HIGH RESOLUTION GROUNDWATER AND SURFACE WATER CHARACTERIZATION: ADVANCED TECHNIQUES TO IMPROVE CONCEPTUAL SITE MODELS

BONITA PEAK MINING DISTRICT OU2

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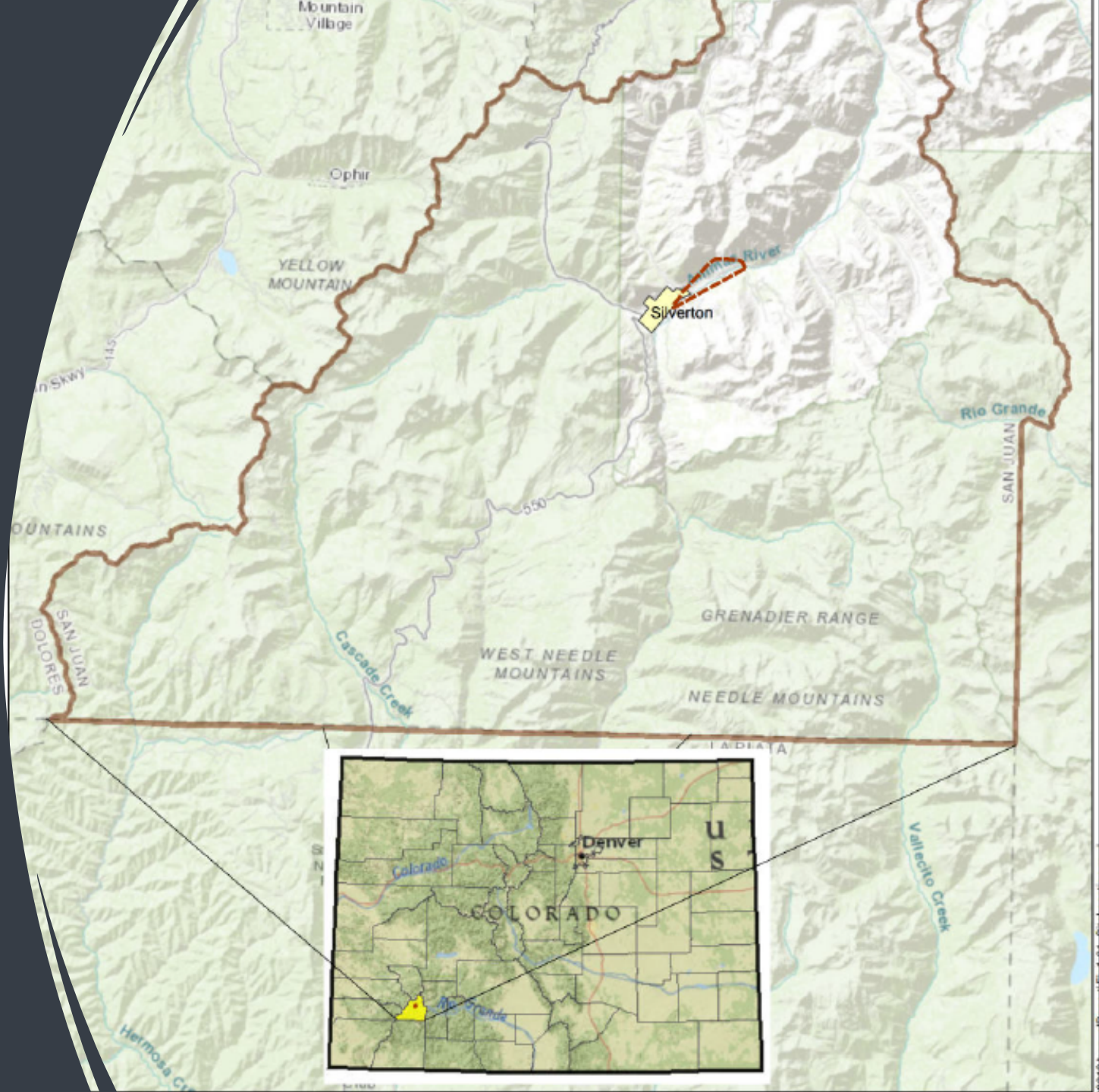
OUTLINE

- Site History
- Existing Data
- Data Needs
- Geophysical Approach
- Results
- CSM Updates
- Next Steps

BONITA PEAK MINING DISTRICT OU2

- Large Mill and mine waste repository
- Adjacent to Animas River
- 1929-1991



IMPOUNDMENTS

- 4 IMPOUNDMENTS
- IMPOUNDMENT 1 BUILT IN 1935
- IMPOUNDMENT VIA SLURRY

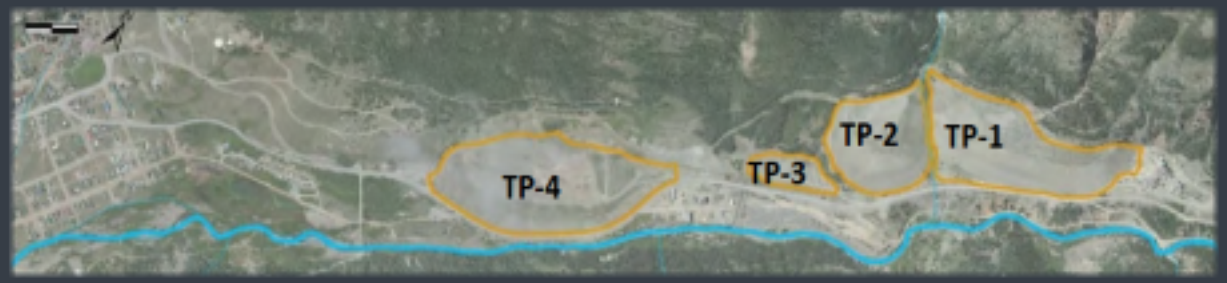
GROUNDWATER SYSTEMS

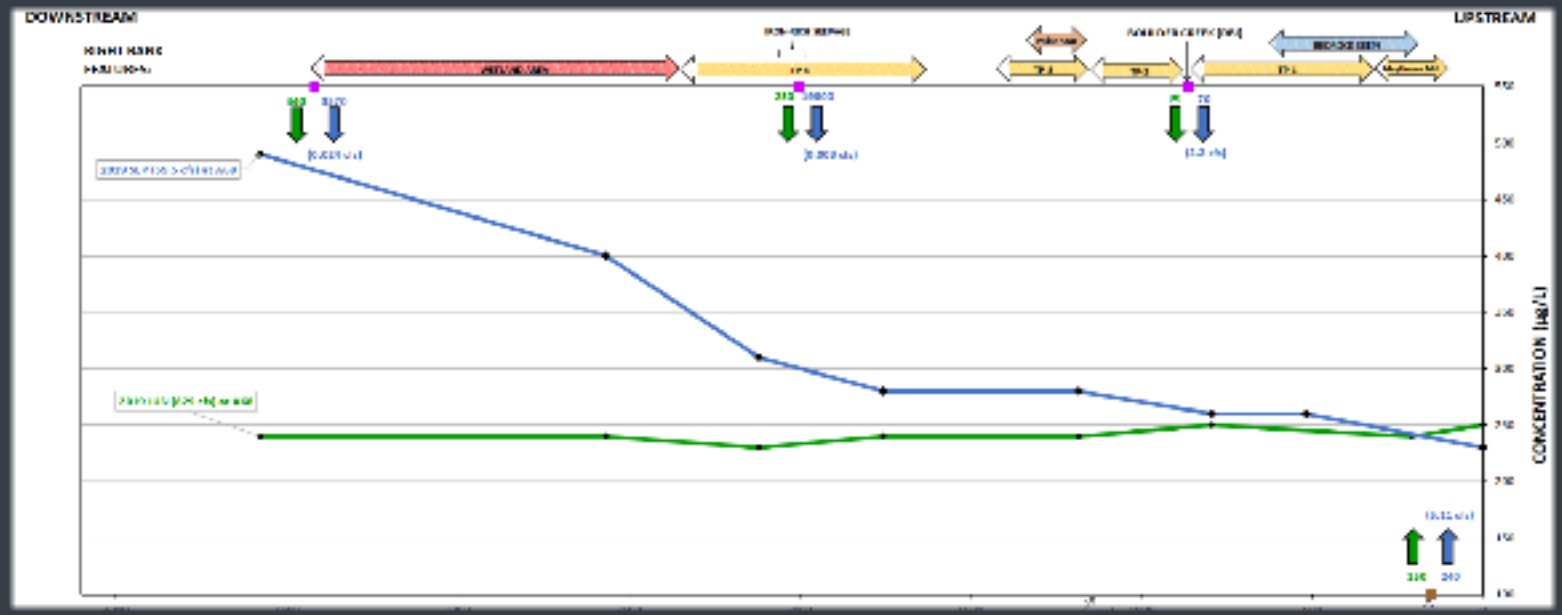
- 3 AQUIFERS
- ALL LIKELY DISCHARGE TO SURFACE WATER
- NUMEROUS SIGNIFICANT SEEPS

EXISTING DATA

SURFACE WATER ZINC CONCENTRATIONS

- SITEWIDE RISK DRIVER
- OVERALL GOAL TO DECREASE ZINC LOAD IN RIVER
- CONCENTRATIONS INCREASE NEAR OBSERVED SEEPAGE

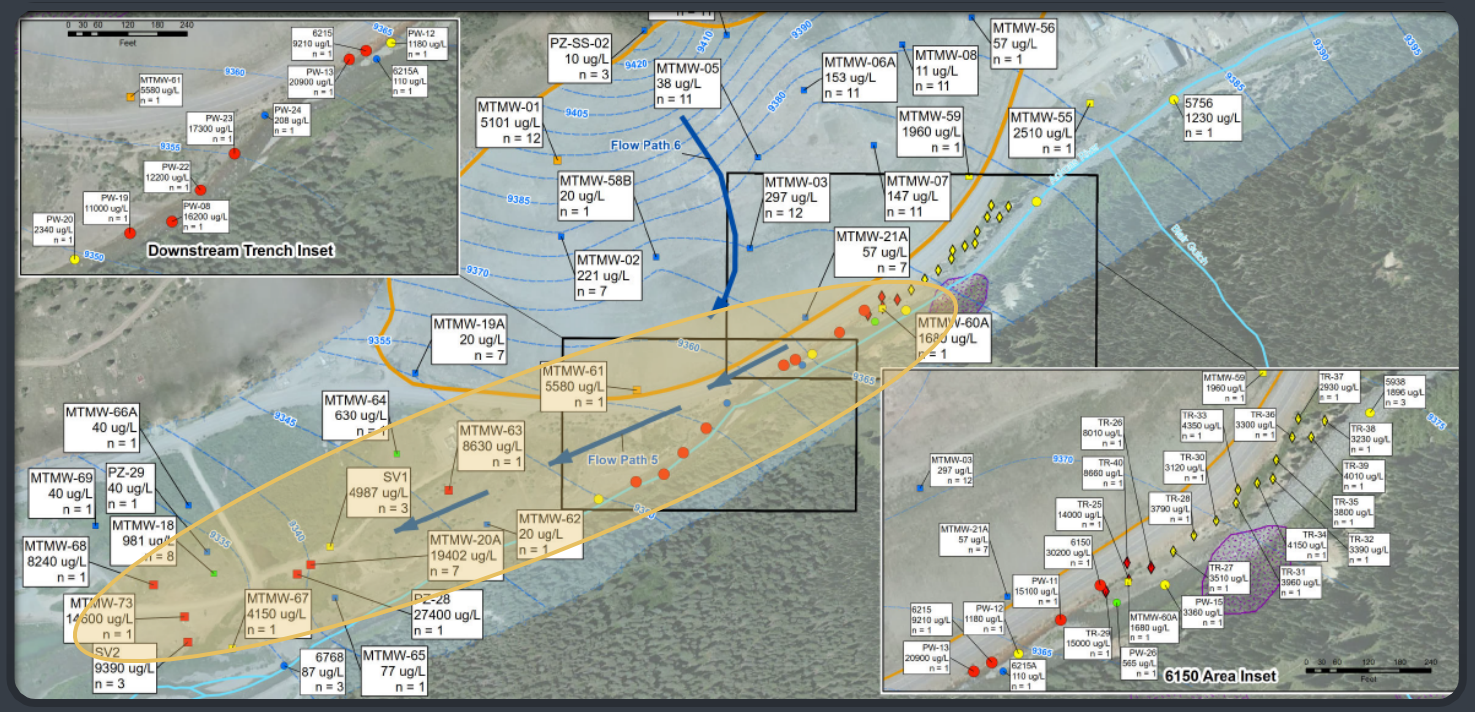


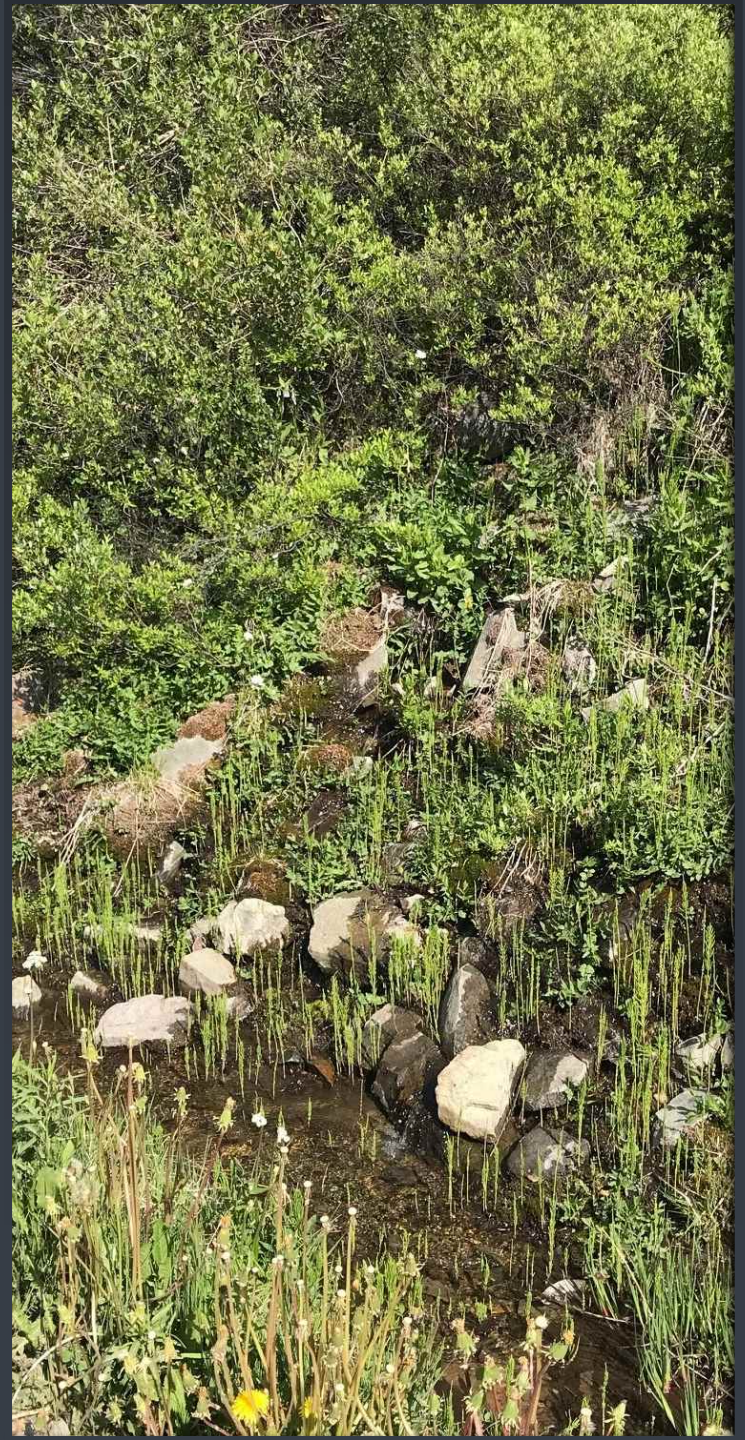


FLOW

GROUNDWATER & POREWATER ZINC CONCENTRATIONS

- GREATEST GROUNDWATER IMPACTS ALONG PREFERENTIAL PATHWAYS
- POREWATER IMPACTS NEAR KNOWN SEEPS



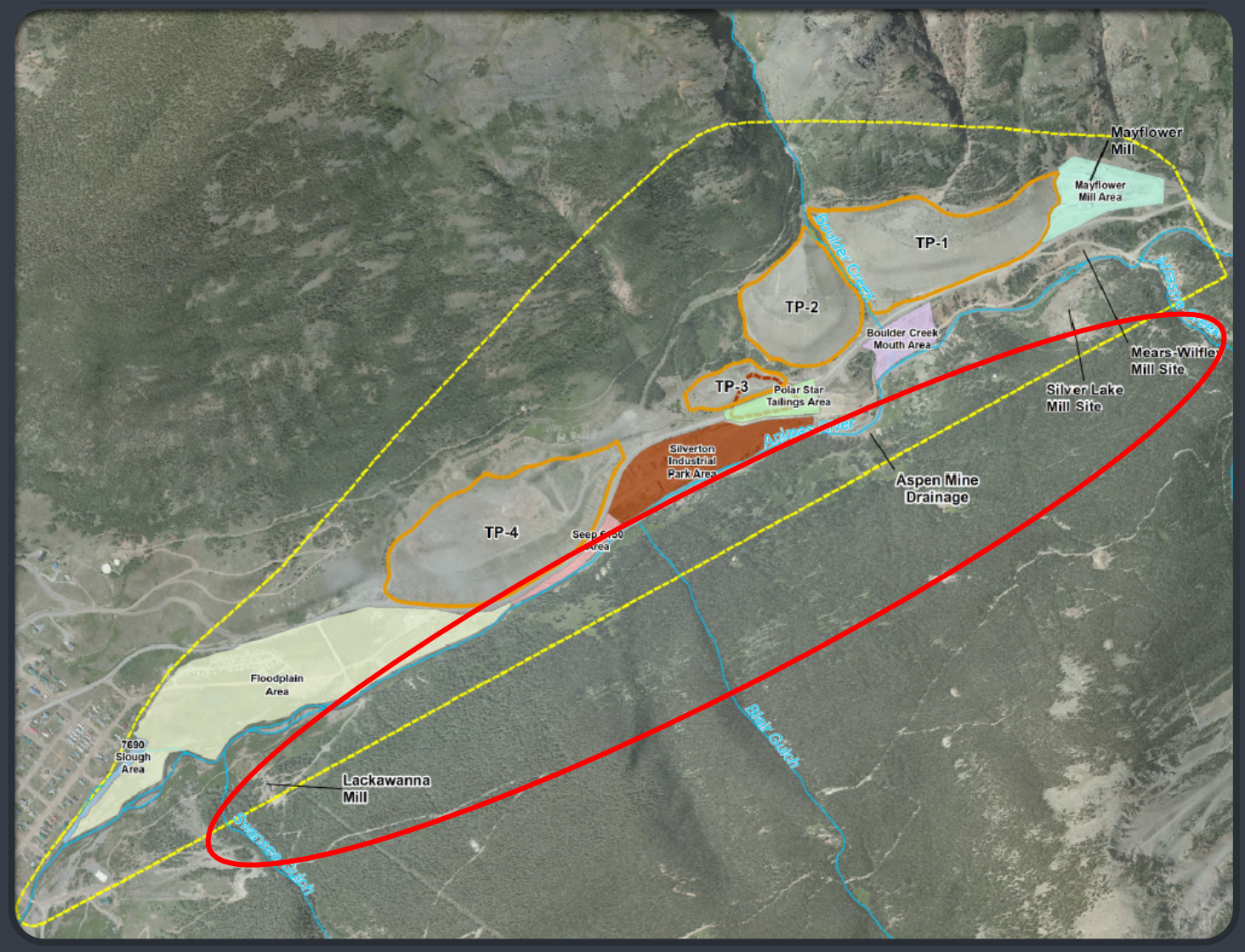


DATA INDICATING GW/SW MAY BE SIGNIFICANT

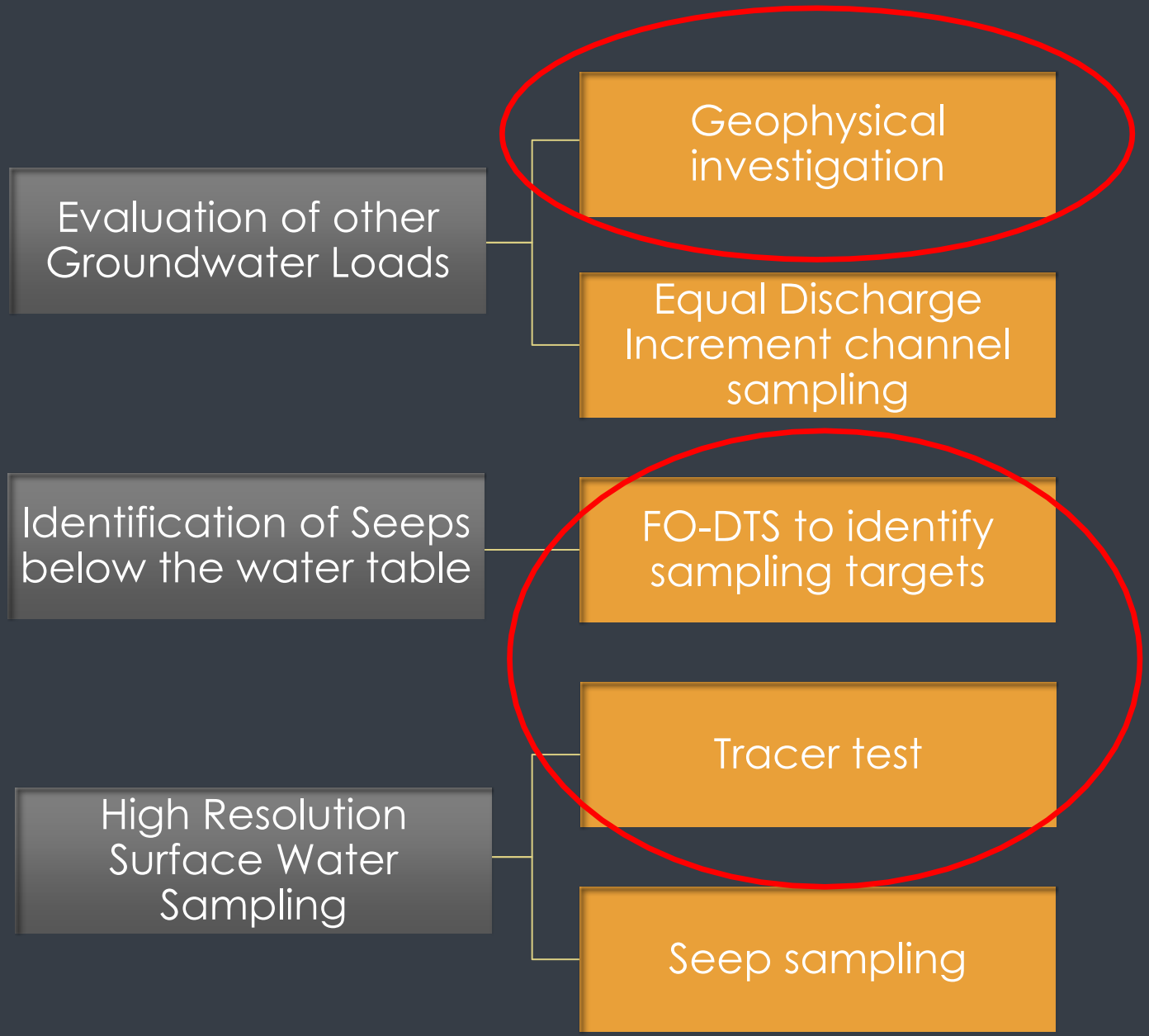
- Proximity
- Site History
- Faulting and fractured bedrock
- Seeps
- GW Potentiometric surface maps
- Surface Water Loading Profiles
- Groundwater Concentration Maps

OTHER CONSIDERATIONS

- Other potential sources exist in study area
- Natural loading may be high (Background)
- Limited impacts in GW below impoundments



DATA NEEDS


Evaluation of other Groundwater Loads
Identification of Seeps below the water table
High Resolution Surface Water Sampling
Geophysical investigation
Equal Discharge Increment channel sampling
FO-DTS to identify sampling targets
Tracer test
Seep sampling

Geophysical Characterization Approach

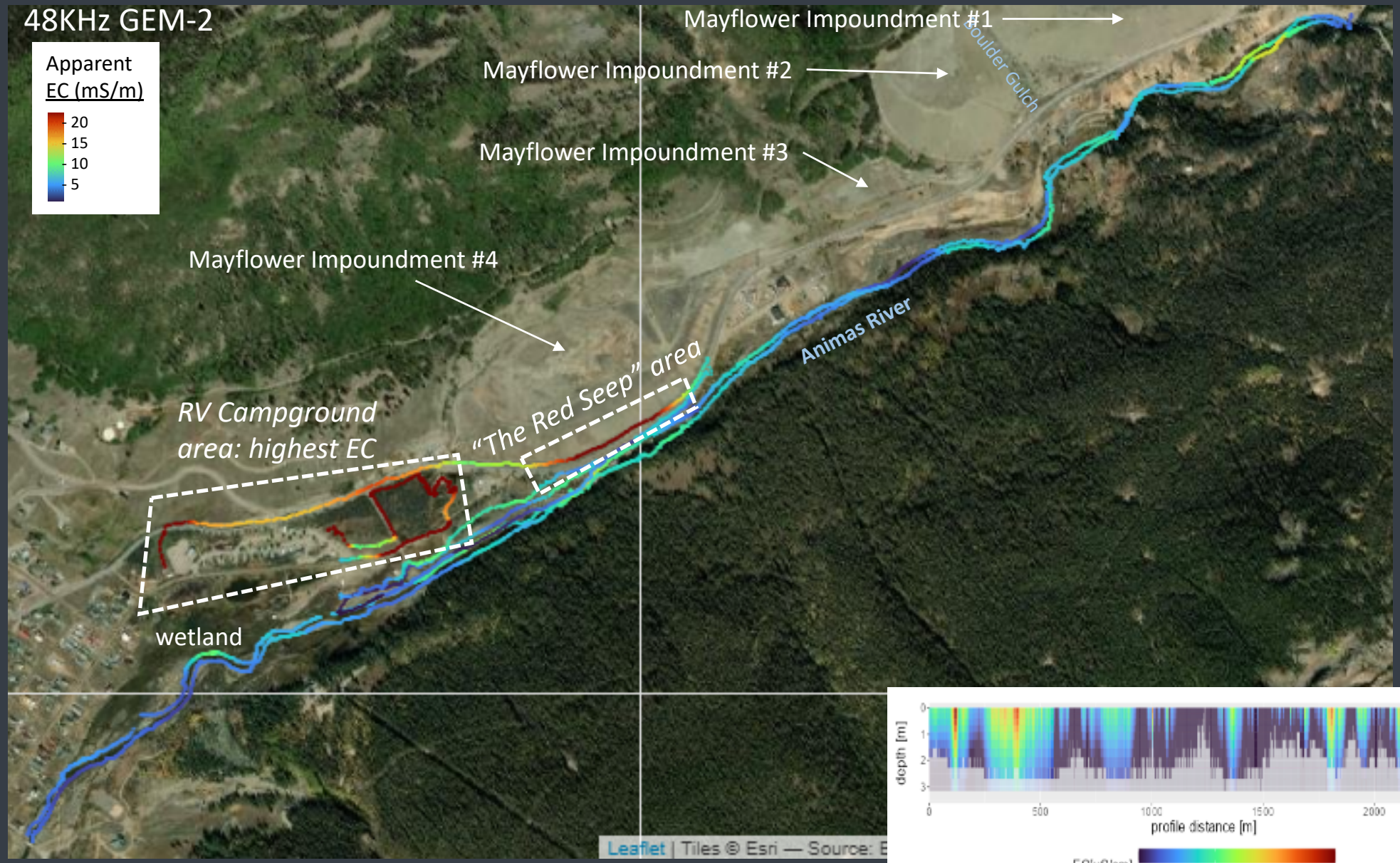
EM and Mag

- White survey lines
- Bridge to Impoundment #1

FODTS

- Green (right bank) and red (left bank – looking downstream) survey lines
- ~ 3 km reach from Arrastra Gulch to the Old Lackawanna Bridge.
- 3 x 1 km of each bank monitored for ~ 2 days each

EM Results & Interpretation



- Highest EC downgradient from Mayflower Impoundment #4
- Elevated EC along riverbanks possibly due to groundwater input: low pH, higher TDS, higher ionic content = higher EC

GEM-2 inversions did not help to reveal vertical EC structure in this area

Magnetic Field Results & Interpretation

Higher magnetic field intensity observed:

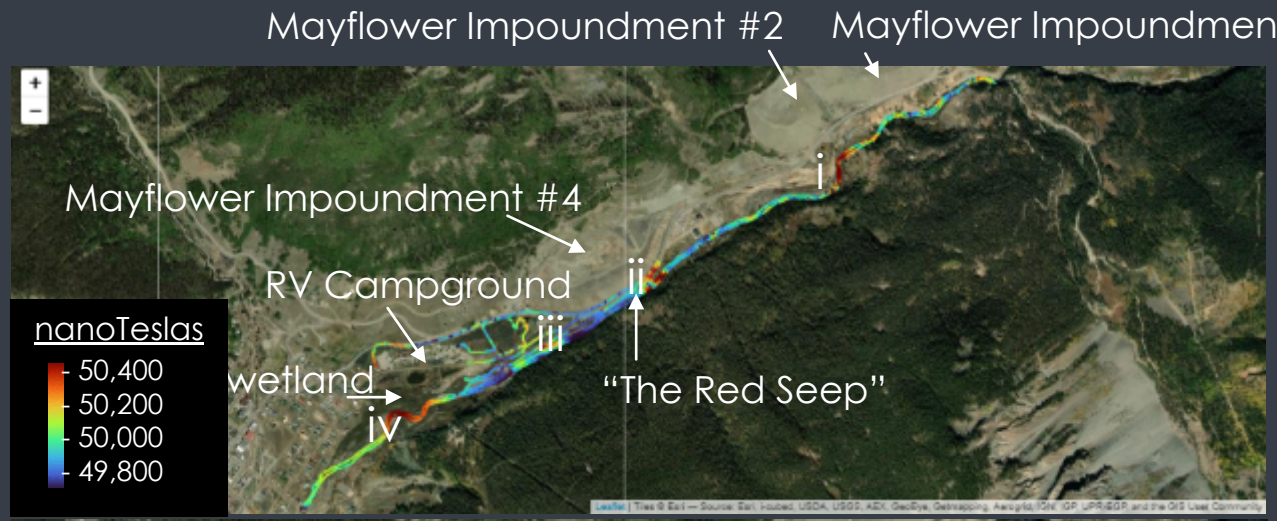
(i) downriver from Boulder Gulch (flows btwn Impoundments 1 and 2).

(ii) upriver from the Red Seep and upgradient of Impoundment 4

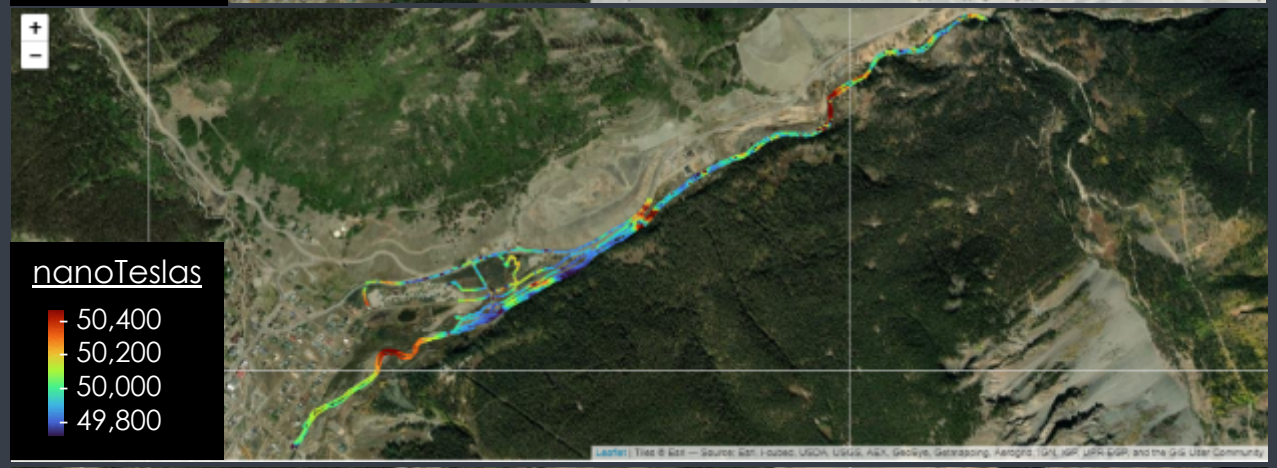
(iii) downgradient of the Red Seep; ~ aligned with the western edge of Impoundment 4

(iv) wetland on right bank; old Lackawanna mill upgradient on left bank.

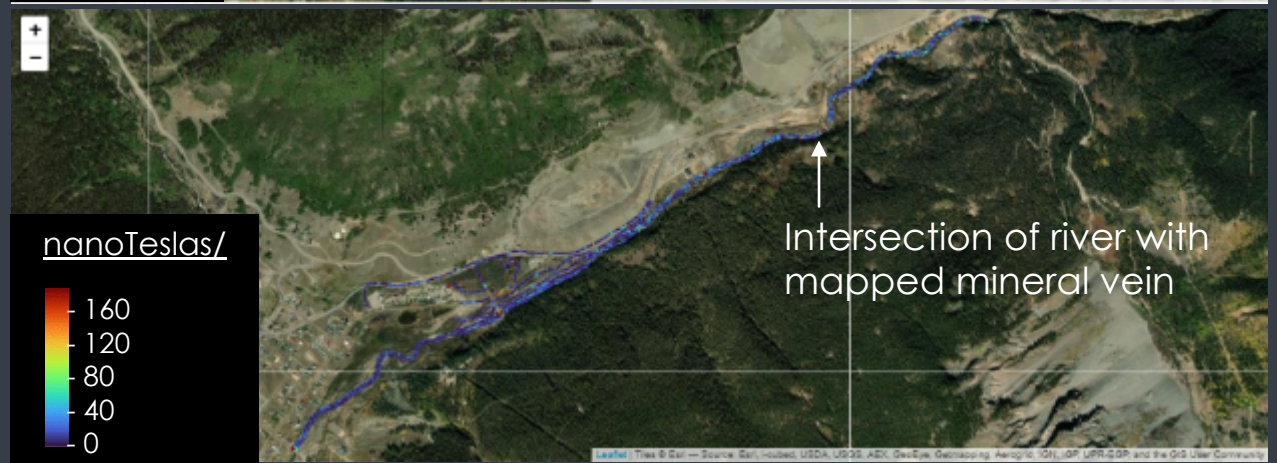
- Highs due to ferrous material or electrical infrastructure
- Highs observed at one of the two mapped mineral veins



Top sensor



Bottom sensor



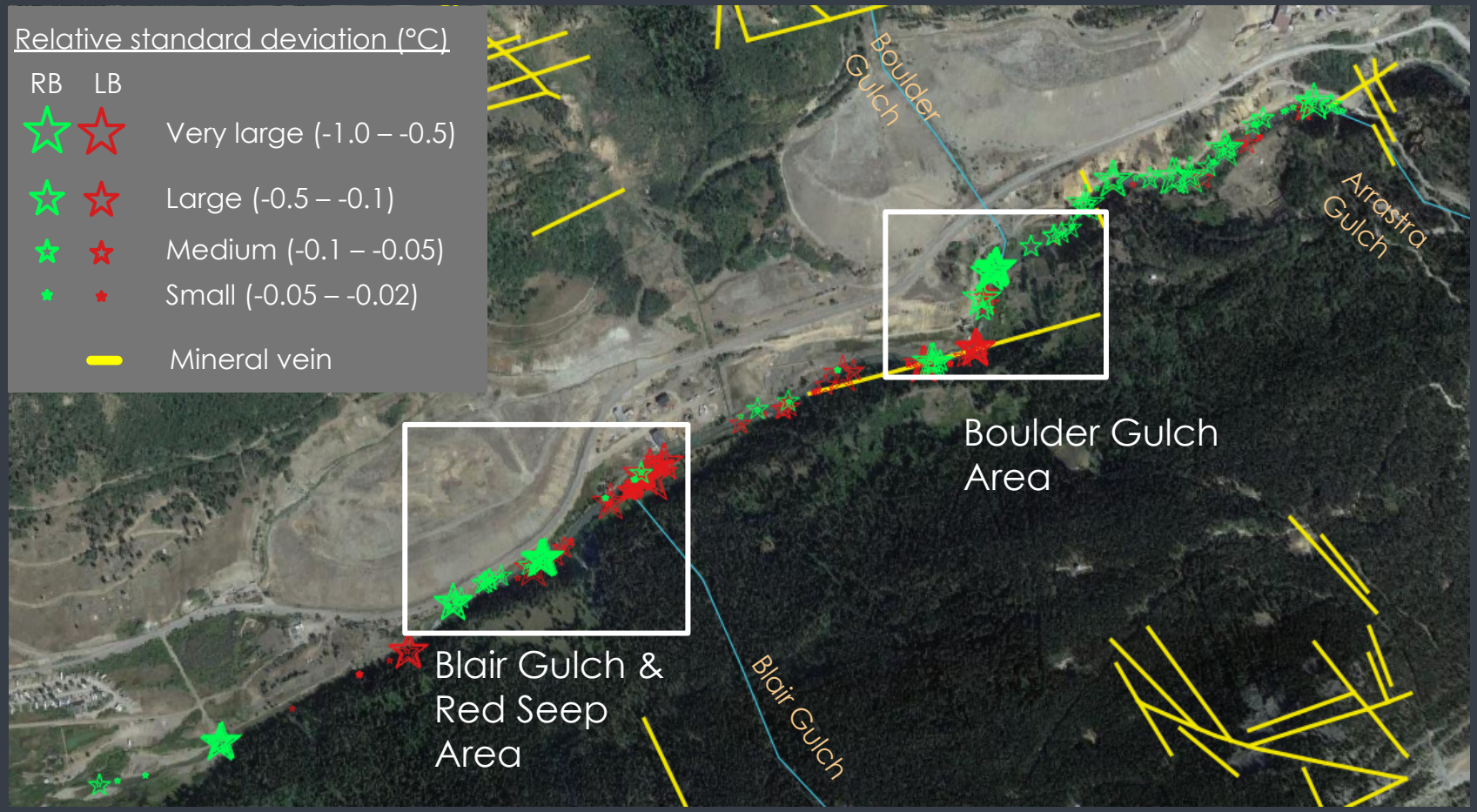
Vertical Magnetic Field Gradient

FIBER OPTIC-DISTRIBUTED TEMPERATURE SENSORS

- Temperature can affect glass fibers and locally change light transmission characteristics of the fiber
- Gives nearly continuous temperature measurements
- Data collected over time can Identify areas of enhanced seepage

FODTS RESULTS & INTERPRETATION

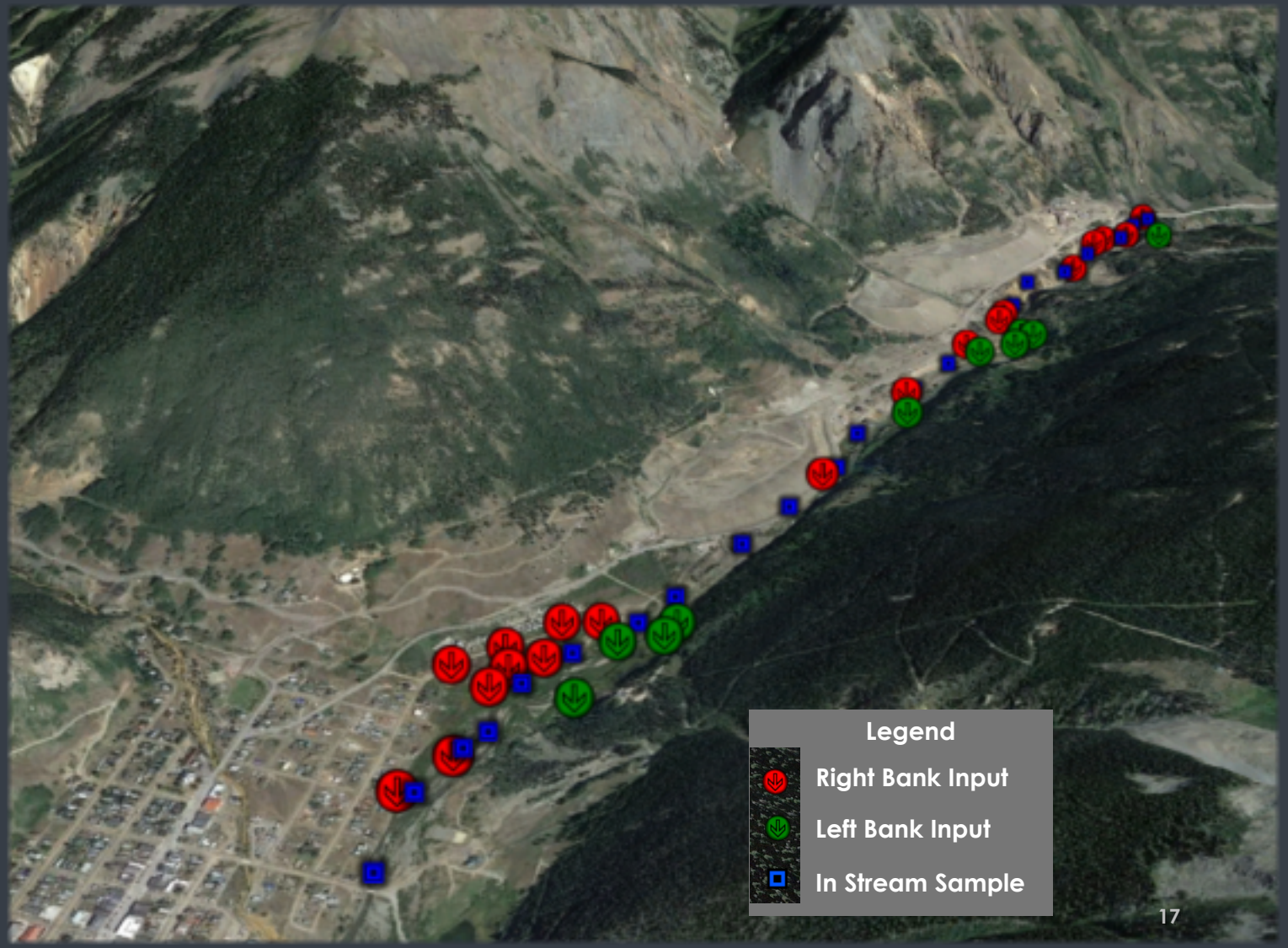
Relative groundwater discharge based on FODTS temperature standard deviation anomalies.



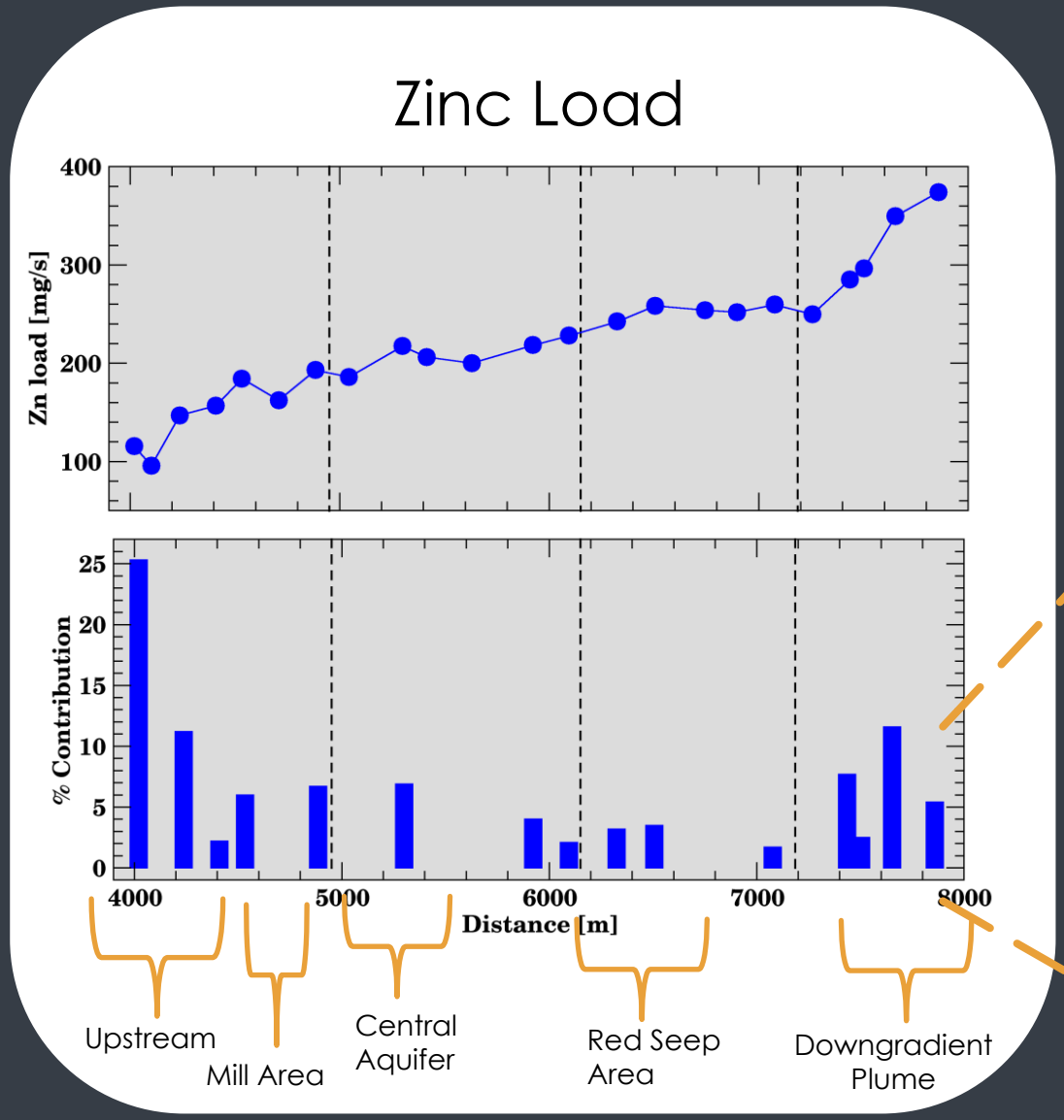
- Numerous temperature anomalies identified likely to be areas of groundwater discharge. Many are known seeps.
- Temperature anomalies decreased in density downriver, suggesting less groundwater input downriver.

TRACER TEST SAMPLING LOCATIONS

- CONSTANT TRACER INJECTION RATE
- BROMIDE
- DILUTION USED TO DETERMINE FLOW



TRACER TEST RESULTS



UPDATED CSM

- Multiple lines of evidence suggest Impoundment 4 impacts GW and SW
- Mineral veins likely preferential GW discharge zones
- GW seeps are more prevalent above Impoundment 4
- Downgradient metals plume likely discharges to river at downgradient boundary of study area

NEXT STEPS

SEEP SAMPLING

ADDITIONAL GW INVESTIGATION/DELINEATION

INVESTIGATION OF POTENTIAL TAILINGS DEPOSITION AREAS

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Questions?