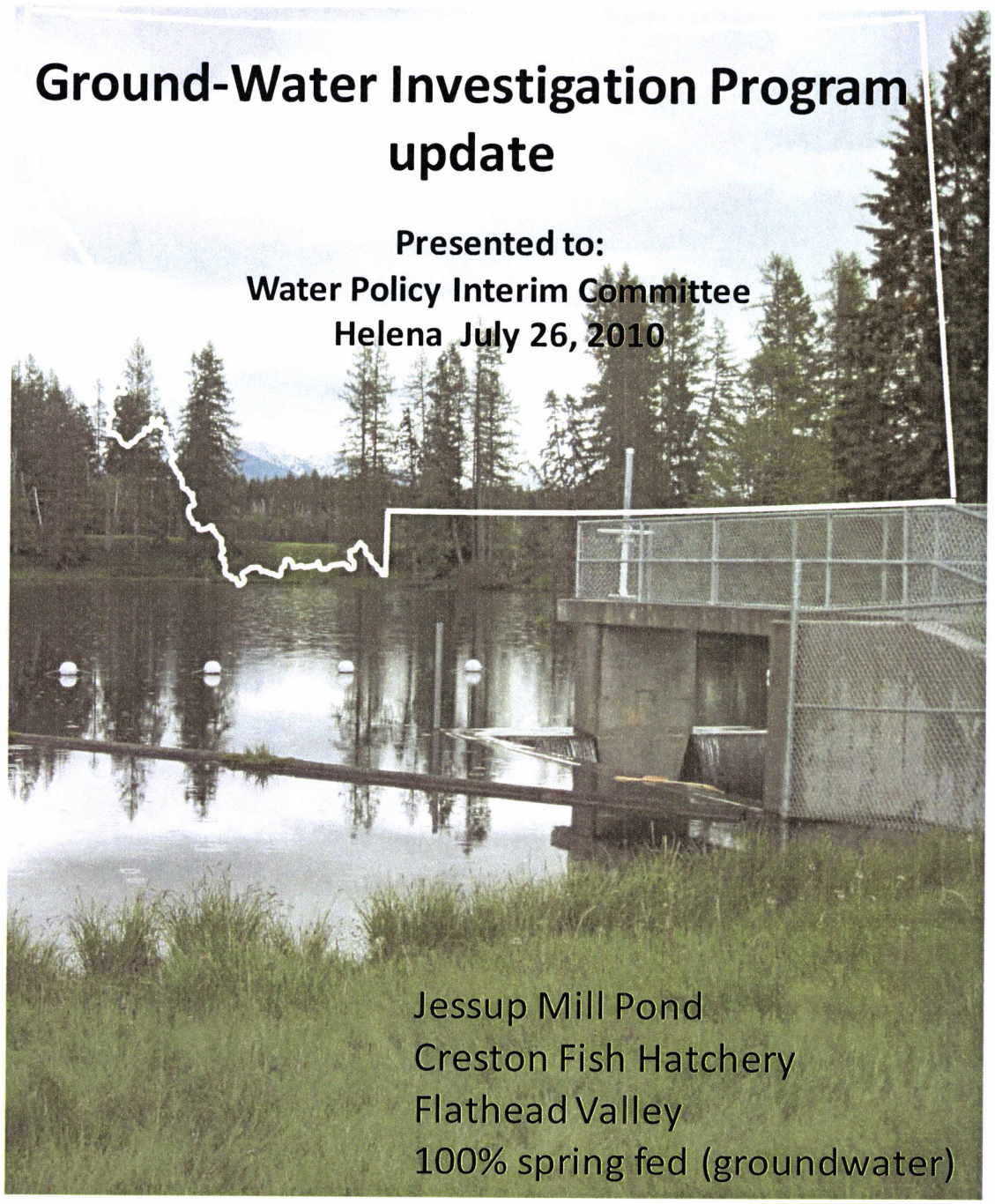
Ground-Water Investigation Program update

Presented to:
Water Policy Interim Committee
Helena July 26, 2010



John Wheaton
Montana Bureau of Mines and Geology

http://www.mbmg.mtech.edu/gwip/gwip.asp

WATER POLICY INTERIM
COMMITTEE
JULY 26, 2010
EXHIBIT 3

Active Projects for the current biennium

North Hills (Helena)
Four Corners (Bozeman)
Belgrade - (Bozeman area)
Lower Beaverhead River west side (Dillon)
Scratchgravel Hills (Helena)
Bitterroot Valley – (Florence)
Flathead Valley Deep Aquifer (Kalispell)

Overview of Activities

Fully engaged in data collection at all project sites

Modelers have now moved from the field back to their offices and are spending most of their time in front of their computers building models.

Preparing for new nominations and ranking for next biennium.

Activities Summary:

Contracts:

25 contracts have been initiated
Include:

- Data analysis
- Drilling
- Aquifer Testing
- Assistance
- Consulting

Bids:

Drill : 1 bid package currently open
Closes next week

Monitoring networks:

Ongoing throughout projects

Data review:

Data are collected, reviewed , archived and incorporated into analysis

Model construction:

Modeling team is moving forward

LOWER BEAVERHEAD PROJECT

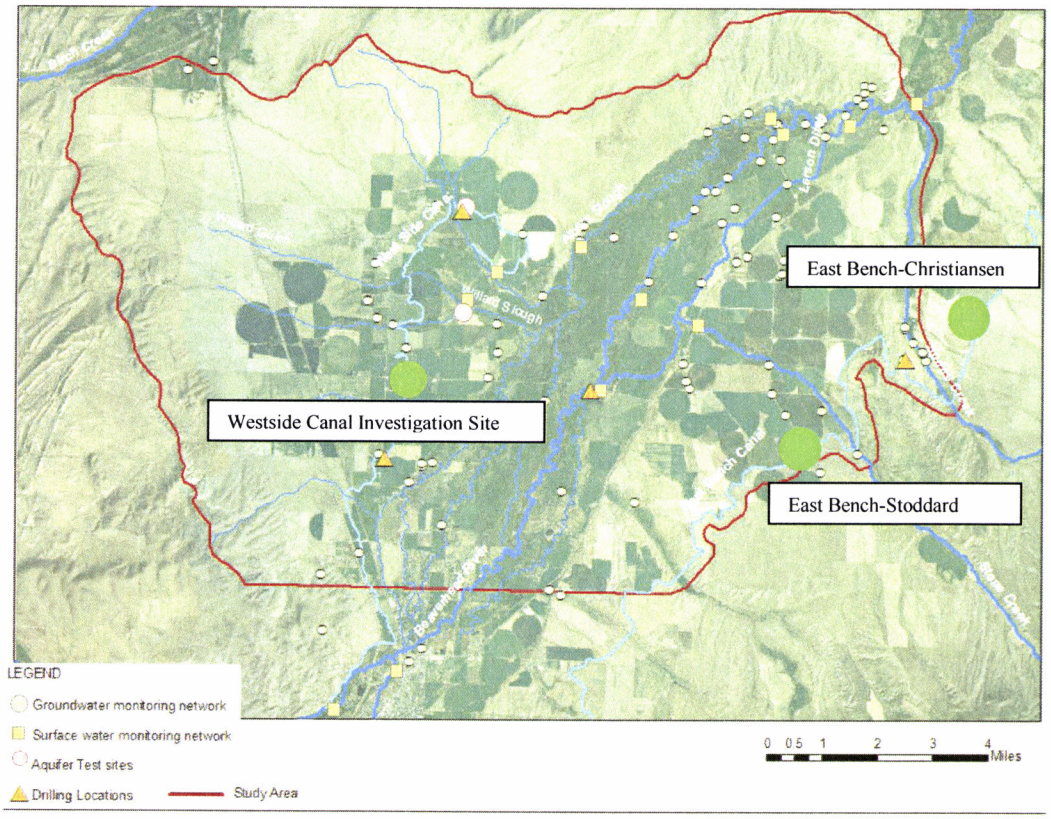
Groundwater and surface water are being investigated in the Lower Beaverhead river basin in order to more quantitatively determine impacts from high production irrigation wells and increased growth on groundwater, and especially how it impacts surface water flows. One major outcome from this study will be a groundwater flow model that reflects current groundwater conditions. Future groundwater withdrawal scenarios can and will be investigated. In order to constrain this modeling attempt, groundwater recharge through canals, and discharge to surface water is being investigated. An attempt to balance surface water in the area is also being conducted, as well as characterizing aquifer hydraulic conductivity, potentiometric surfaces, and geology. The following describes some of the techniques, results, and plans for this study.

RECHARGE

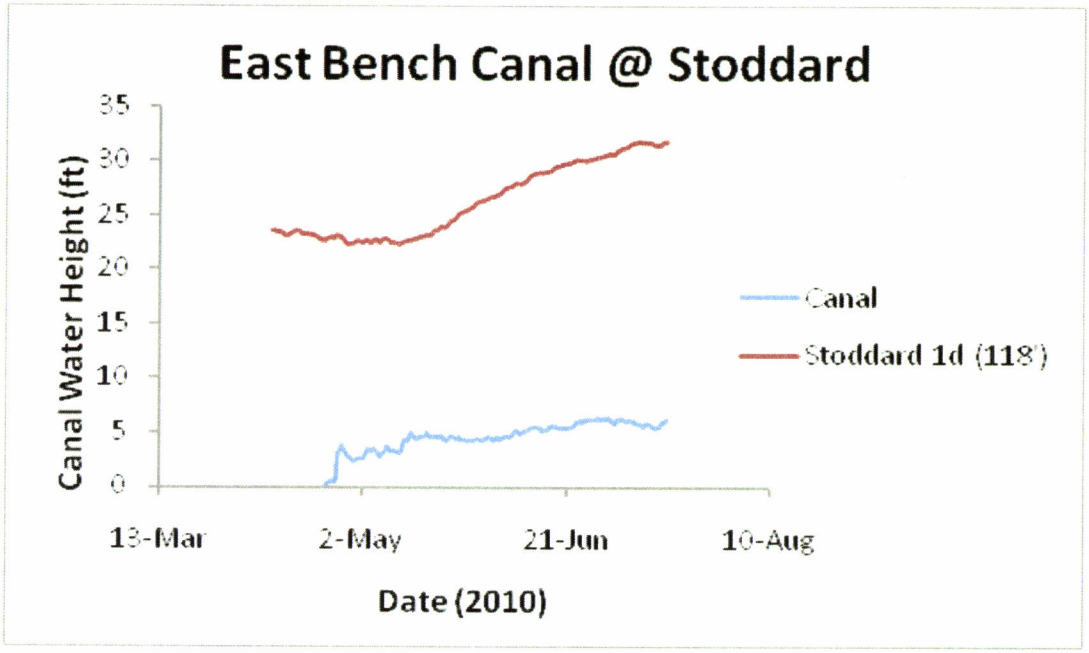
Leakage from irrigation canals is considered one of the potentially significant recharge mechanisms. We are investigating recharge to groundwater from the East Bench Canal and the Westside Canal by:

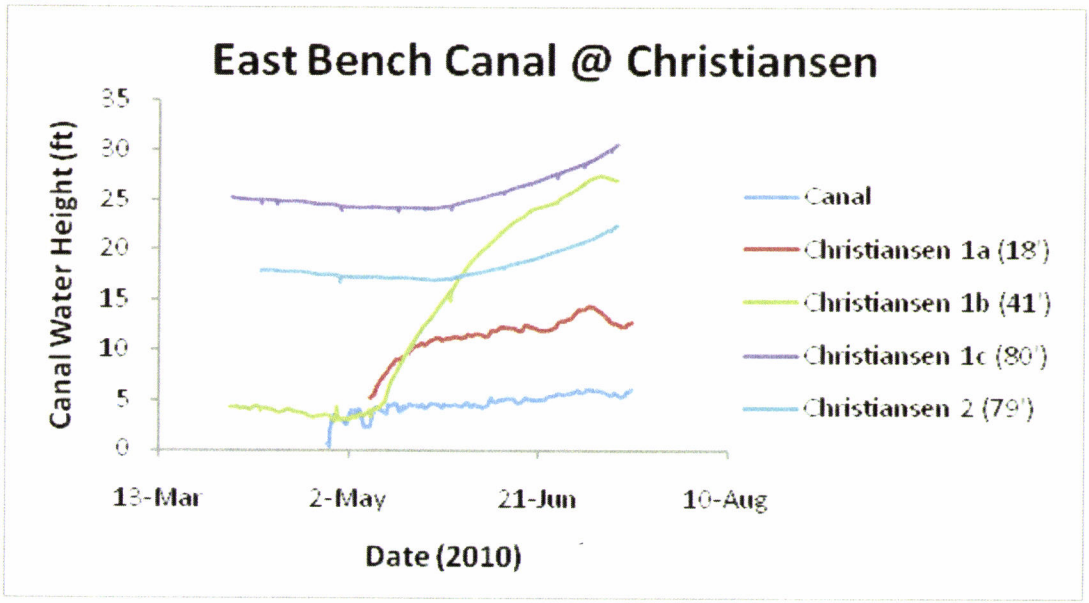
- Installing monitoring wells near the canals in two locations along the Westside Canal and three along the East Bench Canal.
- Instrumenting the canals with staff gages and pressure transducers to record stage levels of water.
- Installing pressure transducers in monitoring with water in them.
- Taking regular (weekly, or bimonthly) recordings of water levels and staff gage readings.
- Collect samples for specific conductivity and stable isotopes (18O and D) weekly or bimonthly.
- Analyze water level, temperature, and chemistry data to see what can be inferred and quantified about groundwater recharge.
- Conducting seepage runs on both canals (ongoing).

CANAL STUDY

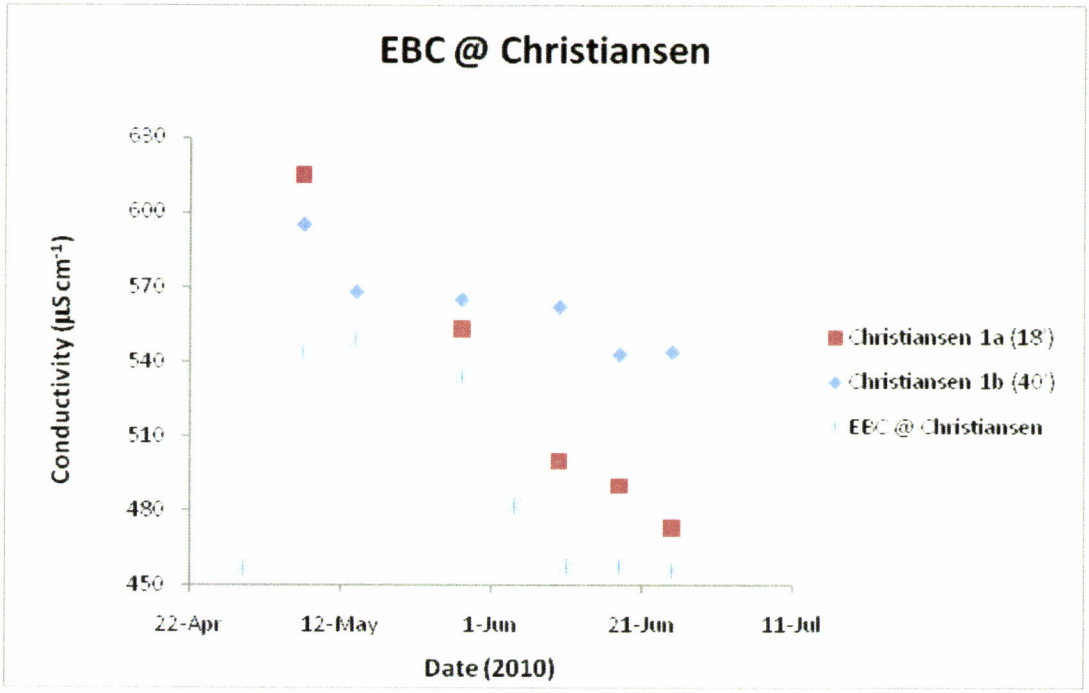


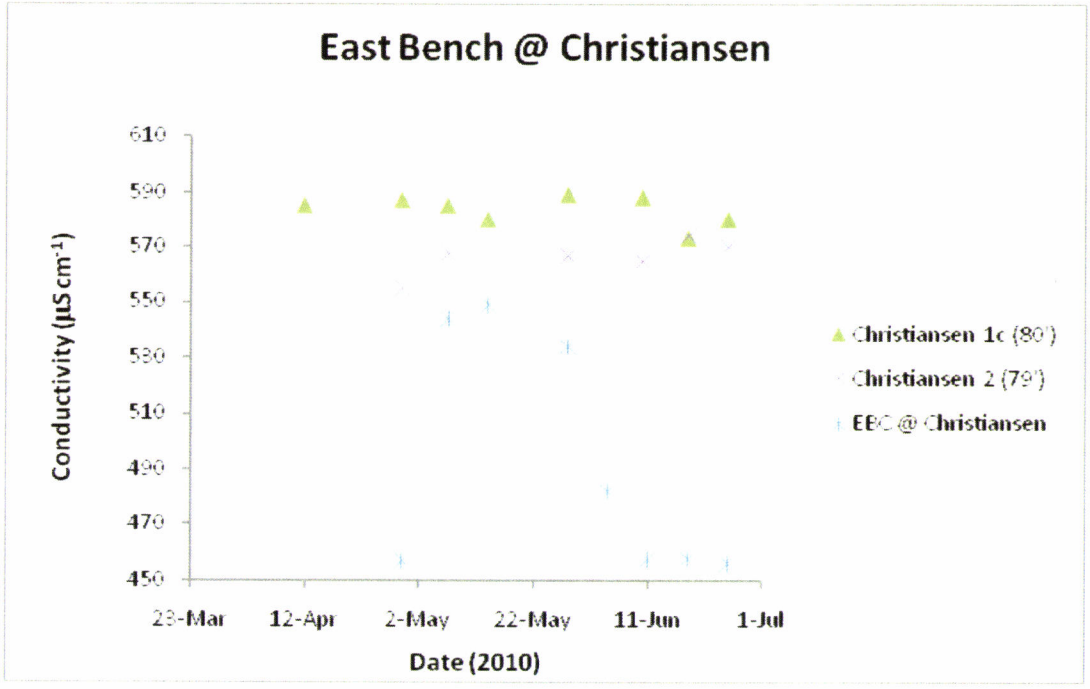
Canal study sites in the Lower Beaverhead River valley north of Dillon.



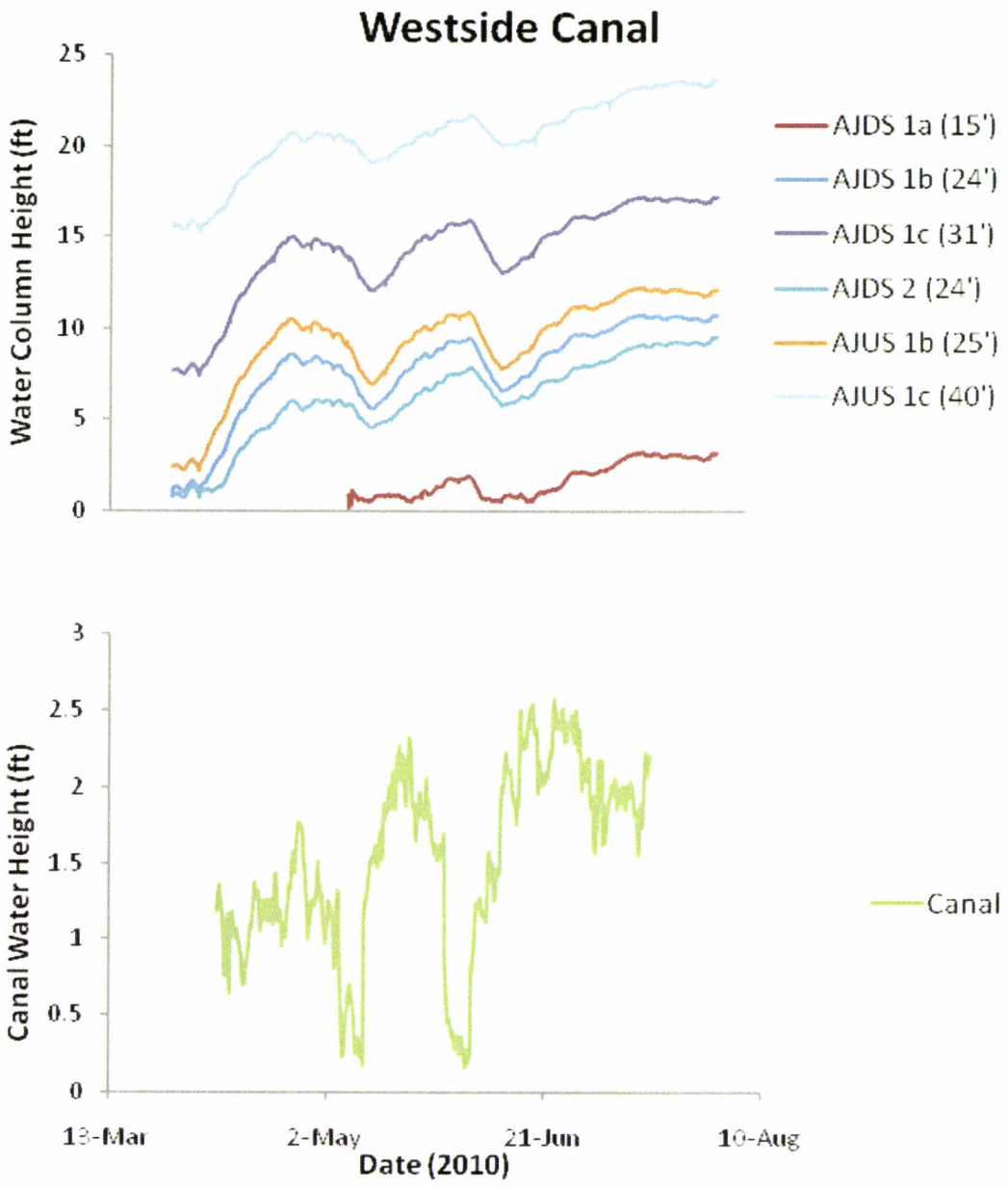


Groundwater levels in monitoring wells respond to water in the irrigation canals.

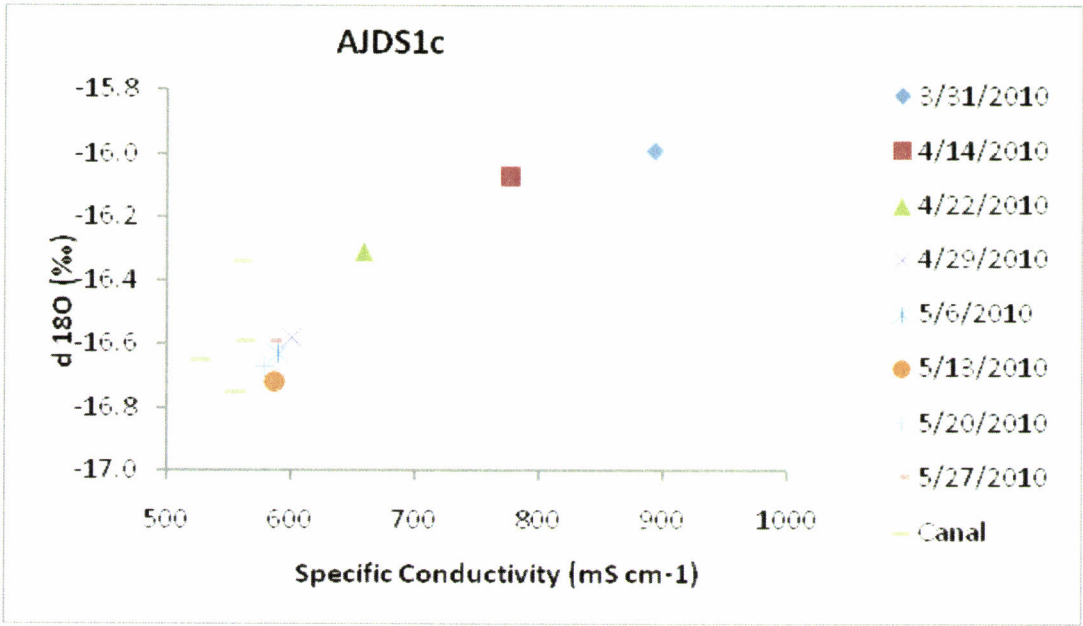




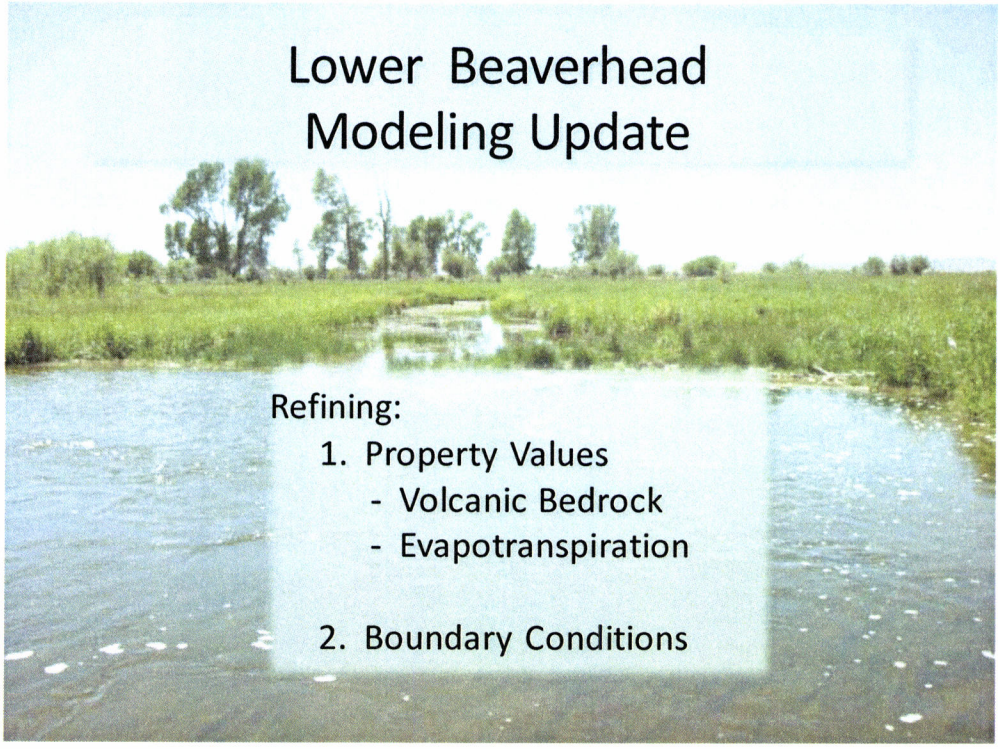
Water quality, indicated here by specific conductivity, shows mixing of canal water with groundwater in shallow monitoring wells and a lack of mixing in deeper monitoring wells within the timeframe shown.



Near the Westside Canal, groundwater-level response to canal flow is nearly instant at all monitored depths.

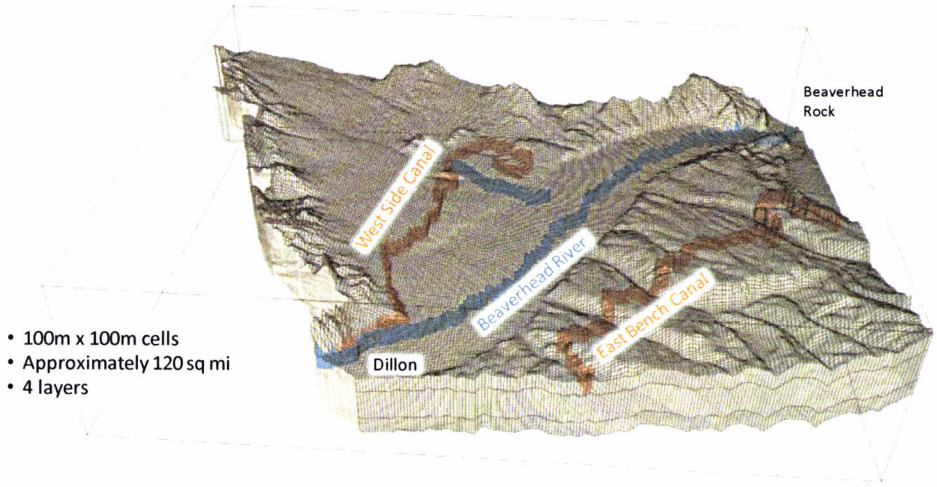


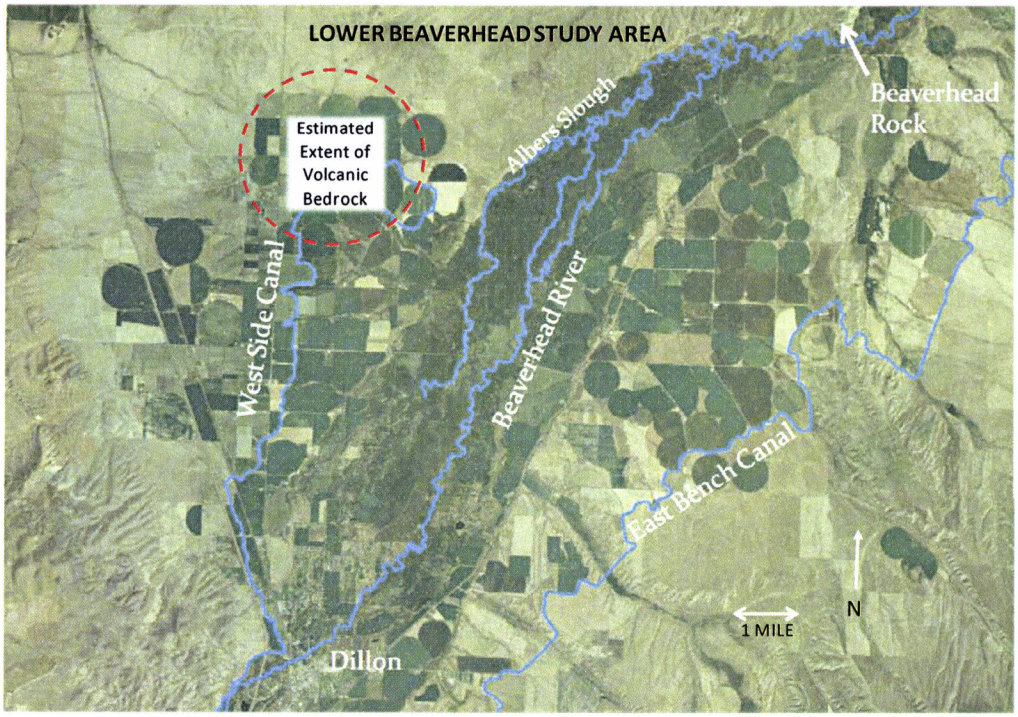
Isotope samples from a 31-foot deep monitoring well adjacent to the Westside Canal indicate mixing of canal water with groundwater.

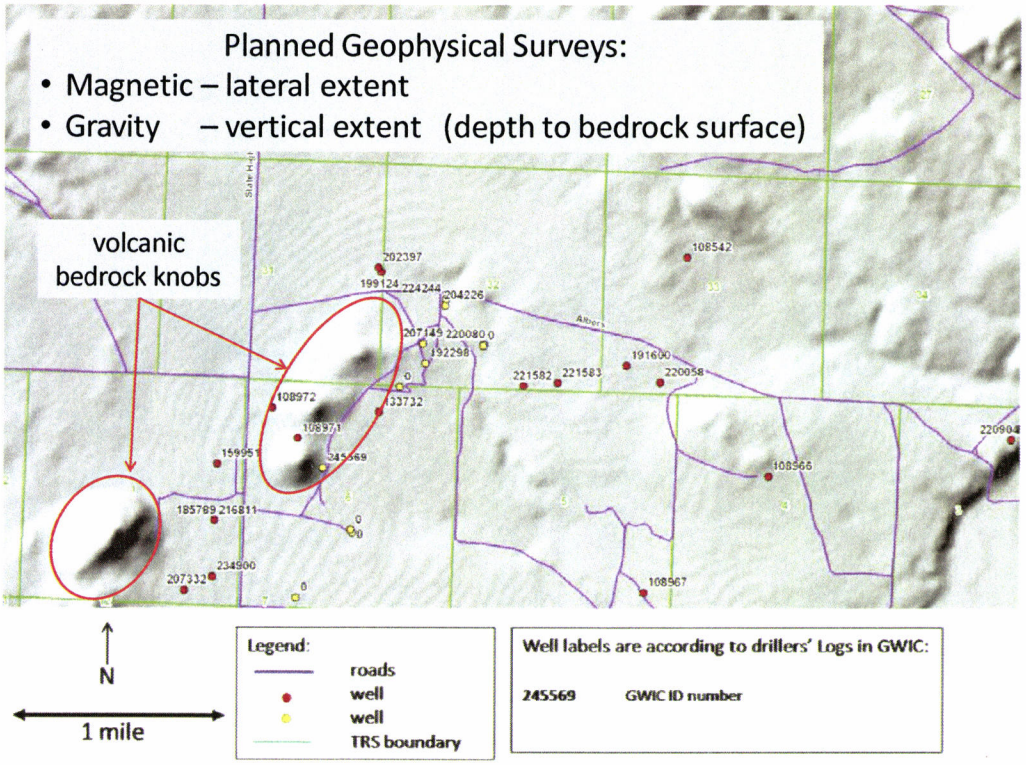


Property Value Refinements:

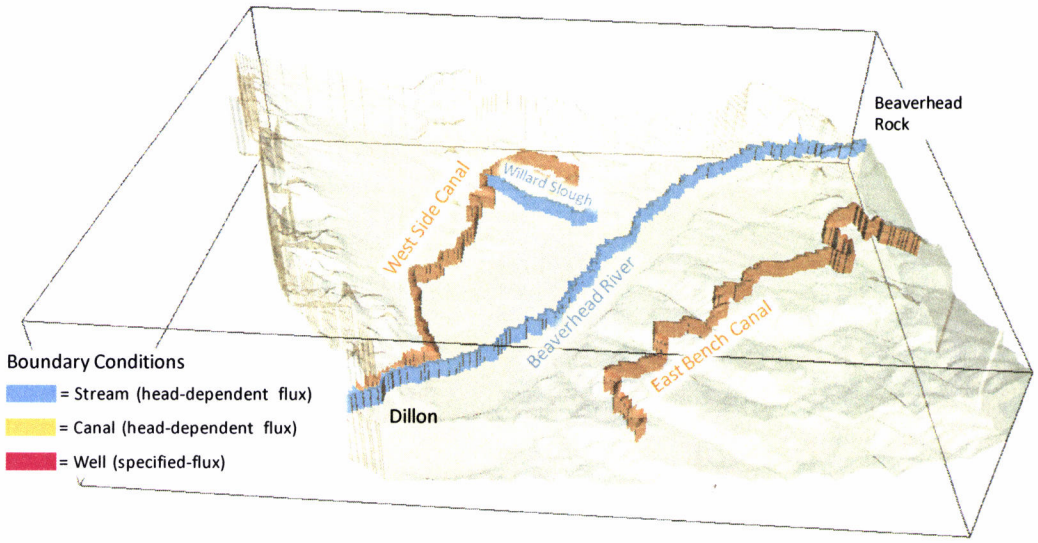
- Aquifer test analysis – 2 tests to date
- Delineate approximate extent of volcanic bedrock (High-K)
- Estimate evapotranspiration rates




LOWER BEAVERHEAD STUDY AREA
Estimated Extent of Volcanic Bedrock
Albers Slough
Beaverhead Rock
West Side Canal
Beaverhead River
East Bench Canal
Dillon
1 MILE
N


Planned Geophysical Surveys:
• Magnetic – lateral extent
• Gravity – vertical extent (depth to bedrock surface)
volcanic bedrock knobs
N
1 mile
Legend:
roads
well
well
TRS boundary
Well labels are according to drillers' Logs in GWIC:
245569 GWIC ID number

Boundary Conditions



REFINEMENT EXAMPLES:

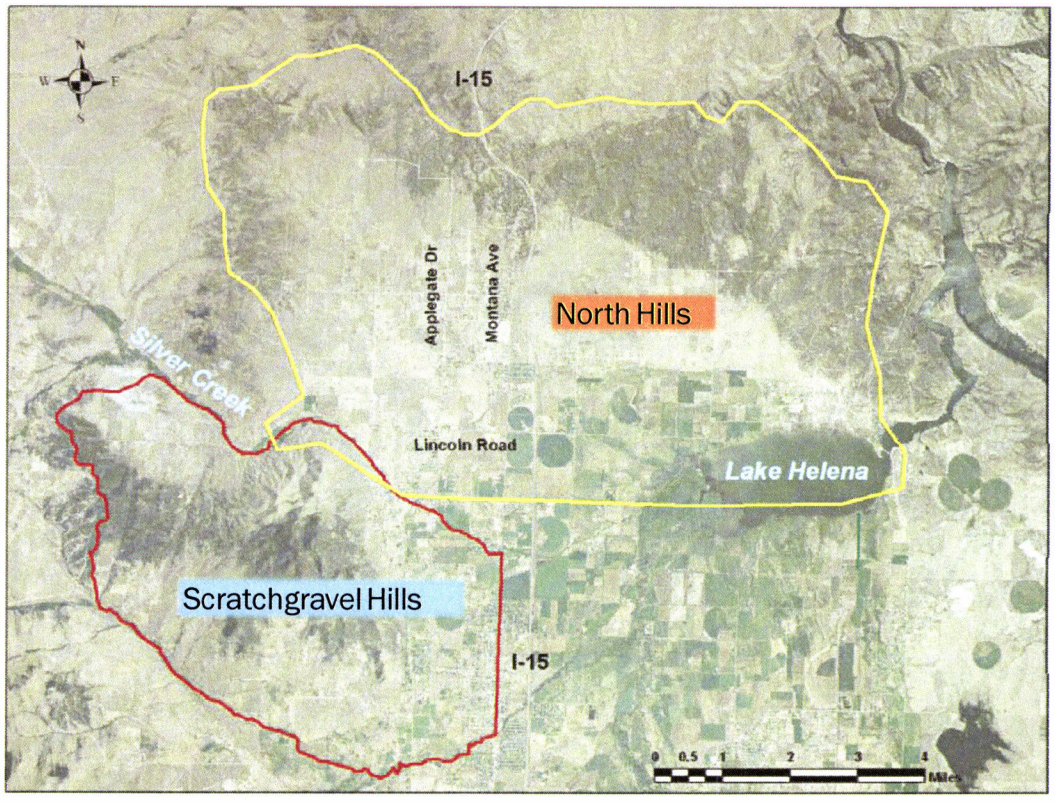
- Sloughs & River: identify losing and gaining reaches

- Canals:
  - estimate seepage rates
  - determine hydraulic connection to groundwater

GROUNDWATER INVESTIGATIONS PROGRAM
HELENA AREA PROJECTS

NORTH HILLS
SCRATCHGRAVEL HILLS

Kirk Waren
Andy Bobst
Julie Ahern
Jane Madison
Allie Brown



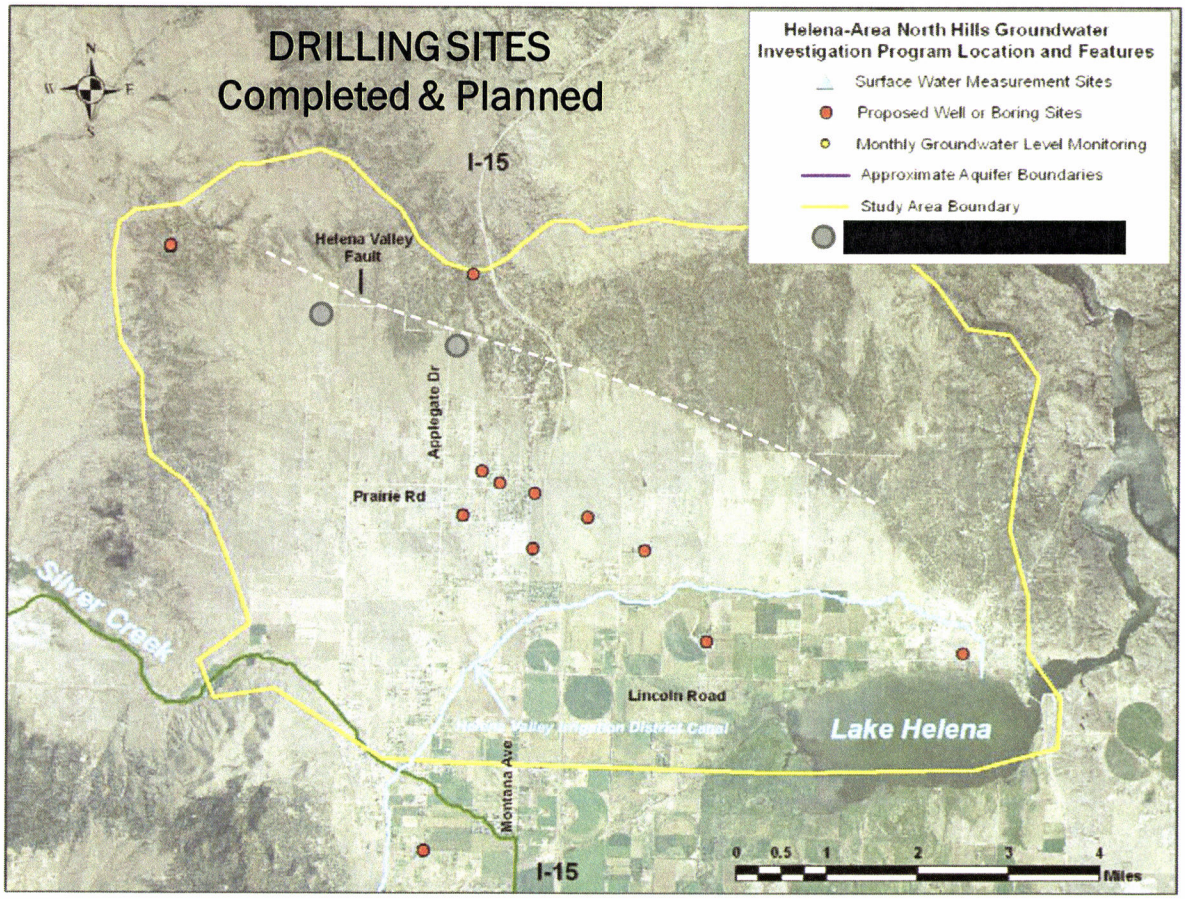
DRILLING PURPOSES

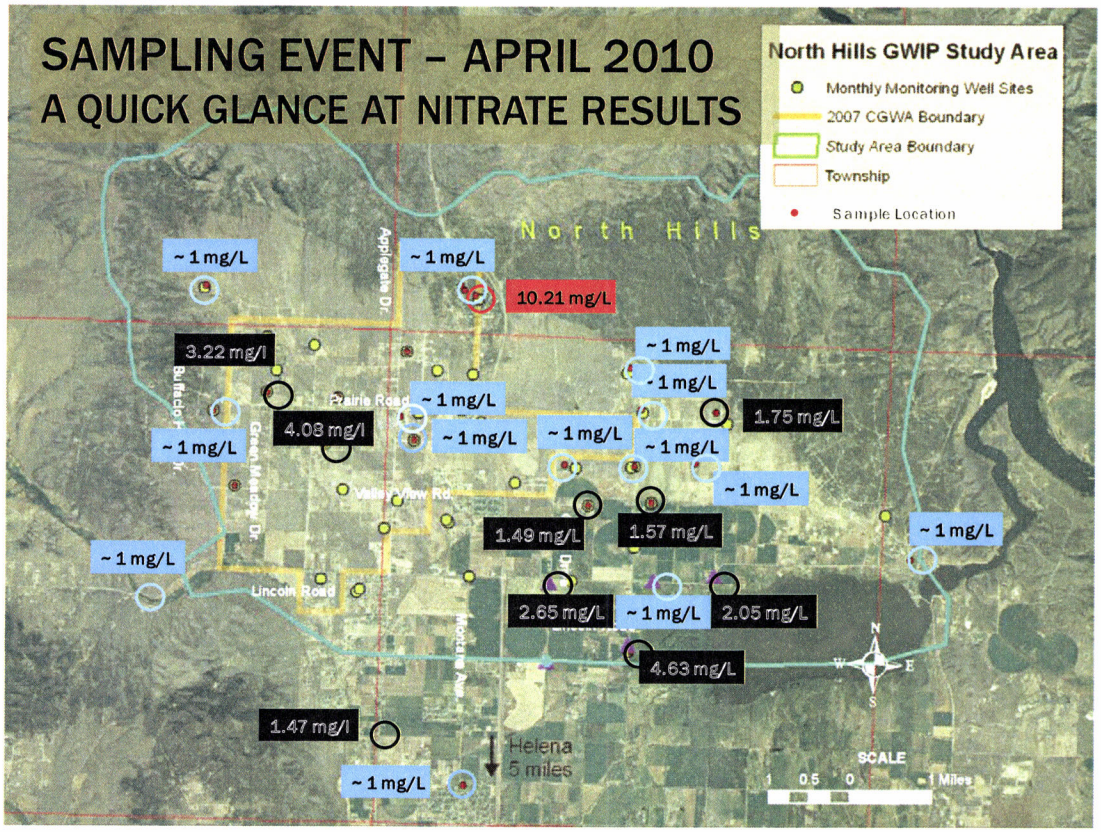
Borings:

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

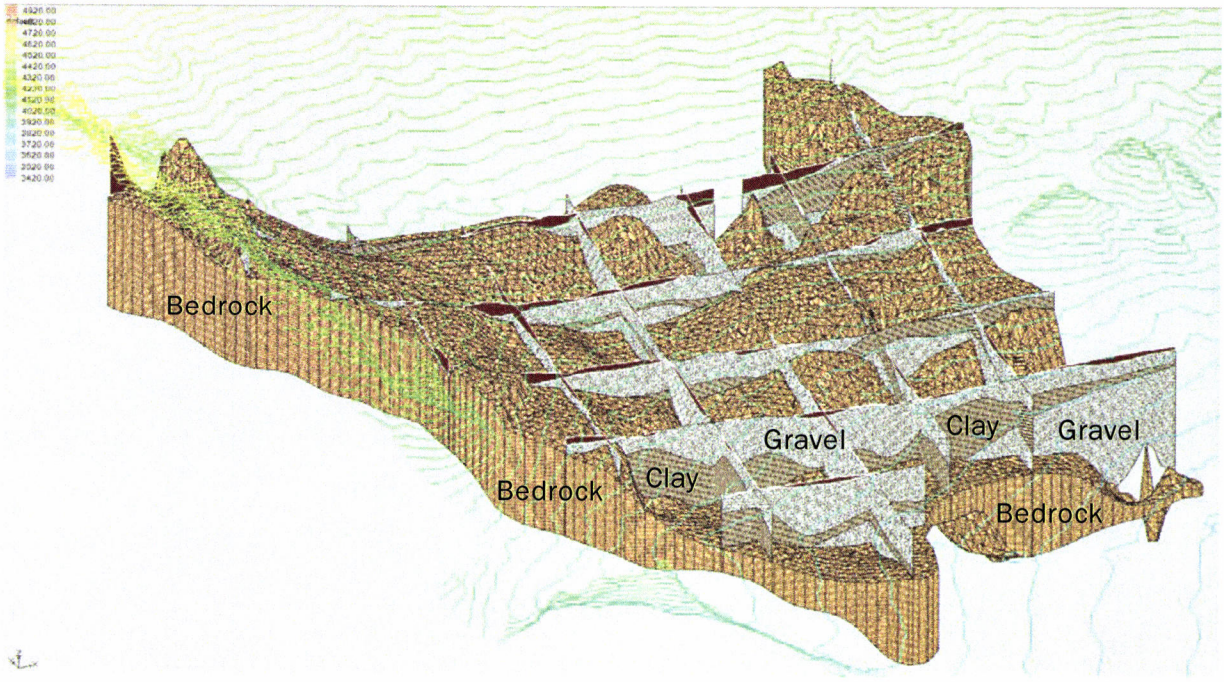
Wells:

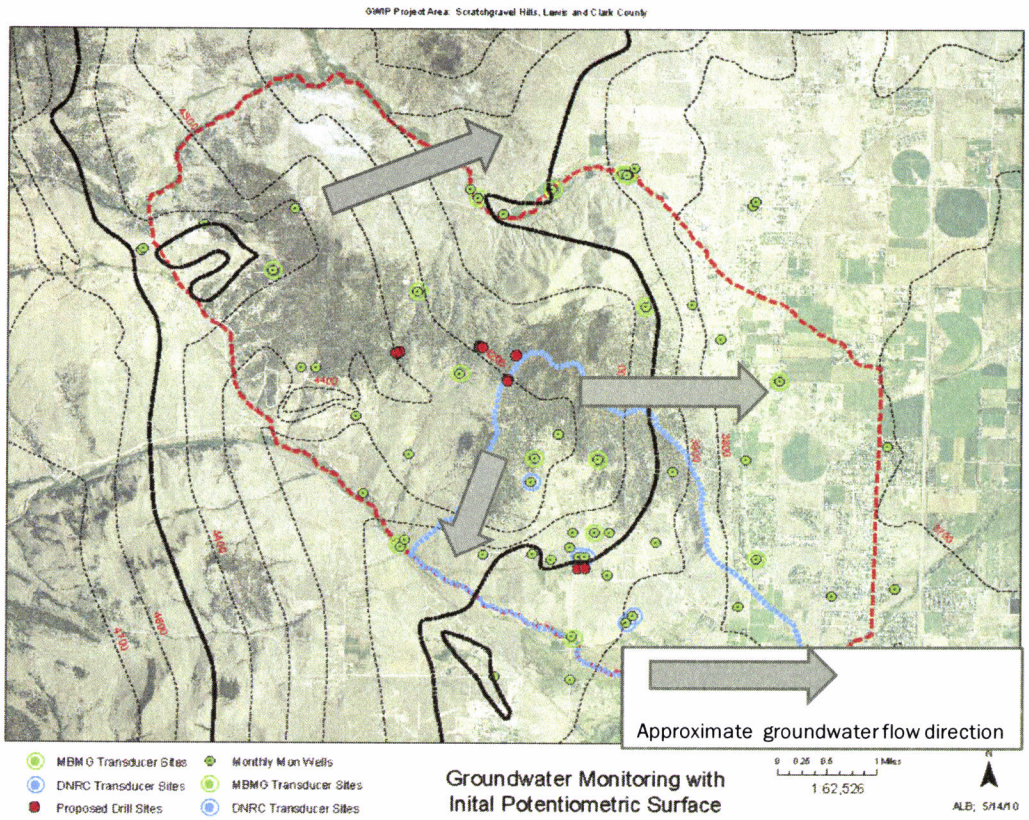
1. Monitor areas of declining water levels
2. ID & measure degree of vertical gradient
3. Aquifer testing
4. Data in areas where no previous wells extisted





THREE DIMENSIONAL INTERPRETIVE PRODUCTS ARE BEING DEVOLOPED USING REPORTED WELL LOG DATA AND THE ADVANCED GROUNDWATER MODELING SYSTEM (GMS) SOFTWARE

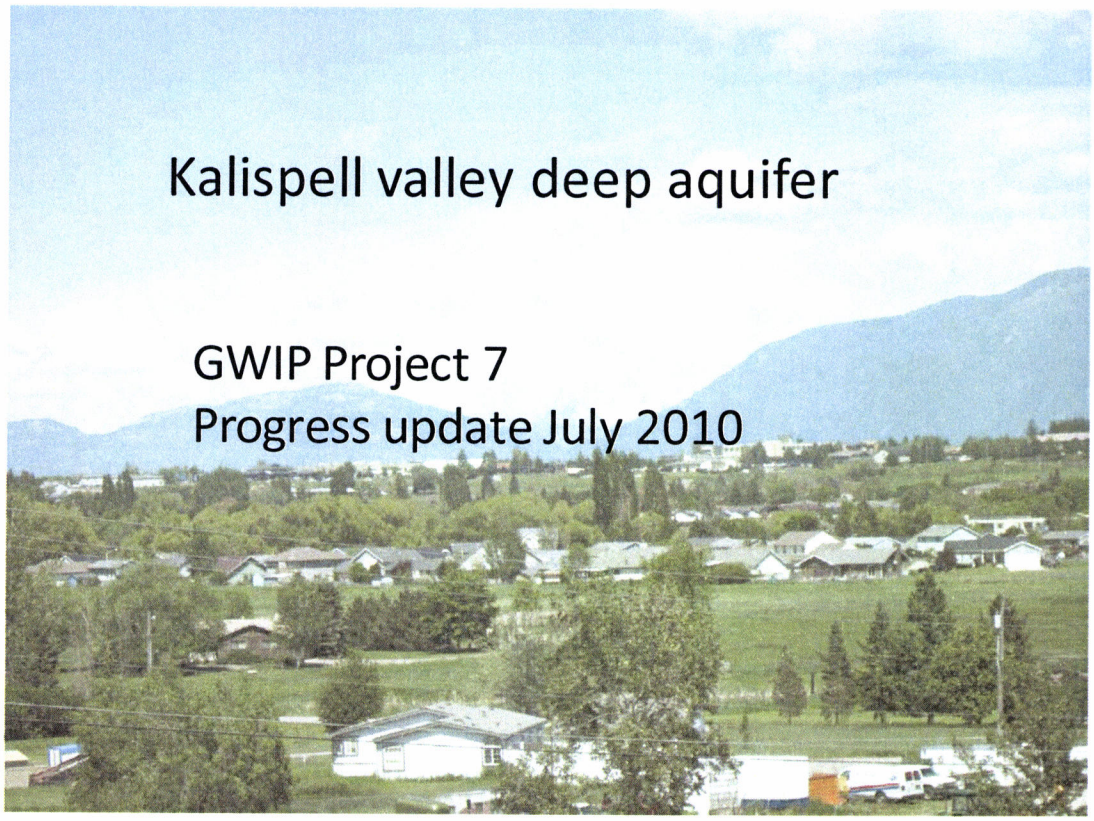




SUMMARY – HELENA AREA PROJECTS

Work To Date

- Data Review & Evaluation
- 4 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



Developing Tasks

- Attempt to determine the amount of mountain front recharge the deep aquifer receives.
- Define the relationship and interaction of the Swan River valley water to the Kalispell valley deep aquifer. This involves understanding the relationships between surface water, pothole lakes, springs, shallow ground water, deep groundwater and the geologic controls on the system.
- Constructing cross sections of the valley geology using well logs and GMS modeling software. This information will be used in constructing a flow model.

Isotope sampling and analysis

The isotopes sampled for this project are all derived from the atmosphere and have been trapped in precipitated water at the time of deposition.

- **Oxygen ^{18}/ Deuterium (^{2}H) ratio**- Oxygen-18 and deuterium concentrations occur in the atmosphere in known concentrations. Variations from these relative concentrations can occur from condensation from the atmosphere at colder temperatures, such as mountain top snowfall, or from evaporation at lower elevations and warmer temperatures. The data from these analyses can assist in determining the source and flow path of recharge water.

- **Tritium (^{3}H)**- A radioactive isotope of hydrogen formed in the atmosphere from above-ground nuclear bomb testing from 1950's through 1963. Ground-water samples with tritium values >1.0 TU (tritium units) were precipitated from the atmosphere within the last 50 years. Ground water containing values <1.0 TU were probably deposited prior to 1950.

Noble Gases- Helium, Neon, Argon, Krypton, Xenon.

- Noble gases are present in atmospheric water in concentrations equal to that of atmospheric air. The gases are transported into the ground water through precipitation.

- Relative concentrations of (all) the noble gases extracted from ground water samples may help determine the temperature of deposition by precipitation and thus provide some indication of the elevation at which recharge occurs (valley bottom or mountain tops).

- Noble gases in ground water will also give an indication of multiple-recharge sources, such as: direct infiltration of precipitation, mountain front streams, bedrock infiltration, rivers, and/or other aquifers, or some combination.

- Noble gas concentrations along with Tritium/Helium-3 ratio can more accurately refine the time period estimate since ground-water recharge.

- Noble gases are increasingly being used to determine the amount of recharge from mountain front sources (such as the Swan Range at Kalispell).

Lost Creek flows east from bedrock (top) to Flathead valley margin (bottom) and loses its entire flow.

Kettle ponds (such as the one at top) may be significant recharge sites for springs like the one at Creston Fish Hatchery (bottom). This is one of at least 20 springs feeding the Jessup Mill Pond.

GWIP FUTURE TO FINISH THIS BIENNIUM AND PREPARE FOR THE NEXT ROUND OF PROJECTS

Next:

Emphasis is on interpreting the data, moving toward models and report writing.

Prepare projects for the next biennium with the Ground Water Assessment Steering Committee