100011171

RED AND BONITA BULKHEAD TEST CLOSURE

July – October 2020

James Hou – EPA RPM

RED AND BONITA OBJECTIVES

- Primary objective was to evaluate the performance of the Red and Bonita Bulkhead once water is impounded behind it
- Secondary Objective is to evaluate the bulkhead closure's effect on nearby adit flows, seeps and springs

SCHEDULE

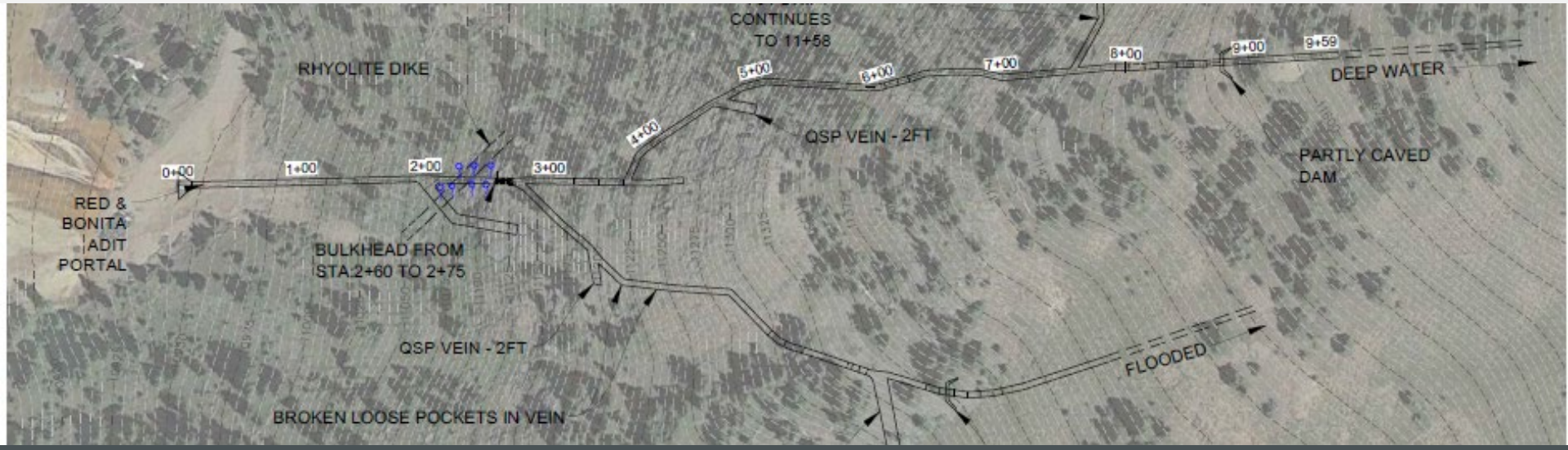
- Phase I: Preparations
  - Improvements to instrumentation, control systems, and baseline surveys (June 16-July 14, 2020)

  Phase 2: Mine pool at 50' (July 15-27, 2020)

  Phase 3: Increased mine pool to 184' (July 27-September 21, 2020)
  - Unable to reach 200' goal due to seasonal constraints

  Phase 4: Drawdown (September 21-October 22, 2020)

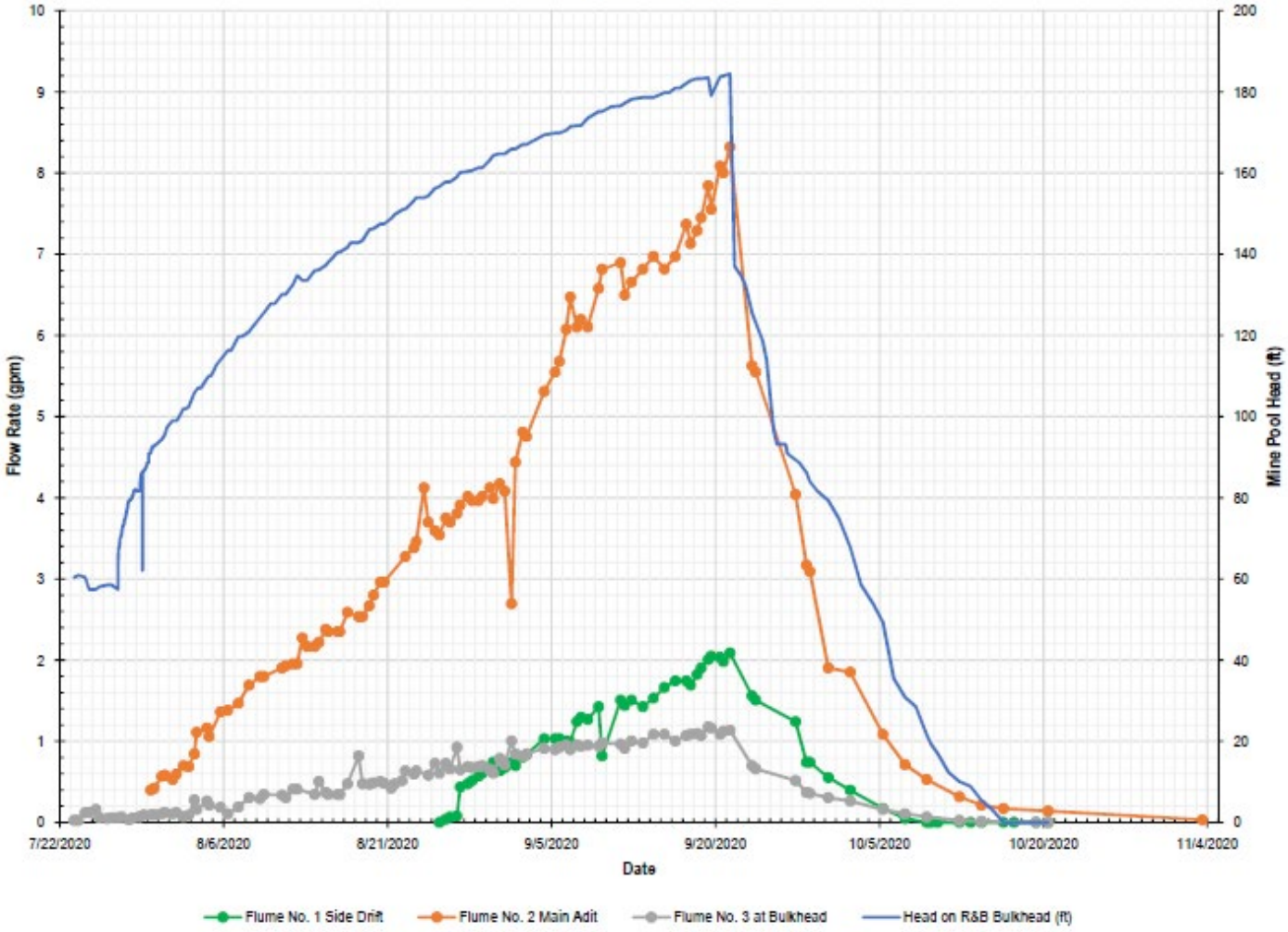
  Phase 5: Post-drain monitoring (October 22-November 4, 2020)

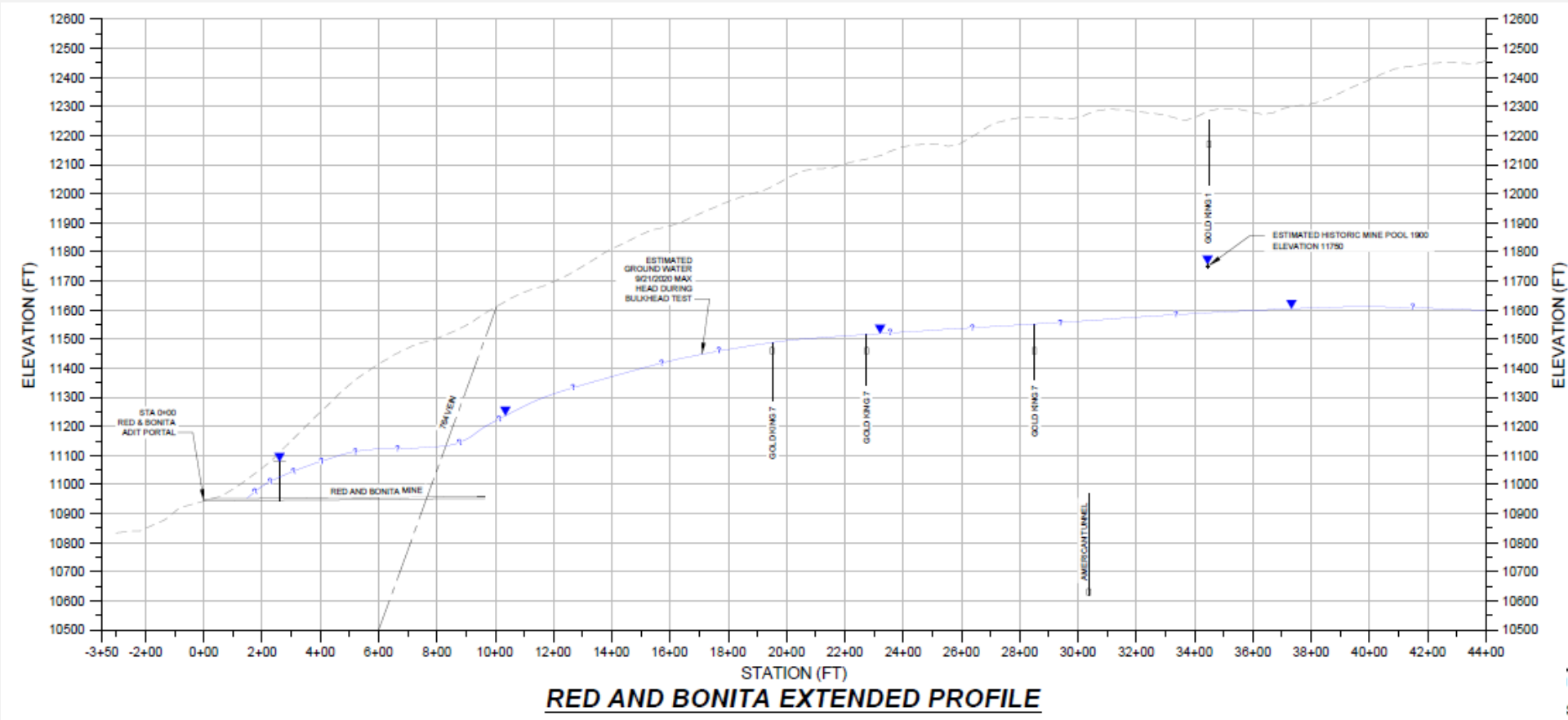


RED & BONITA PLAN VIEW

- Bulkhead from 260'-275' inby the portal
- Flumes located at bulkhead, side drift, and main adit portal

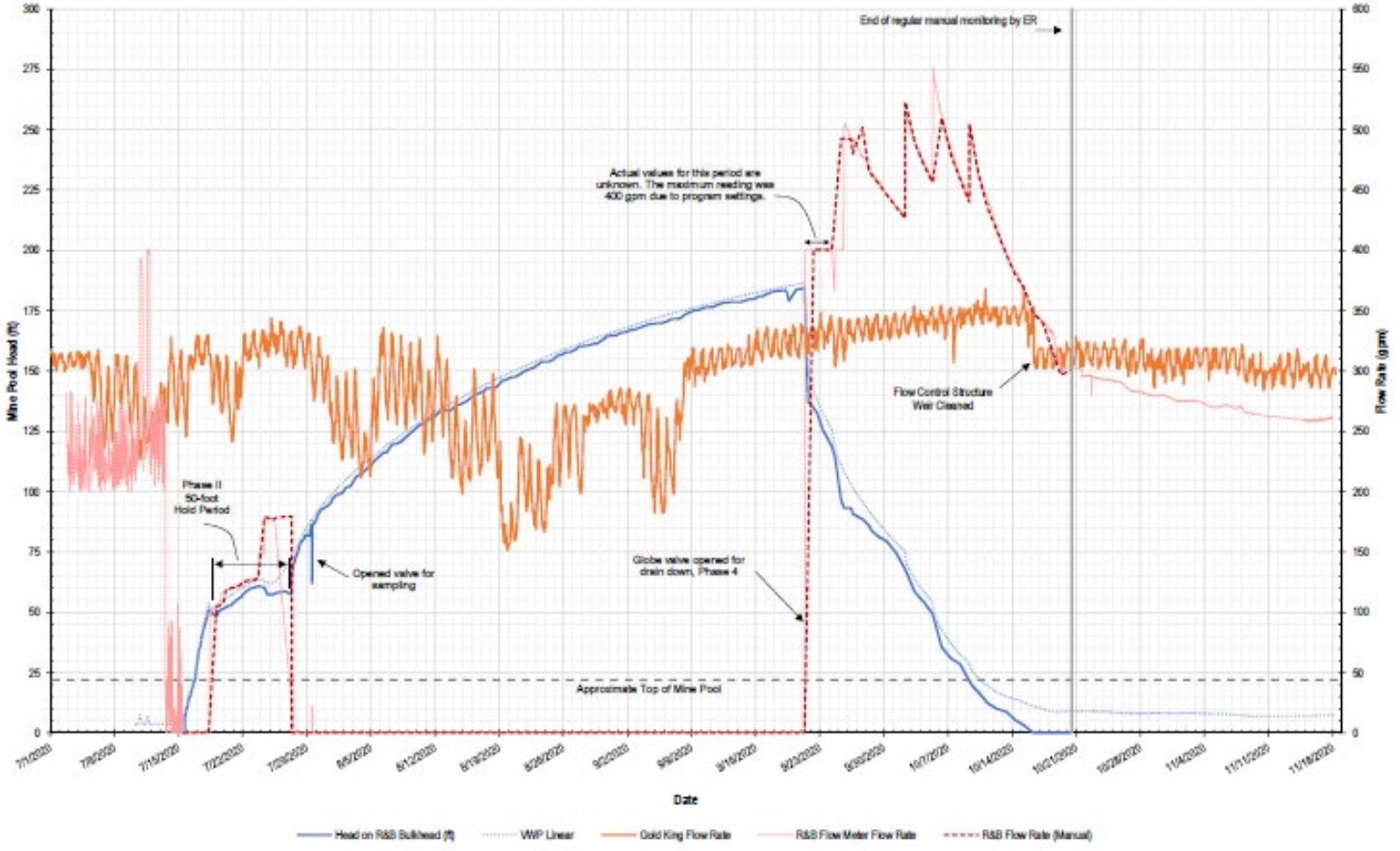
FIGURE 2.7: Red & Bonita Adit Flume Flow Rates





RED AND BONITA EXTENDED PROFILE

FIGURE 2.5: Head on Red & Bonita Bulkhead and Gold King Flow Rate - Full Time Period



CONCLUSIONS

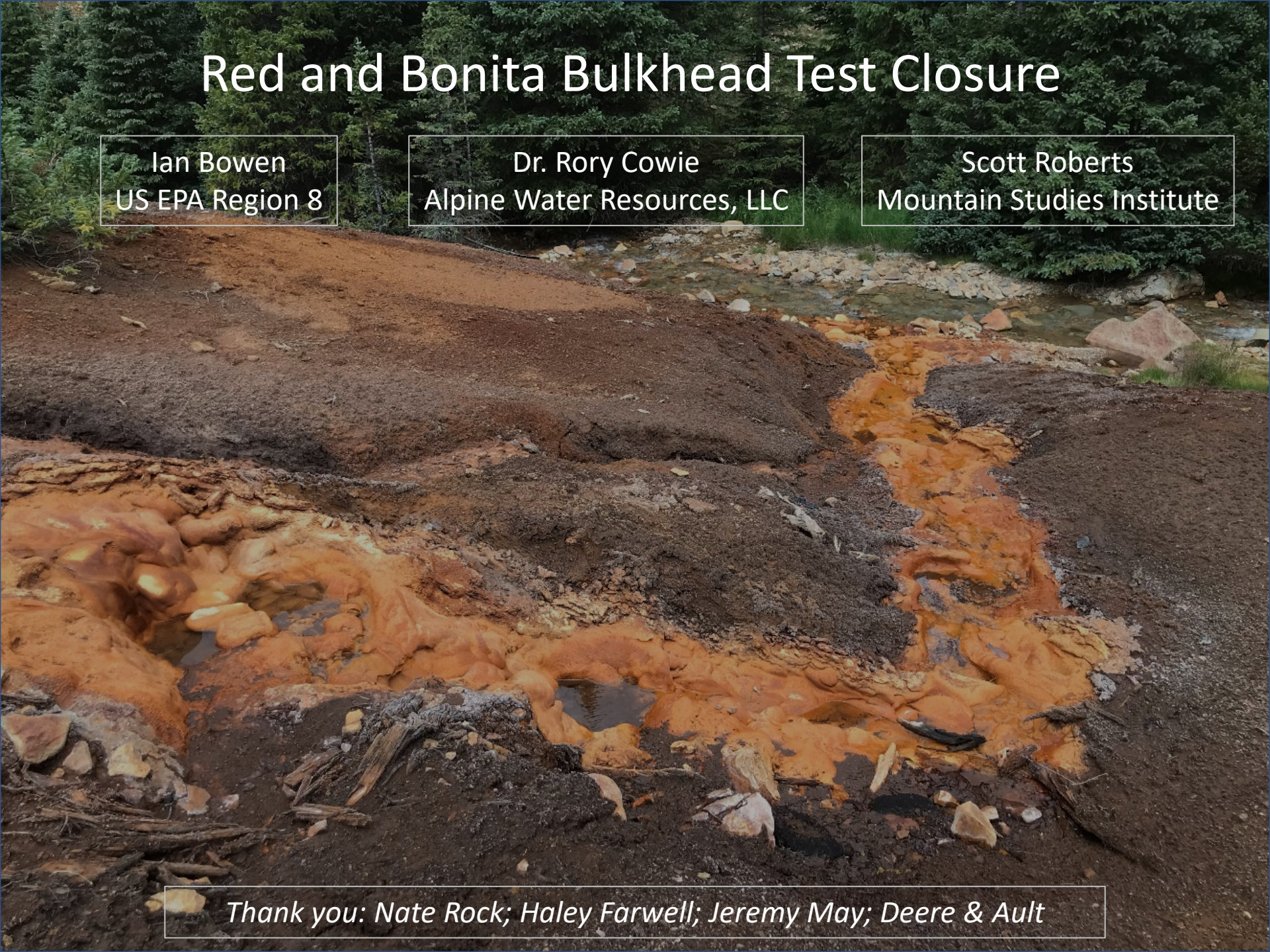
- Bulkhead performed as designed
  - No engineering improvements planned at this time
- 2020 test took full advantage of the construction season
- Future test recommended
  - At least 1 year
  - Most bulkhead closures require several years to stabilize
- Monitoring results identified key locations for future monitoring

Red and Bonita Bulkhead Test Closure

Ian Bowen
US EPA Region 8

Dr. Rory Cowie
Alpine Water Resources, LLC

Scott Roberts
Mountain Studies Institute



Thank you: Nate Rock; Haley Farwell; Jeremy May; Deere & Ault

Objectives:

Was there a measurable hydrologic and/or water quality response?

R&B prior to closure:
228 gpm
142 kg/day iron
20.6 kg/day zinc

What would happen during closure…

Routed to known emergence points?

Draining mines

Existing seeps/springs

What would happen during closure…

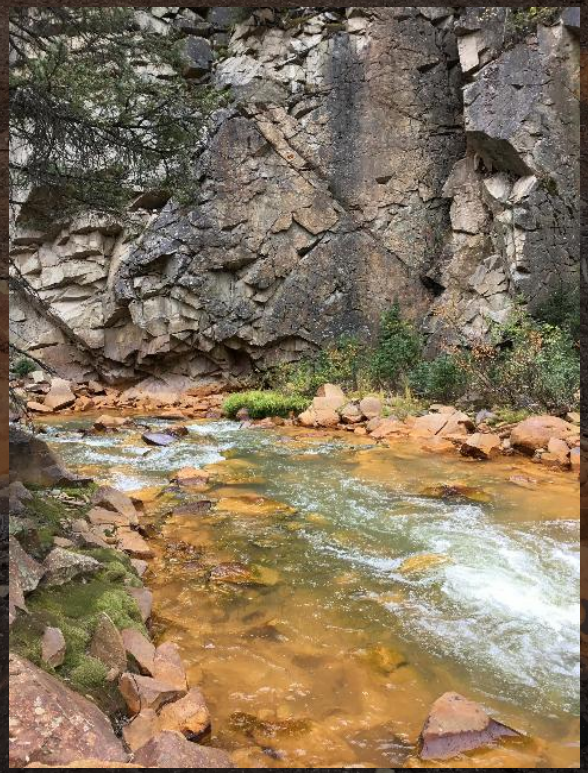
New route to surface?

Dry mines

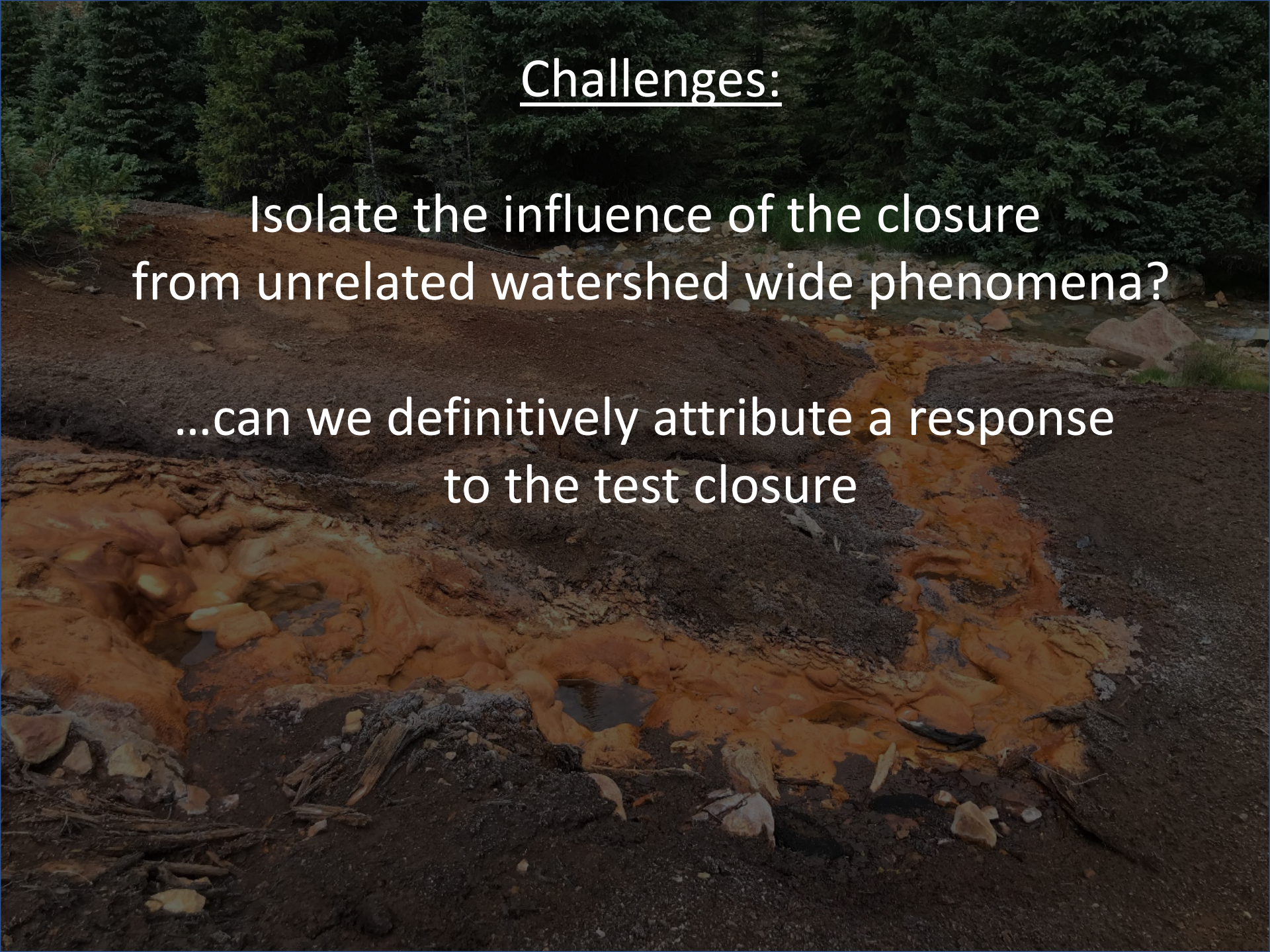
New surface water expressions

What would happen during closure…

…or, if R&B drainage was effectively contained within mine workings…can you detect a reduction in metal loads downstream of R&B?



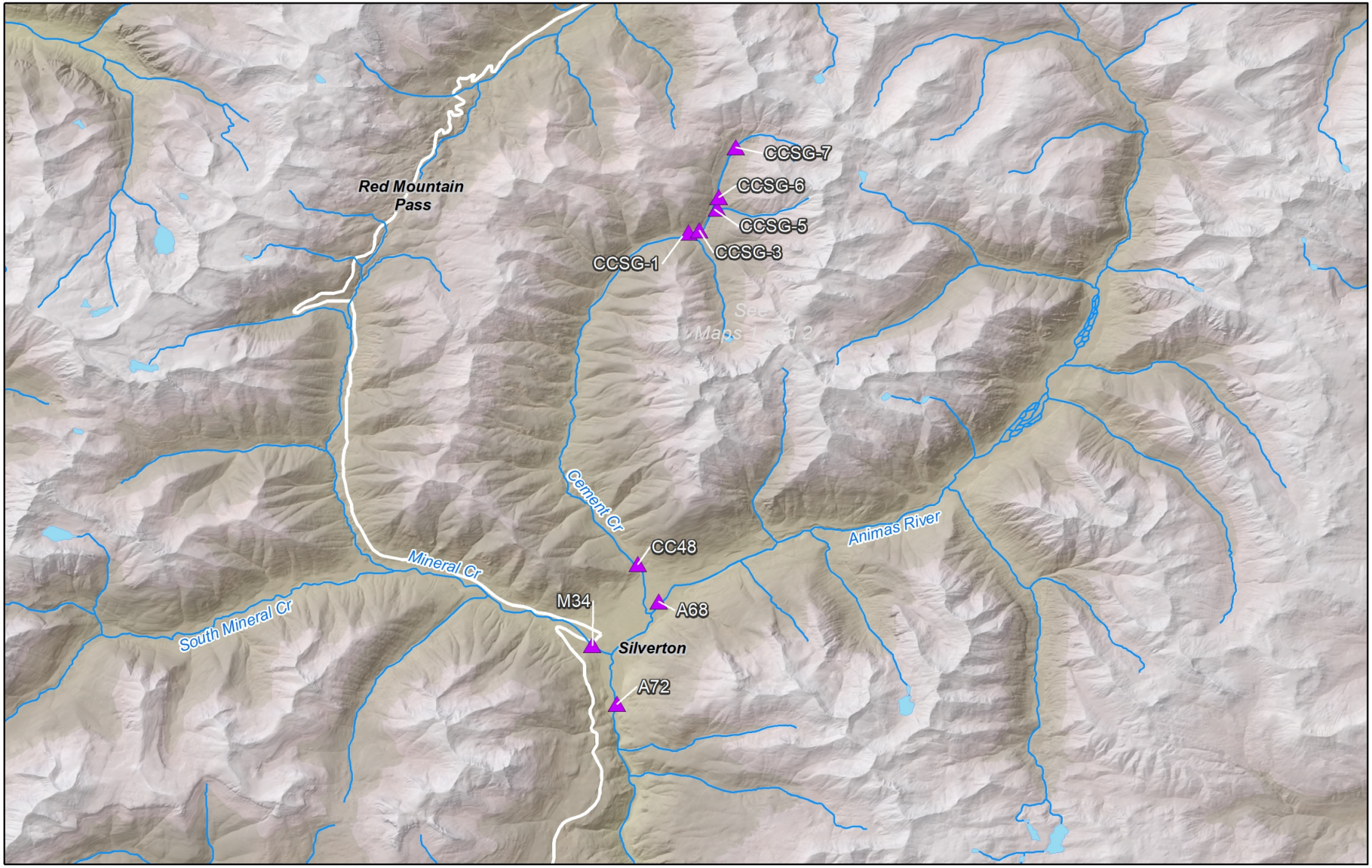
Surface water



Challenges:

Isolate the influence of the closure
from unrelated watershed wide phenomena?

…can we definitively attribute a response
to the test closure



BPMD
Red and Bonita Report

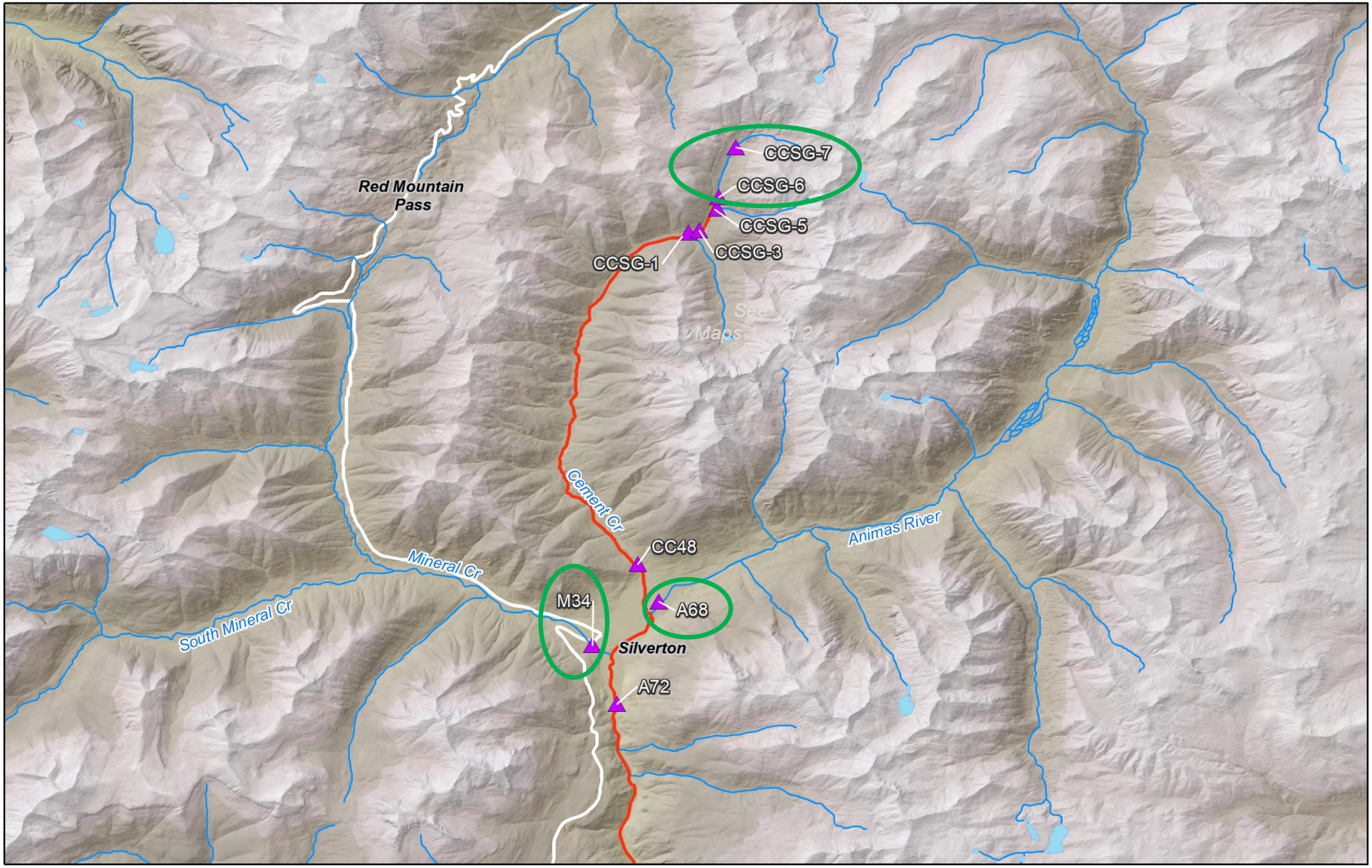
Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

Red and Bonita Test Closure Monitoring Locations

- Surface Water
- Streams/Rivers

N

0 0.5 1 2 3 4 5 Miles



BPMD
Red and Bonita Report

Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

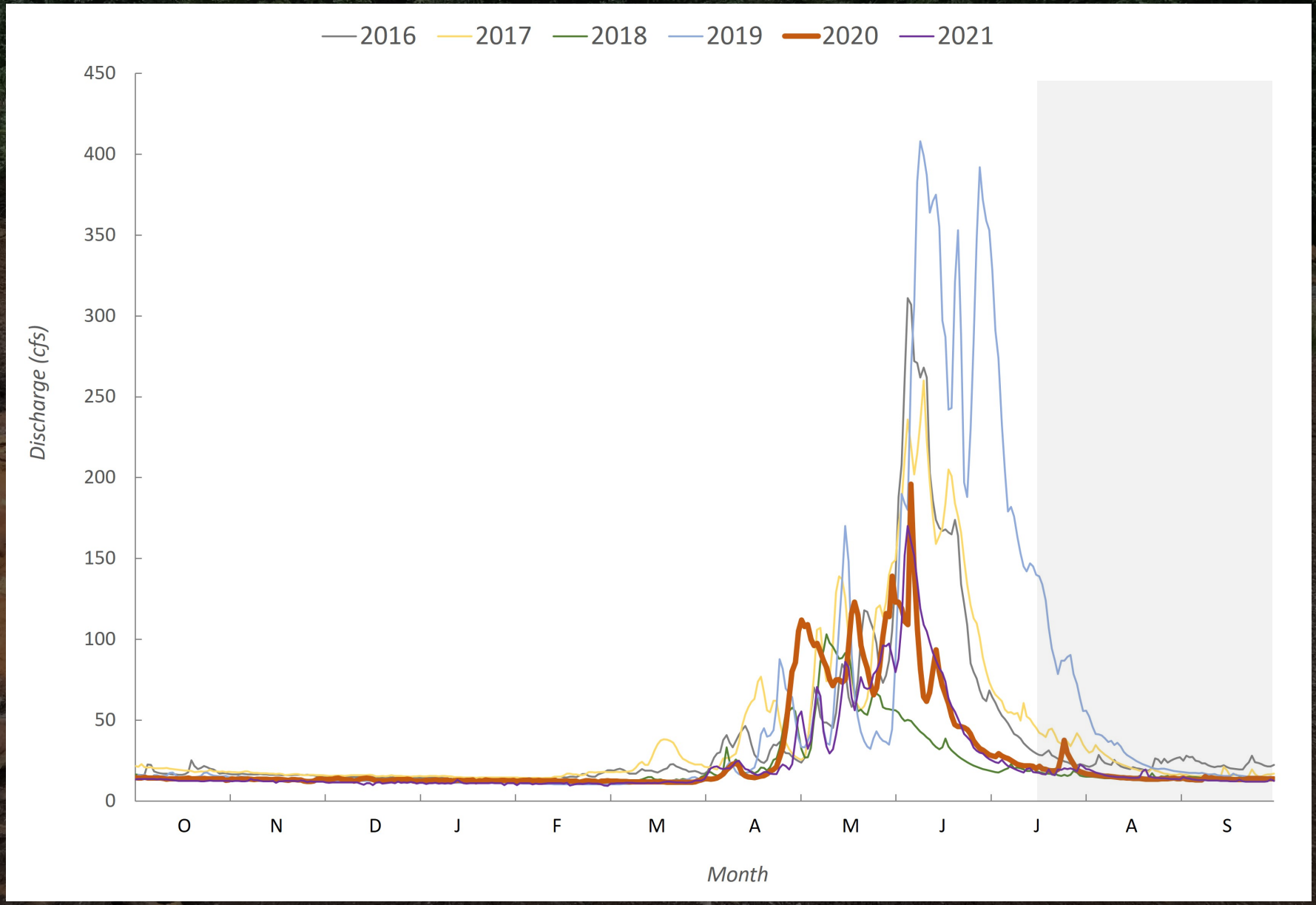
Red and Bonita Test Closure Monitoring Locations

- Surface Water
- Streams/Rivers

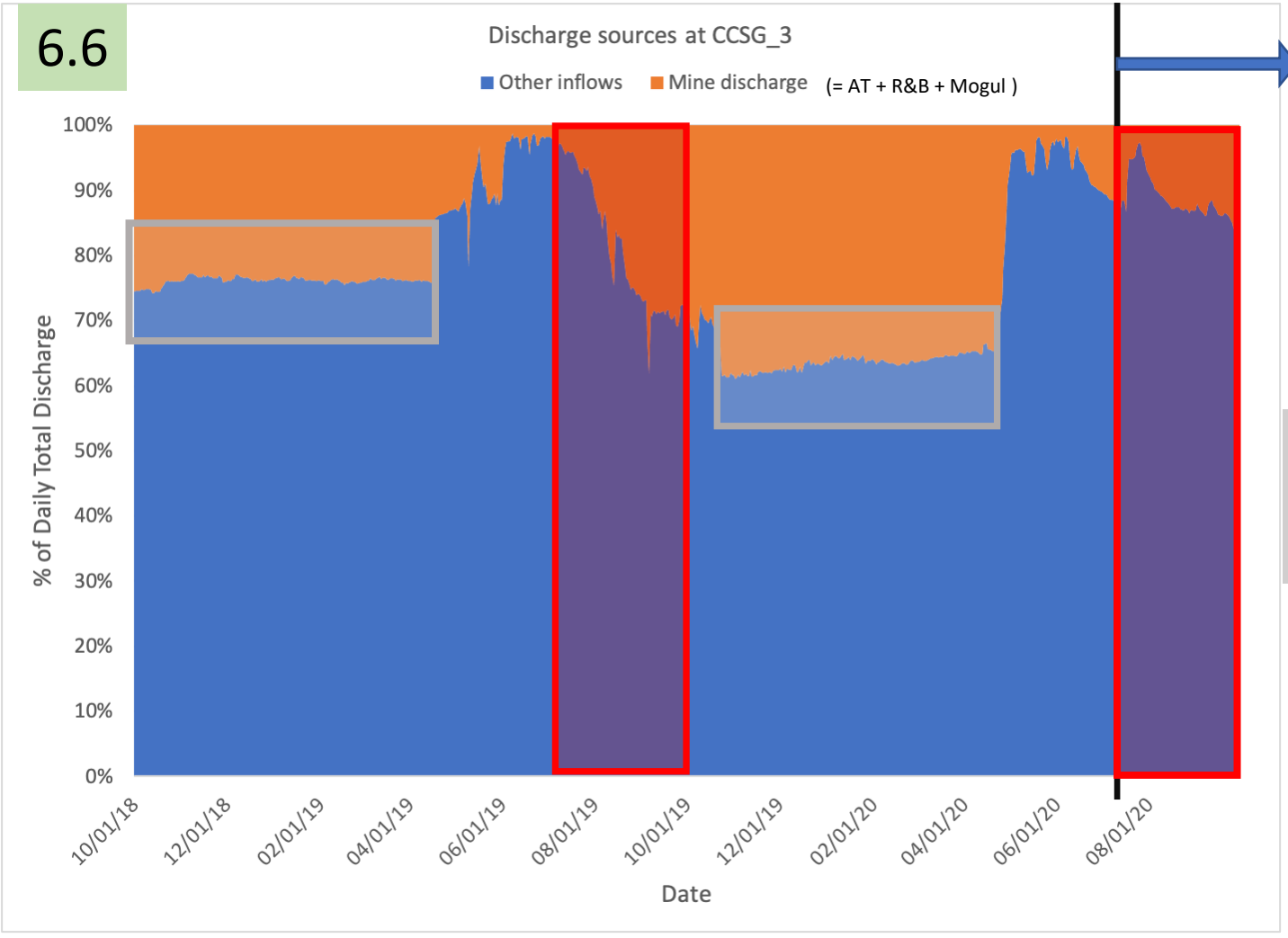
N

0 0.5 1 2 3 4 5 Miles

Streamflow at Cement Creek USGS Gage CC48



6.6



Bulkhead test period,

Increasing % mine contributions during Recession limb of hydrograph stopped When BH closed

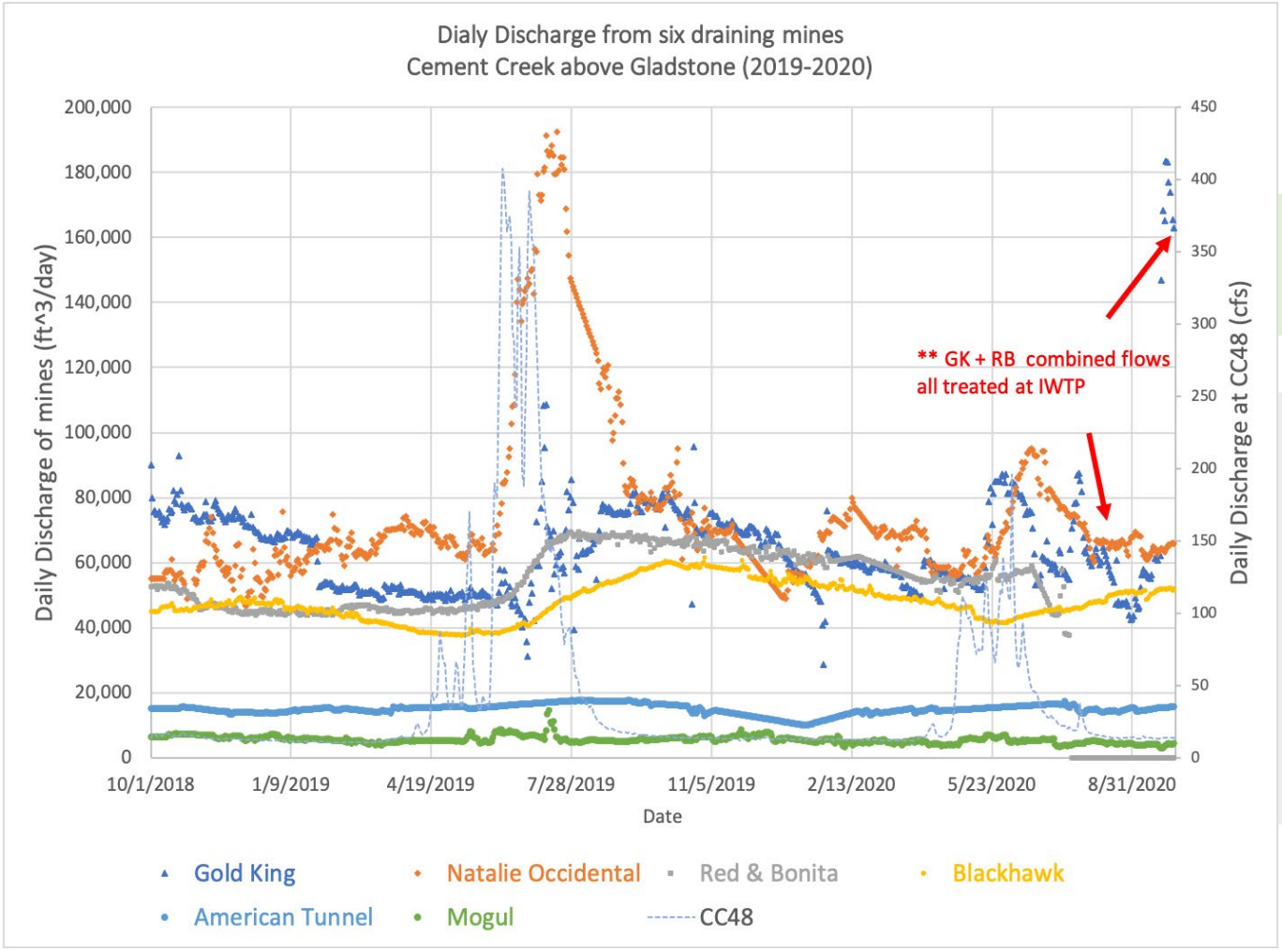
Red boxes represent same time period In 2019 (no BH test) and 2020 (R&B closed)

Grey Boxes represent baseflow periods When discharge is most steady and mines Represent greatest % Q in stream. **Ideal time period to perform BH closure test and quantify load changes not dominated by annual runoff hydrograph***

In 2019 R&B Q also increases in same window When melt runoff is decreasing due to lag in Melt signal (snowmelt increased stream flow First then mine discharge later at R&B)

Draining Mines
&
Existing Seeps/Springs

4.0 Hydrology: Timing and Magnitude of mine Discharges in Cement Creek



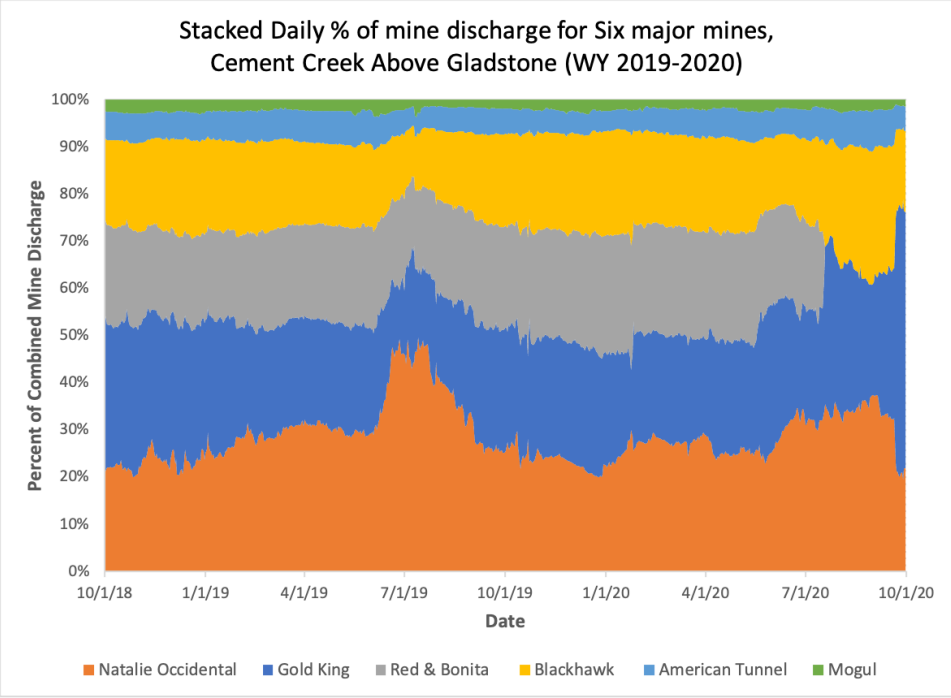
How do changes in timing and Magnitude of mine discharge Explain BP groundwater?

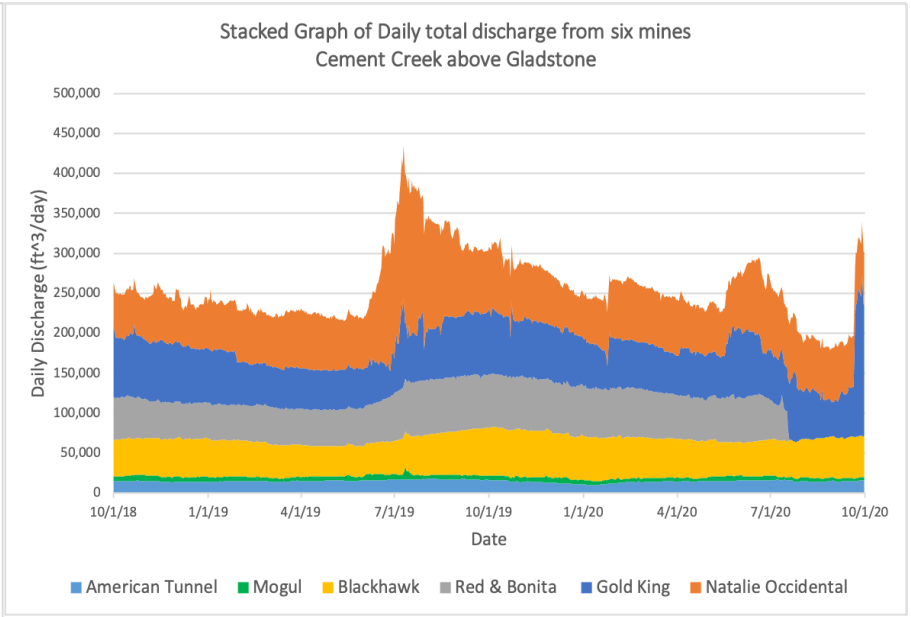
- Seasonal increases in mine discharge are greatest at non-bulkheaded mine Sites.

- Major increases in mine discharge close to timing of peak stream discharge Indicates rapid melt water infiltration Into mine workings (N.O. and GK)

- Delayed and gradual increases in mine discharge indicated a delayed groundwater signal at Blackhawk and Red and Bonita.

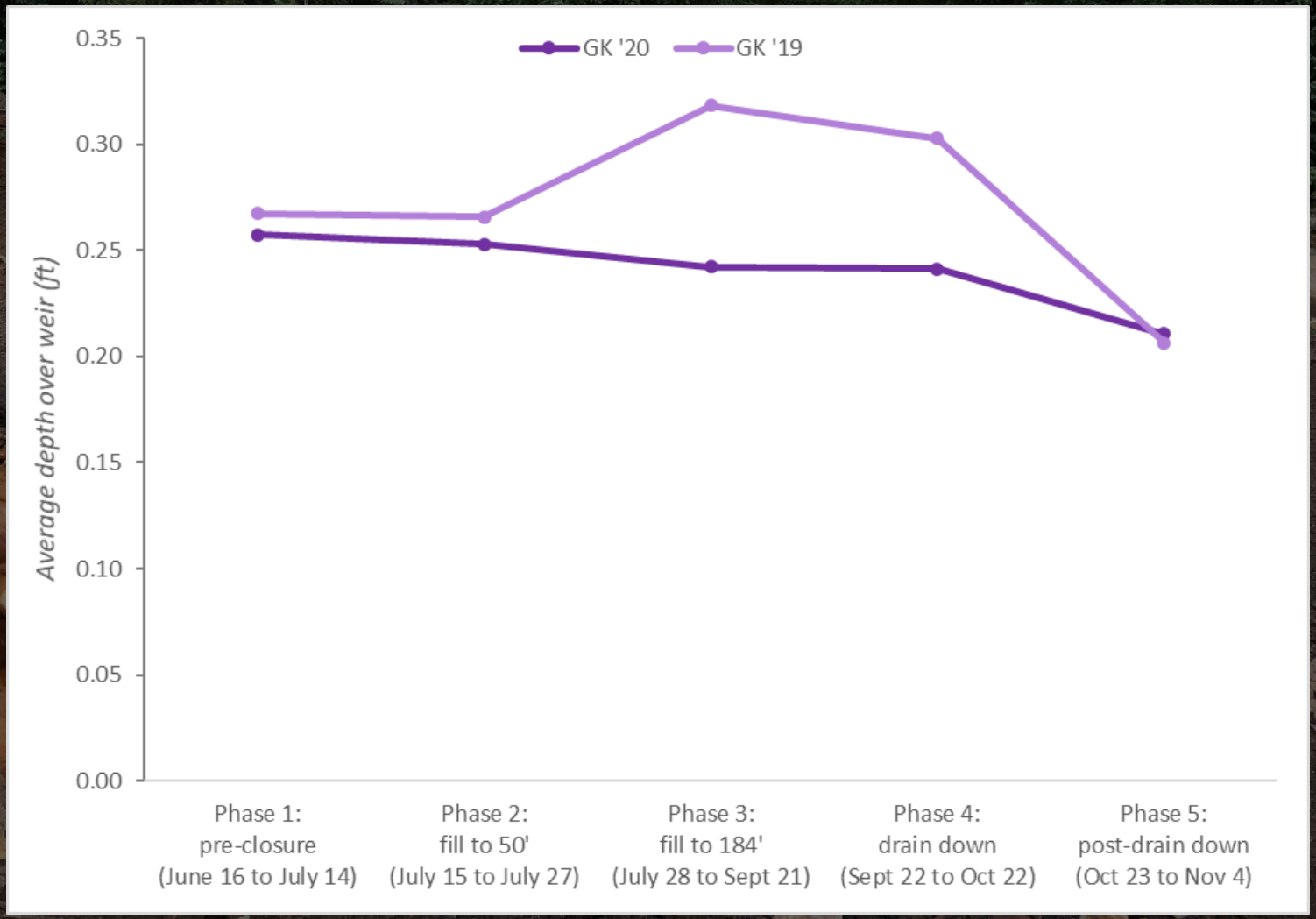
4.0 Quantifying mine discharges from major sources in Cement Creek



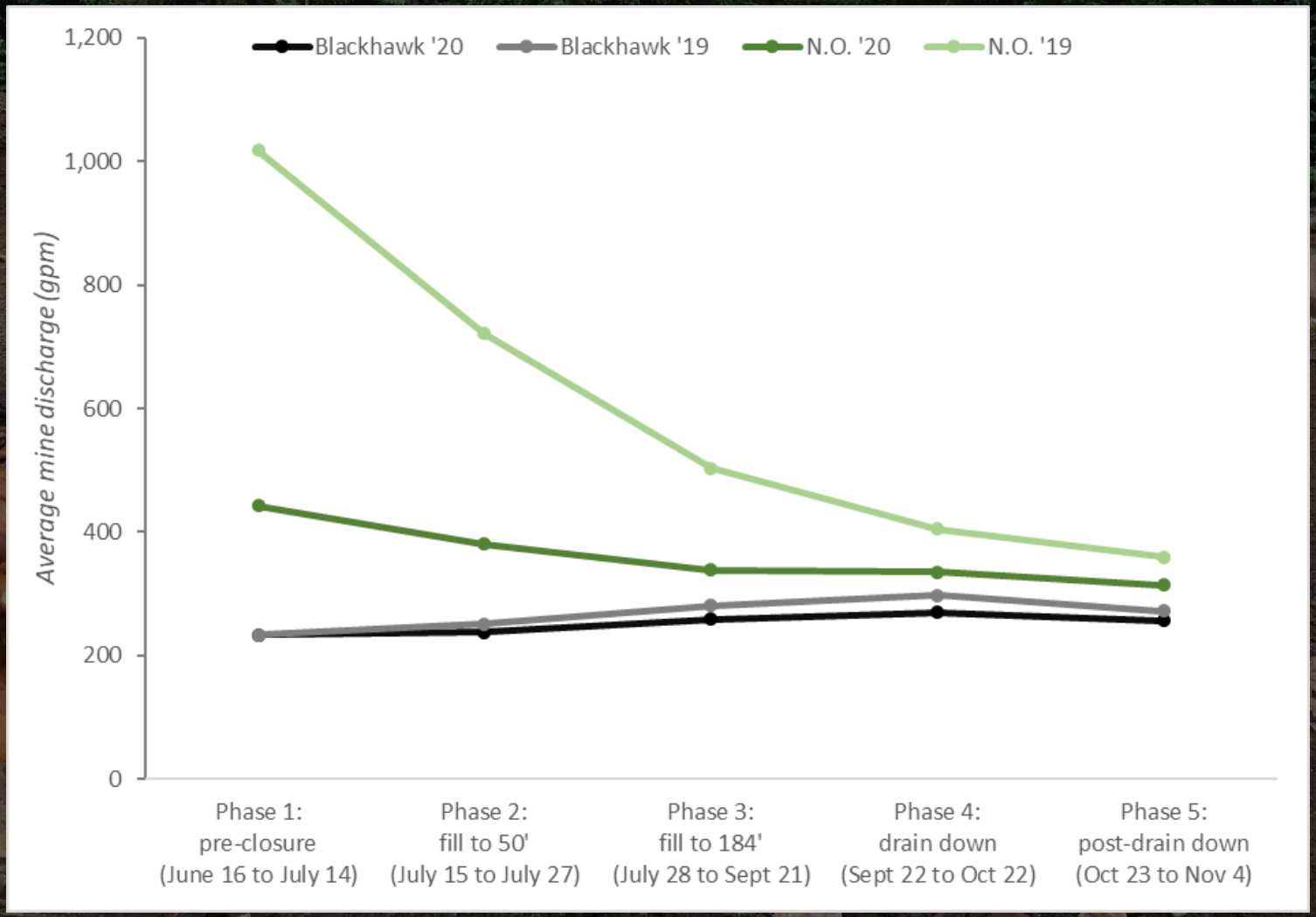


Next step is combining continuous discharge data with intermittent chemistry data to Produce estimate of continuous metals loading to improve CSM and understanding of temporal Patterns of loading which will impact ranking of remedial actions

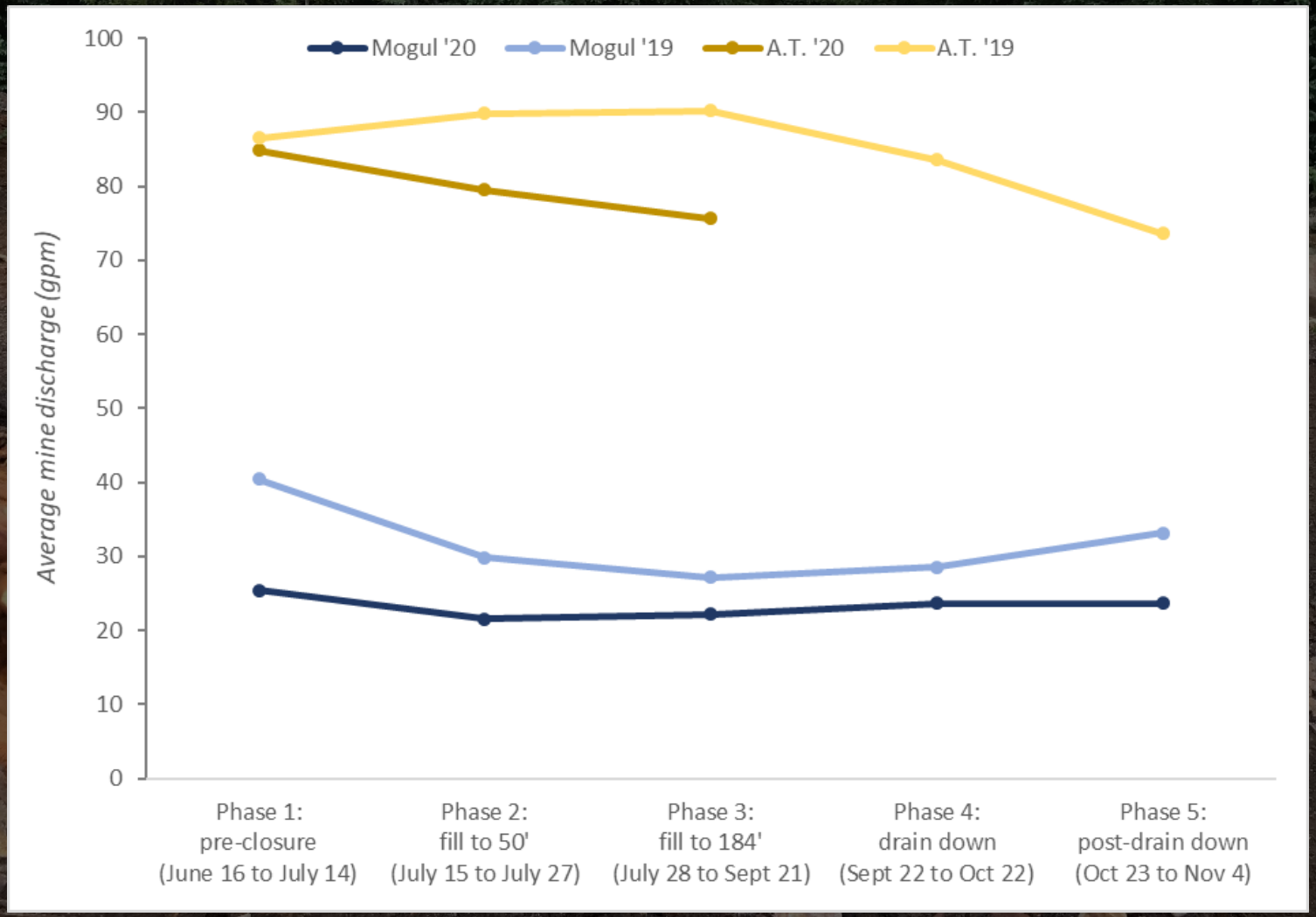
Draining Mines:



Draining Mines:

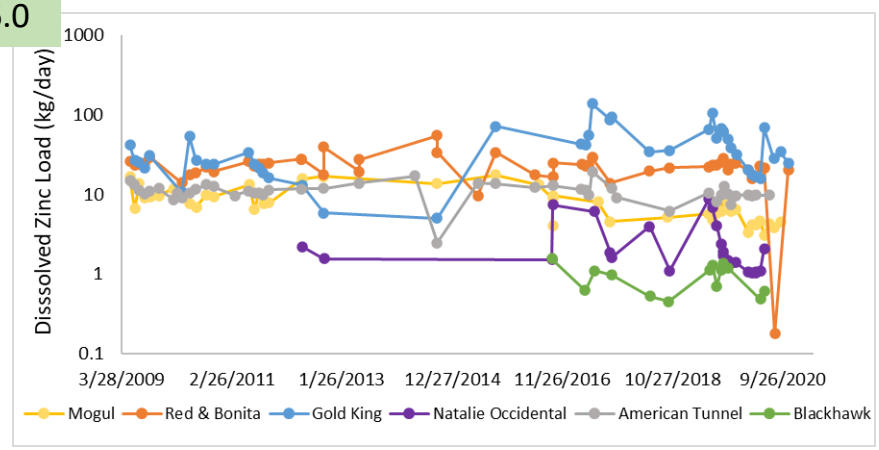


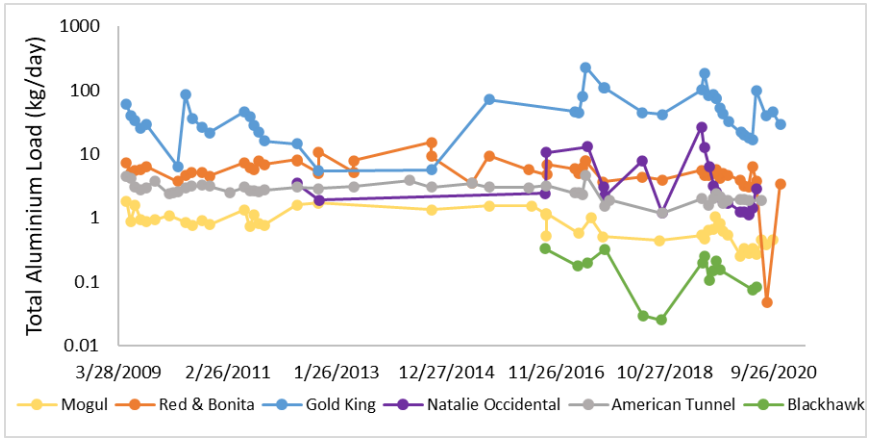
Draining Mines:

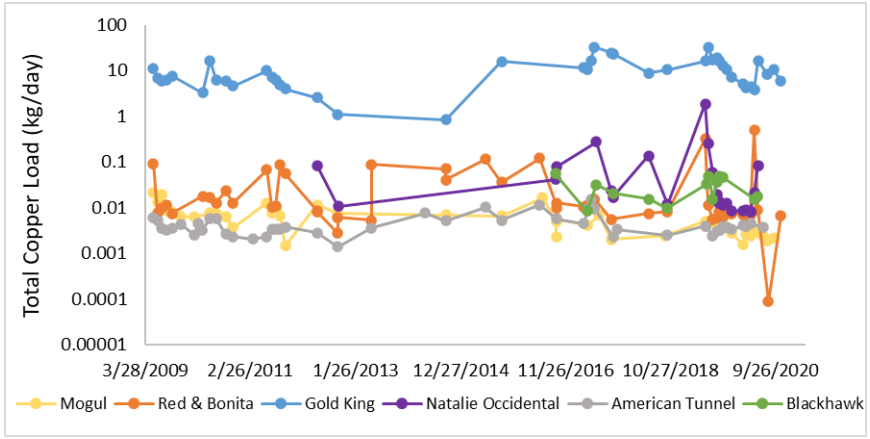


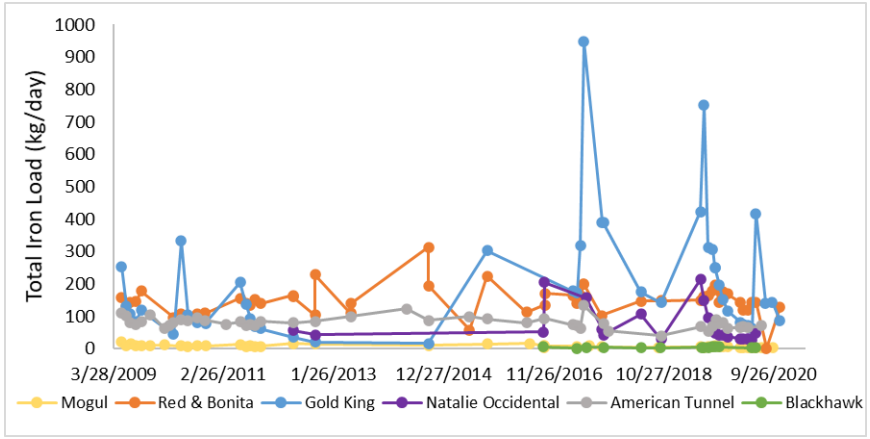
Time series of metals concentrations from draining mines

6.0





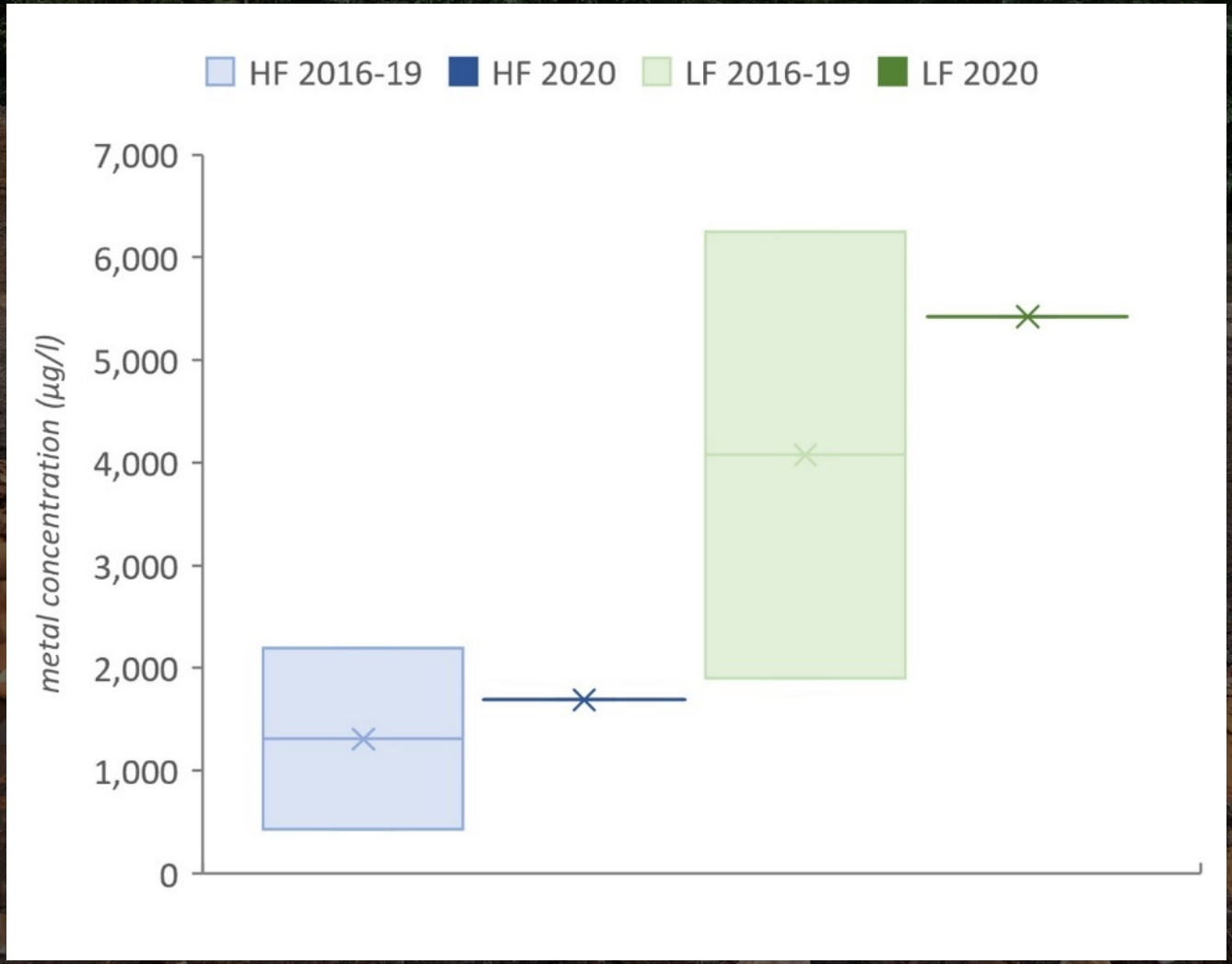




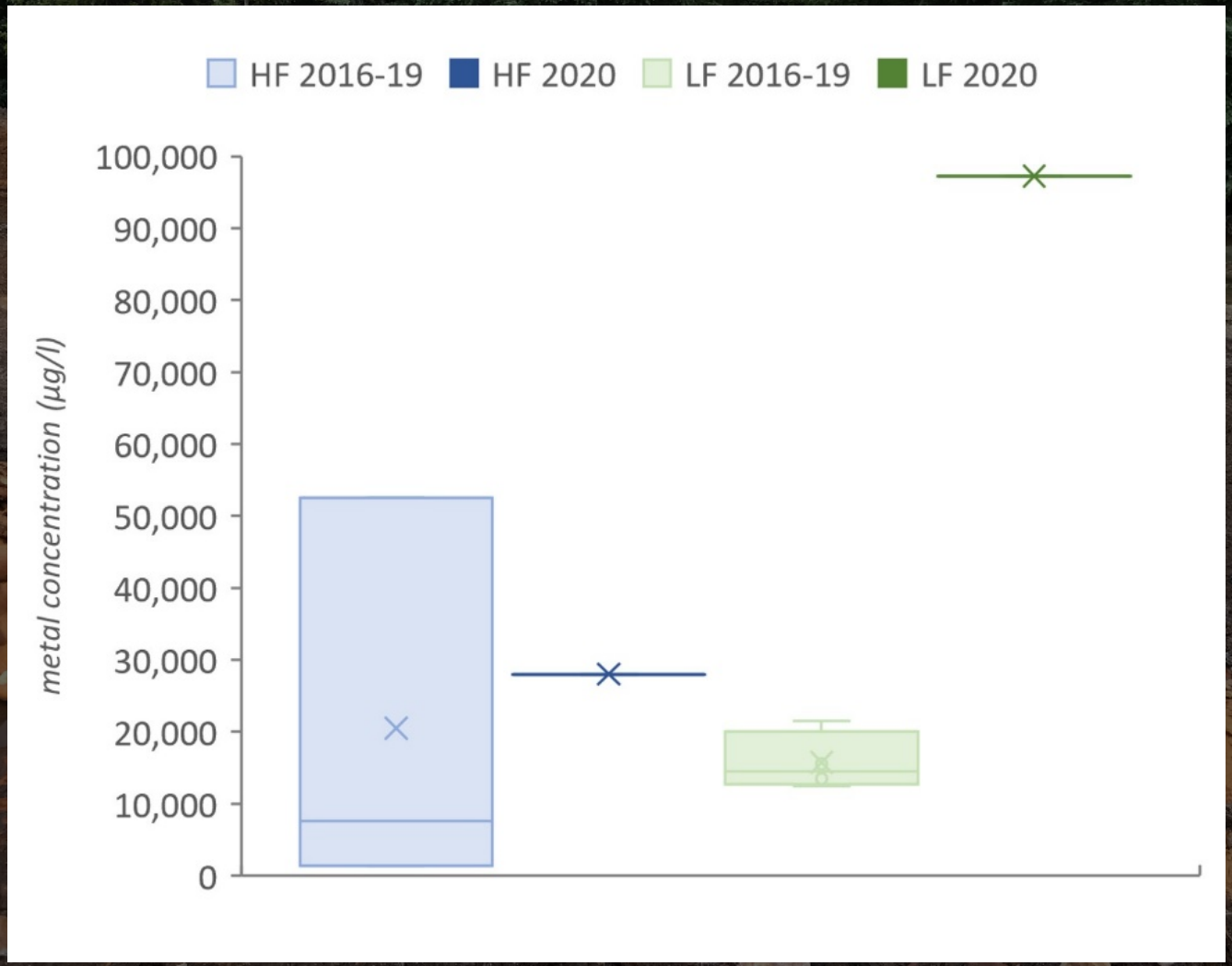
Do any changes or trends correlate with mine remediation activities (bulkheads) or changes caused by GK release?

Gold King: Total zinc

SS084 – total zinc



SS062 – total lead



SS062 & SS236

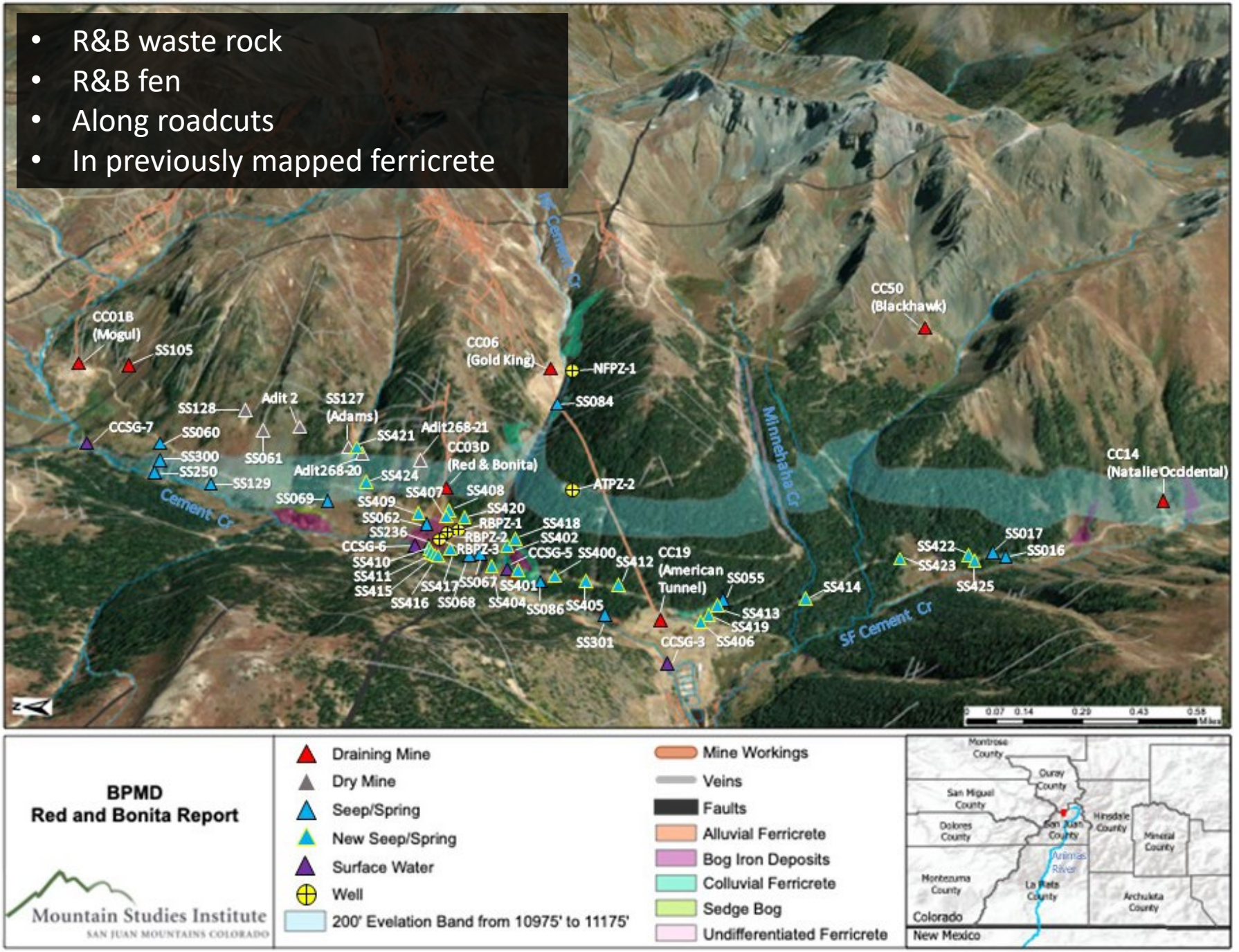
Concentrations of total lead and total iron were higher than previous years and inconsistent with high-flow conditions preceding the test

Dry Mines
&
New surface water expressions

Dry Mines stayed dry…

25 locations in the R&B vicinity where we observed water seepage or flow at the surface that was not observed immediately prior to the test closure

- R&B waste rock
- R&B fen
- Along roadcuts
- In previously mapped ferricrete



BPMD
Red and Bonita Report

Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

- Draining Mine
- Dry Mine
- Seep/Spring
- New Seep/Spring
- Surface Water
- Well
- 200' Evelation Band from 10975' to 11175'

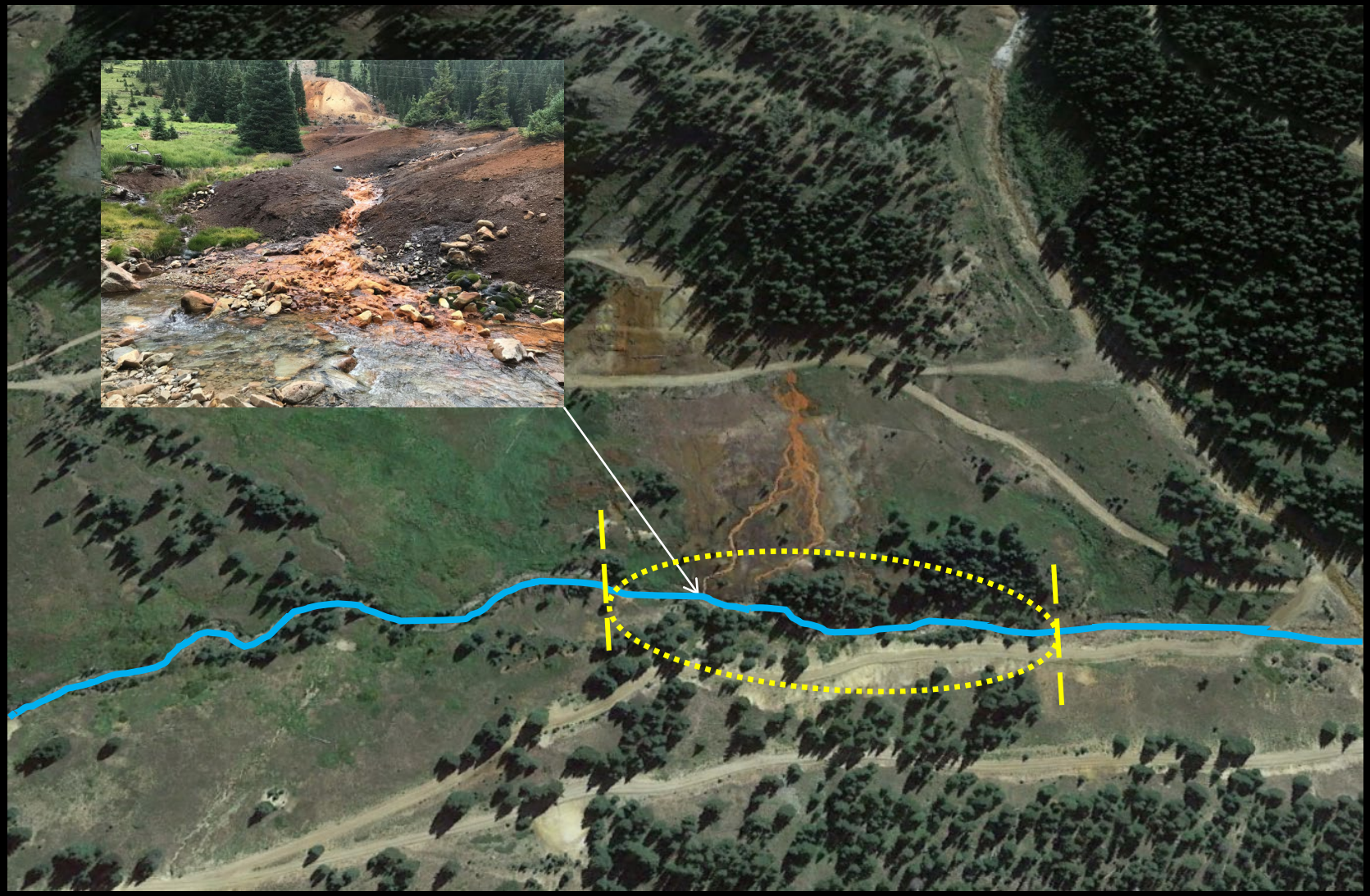
- Mine Workings
- Veins
- Faults
- Alluvial Ferricrete
- Bog Iron Deposits
- Colluvial Ferricrete
- Sedge Bog
- Undifferentiated Ferricrete

The existence of bogs, ferricrete, and manganocrete suggest historical expression of groundwater. It is possible that as water backed up behind the closed R&B bulkhead, some water was rerouted to pre-existing pathways and emerged to the surface at these locations of older groundwater expressions

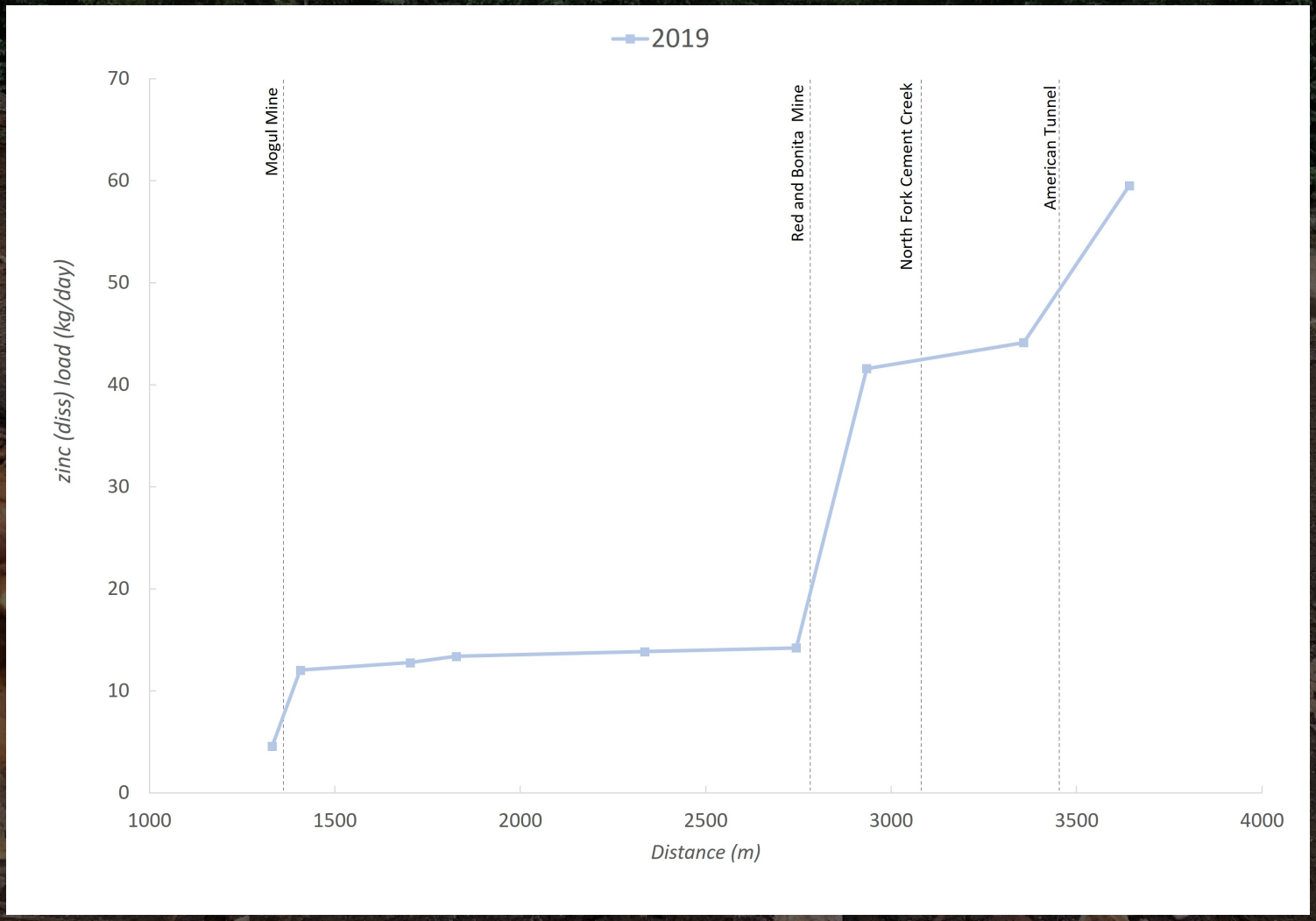
Most were observed in late August 2020, bulkhead pressure was between 140-155’ of head

Combined flows from all new emergences was 23 gpm (~10% of R&B flow)

Surface Water

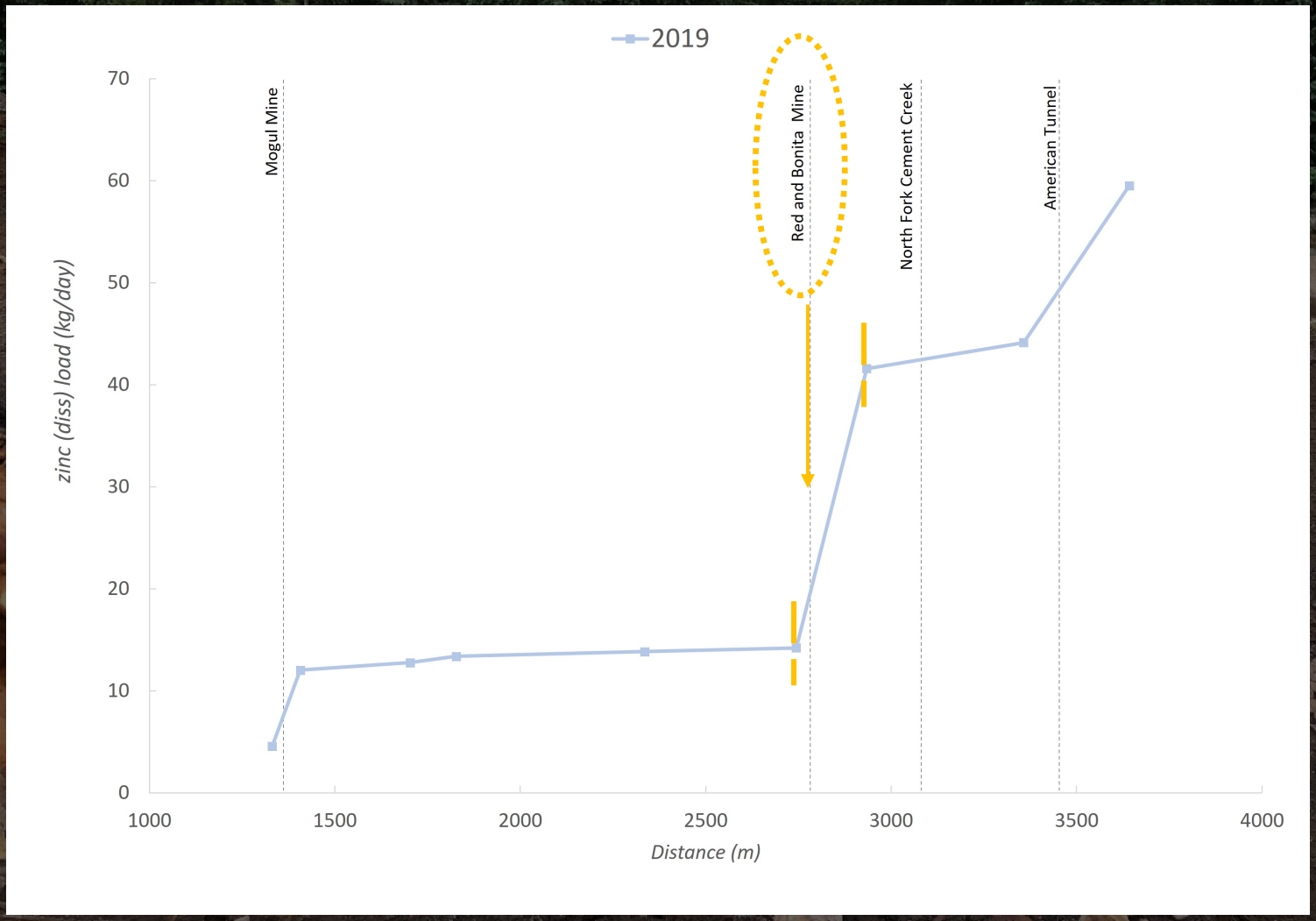


Cement Creek profile



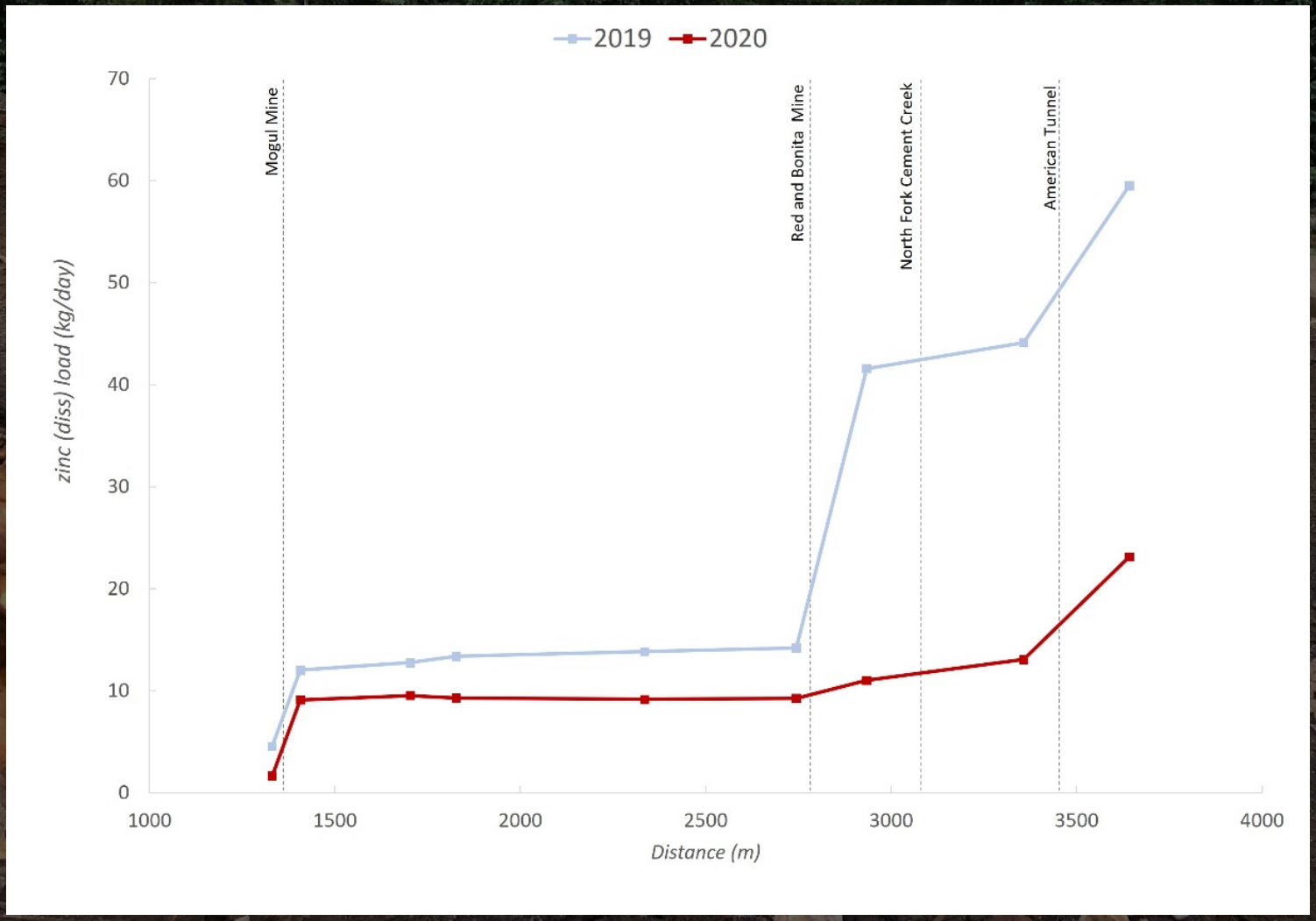
Source: Runkel et al., USGS data release

Cement Creek profile



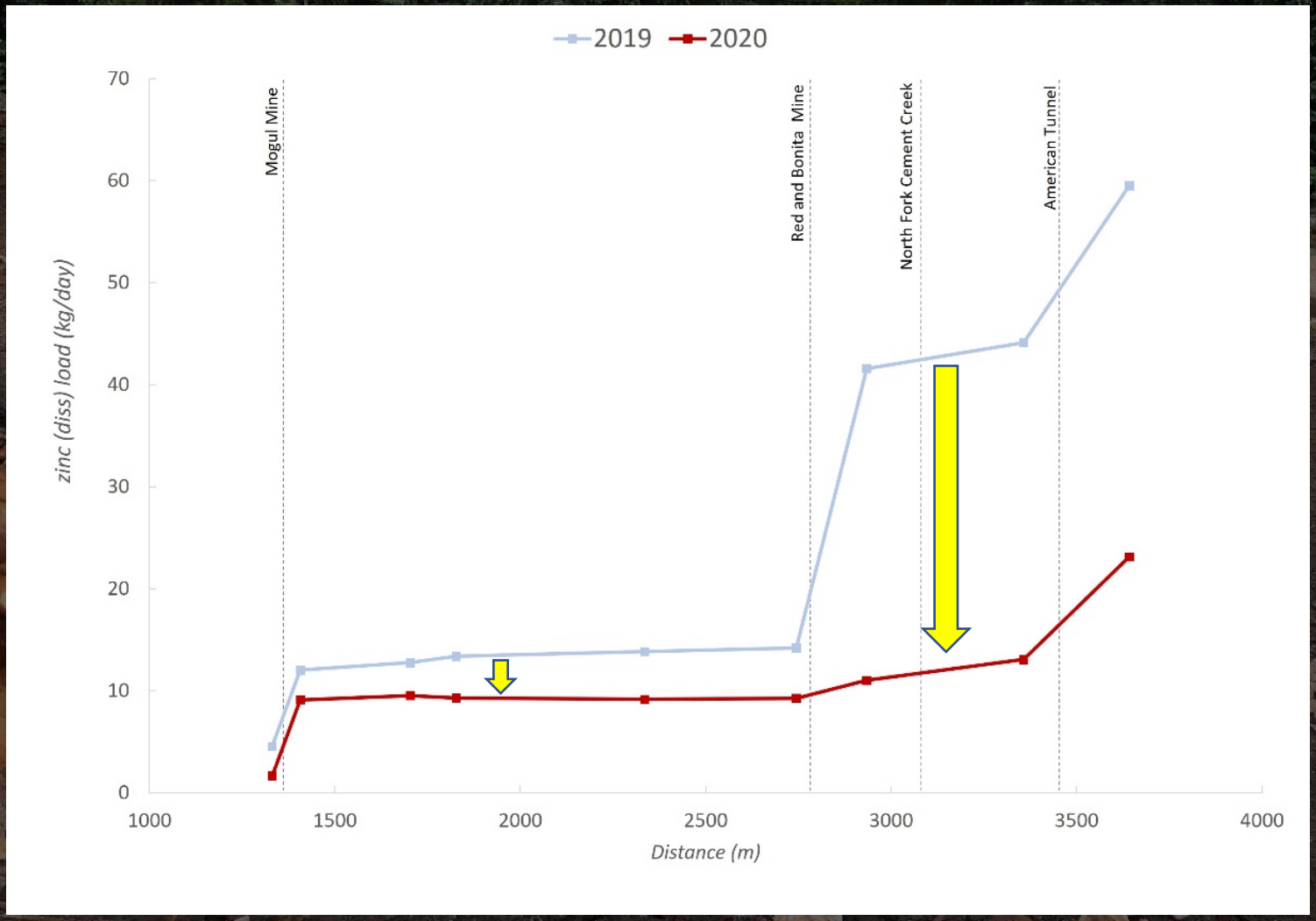
Source: Runkel et al., USGS data release

Cement Creek profile

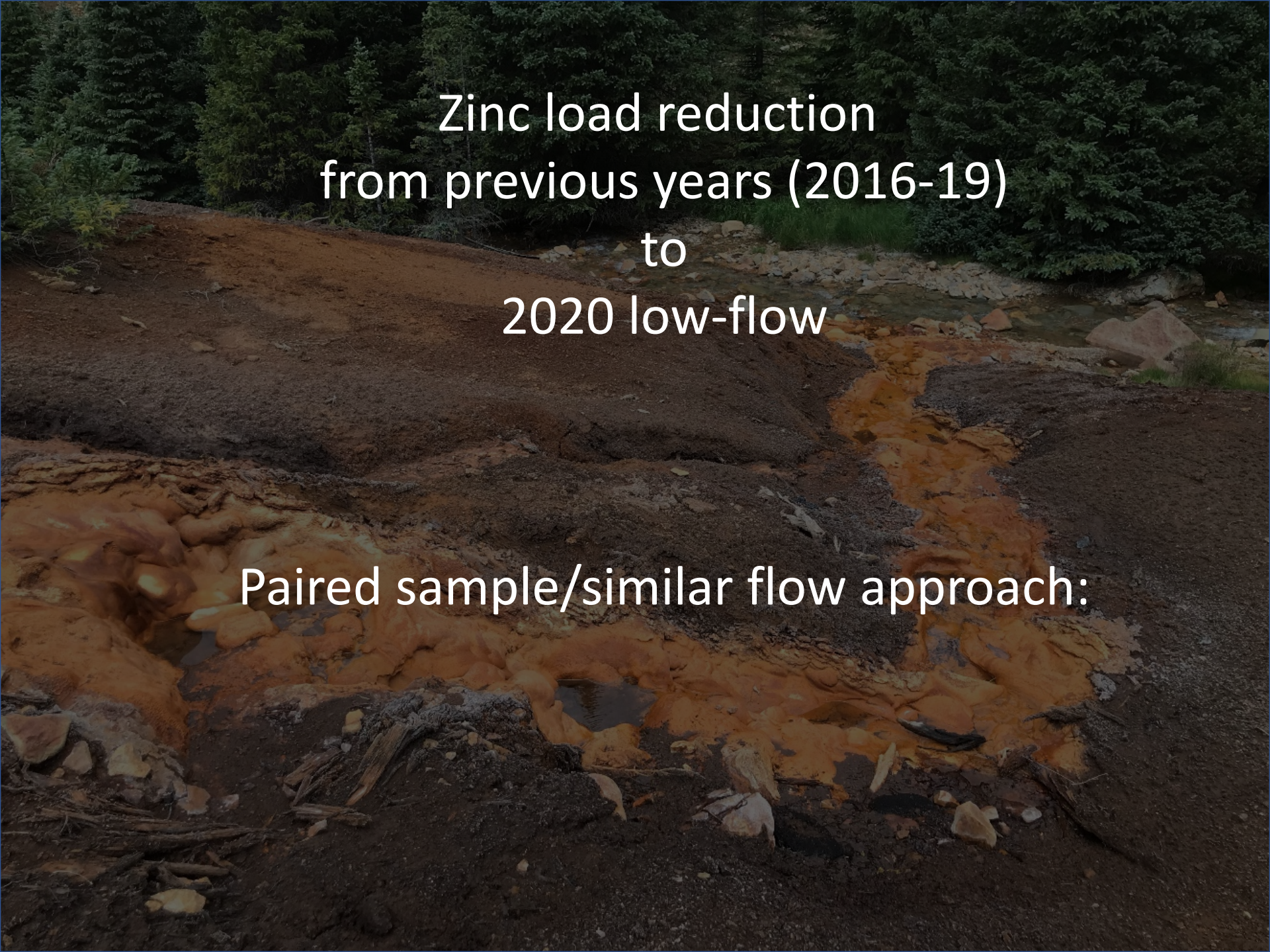


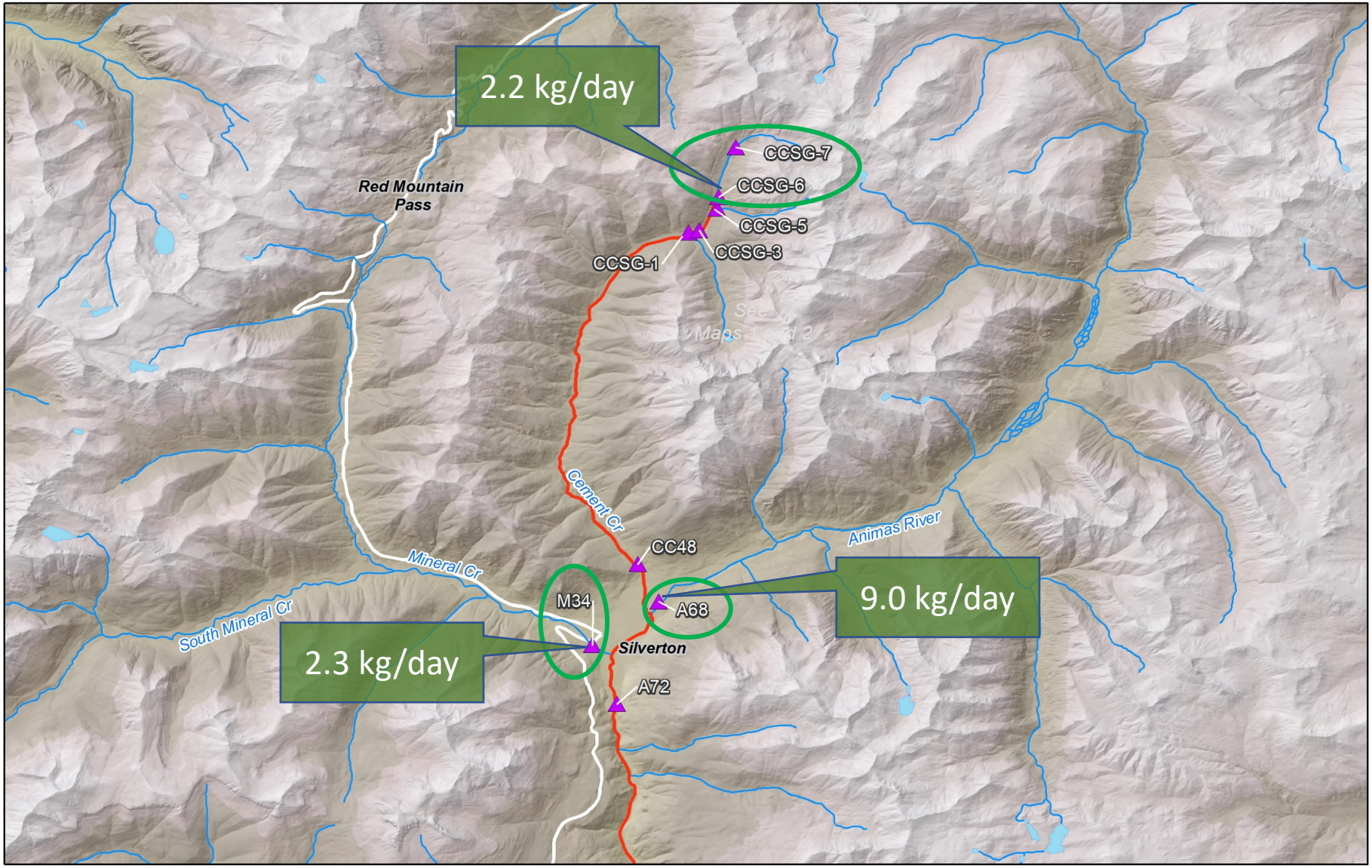
Source: Runkel et al., USGS data release

Cement Creek profile



Source: Runkel et al., USGS data release


Zinc load reduction
from previous years (2016-19)
to
2020 low-flow
Paired sample/similar flow approach:



BPMD
Red and Bonita Report

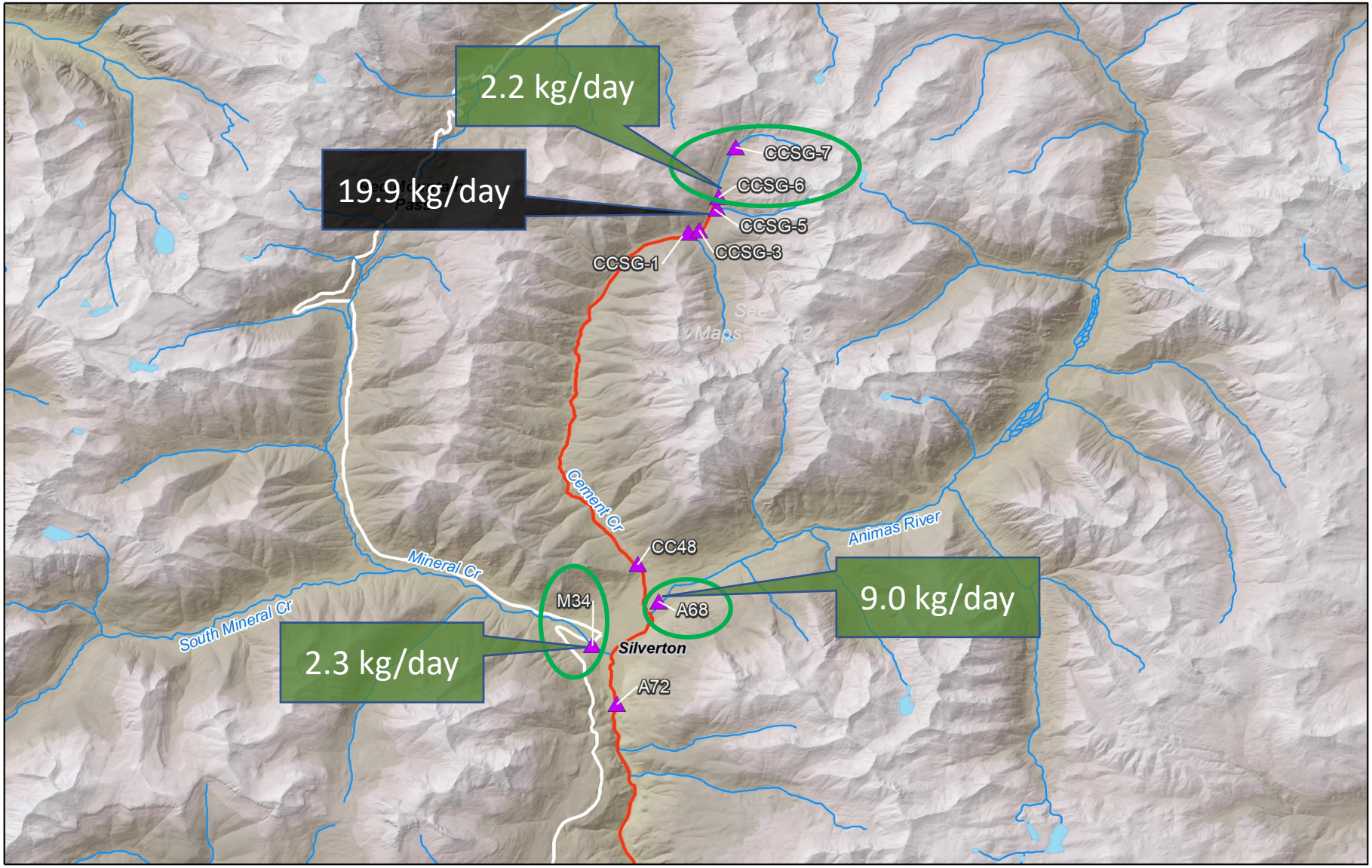
Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

Red and Bonita Test Closure Monitoring Locations

- Surface Water
- Streams/Rivers

N

0 0.5 1 2 3 4 5 Miles



BPMD
Red and Bonita Report

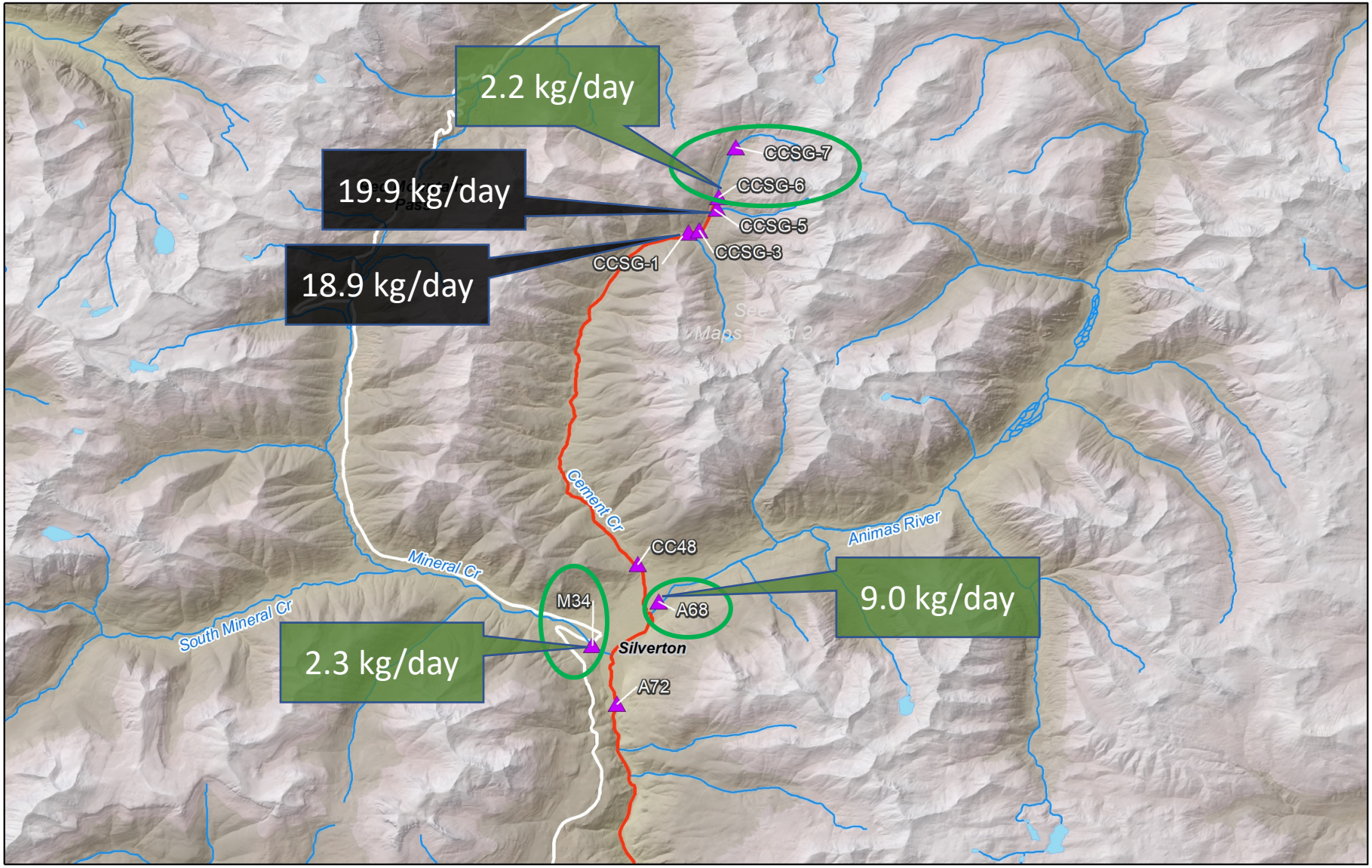
Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

Red and Bonita Test Closure Monitoring Locations

- Surface Water
- Streams/Rivers

N

0 0.5 1 2 3 4 5 Miles



BPMD
Red and Bonita Report

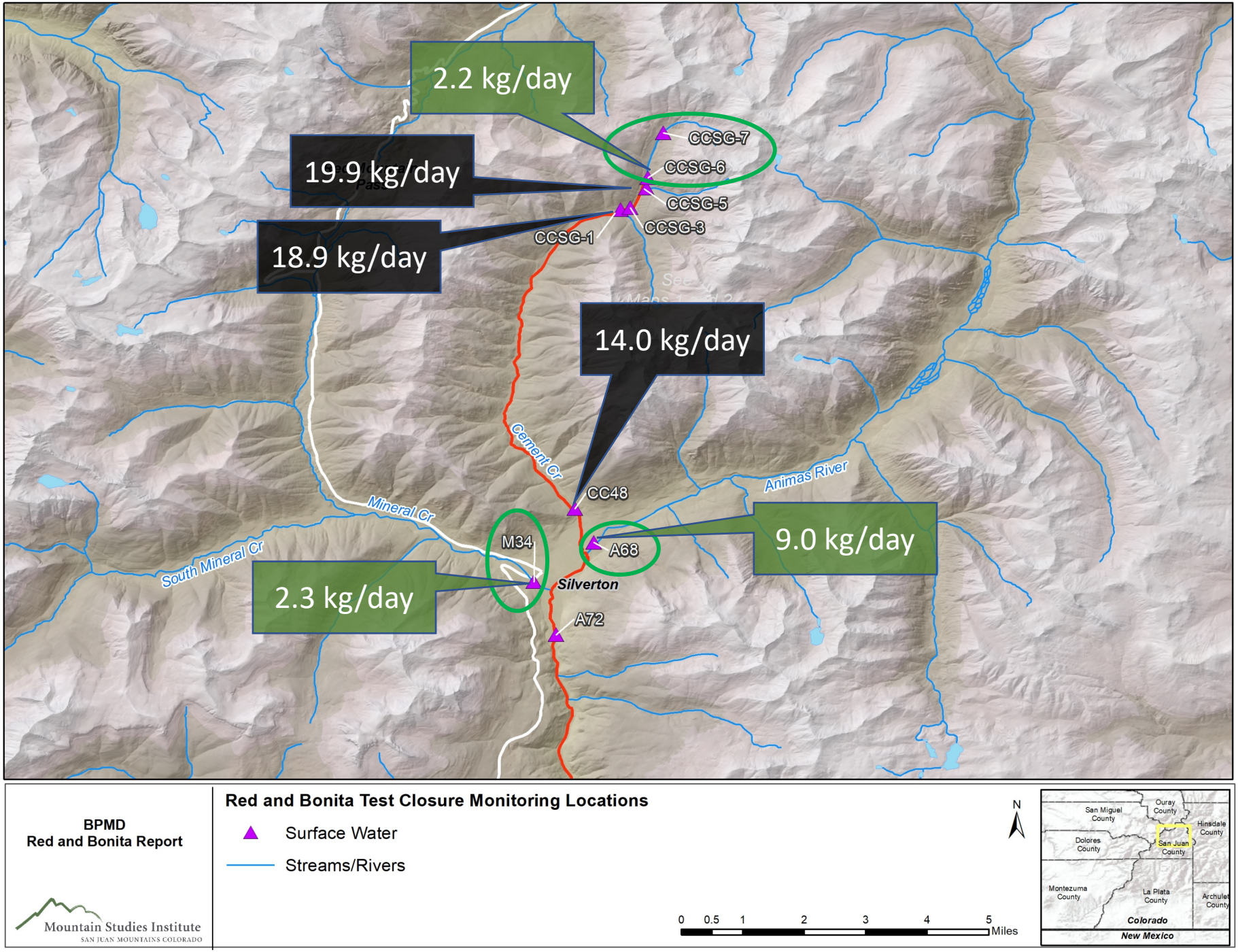
Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

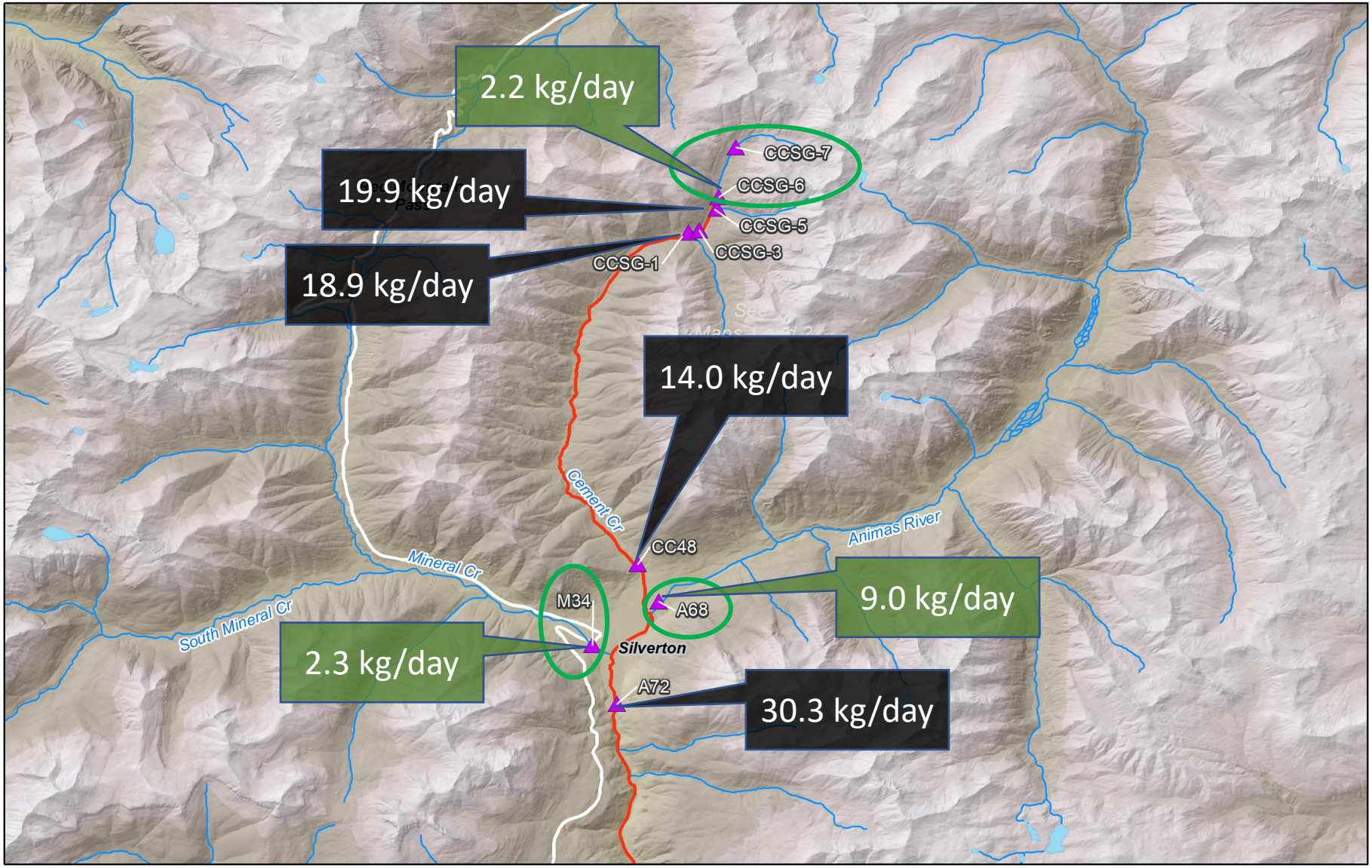
Red and Bonita Test Closure Monitoring Locations

- Surface Water
- Streams/Rivers

N

0 0.5 1 2 3 4 5 Miles


2.2 kg/day
19.9 kg/day
18.9 kg/day
14.0 kg/day
9.0 kg/day
2.3 kg/day
CCSG-7
CCSG-6
CCSG-5
CCSG-3
CCSG-1
CC48
A68
M34
A72
Silverton
Cement Cr
Mineral Cr
South Mineral Cr
Animas River
BPMD
Red and Bonita Report
Red and Bonita Test Closure Monitoring Locations
Surface Water
Streams/Rivers
Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO
N
0 0.5 1 2 3 4 5
Miles
San Miguel County
Ouray County
Hinsdale County
Dolores County
San Juan County
Montezuma County
La Plata County
Archuleta County
Colorado
New Mexico



BPMD
Red and Bonita Report

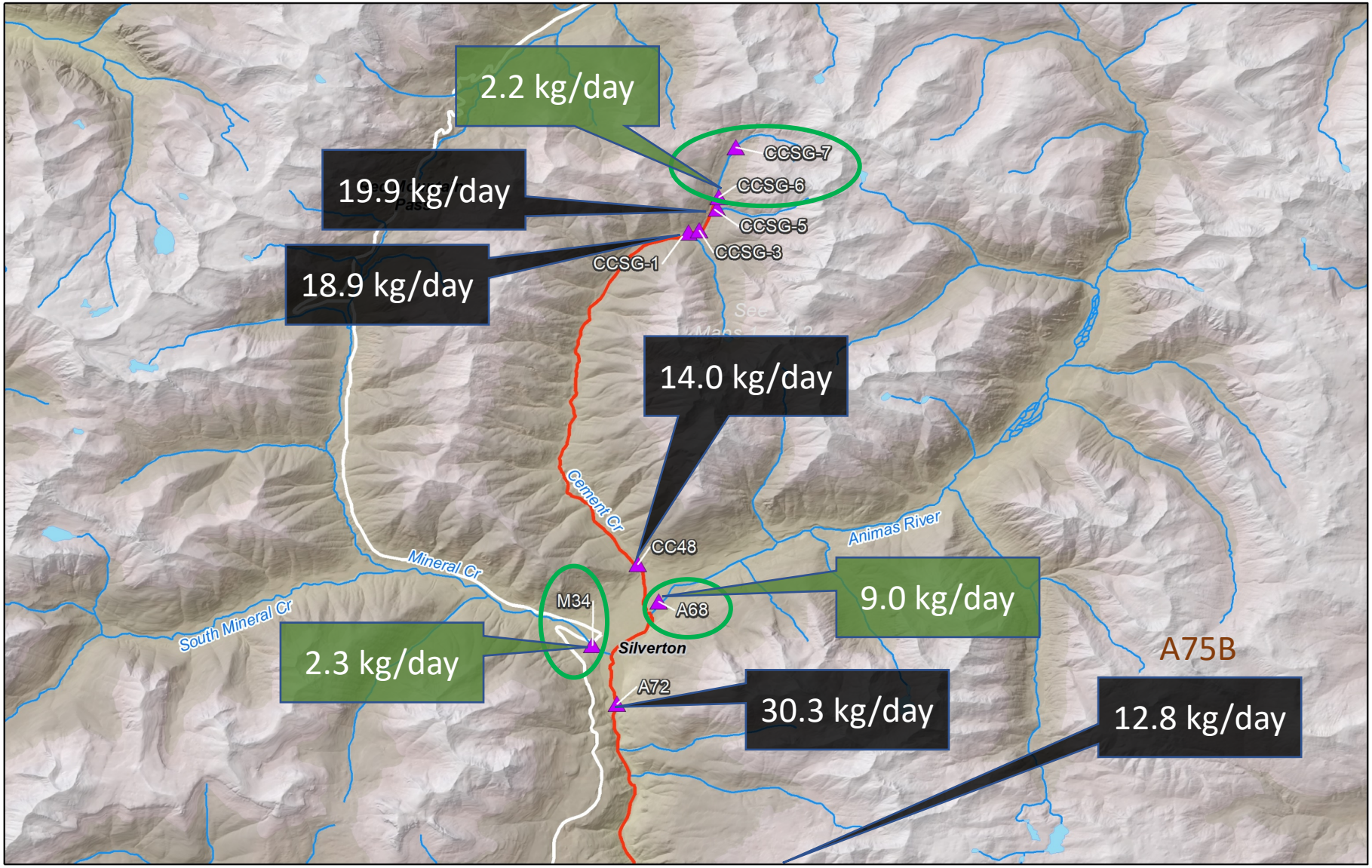
Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

Red and Bonita Test Closure Monitoring Locations

- Surface Water
- Streams/Rivers

N

0 0.5 1 2 3 4 5 Miles



BPMD
Red and Bonita Report

Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

Red and Bonita Test Closure Monitoring Locations

- Surface Water
- Streams/Rivers

N

0 0.5 1 2 3 4 5 Miles

Summary/Discussion:

- Longer test would allow greater inferences
- Little to no indication of response
(e.g., increased flows; similar trends to previous years)
at draining mines and seeps/springs
- Hydrologic response of test could have been masked by large interannual variability
- High frequency monthly sampling is crucial

Summary/Discussion:

- Zinc loads reduced at all surface water sites

  Magnitude of reduction was greatest at sites downstream of R&B

- Water quality of surface water sites downstream of R&B in 2020 was less similar to R&B than previous years

  Multivariate approach incorporating full suite of metals

Prioritize future R&B closure monitoring:

- SS062, SS236
  (higher Pb and Fe in low-flow ‘20)

- New surface water expressions
  R&B waste rock; R&B fen; ferricrete; up-gradient

- Similarity to R&B water quality
  SS405; SS413; SS417; SS418 (via multivariate)
  others (via isotopes, tritium, dating, etc.)

- *Surface water sites*
  closely bracket R&B on Cement Creek; N Fork Cement
  synoptic sampling

Thank you

Ian Bowen
US EPA Region 8
Bown.Ian@epa.gov

Dr. Rory Cowie
Alpine Water Resources, LLC
rory@alpinewaterresources.com

Scott Roberts
Mountain Studies Institute
scott@mountainstudies.org