Implementing Source Control at the Pennsylvania Mine, Summit County, Colorado

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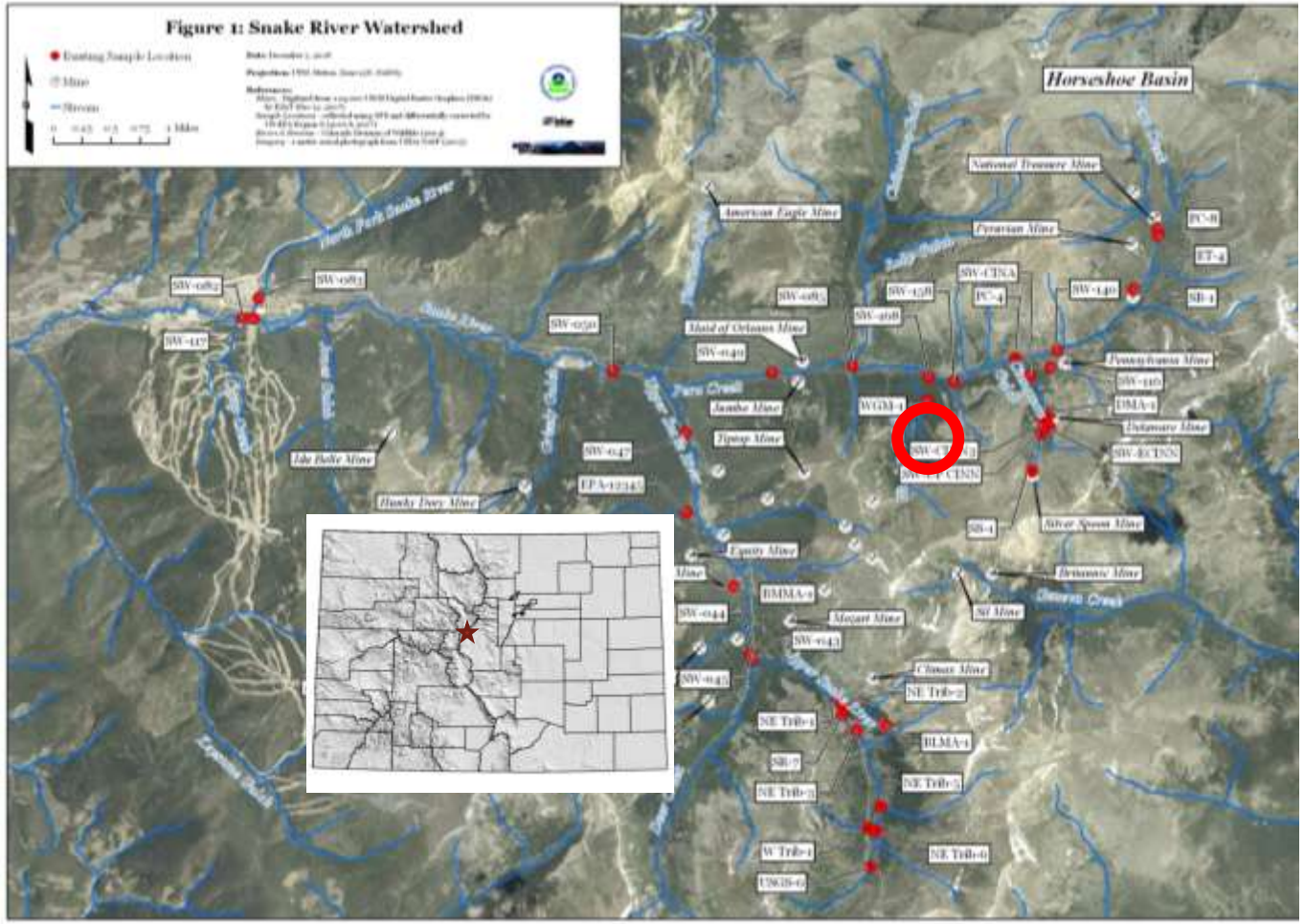
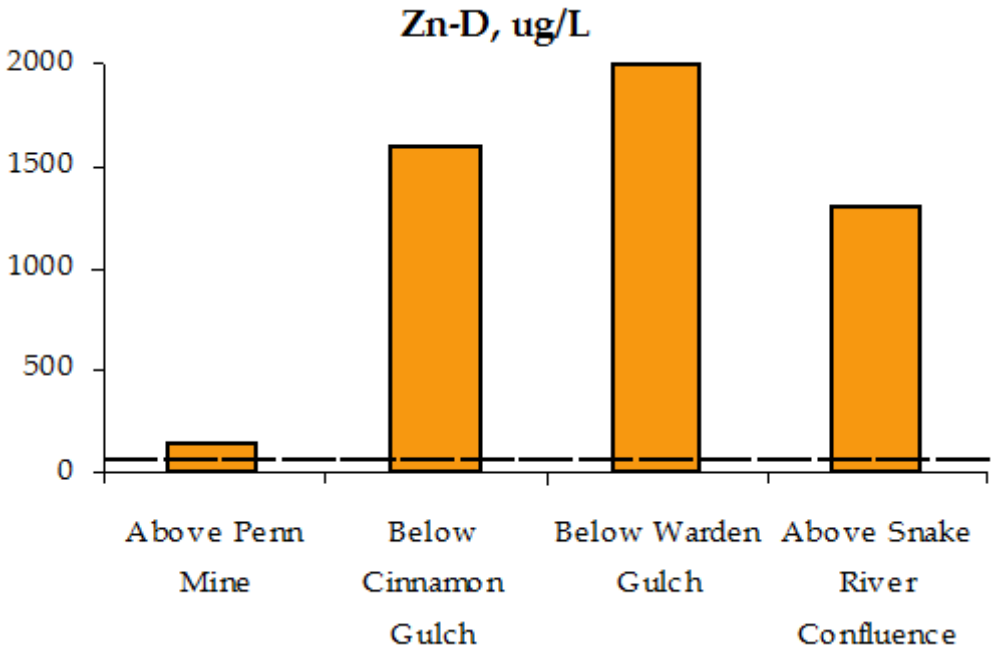
Pennsylvania Mine

- Penn Mine setting, geology and history
- Watershed and site remedial history
- Source control investigation
- Remedy implementation

Setting

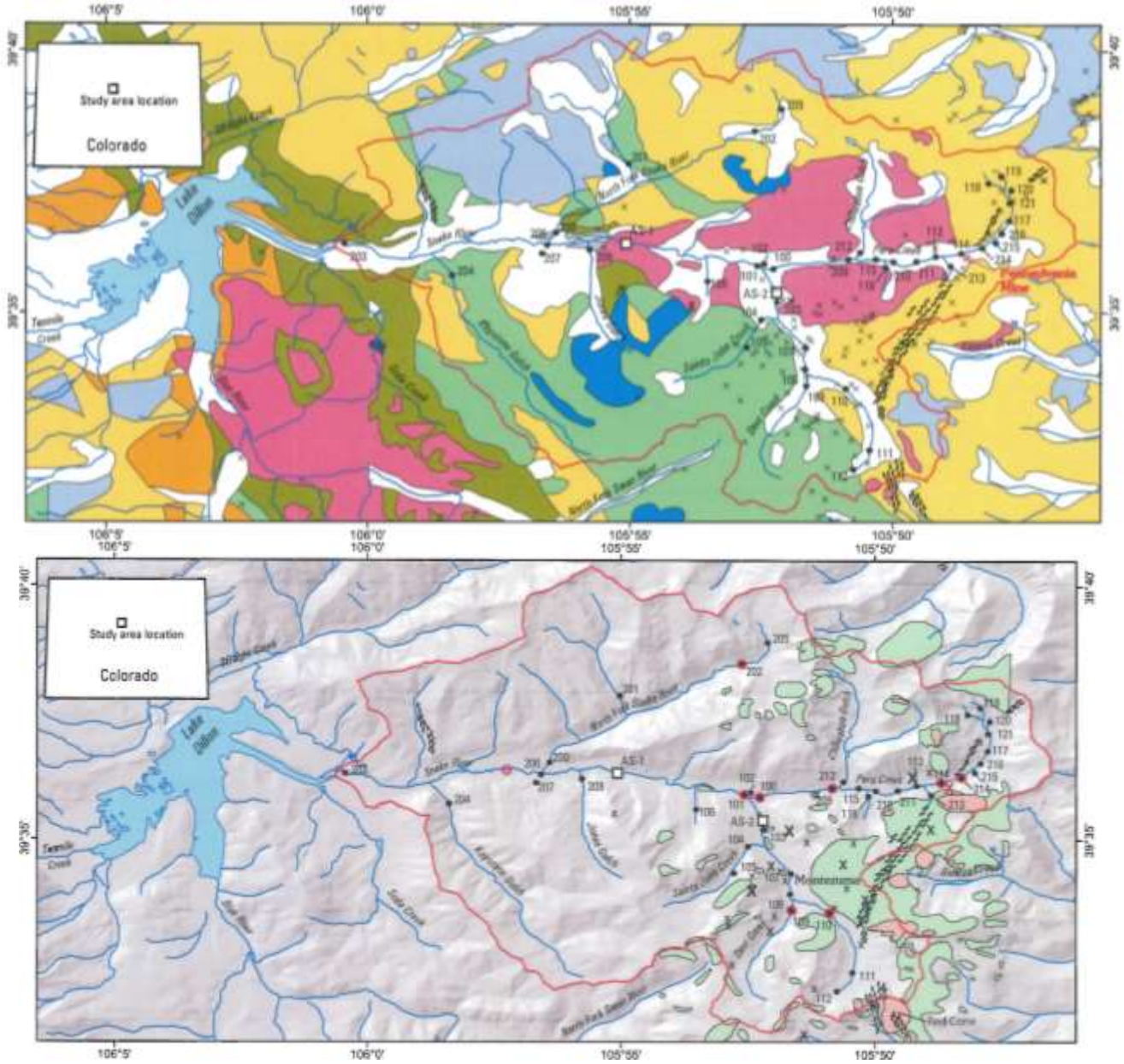


- Located in Upper reaches of Peru Creek, a tributary to the Snake River.
- Pennsylvania Mine - single largest manmade metals contributor to the Snake River (~40,000lbs Zn/yr).

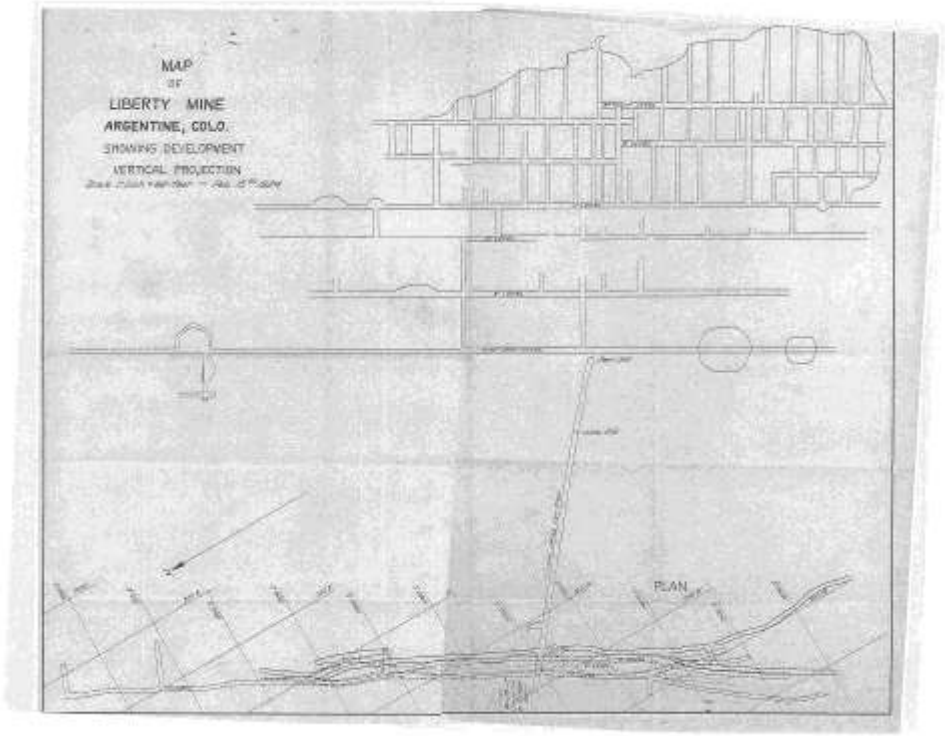


Geology

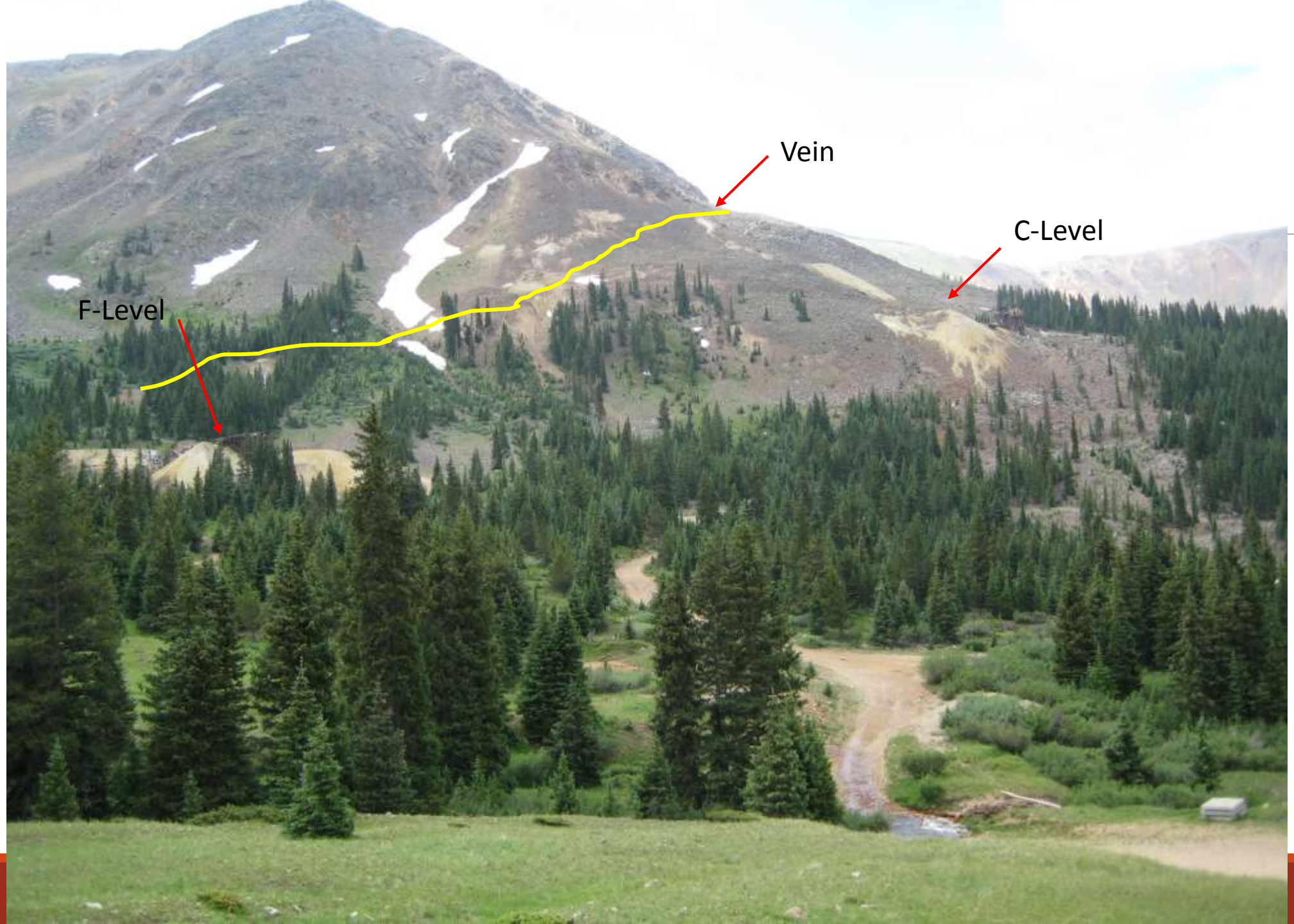
- Geology dominated by Montezuma Stock.
- Majority of mining along stock margins.
- Significant hydrothermal alteration throughout Peru Creek and Snake River watersheds.



History



- Vein originally discovered in 1879.
- Mined for gold and silver through 1950's.
- Six main levels, A – F.
- Production:
  - > 3,500 ounces gold
  - > 895,000 ounces silver
- All portals into mine workings are collapsed.

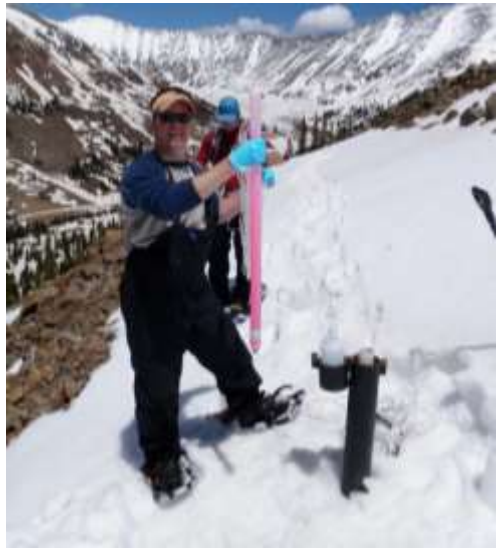

Vein
C-Level
F-Level

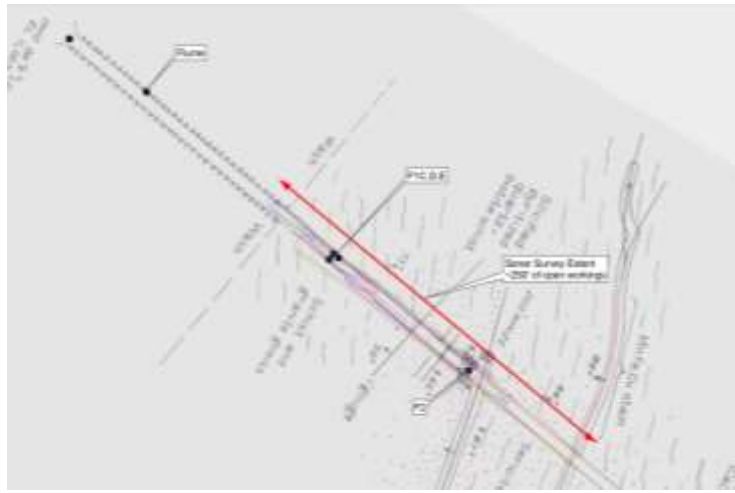
Remedial History

- Investigated in mid 1980's for wetland remediation.
- Passive treatment system constructed in mid 1990's…never operated.
- Numerous non-point source projects completed in watershed.

Site Characterization

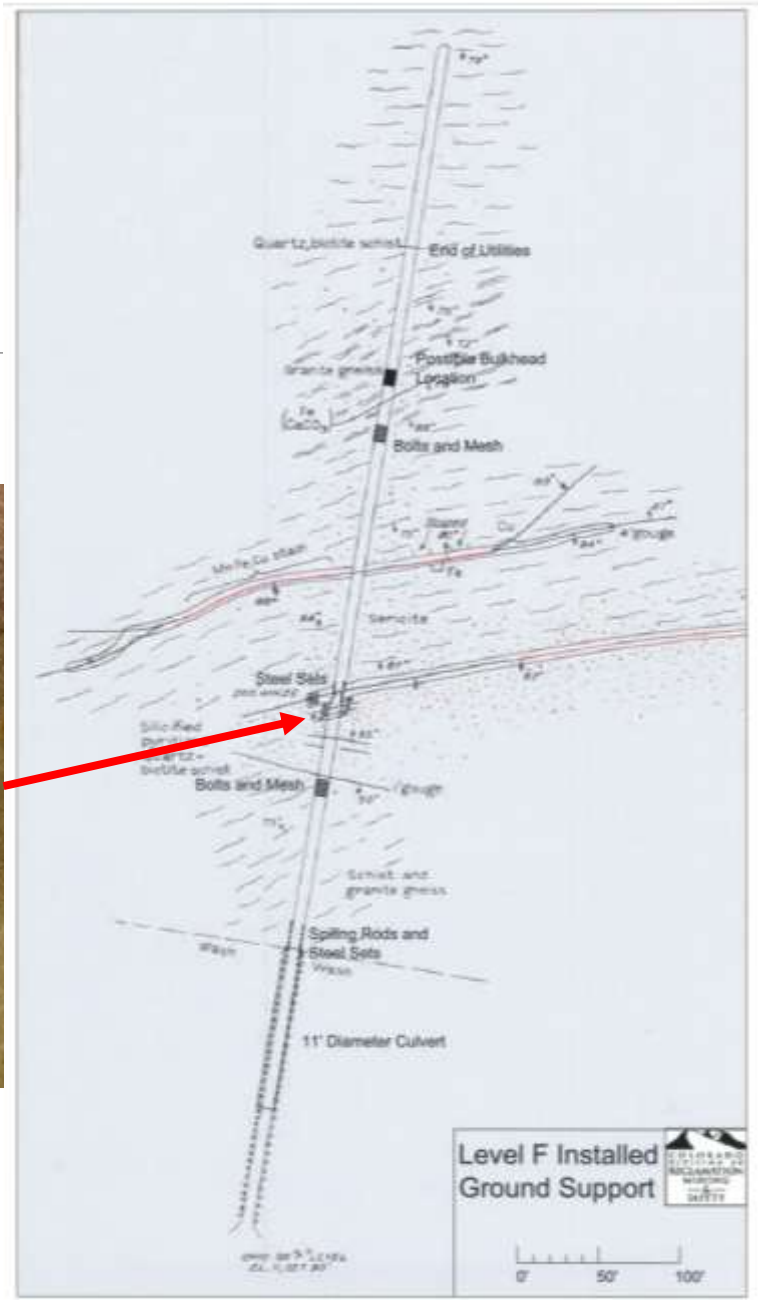
- Conduct site wide water sampling to establish baseline conditions.
- Use dye tracing and stable water isotopes to establish underground flowpaths.
- Conduct subsurface drilling to locate and establish condition of mine workings.



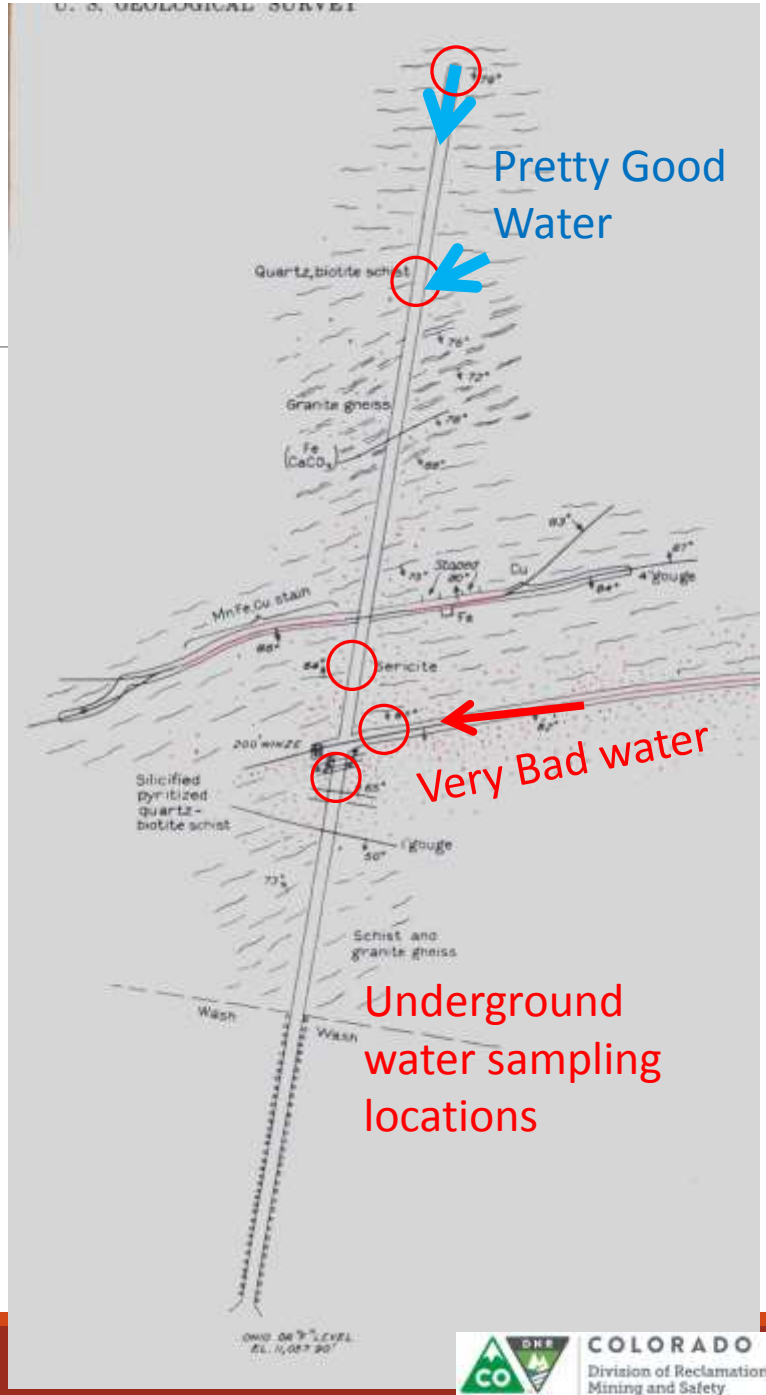


Portal Rehab

Underground Rehab



Underground Characterization

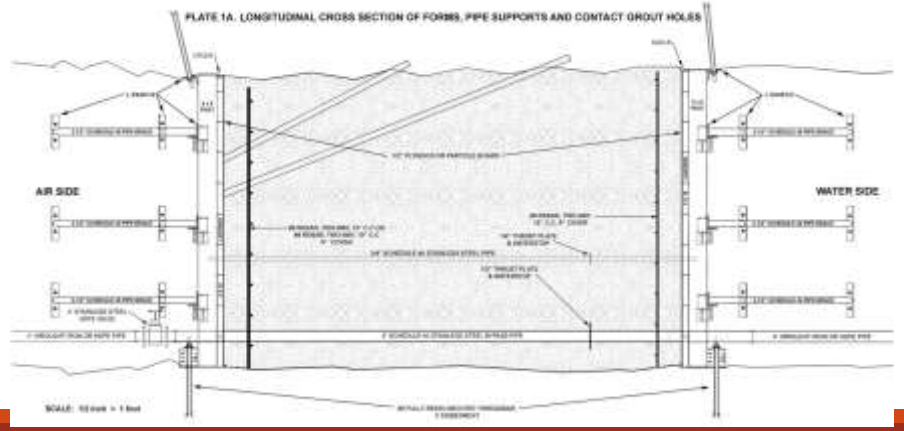


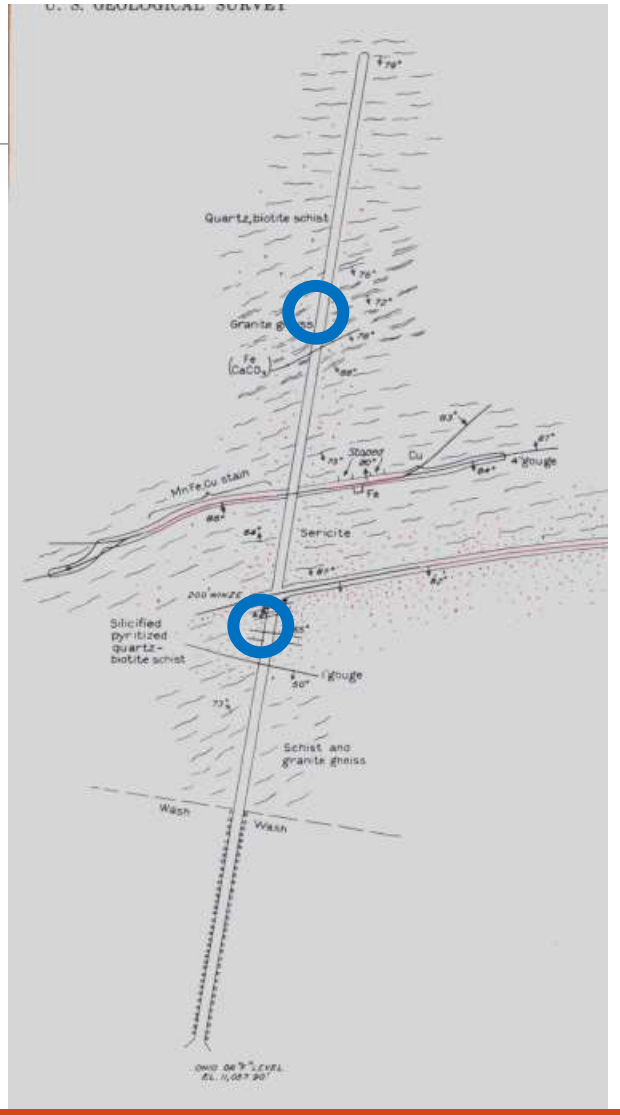
Data Evaluation

Investigations indicated:

- Bulkheads are viable source control option.
- Multiple bulkhead approach.
- Possible opportunity for inflow reduction on Level C and in mine treatment.

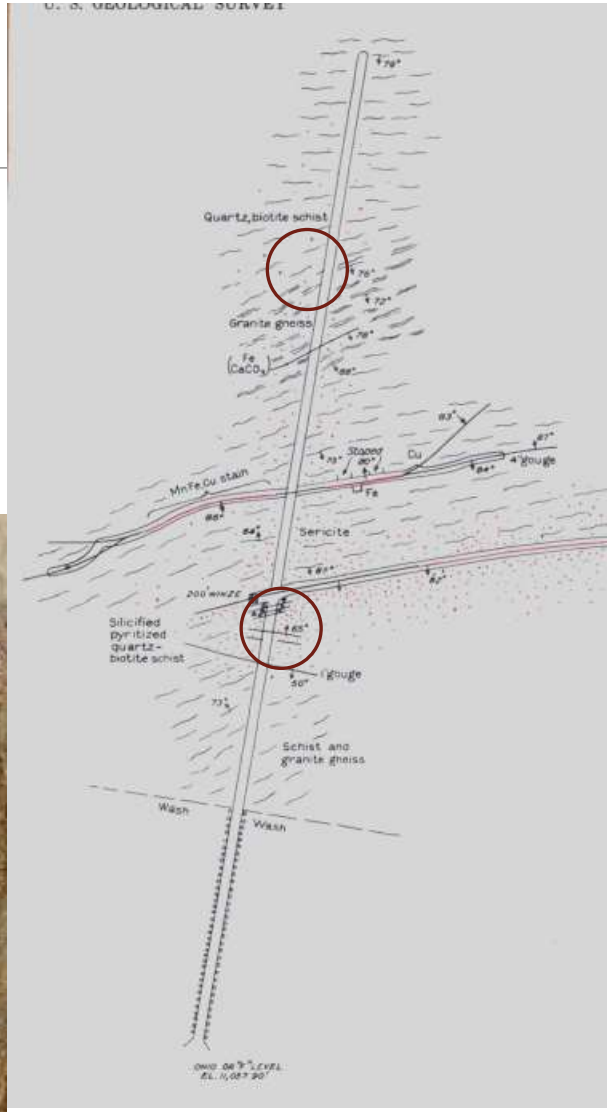
Implement as phased approach.

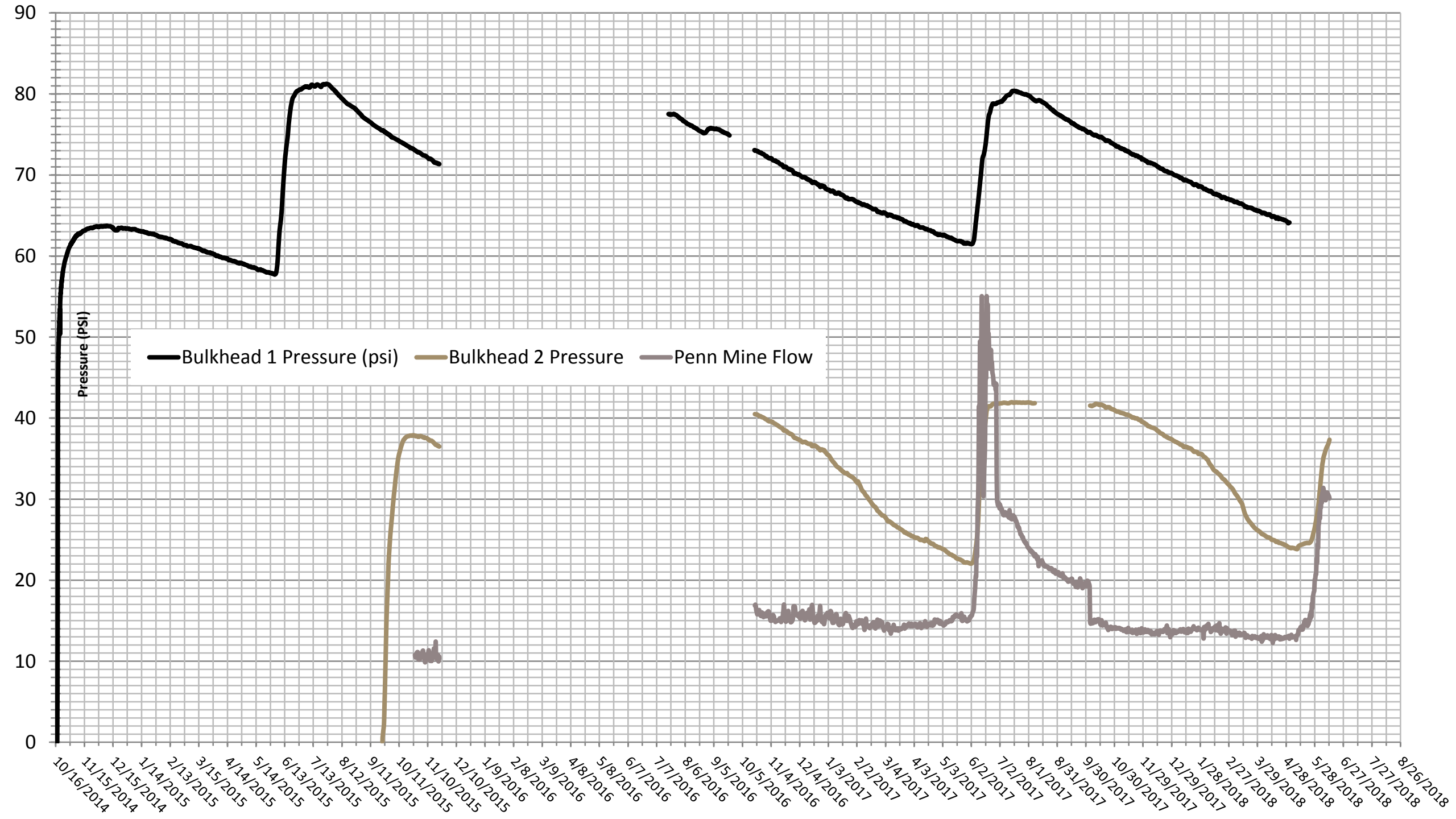




Bulkheads

- Flow reduction up to 90%;
- Steady state reached quickly;
- Peak flow controlled.




Pressure (PSI)
Bulkhead 1 Pressure (psi)
Bulkhead 2 Pressure
Penn Mine Flow
0
10
20
30
40
50
60
70
80
90
10/16/2014
11/15/2014
12/15/2014
1/14/2015
2/13/2015
3/15/2015
4/14/2015
5/14/2015
6/13/2015
7/13/2015
8/12/2015
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5/3/2017
6/2/2017
7/2/2017
8/1/2017
8/31/2017
9/30/2017
10/30/2017
11/29/2017
12/29/2017
1/28/2018
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3/29/2018
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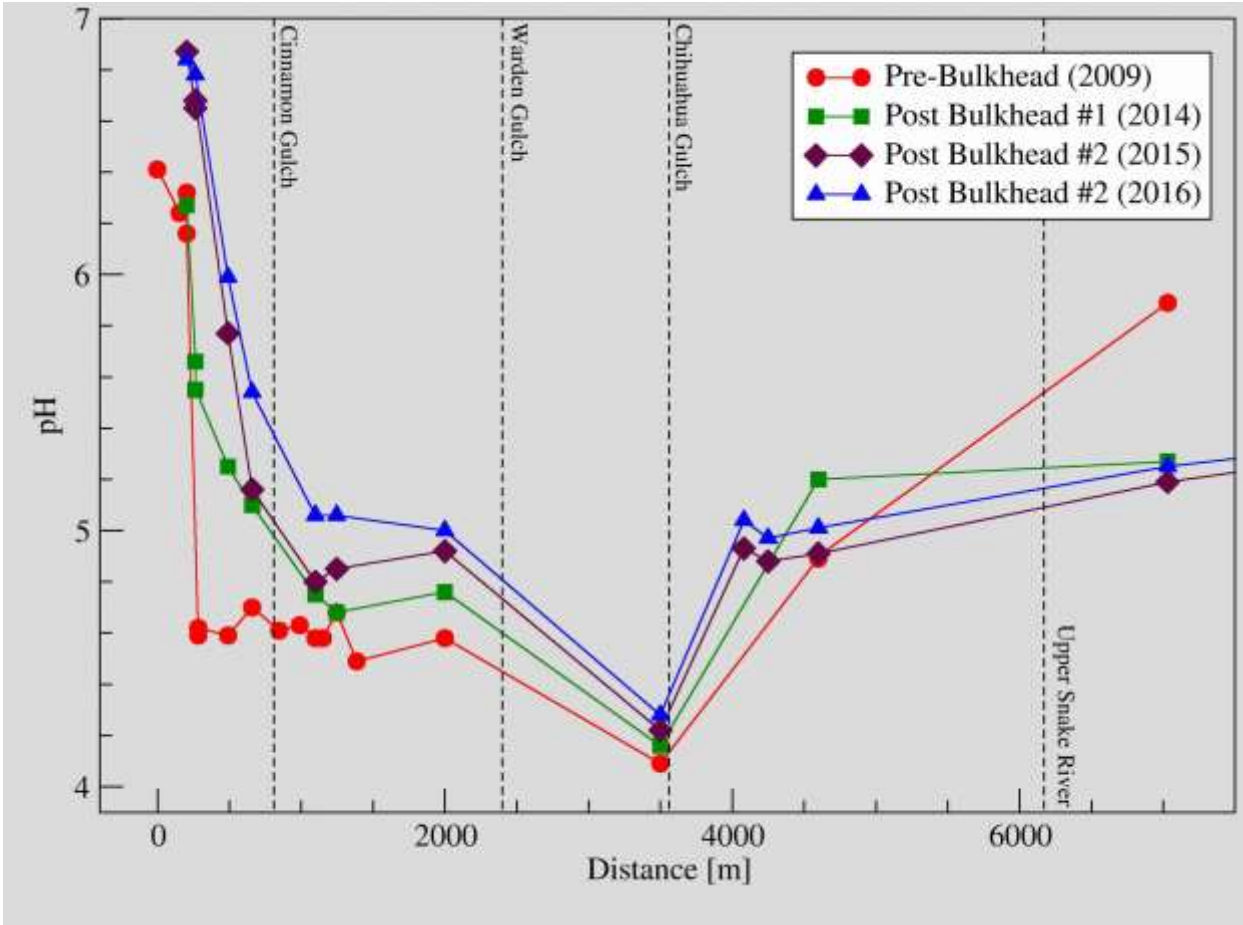
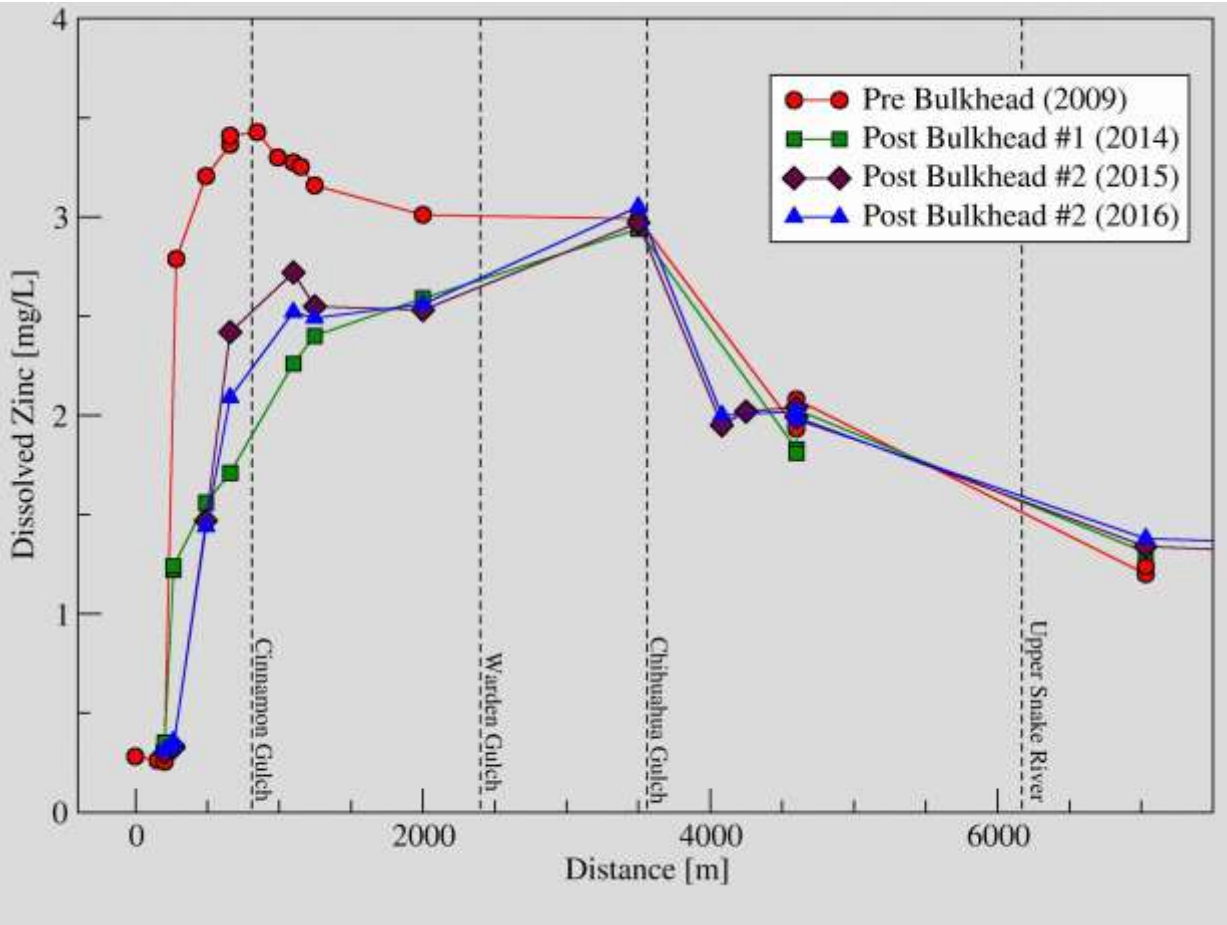
5/28/2018
6/27/2018
7/27/2018
8/26/2018

Bulkhead Results – pH and Zn





Data compiled by USGS

Effect of Penn Mine Bulkheads

- % Load reduction compared to 2009 baseline, downstream in Peru Creek.
- Small improvements after first bulkhead (2014).
- Larger improvements following second bulkhead.

	Al	Cd	Cu	Fe	Mn	Pb	Zn
2014	-83%	-16%	5%	-76%	-24%	10%	-21%
2015	-14%	37%	50%	76%	22%	51%	29%
2016	-10%	38%	57%	83%	35%	66%	33%

Data compiled by USGS

Penn Mine Accomplishments

- Eliminated portal blowout events.
- Reduced chronic loading to Snake River.
- Increased survivability of fish in the Snake River.
- Reduced long term O&M.
- Investigation, implementation and operation of bulkheads ~ $2 million.
- Maintained existing land use and character of Peru Creek Watershed.

Questions?