

# THE DEAD PARROT'S SOCIETY

Date-Driven Process That Supported Removal of  
the Parrot Tailings Impoundment

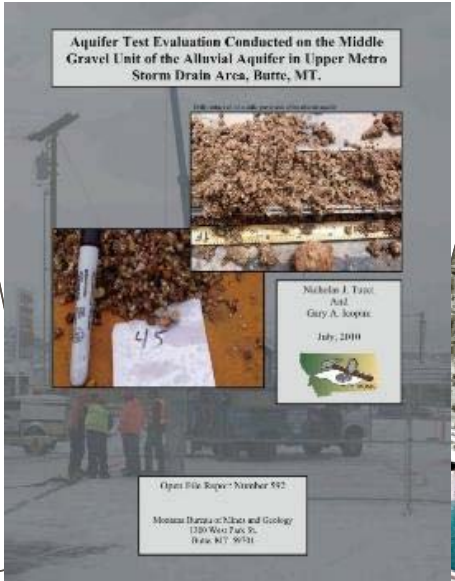
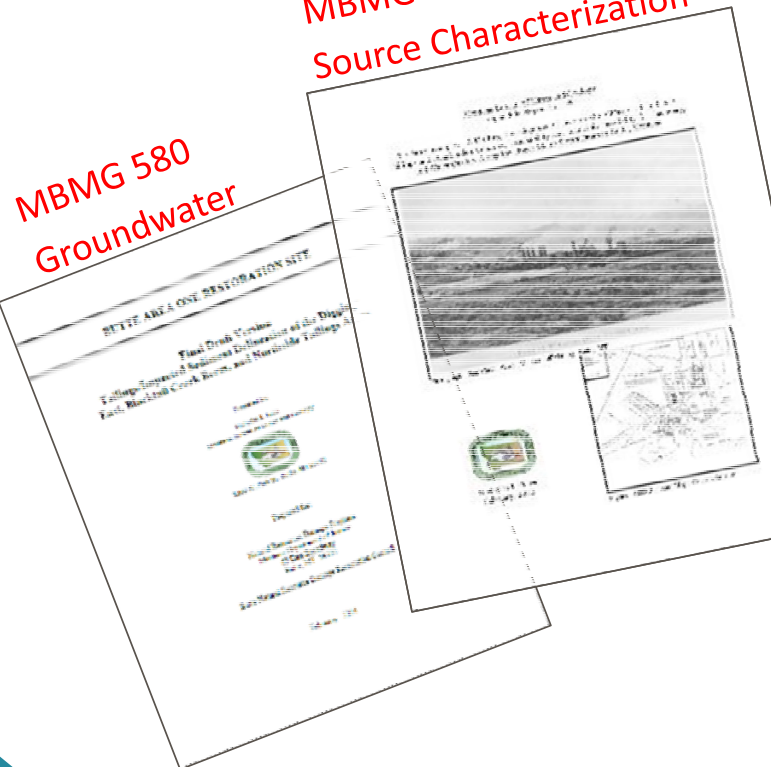
Nicholas J Tucci  
Senior Geochemist

**HALEY**  
**ALDRICH**

# Parrot Tailings Data-Driven Process

**MBMG 590**  
Source Characterization

**MBMG 580**  
Groundwater



**MBMG 592 Hydrogeology**

**MBMG 613**  
Geochemistry



**MBMG RI22**  
Fate & Transport



Significant  
Data Gaps



Robust  
Characterization

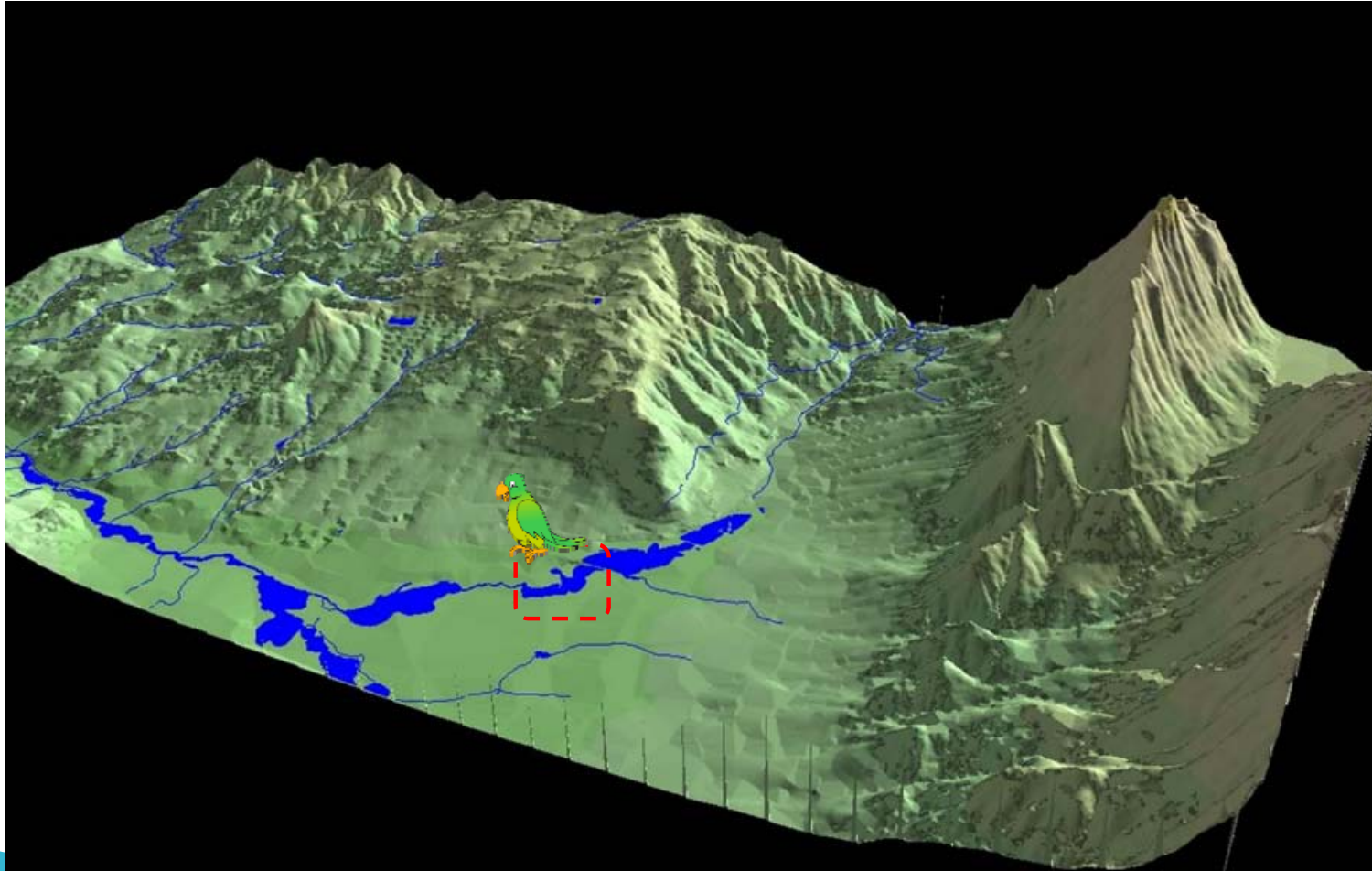


Butte: A  
1880' to

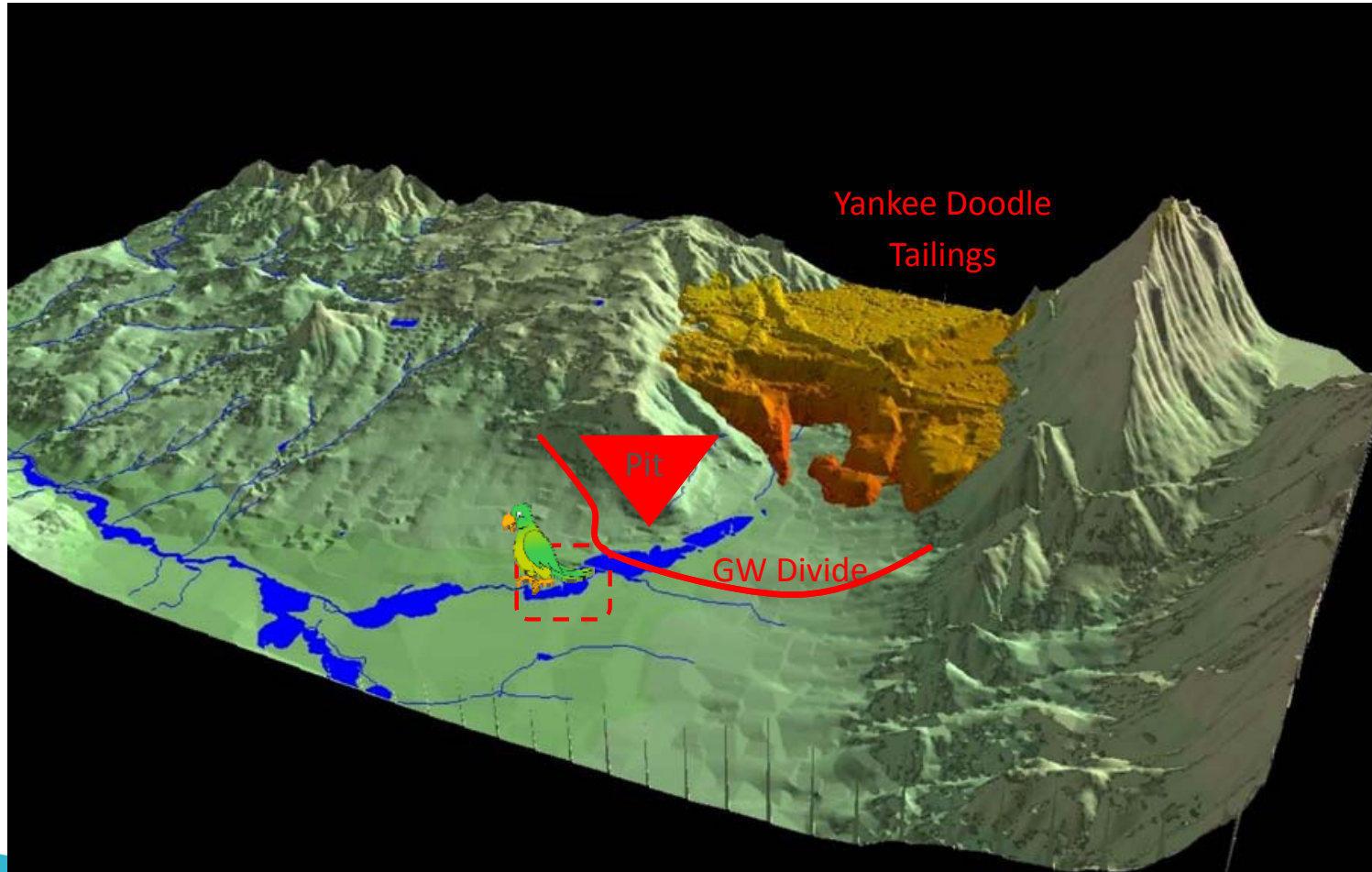
Creek



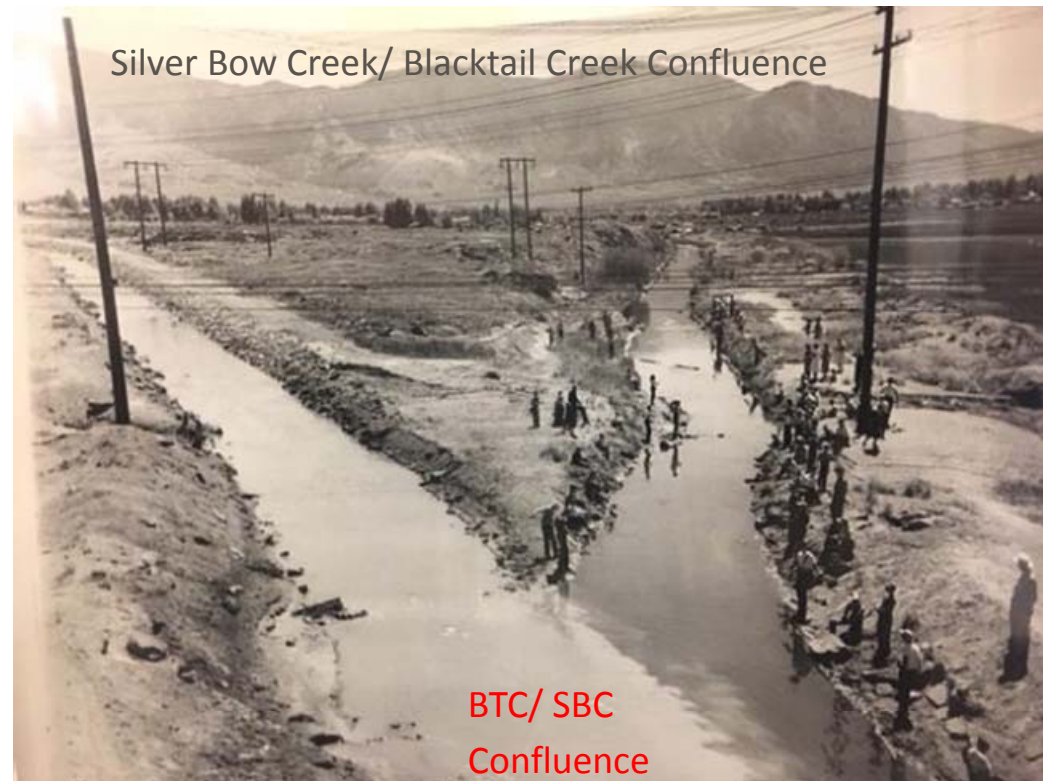
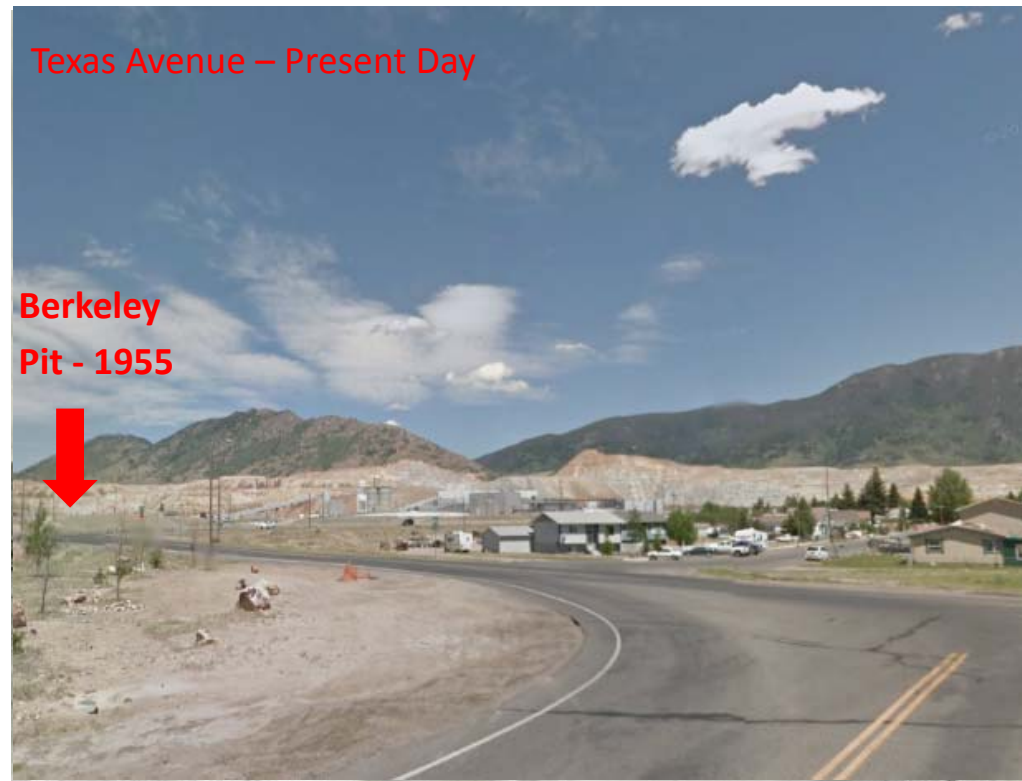
# Butte Circa 1905



# Butte – Post Berkeley Pit



## A Tale of Two Sources: 1) Historic Mine Discharges to Historic Silver Bow Creek



# A Tale of Two Sources: 2) Mine Wastes Left In Place



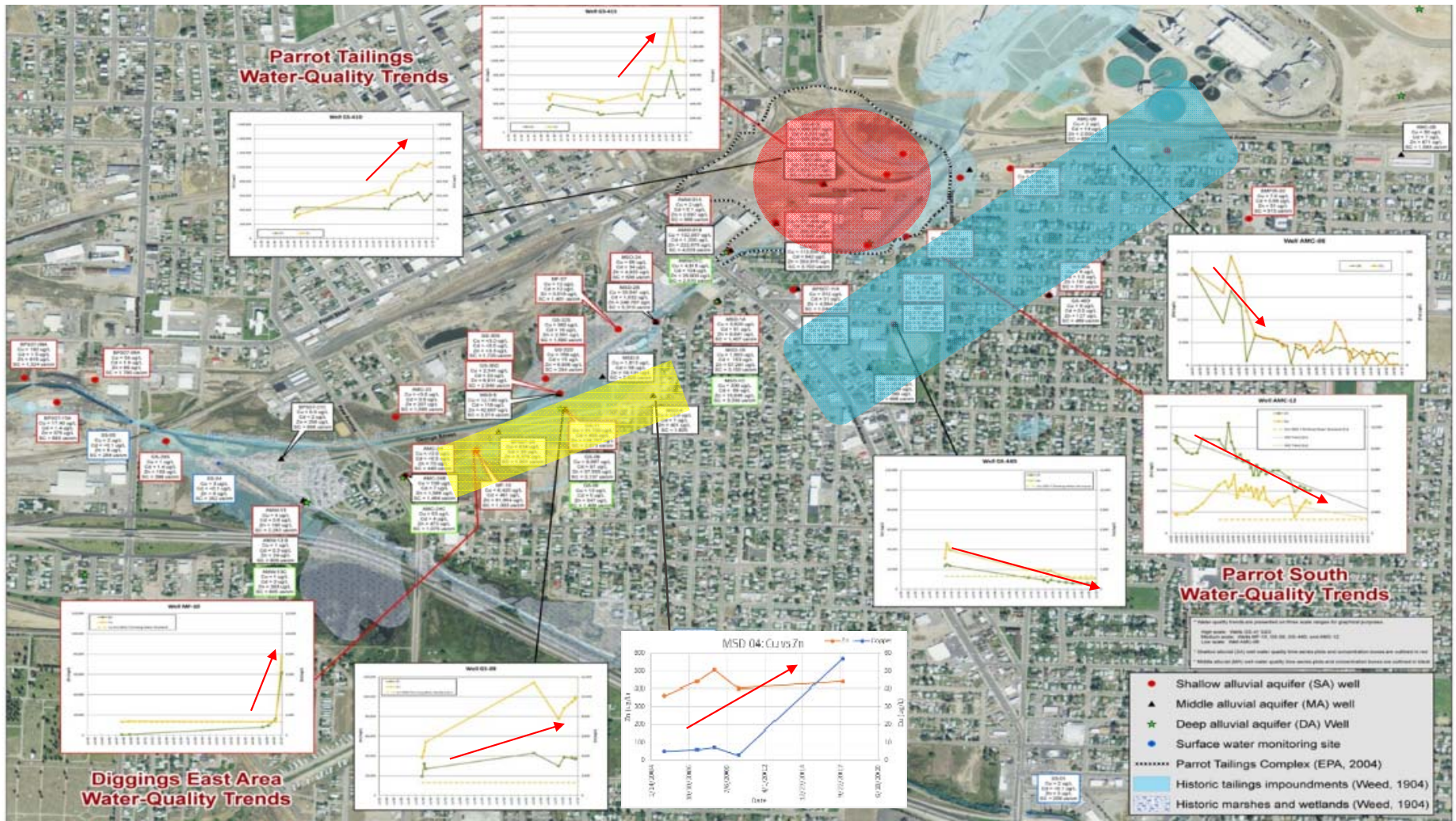




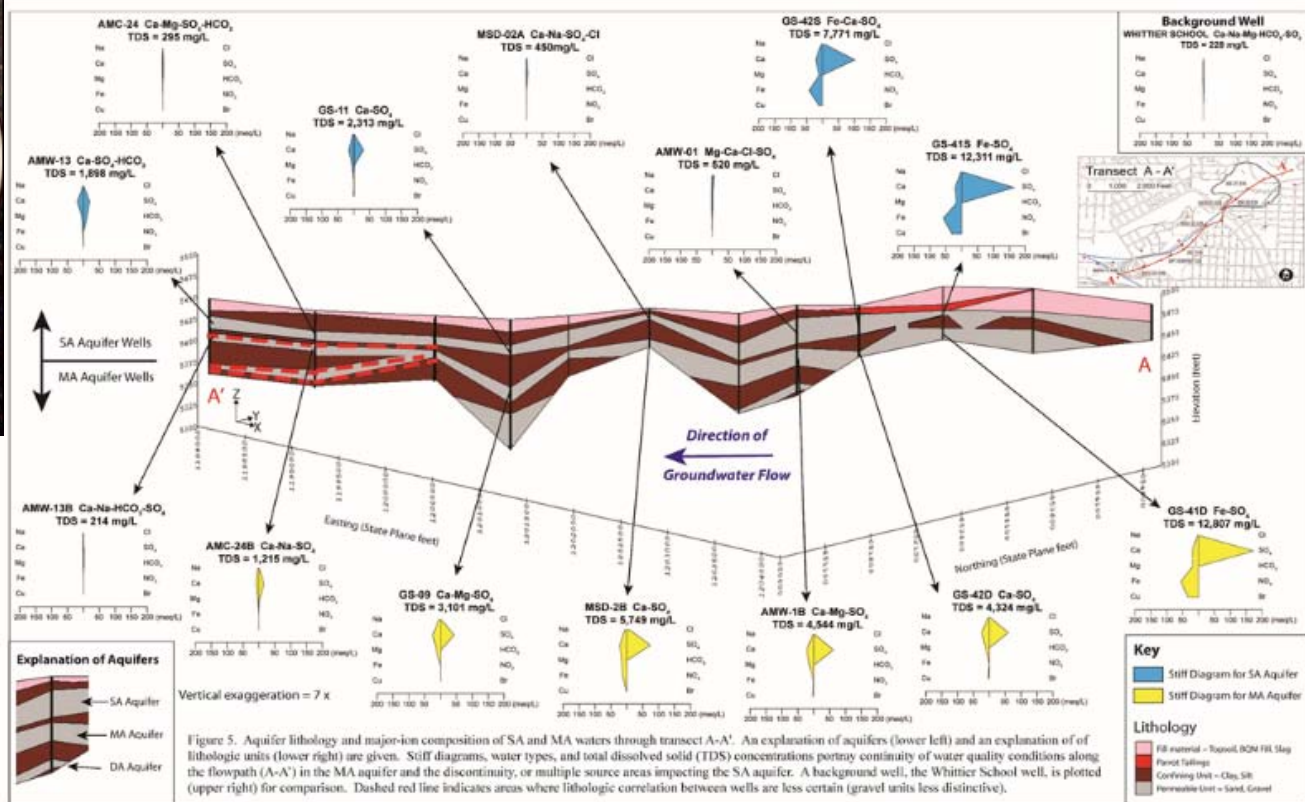
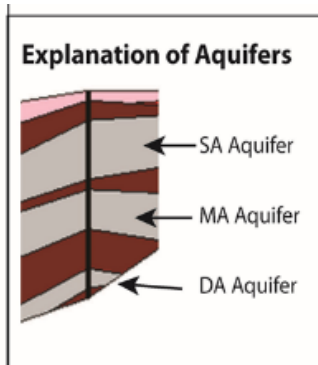
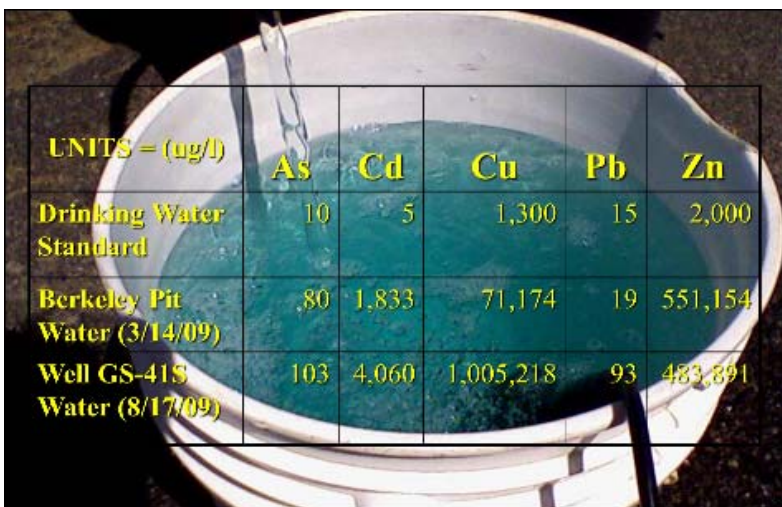
## Groundwater

	As (ug/l)	Cd (ug/l)	Cu (ug/l)	Zn (ug/l)
EPA Drinking Water Standard	10	5	1,300	5,000
Berkeley Pit	50	1,853	46,464	551,154
Parrot Plume (GS-41S)	103	4,060	1,005,218	483,981

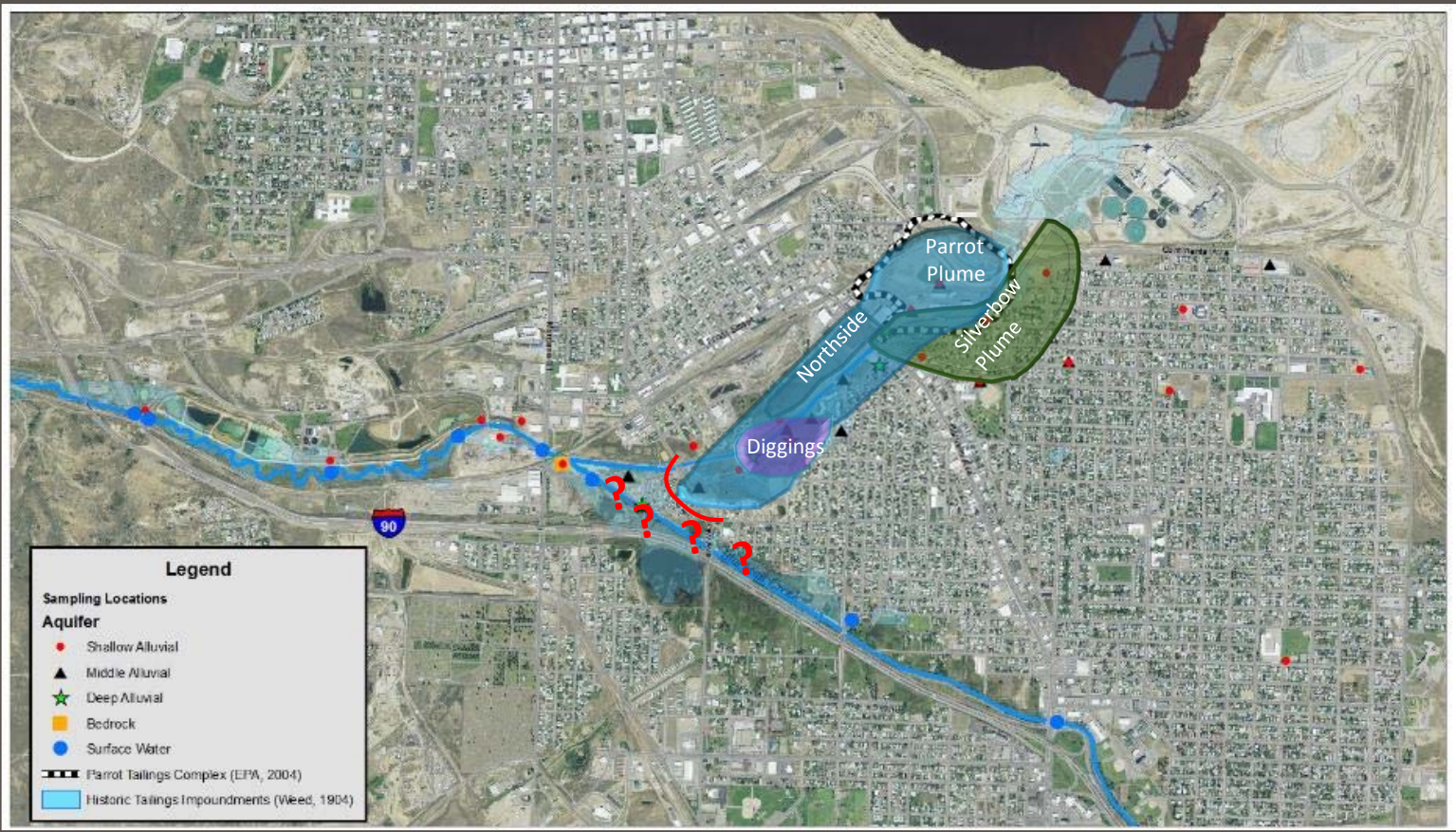
# Groundwater Quality Trends: A Tale of Two Sources



# Updated Conceptual Site Model: Geology



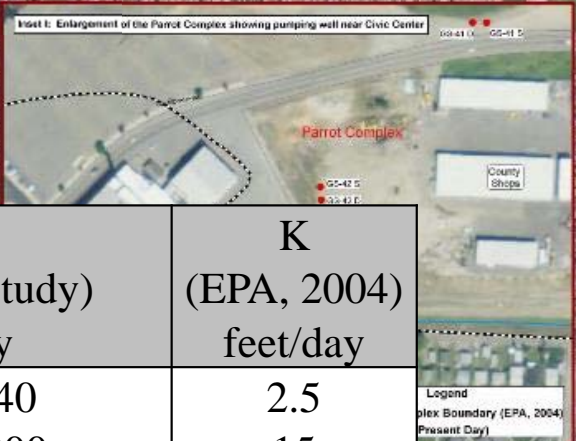
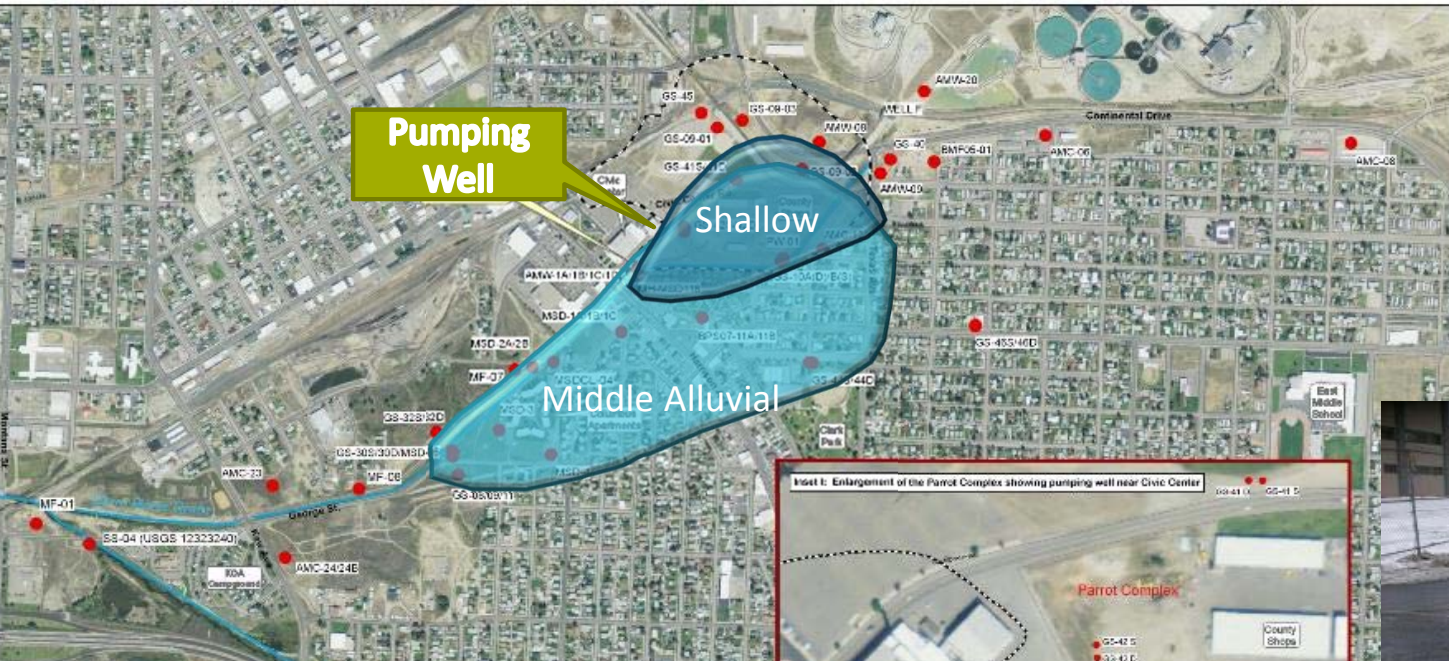
# Updated Conceptual Site Model: Contaminant Plume Fingerprinting



## A TALE OF Two Sources

- Parrot Plume: Active
- Digging's East: Active
- Northside: Active
- Silver Bow Creek: Inactive
  - Mine Discharge ceased in 1982.
  - Substantial water quality improvement

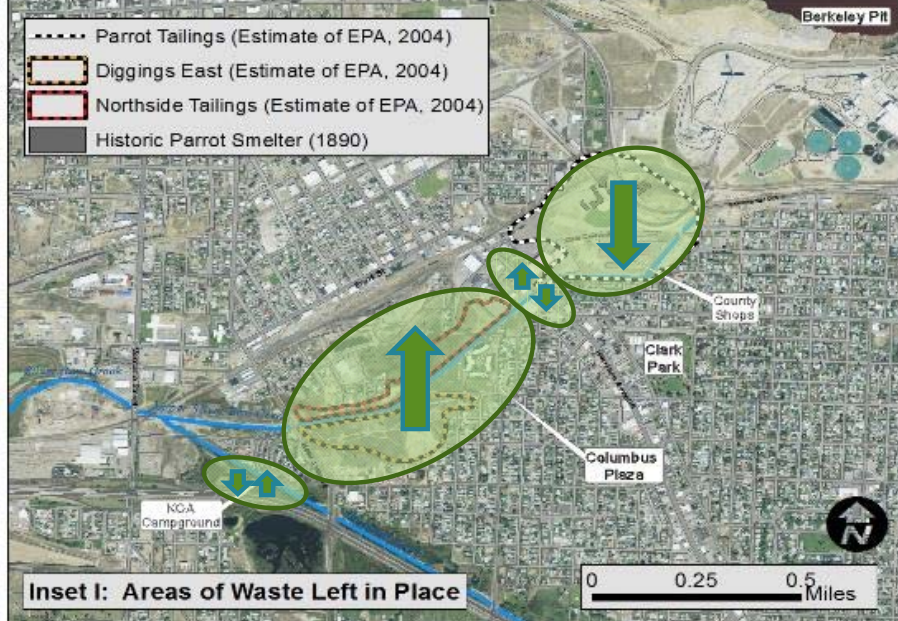
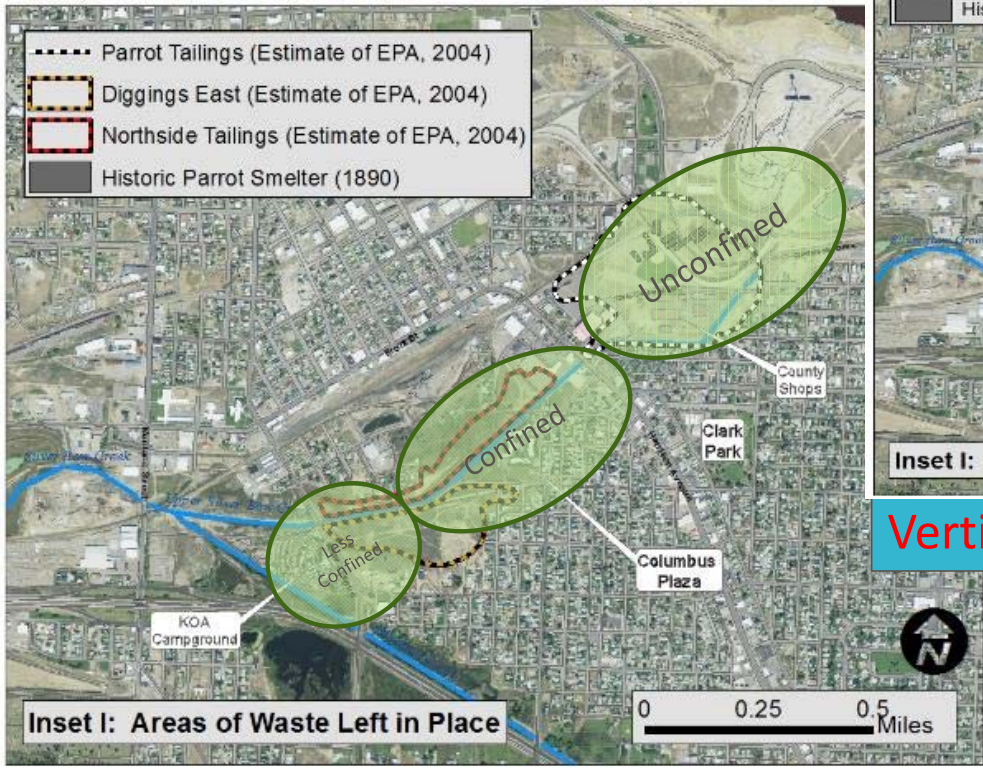
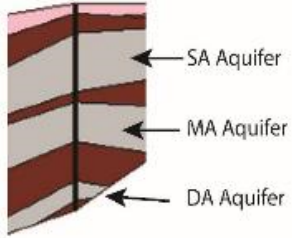
# Update Conceptual Site Model: Hydrogeology



	K (current study) feet/day	K (EPA, 2004) feet/day
Above Harrison	120 to 640	2.5
Below Harrison	480 to 1000	15
Average	603	9

# Update Conceptual Site Model: Hydrogeology

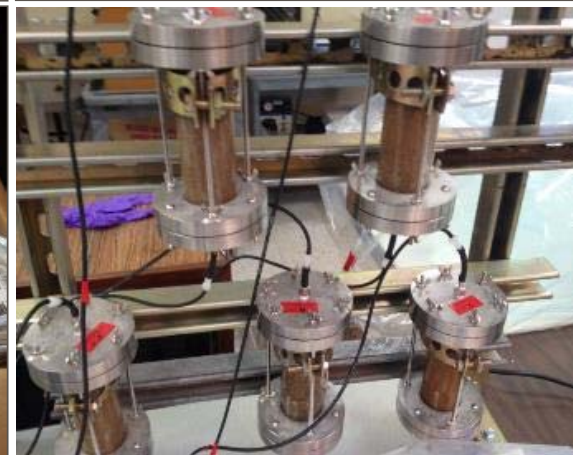
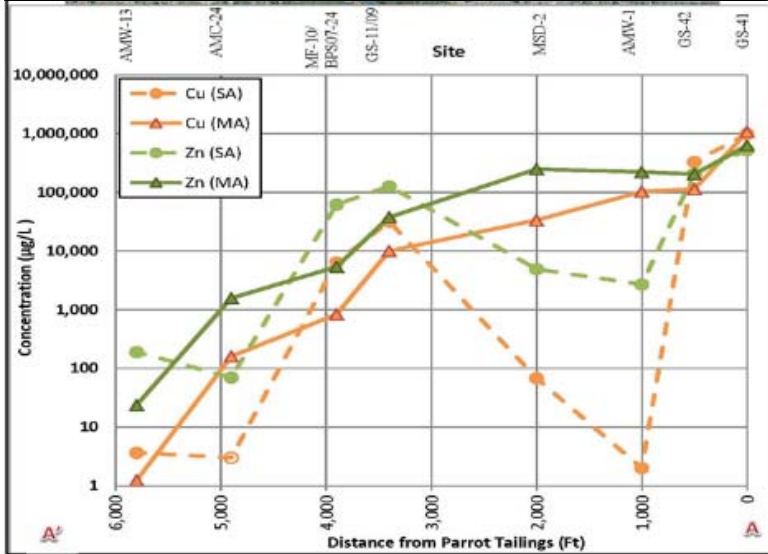
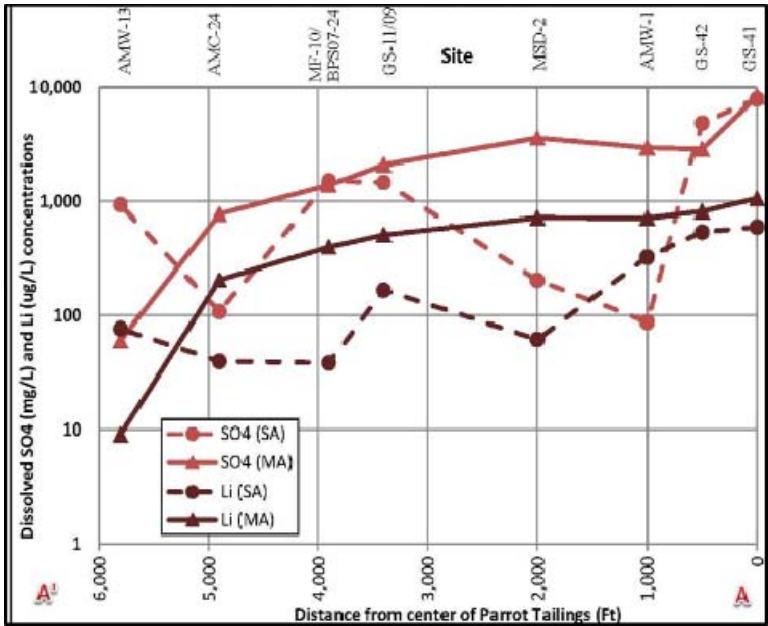
## Explanation of Aquifers



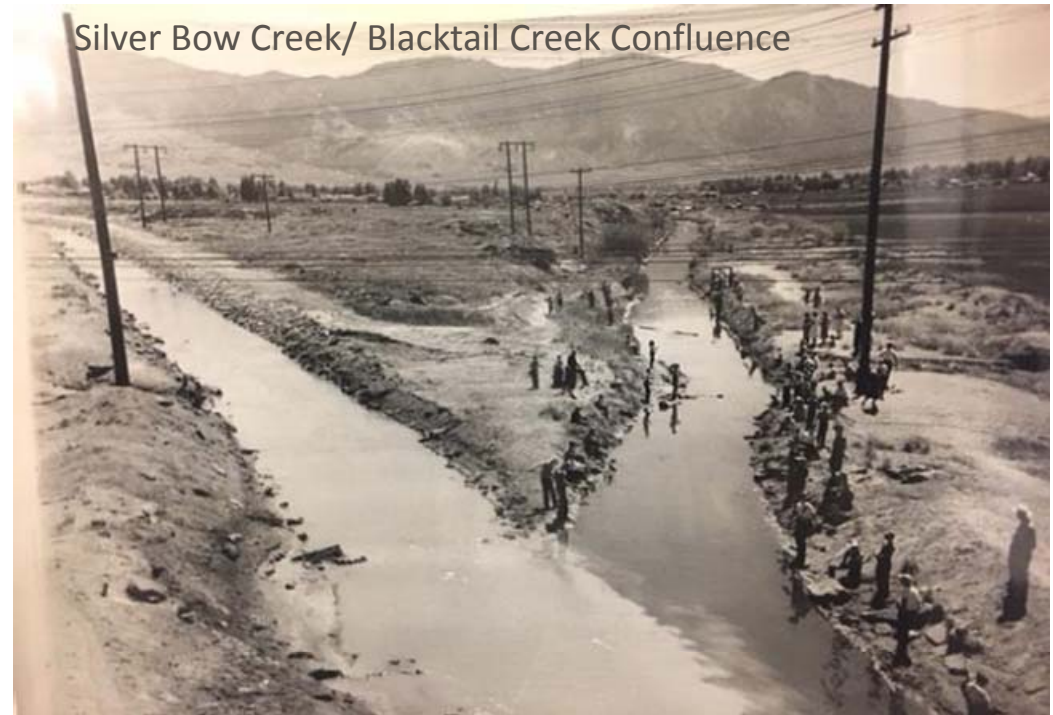
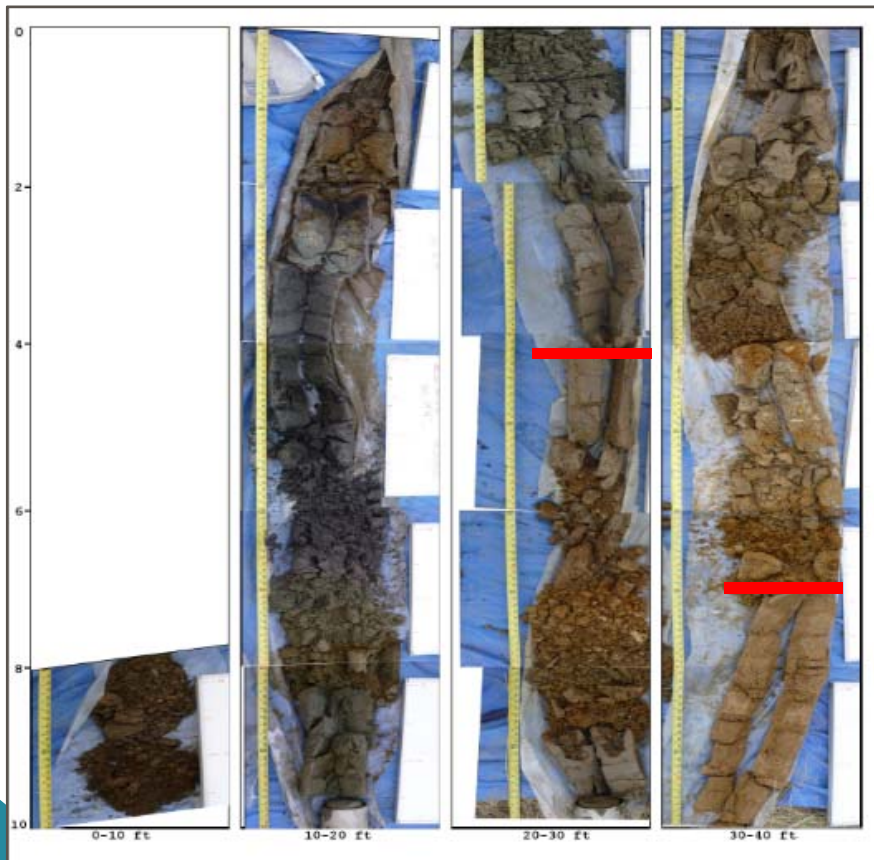
## Vertical Gradients Between SA/MA Units

Parrot Tailings is the only area where shallow contamination can migrate to the deeper zones.

# Geochemical Fingerprinting of Plume



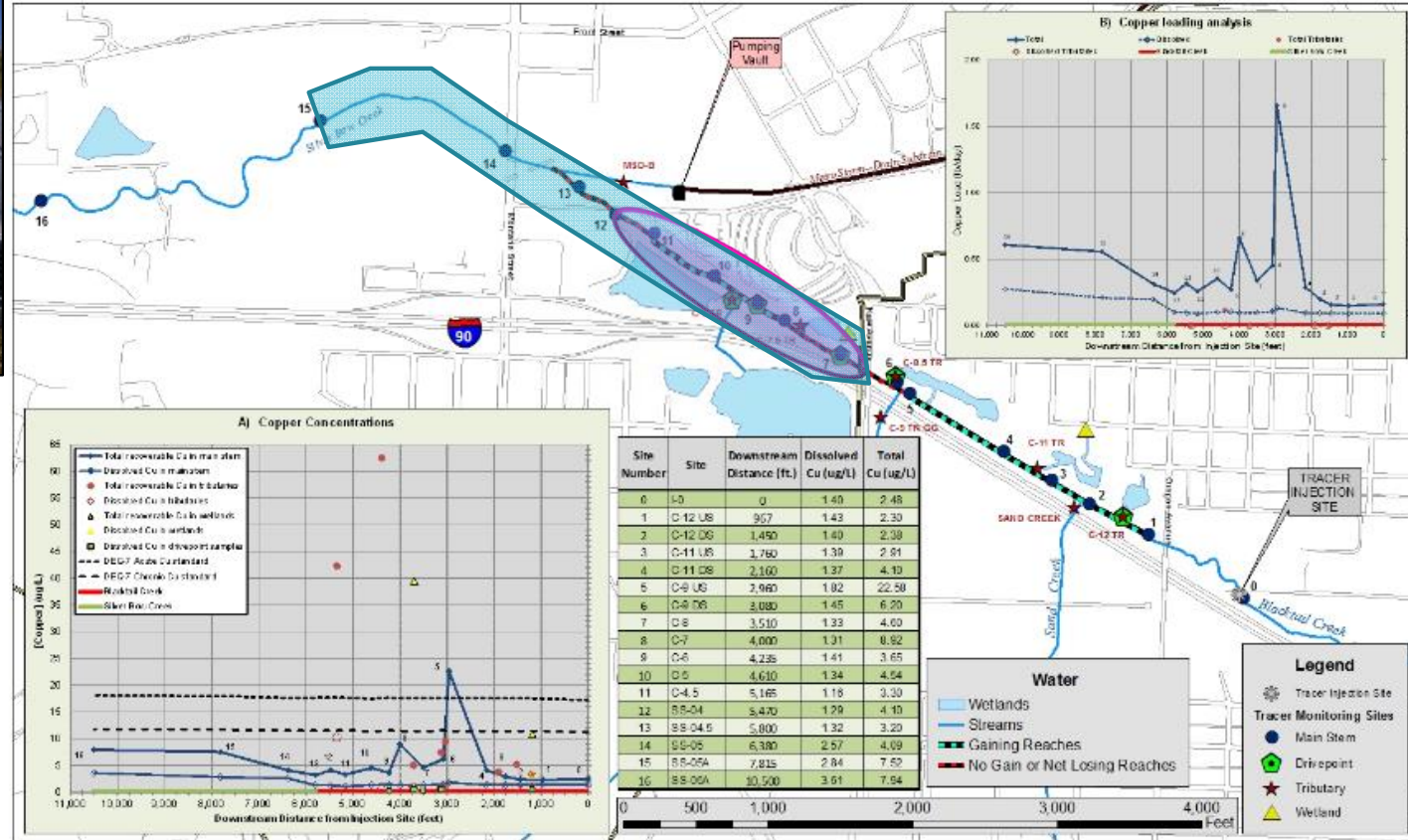
## Natural Attenuation of Parrot Plume COCs is a Finite Mechanism



Halo Zone of Fe-stained clasts in confluence area created by historic mine Discharges to SBC are the current primary finite attenuation mechanism For COCs in deeper contaminant flow paths.



# Blacktail and Silver Bow Creek Tracer Study



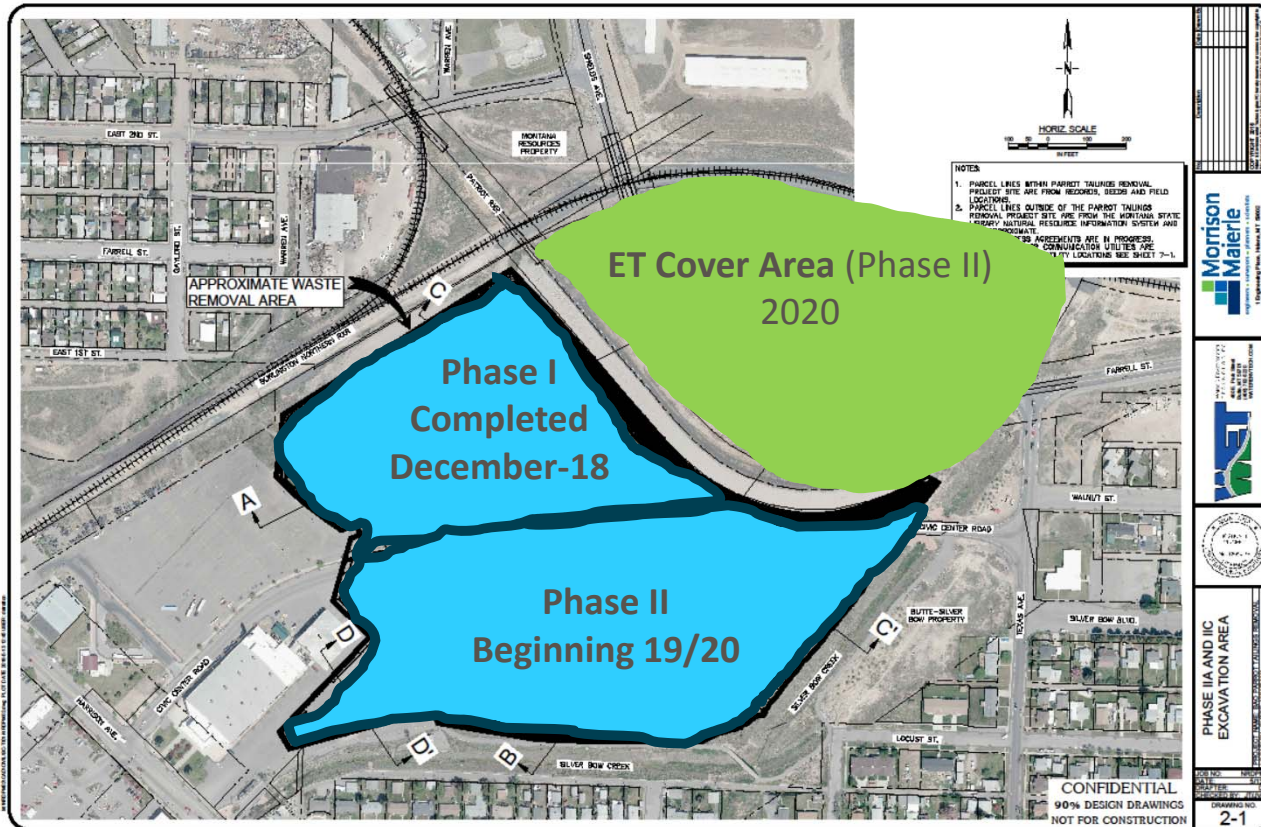
## Updated Conceptual Site Model

- Parrot Tailings are the only source of deep COCs to groundwater.
- Interbedded gravel units (MAU, LAU) are continuous and acting as preferential flow paths for the Parrot groundwater plume.
- Interbedded silt and clay units acting as confining units, impeding capture and treatment remedy of deeper portions of the plume.
- Groundwater velocities are 2 orders of magnitude greater than previously reported.
- Natural attenuation mechanisms are finite, COC break-through is observed, the deeper Parrot plumes are advancing presenting future risk to surface water.
- Increases in COC concentrations and loading are observed in surface water.

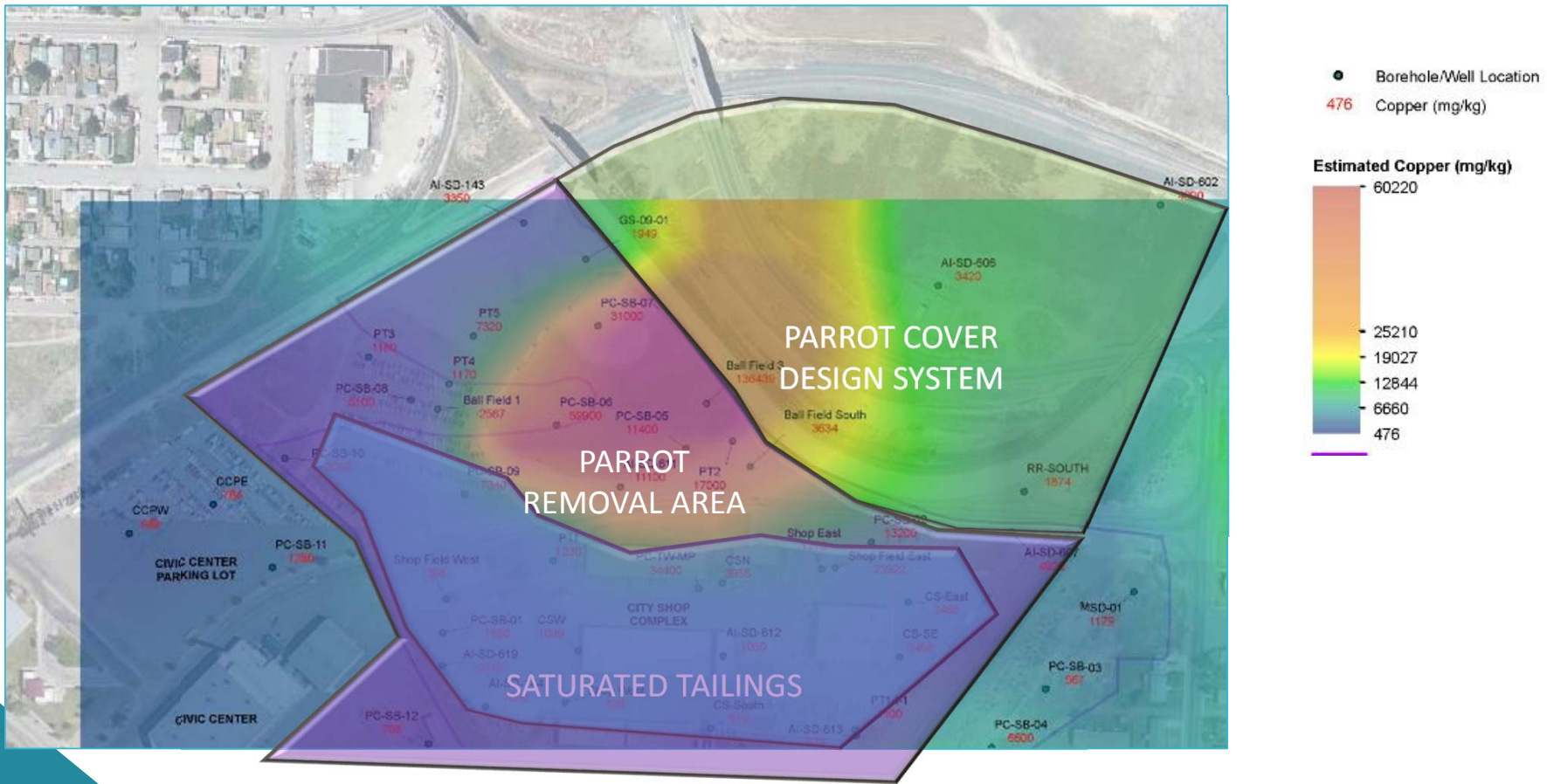
## STATE RESTORATION DECISIONS/ MILESTONES

- **February 2015:** State issues Preliminary Conceptual Restoration Plan.
- **October 2015:** Governor Bullock announces Removal of Parrot Tailings.
- **July 2016:** Parrot bid documents prepared.
- **January 26, 2018:** BPSOU CD Agreement In Principal.
- **March 23, 2018:** Phase I Parrot Removal Out to Bid.
- **December 2018:** Complete Phase I Parrot Removal

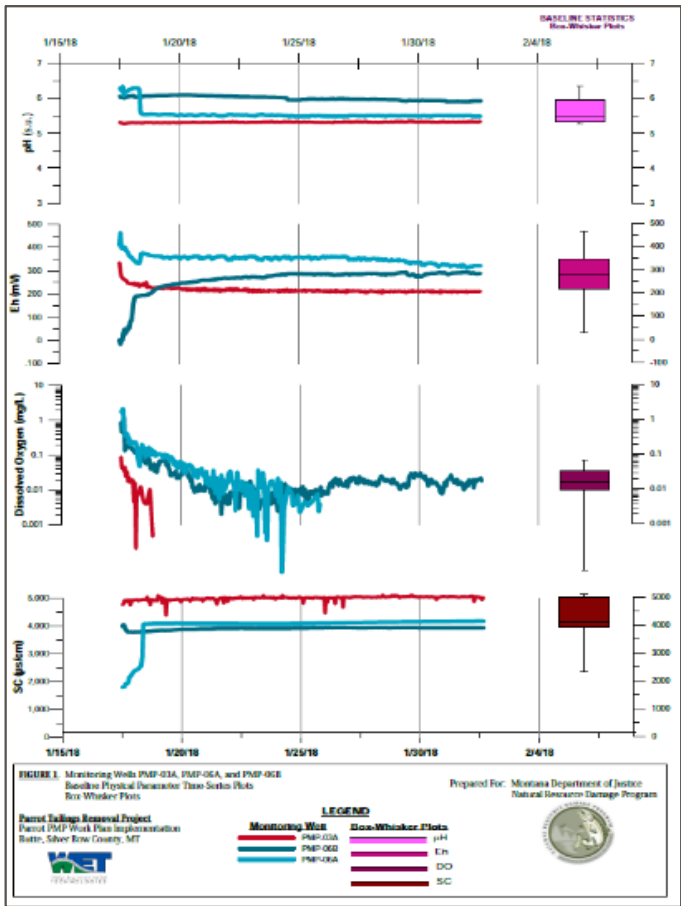
# Parrot Tailings Removal Plan



# Copper in Parrot Waste Material



# Unprecedented Performance Assessment Monitoring Program



Questions???