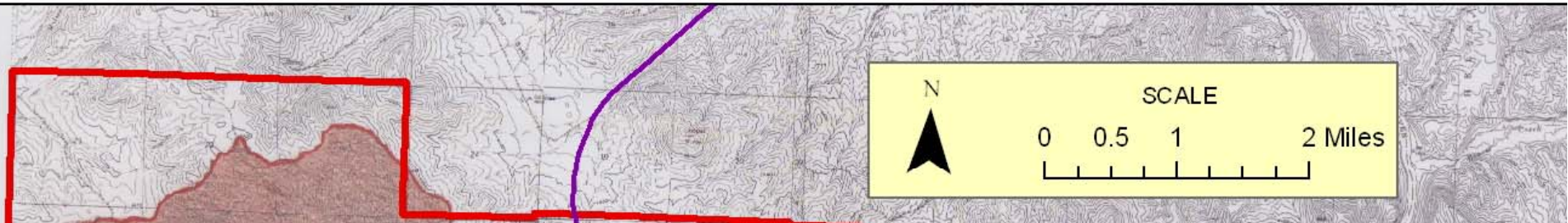
Aquifer Delineation Madison, 2006)



Bedrock Geologic Map
Thamke, 2000 (USGS)

- Spokane Formation - argillite and siltite
- Greyson Formation - siltite and argillite
- Oligocene Sedimentary Rock - sandstone, volcanic tuff, conglomerate

Stripes denote bedrock overlain by quaternary deposits



- | | | | |
|------|---|------|--|
| Qah | Alluvium of Lake Helena fan
0-35 feet | Qahb | Boulder alluvium on Lake Helena Fan
0-40 feet |
| Qad | Alluvium of Diamond Spring Gulch
0-20 feet; thickens to 60 feet
south of Cactus Flat fault | Qado | Older alluvium of Diamond Spring Gulch
0-30 feet; thickens locally to 45 feet
south of Cactus Flat fault |
| Qabd | Alluvium of Diamond Spring basin area
0-40 feet; thickens locally to 90 feet
south of Cactus Flat fault | Qasb | Alluvium derived from southwest bedrock
outcrops 0-25 feet |
| Qsa | Alluvium of Silver Creek 0-50 feet | Qoas | Older alluvium of Silver Creek 0-65 feet |
| Qca | Colluvium and alluvium on steep
Slopes on east side of
Scratchgravel Hills | R | Bedrock outcrop area |

----- Inferred fault

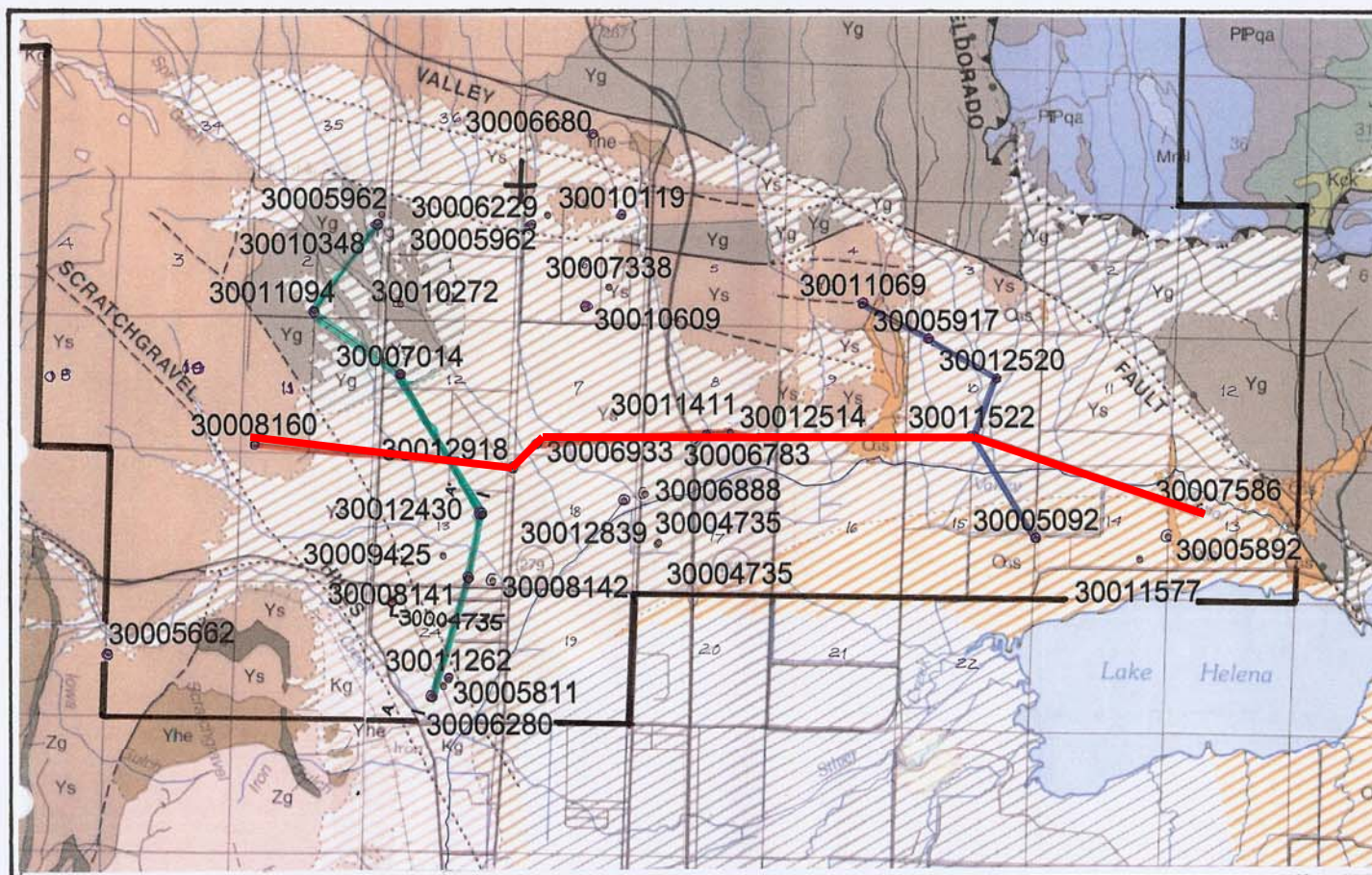


Reynolds Surficial Geologic Map
2008, unpublished

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

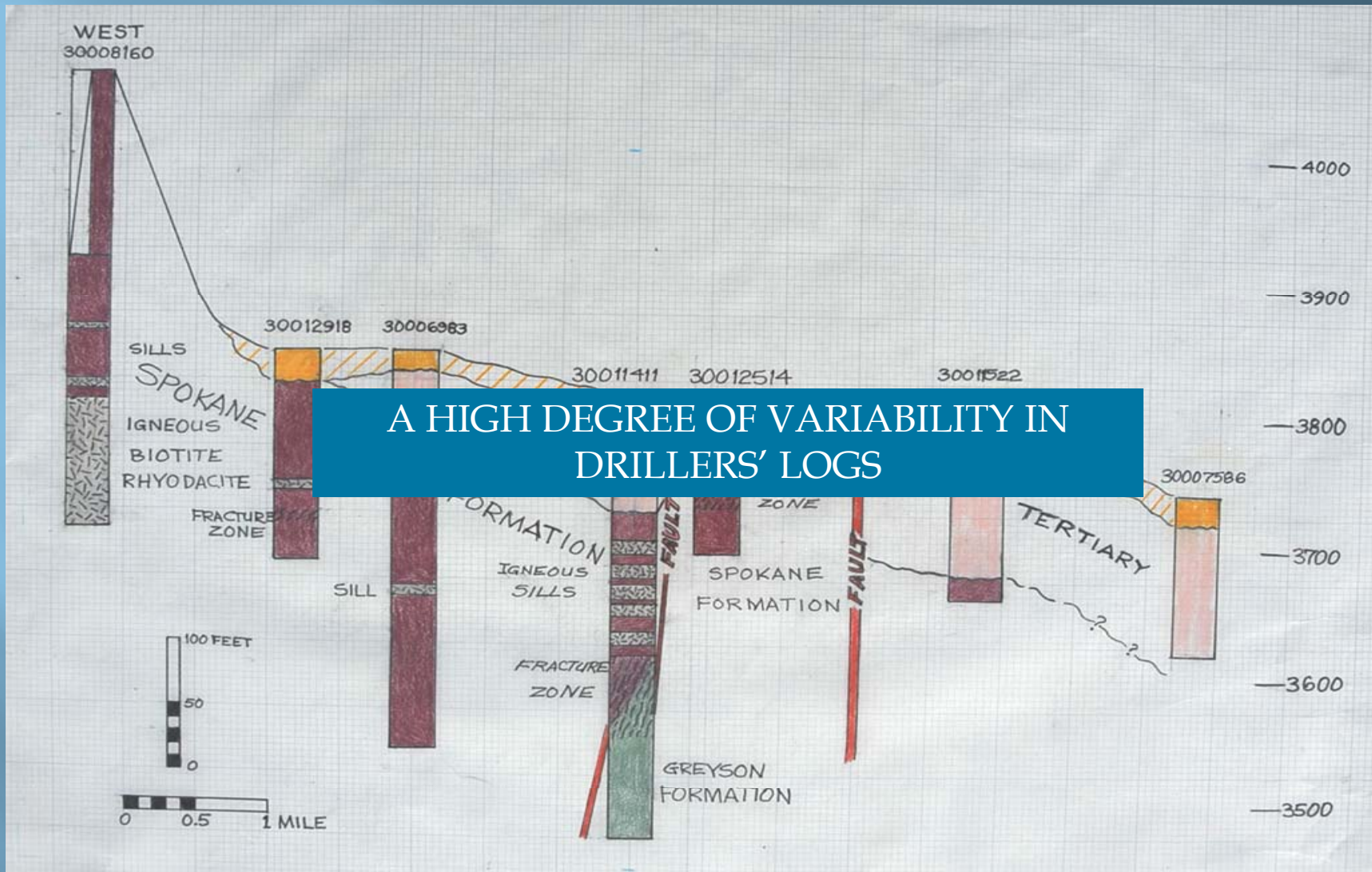
outcrops 0-25 feet

**MAP SHOWING THE LOCATIONS OF WELLS FROM WHICH DRILL CUTTINGS
WERE EXAMINED FOR THIS STUDY**



- LINE OF WEST TO-EAST STRATIGRAPHIC SECTION
- WESTERN LINE OF NORTH-TO-SOUTH SECTION
- EASTERN LINE OF NORTH-TO-SOUTH SECTION
- BOUNDARY OF SOUTHERN PART OF NHCga

Base map from M.W. Reynolds (2000), in
Thamke, 2000, USGS WRI Report 00-4212
Well locations plotted by R. Levens, 2007,
Montana DNRC



A HIGH DEGREE OF VARIABILITY IN DRILLERS' LOGS

WEST-TO-EAST STRATIGRAPHIC SECTION,
CENTRAL PART OF NHC GA

North Hills Area

Finding Answers Via...

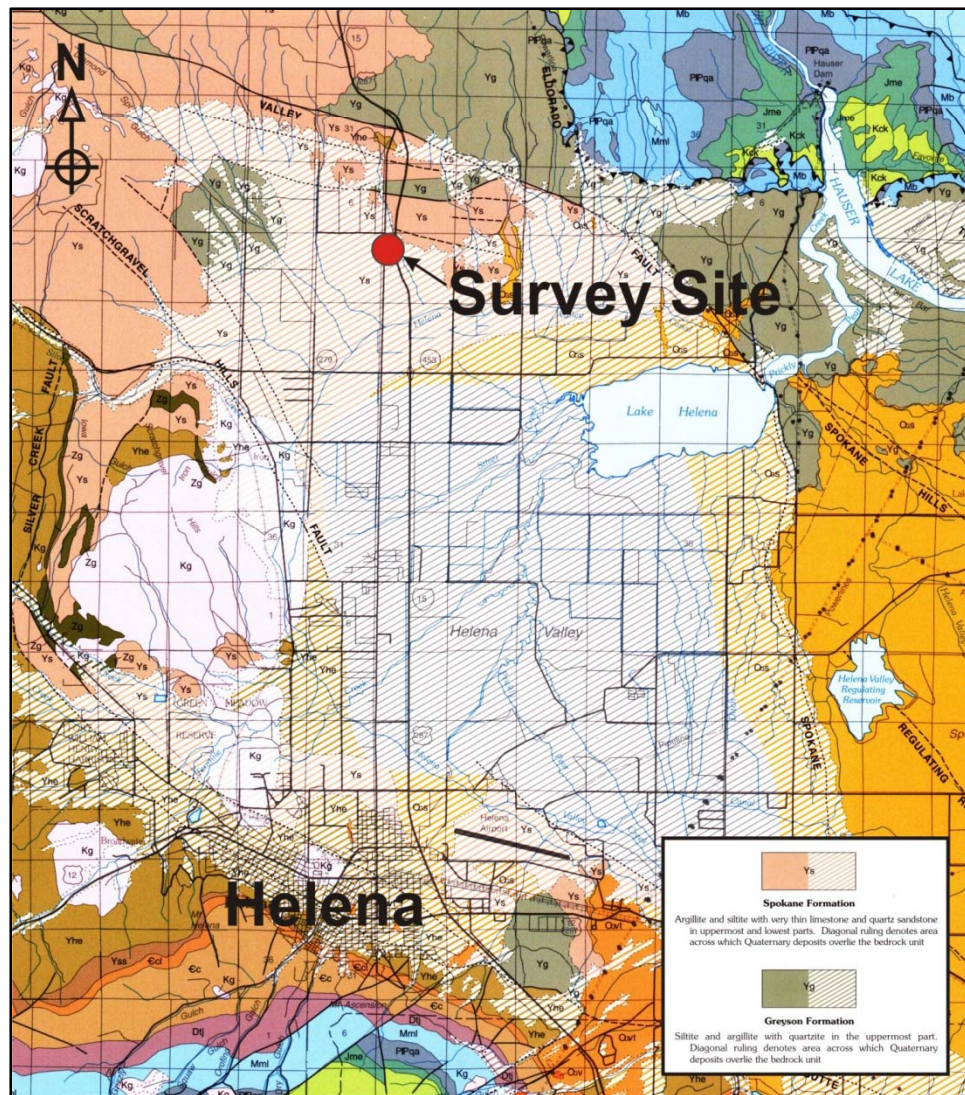
- ▣ Review of Existing Data
- ▣ **Geophysical Surveys & Exploratory Drilling**
- ▣ Monitoring Network
- ▣ Aquifer Tests
- ▣ Groundwater Flow Modeling

North Hills Area

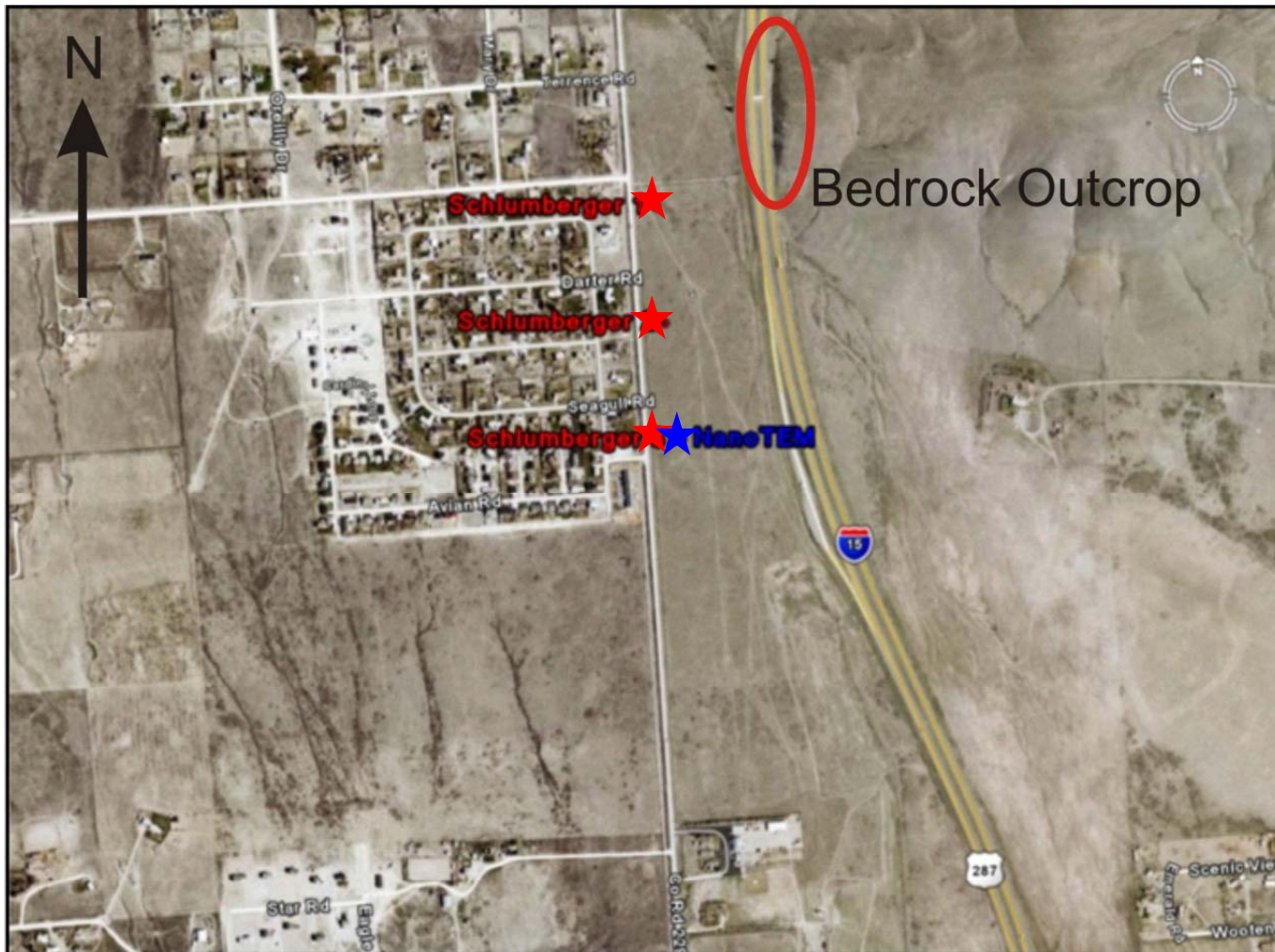
Geophysical Surveying

- ▣ Montana Tech student project: resistivity sounding conducted in a shallow bedrock/ possible fault zone area – October 2009
- ▣ Further resistivity sounding north of previous area - February 2010
- ▣ MTech field camp - Summer 2010
- ▣ Additional geophysical work proposed using other methods; bid document near completion

Geophysical Test Site – MT Tech students Brian Williams and David Sunwall



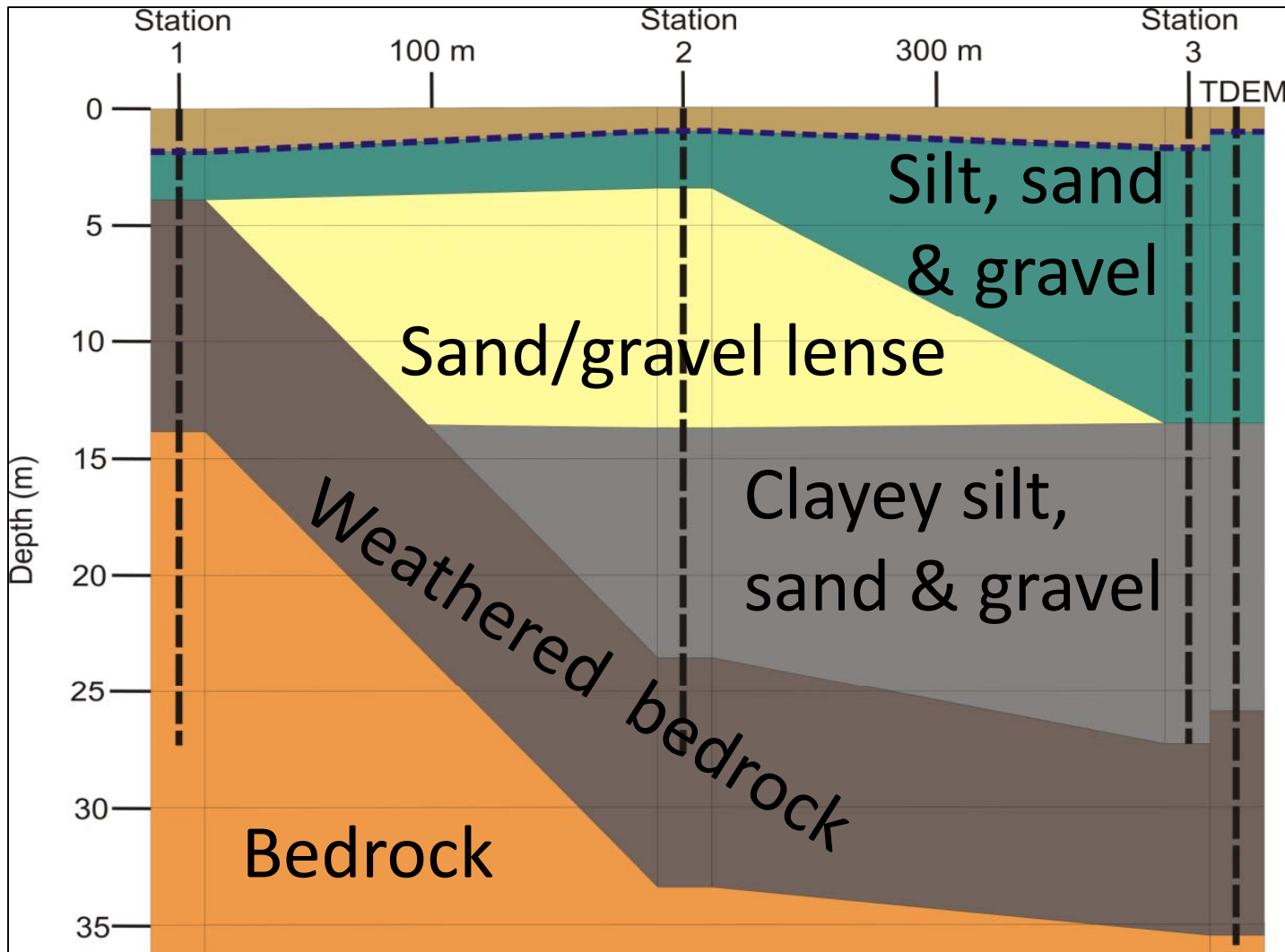
Site Details



Geophysical profile

N

S



North Hills Area

Finding Answers Via...

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

North Hills Area *Monitoring*

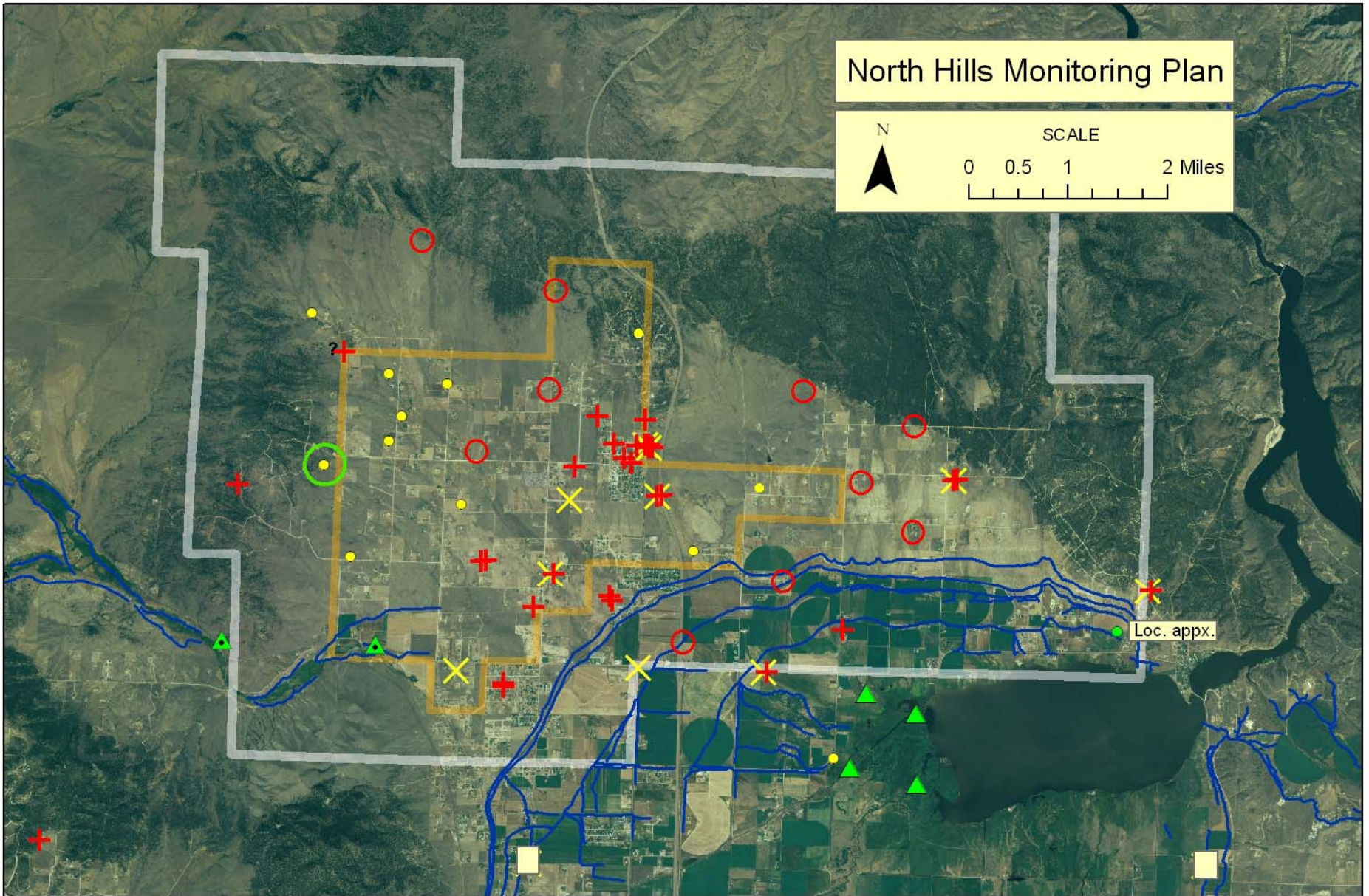
- ▣ Contract with Lewis and Clark Water Quality Protection District
 - monthly monitoring of ~ 30 additional wells
- ▣ Monitoring well reactivations & additions
 - e.g. unused state-owned well at key location
- ▣ 4 surface-water monitoring sites near Lake Helena
- ▣ 2 sites with seasonal stage recorders and piezometers in place on Silver Creek

North Hills Monitoring Plan



SCALE

0 0.5 1 2 Miles



Recently-Added Monitoring Sites

- New monthly monitoring site
- GWIP stream monitoring site with piezometers
- Precipitation gage site

Currently-Monitored Sites

- Monthly L&C
- Quarterly GWAP
- Stream L&C/EPA/DNRC

Helena Valley Irrigation District (HVID) and other canals - many measurements being assembled for the Helena Valley HVID ditches, laterals, and drains

- Proposed additional monthly groundwater level monitoring

North Hills Area

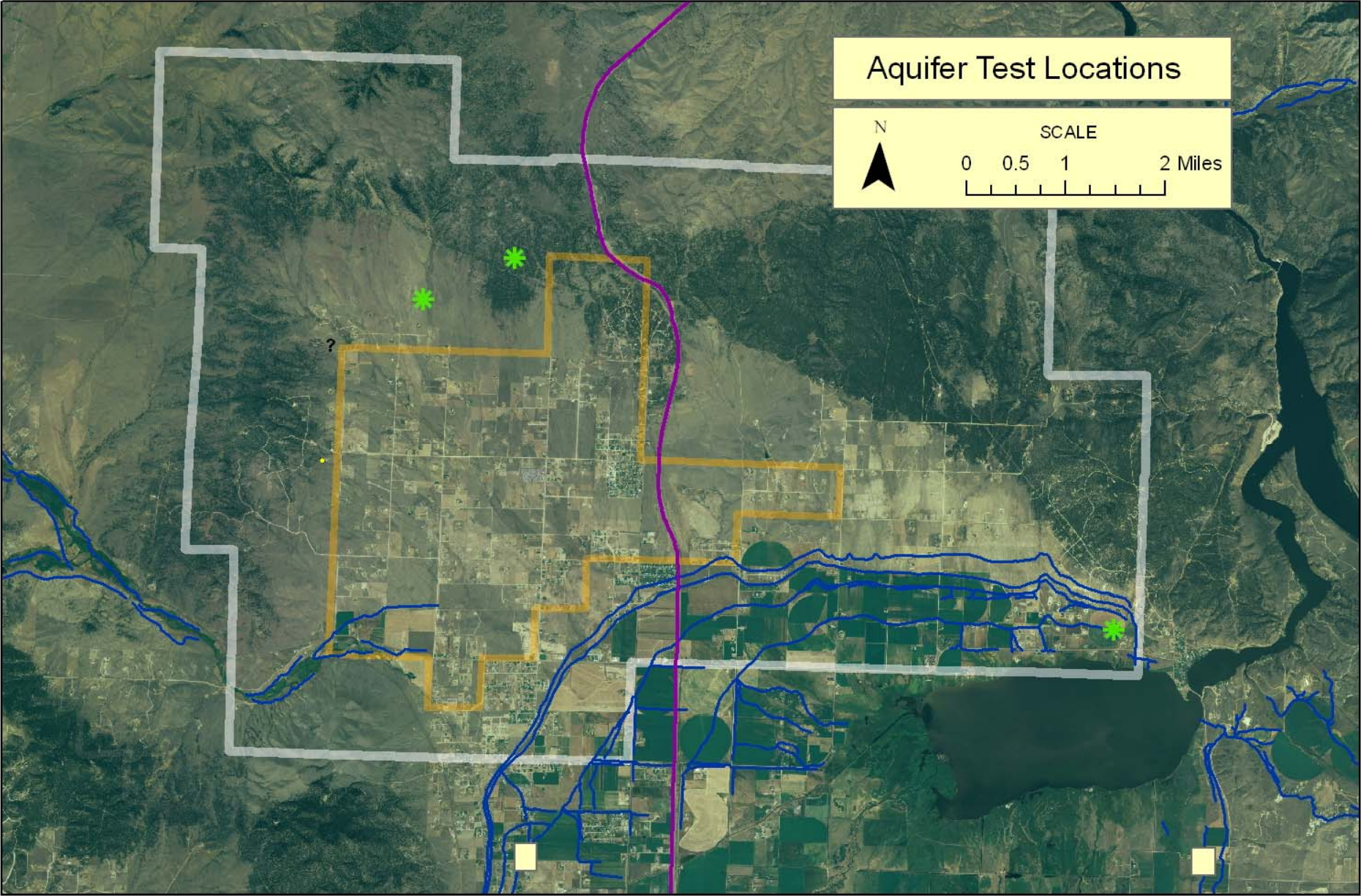
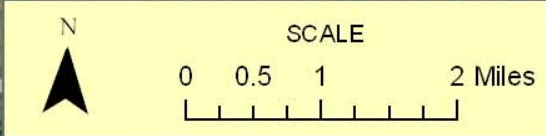
Finding Answers Via...

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

North Hills Area *Aquifer Testing*

- ▣ Aquifer test conducted in November
 - long-duration
 - multi-well
 - analysis underway
- ▣ Two drilling exploration and aquifer test sites currently being pursued, landowner access attained, bid process underway

Aquifer Test Locations



Recently-Added Monitoring Sites

- New monthly monitoring site
- ▲ GWIP stream monitoring site with piezometers
- Precipitation gage site

Currently-Monitored Sites

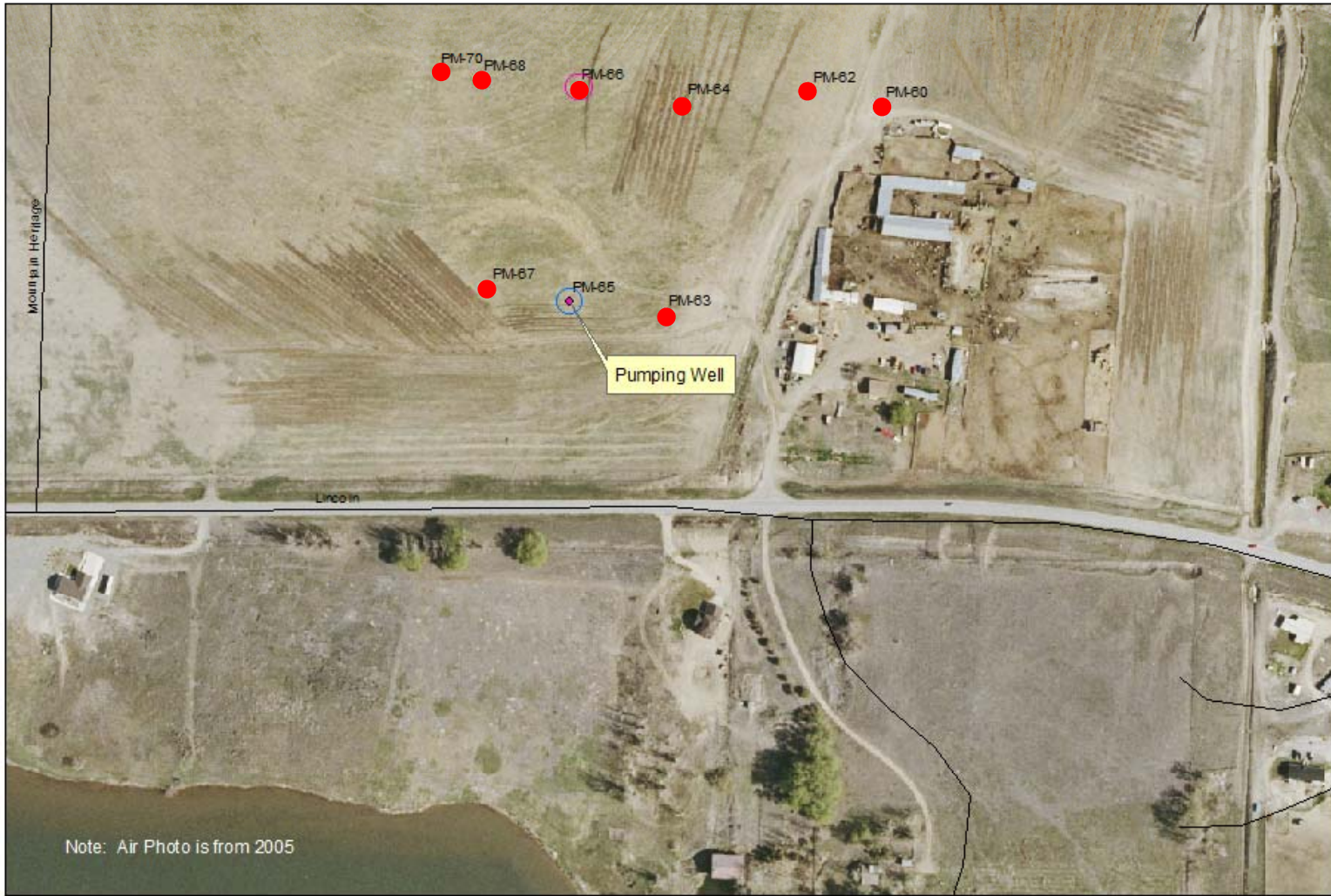
- + Monthly L&C
- × Quarterly GWAP
- ▲ Stream L&C/EPA/DNRC

- Helena Valley Irrigation District (HVID) and other canals - many measurements being assembled for the Helena Valley HVID ditches, laterals, and drains
- Proposed additional monthly groundwater level monitoring
- ✱ Proposed exploration drilling and aquifer test sites

Panoramic Meadows Pump Test

- 6-day constant rate pumping test - 11/18/09-11/24/09
- Average pumping rate = 38.2 gpm
- Used 10 pre-existing wells (1 pumping, 9 observation)
- Near Lake Helena; west side of study area
- Wells in well lithofied fractured Oligocene bedrock.
- Monitored drawdown and recovery to determine aquifer characteristics

GWIP Project Area: North Hills, Lewis and Clark County



● Observation Wells

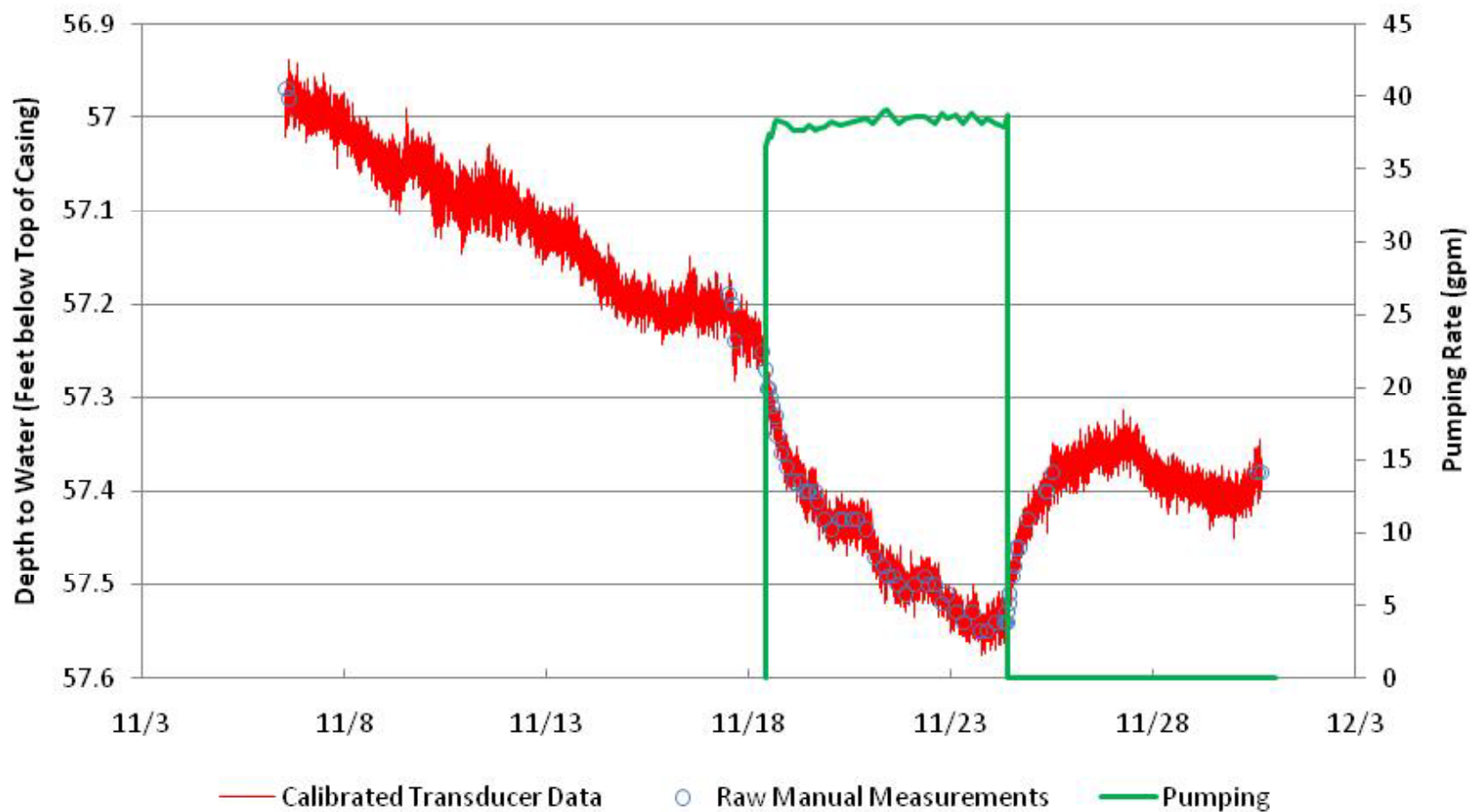
Panoramio Meadows Pump Test

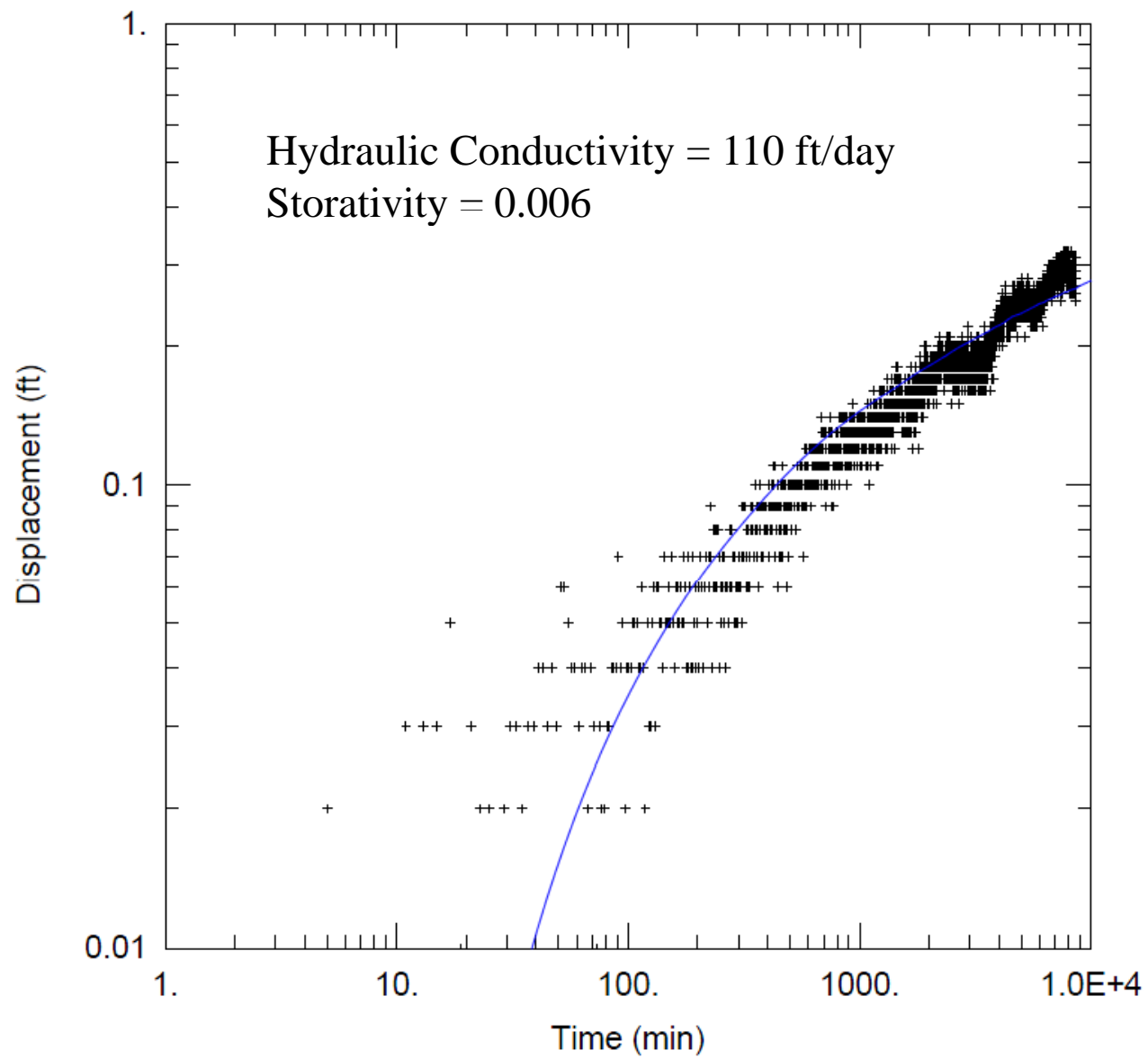


0 70 140 280 Feet

ALB; 12/31/09

Calibrated Transducer Data PM-66





North Hills Area

Finding Answers Via...

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

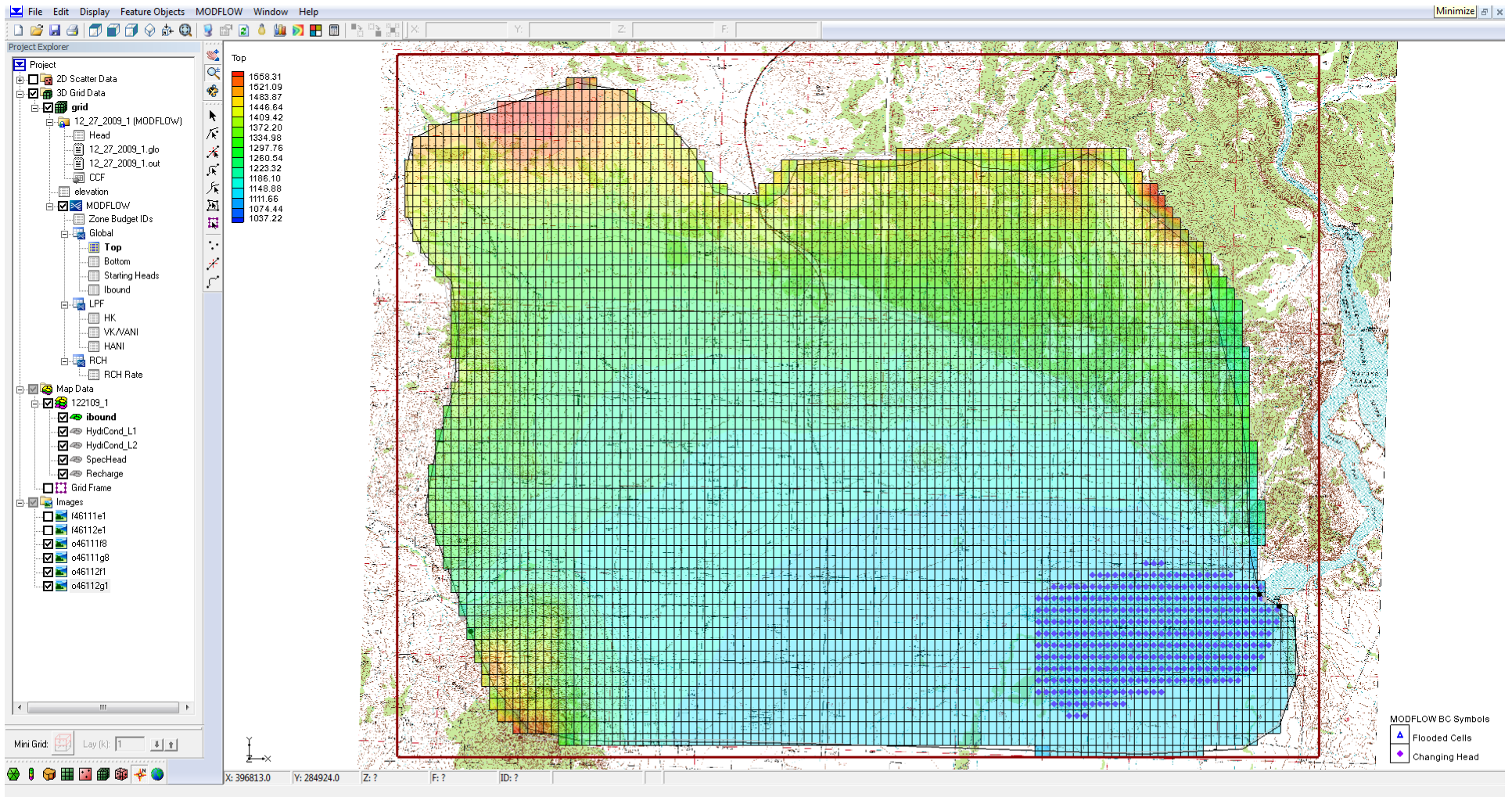
North Hills Area Update January 2010

Groundwater Modeling

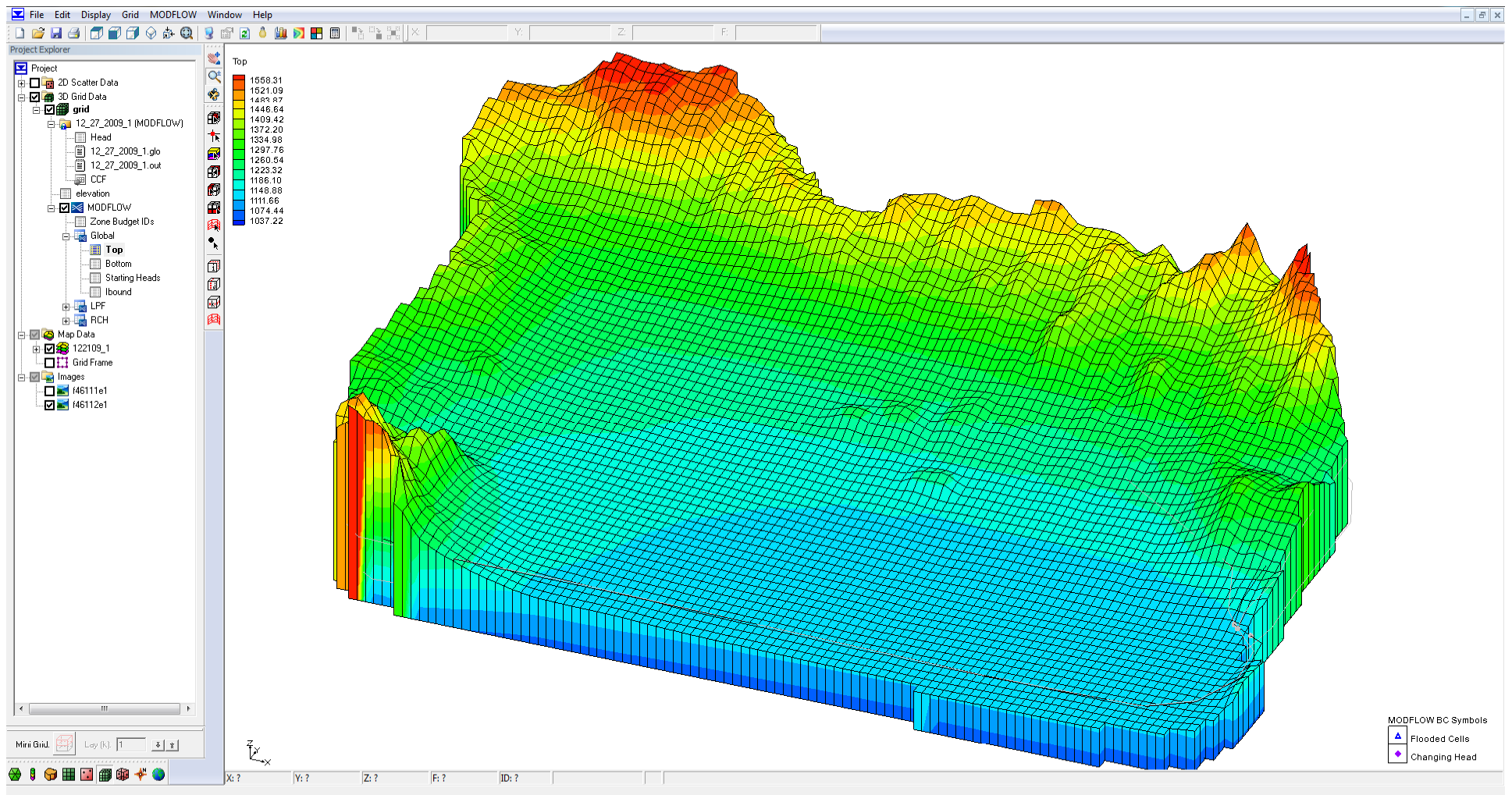
- ▣ Phase 1: groundwater model framework underway

- ▣ Evaluation of existing data
 - Aquifer test data and other relevant geologic and hydrologic data (e.g. borehole logs)
 - hydrogeologic units >> model layers
 - aquifer test results >> aquifer property inputs

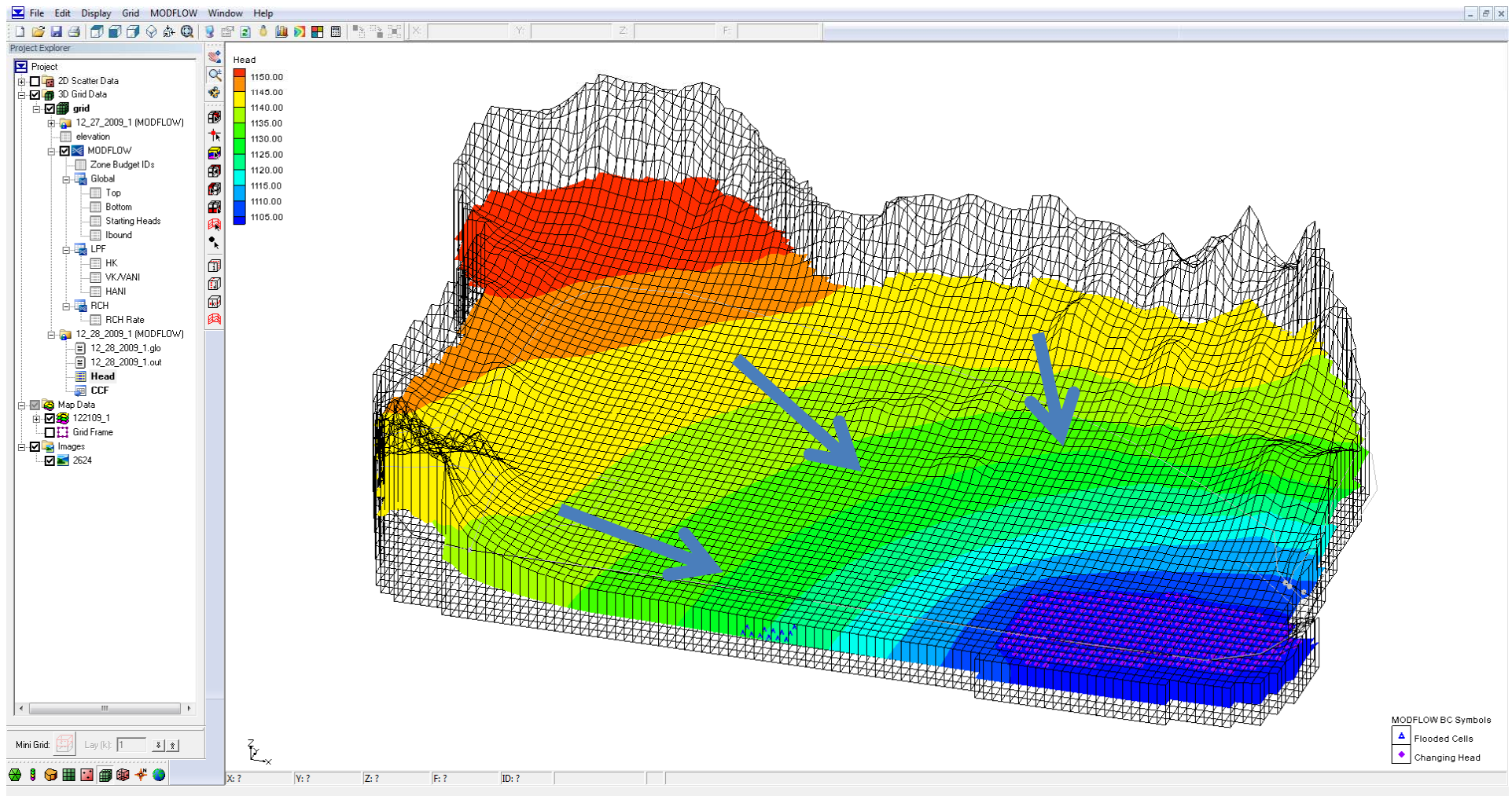
- Assign model grid and active cell areas



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



- Preliminary groundwater surface generated from areal recharge and known water elevations
- Arrows show groundwater flow direction



North Hills Area

Other Upcoming Work

- ▣ Groundwater Sampling – March/ April 2010
- ▣ Sonic (exploratory) drilling – March/ April 2010
- ▣ Precipitation gage installations – Snow & Rain
- ▣ Temperature sensors and crest gages – Spring Runoff
- ▣ ET results in June 2010 (METRIC)

Scratchgravel Hills Area

Key Questions

- ▣ *Green Meadow Controlled Groundwater Area: Will withdrawals exceed recharge?*
- ▣ *Upper Missouri Closed Basin: Will groundwater pumping affect surface-water flows?*

Scratchgravel Hills Area

Finding Answers Via...

- ▣ Review of Existing Data
- ▣ Monitoring Network
- ▣ Aquifer Tests
- ▣ Groundwater Flow Modeling

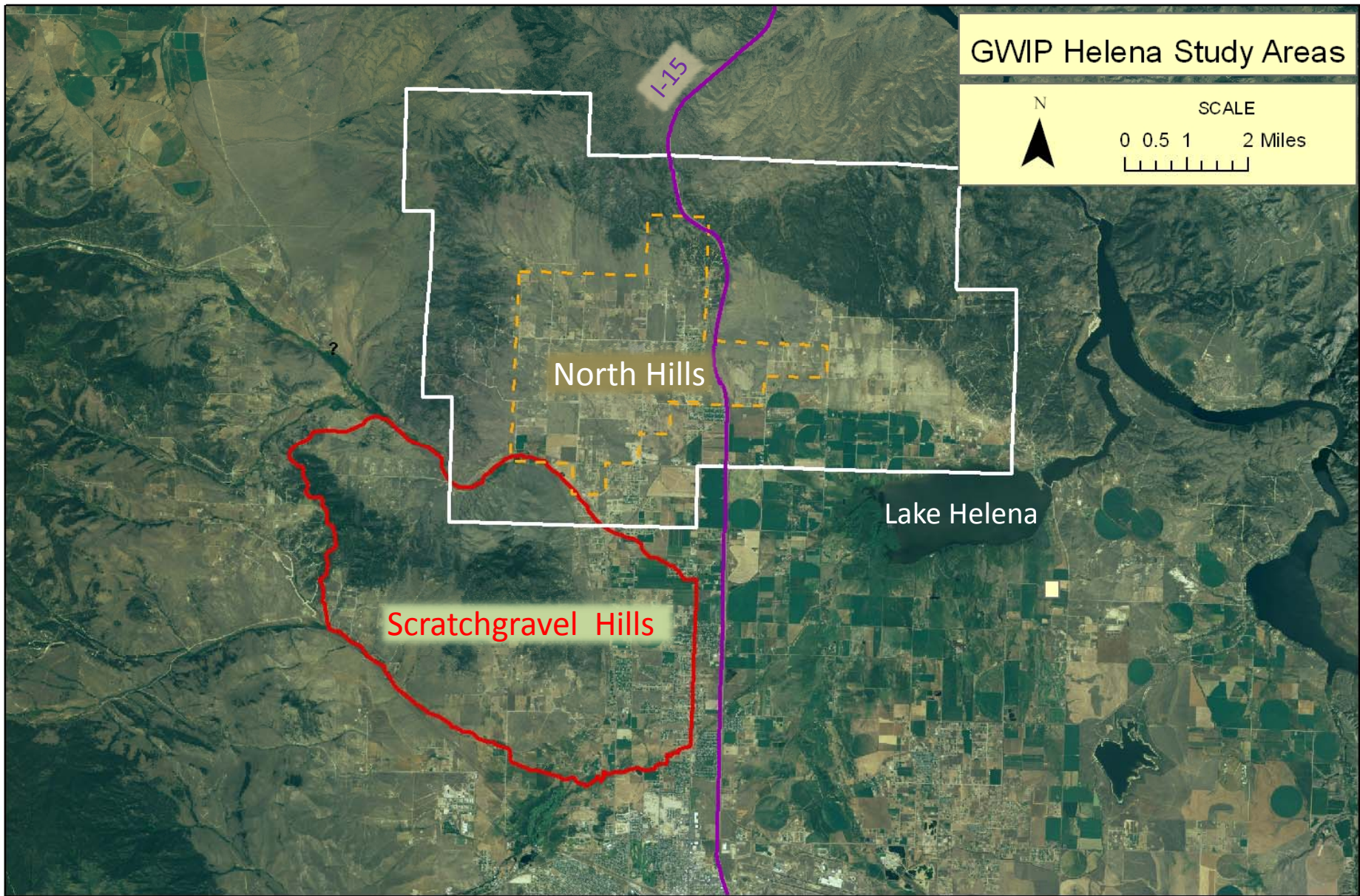
Scratchgravel Hills Area




- ▣ Contract with Lewis and Clark Water Quality Protection District
 - monthly monitoring of ~ 20 additional wells
- ▣ Monitoring-well network underway
- ▣ 2 Silver Creek stream-monitoring sites
- ▣ 3 Sevenmile Creek stream-monitoring sites (with seasonal stage recorders)
- ▣ Drilling and aquifer test site proposed
- ▣ Groundwater model under construction

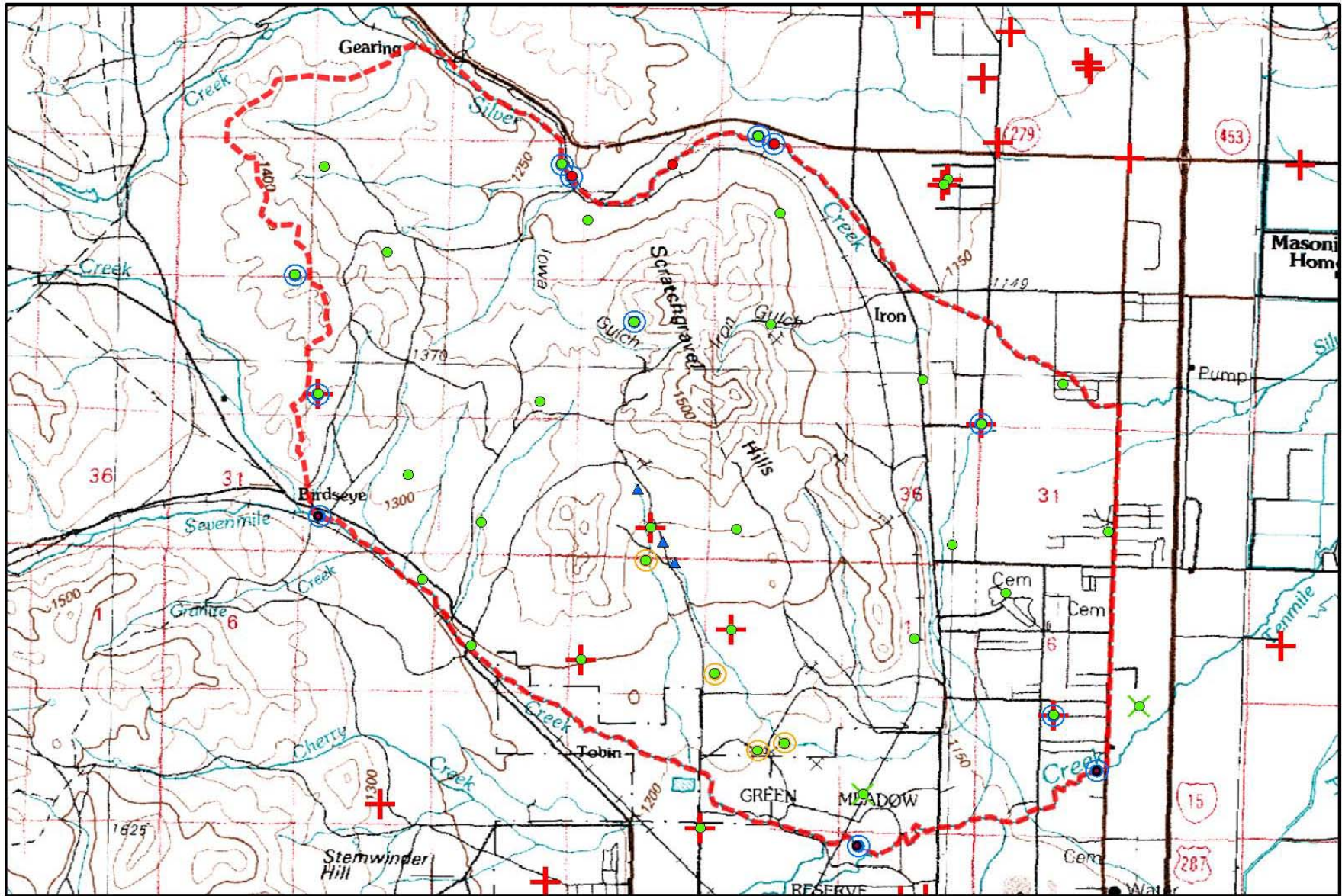
GWIP Helena Study Areas



SCALE
0 0.5 1 2 Miles
[Scale bar with tick marks]



-  Scratchgravel Hills Study Area
-  Former North Hills Controlled Groundwater Area and Approximate GWIP Study Area
-  Current North Hills Controlled Groundwater Area

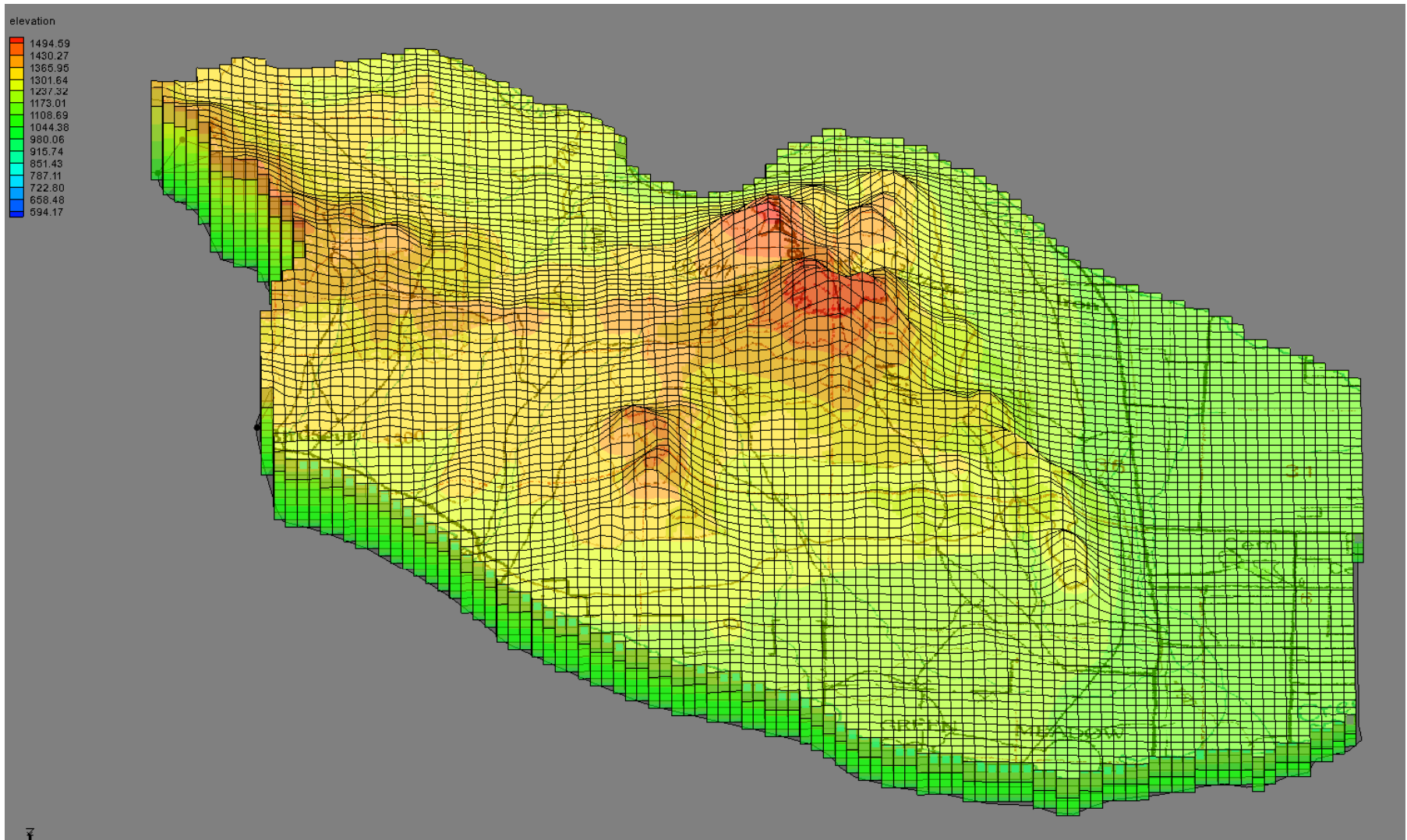


- | | |
|----------------------------------|----------------------------------|
| ▲ SG Monitored Springs | Currently_Monitored_Wells |
| ● Actual Piezo Locations | Monitoring |
| ● Proposed Piezo Locations | ⊕ Monthly L&C |
| ● Proposed Mon Wells (monthly) | ⊗ Quarterly GWAP |
| ● Proposed MBMG Transducer Sites | |
| ● DNRC Transducer Sites | |

Proposed Scratchgravel Monitoring Plan



Early formulation and testing of the Scratchgravel groundwater model is underway



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

SUMMARY

Work To Date

- Data Review & Evaluation
- Expansion of Monitoring Network
- Geophysical Student Project
- Panoramic Aquifer Test
- Development of Groundwater Model Framework

SUMMARY

Upcoming Work

- Monitoring - Ongoing
- 2 Aquifer Tests – Winter
- Exploratory Drilling – Winter/Spring
- Groundwater & Surface-water Sampling - Spring
- Geophysical Surveying – Winter & Summer
- Groundwater Modeling - Ongoing

QUESTIONS?

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