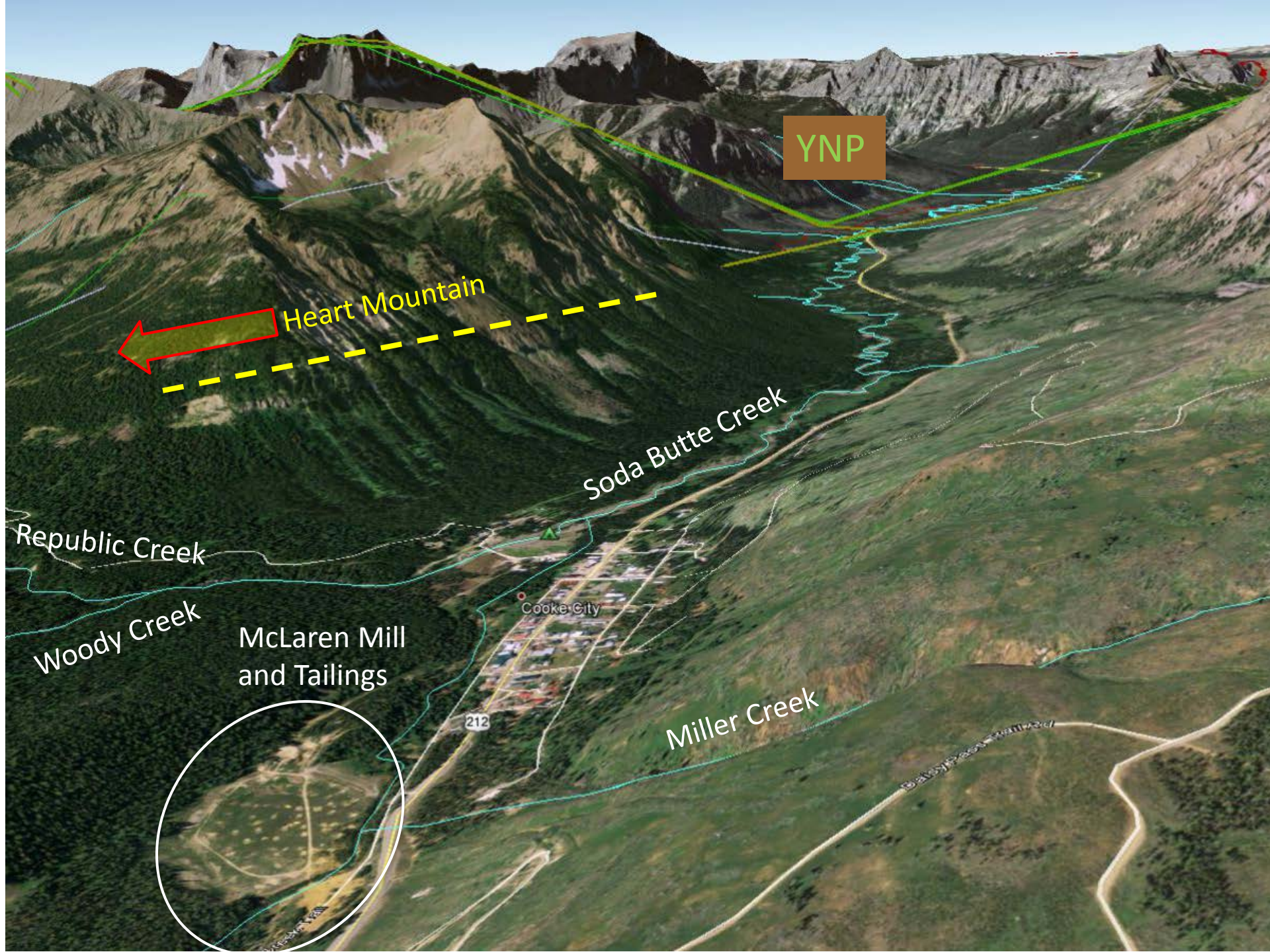
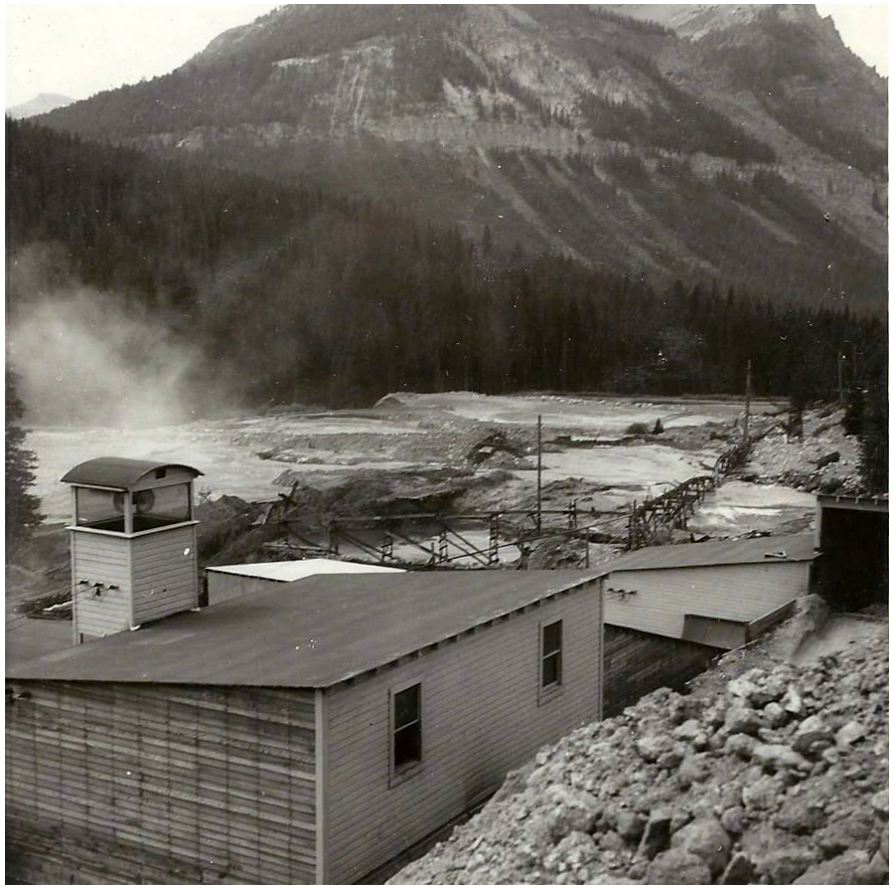
Groundwater Modeling Used to Design of a Tailings Impoundment Removal near Yellowstone National Park

Tom Henderson, Montana DEQ
Mike Boduin, PE Pioneer Technical Services
April 13, 2017


YNP
Heart Mountain
Soda Butte Creek
Republic Creek
Woody Creek
McLaren Mill
and Tailings
Cooke City
212
Miller Creek

McLaren Mill and Tailings and National Park Service Concerns



McLaren Gold Mine Mill, 1946. Courtesy of Cooke City Montana Museum.

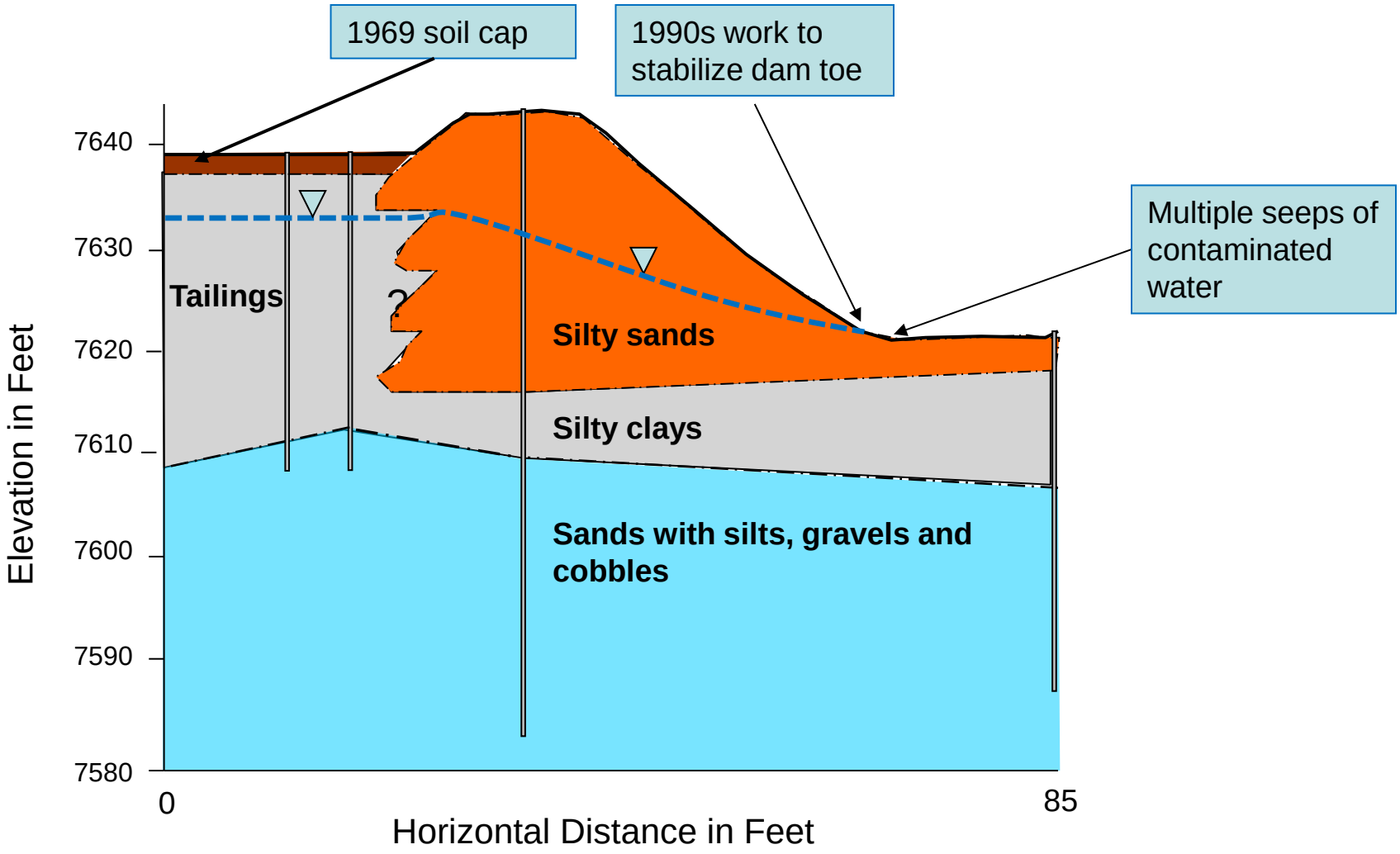
- 1933 – 1953: Approximately 250,000 yd^3 tailings in floodplain
- Memos to Chief Ranger describe annual inspections
  - water below Mill 'milky' in July and August
  - settling pond dyke 'leaking badly' (16 Jun 1949)
  - section of settling pond earthen wall '**washed out during heavy rain**' (27 Jun 1950)
- Mines '*adversely affected the fish producing capacity of SBC*' (Mills 1968)

Soda Butte Creek Below Tailings Pre-reclamation

Tailings Discharges (USGS):
Fe 418 mg/L
Al 122 mg/L
Cu 6 mg/L
Pb 0.6 mg/L
Cd 0.06 mg/L

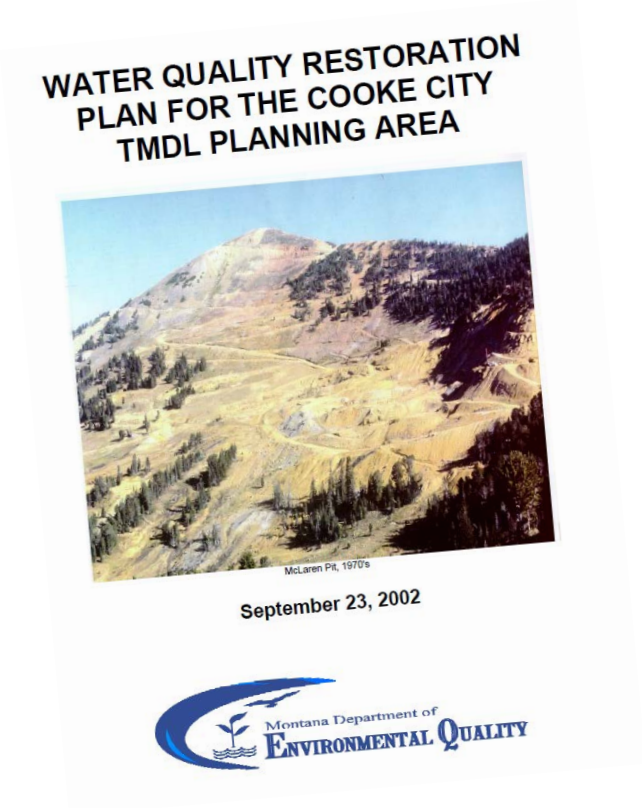
Approximate Annual Loads:
40,000 lb Fe
12,000 lb Al
590 lb Cu
58 lb Pb
6 lb Cd

Tailings Dam Cross-Section



Targeted Load Reductions

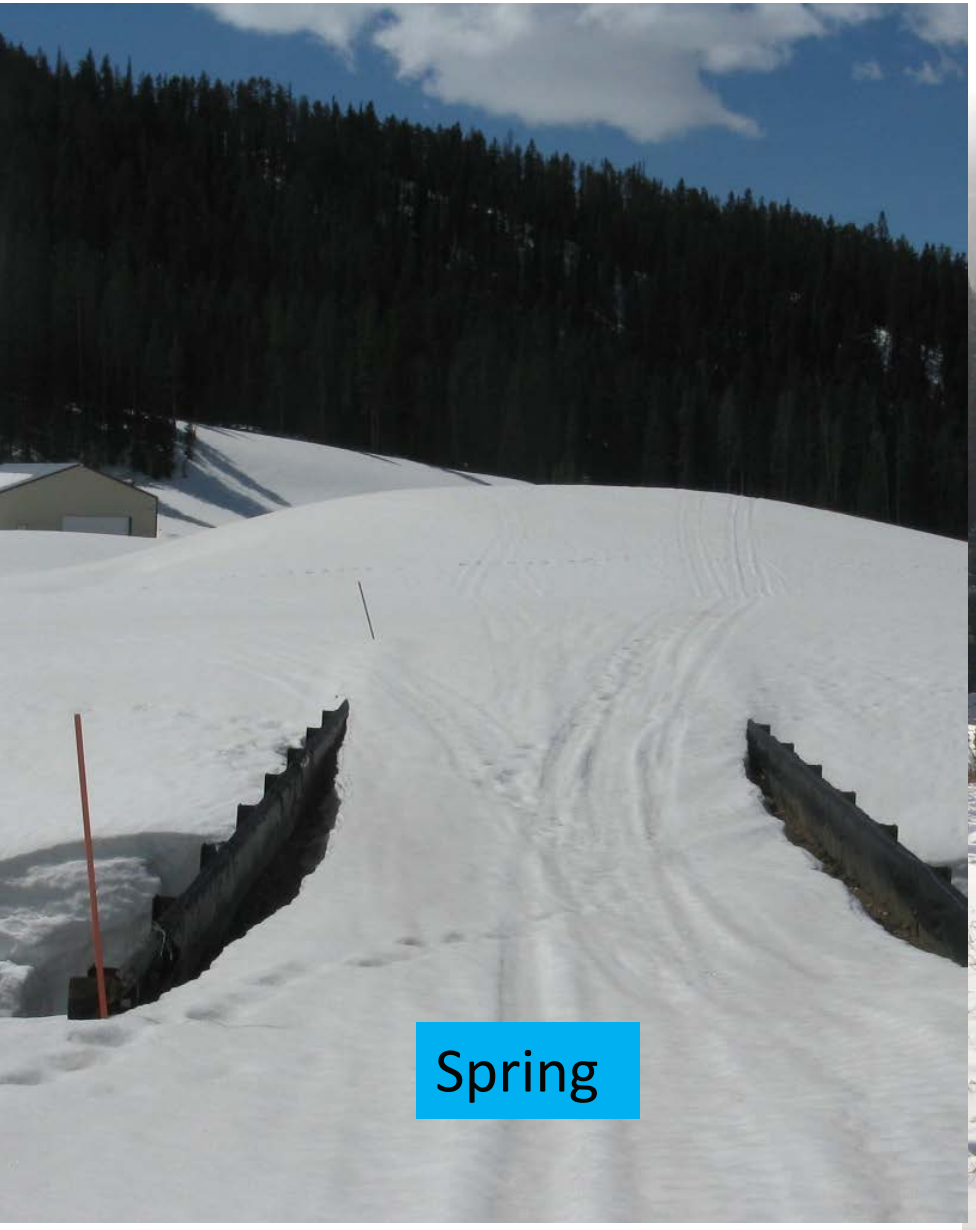
MT DEQ 2002 – 'Given the high iron loading from the McLaren Tailings, it is assumed that at least a 99% reduction in total load for iron will be needed to satisfy iron loading allocation…this 99% load reduction will likely be similar for copper, manganese, and other metals.'

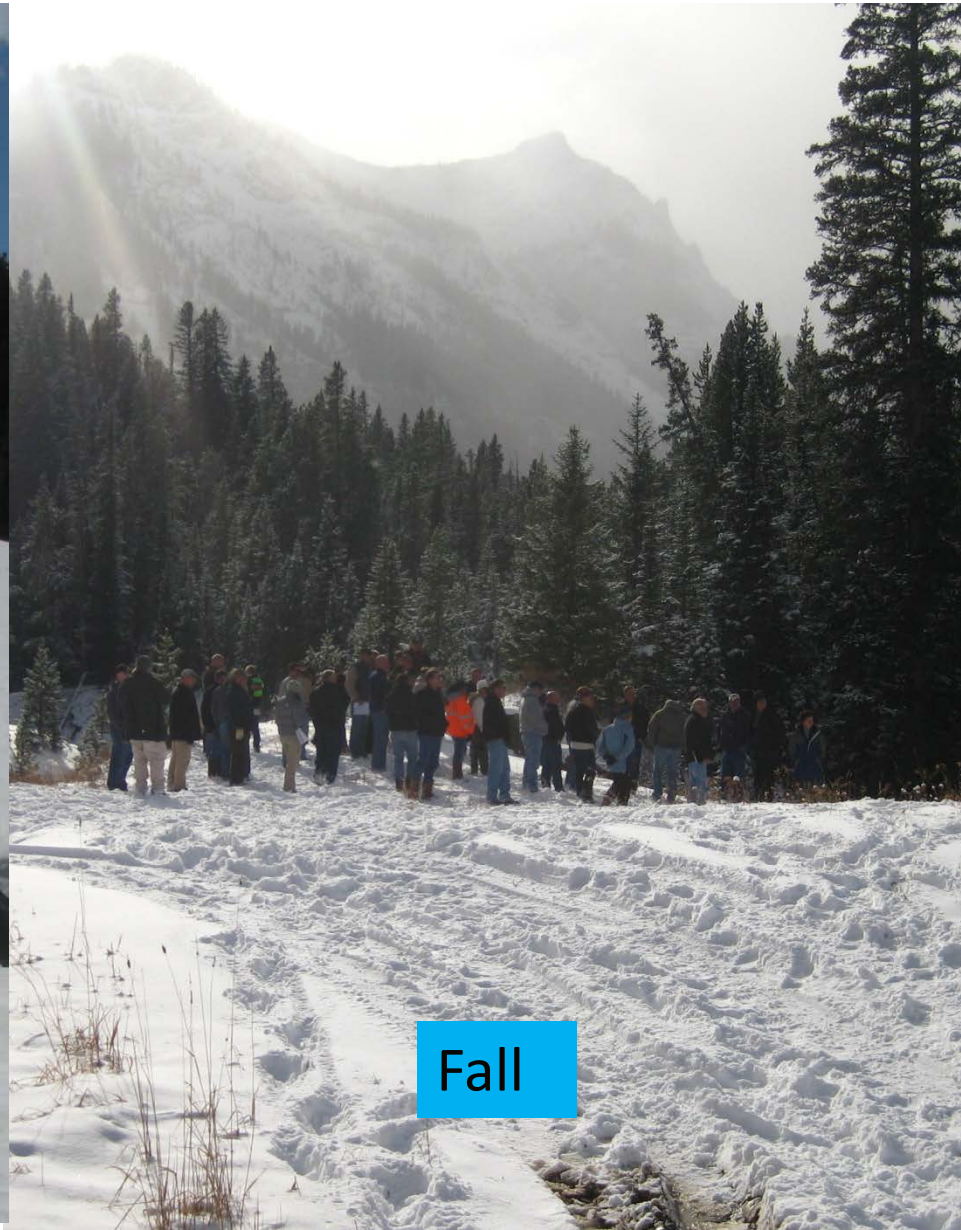


Yashan et al. 2002. Water Quality Restoration Plan for the Cooke City TMDL Planning Area. Montana Department of Environmental Quality. Helena, Montana. 208 pp. Published September 23, 2002.

New World Mining District

Climate at 7700 Feet AMSL





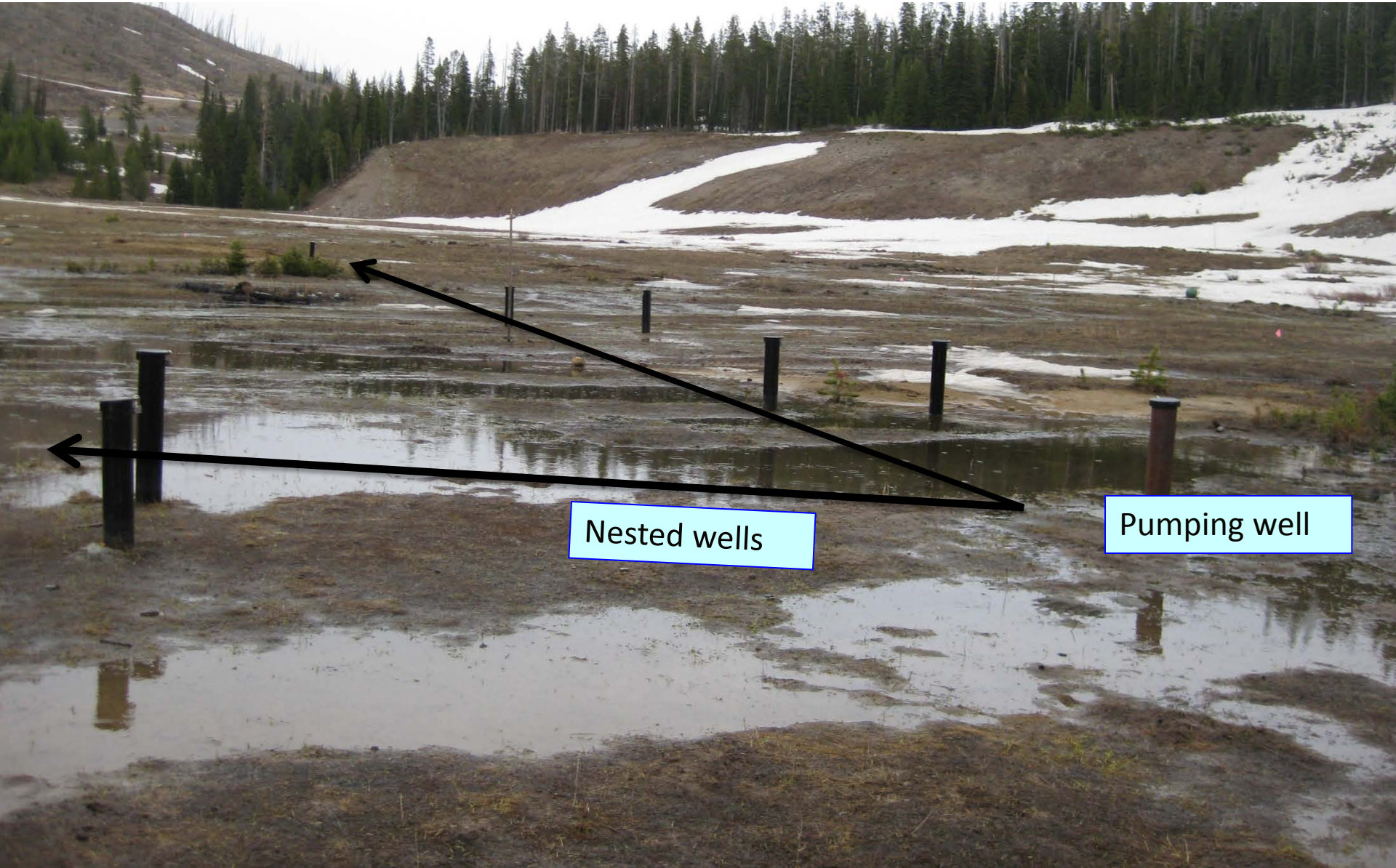
Tailings Impoundment

Ag, As, Cd, Cu, Fe, Pb, Zn
10 - 1000x Montana standards
~1 - 5 million gallons

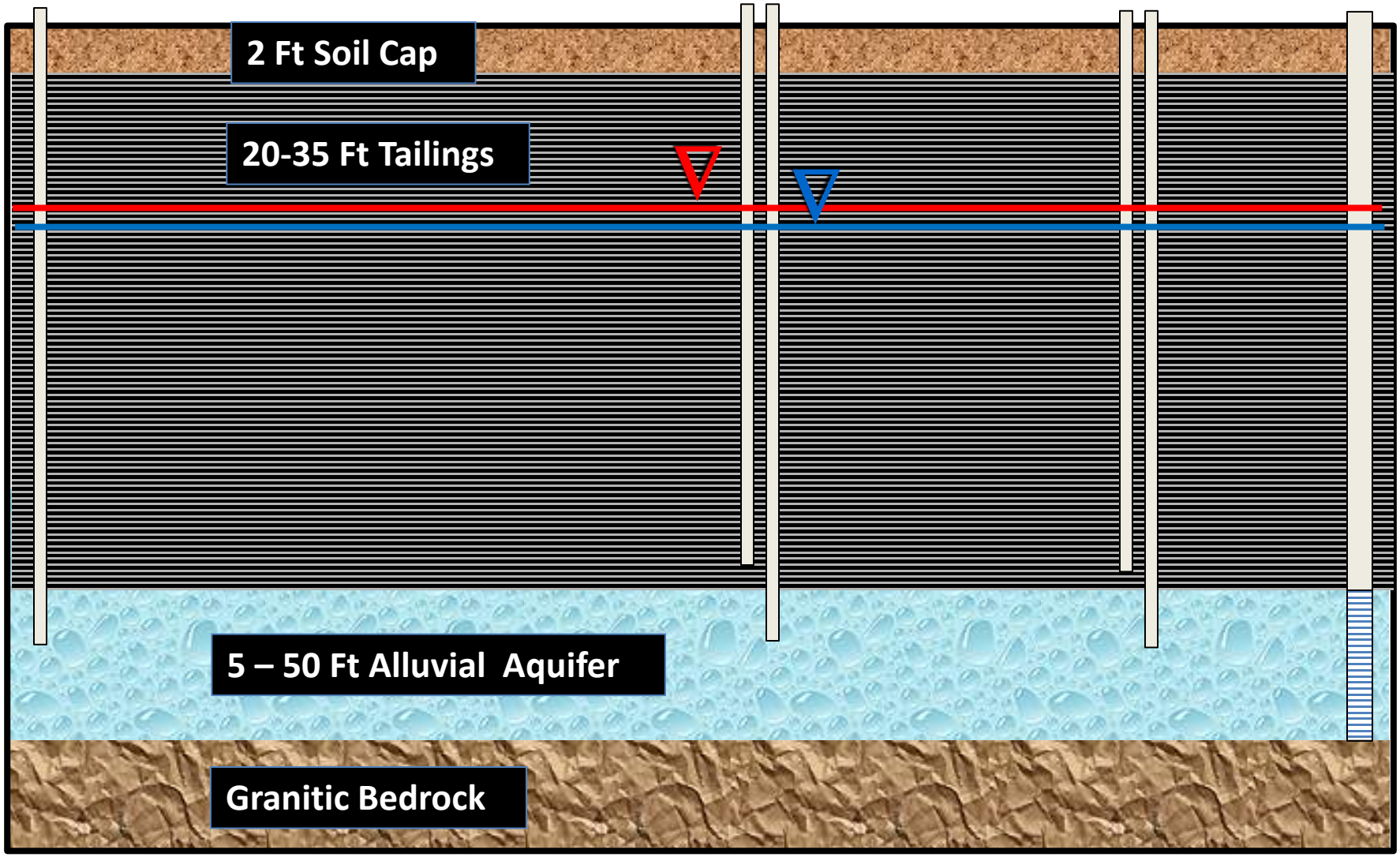
07/11/2011

Tailings Stabilization (?)

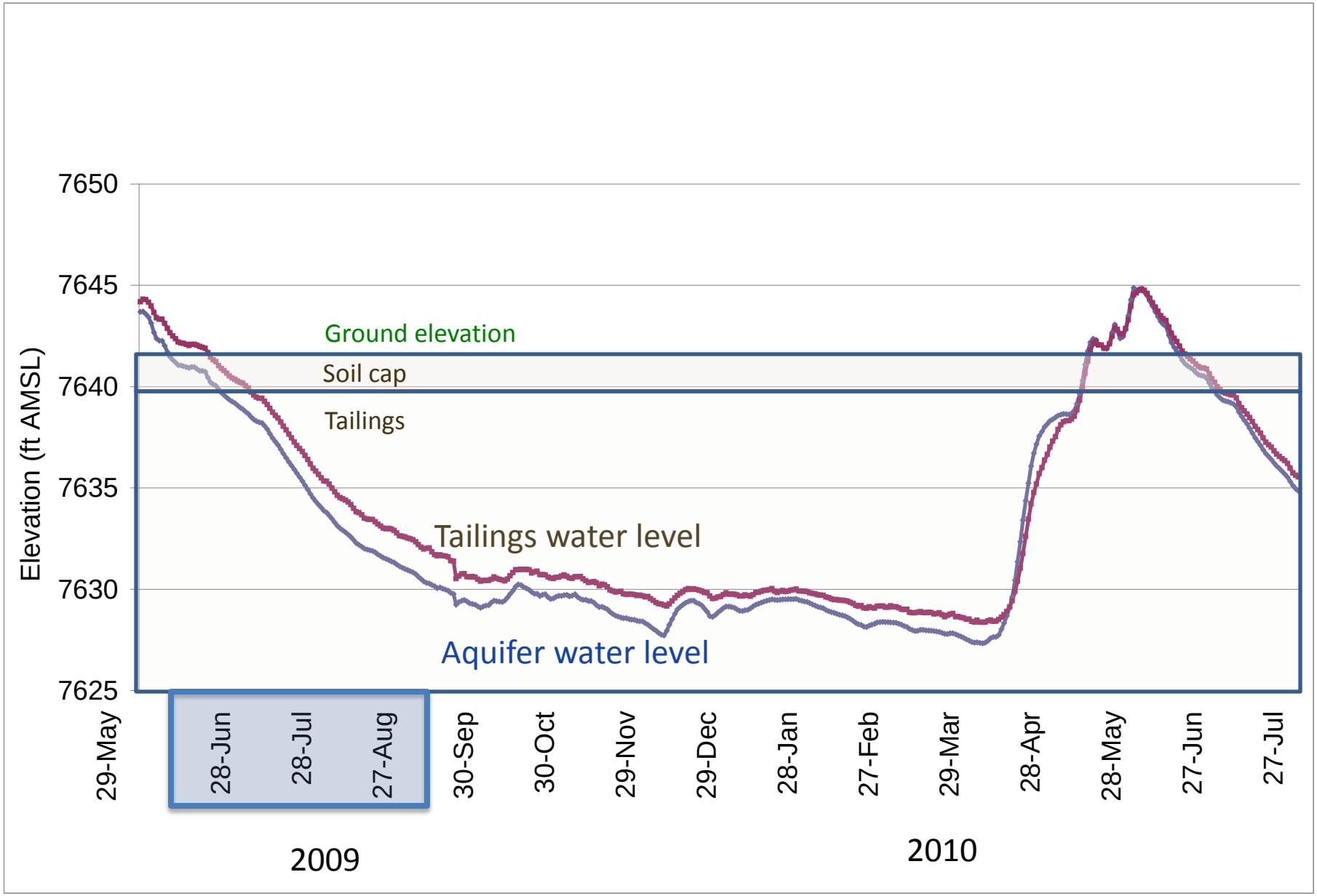
Design Investigations



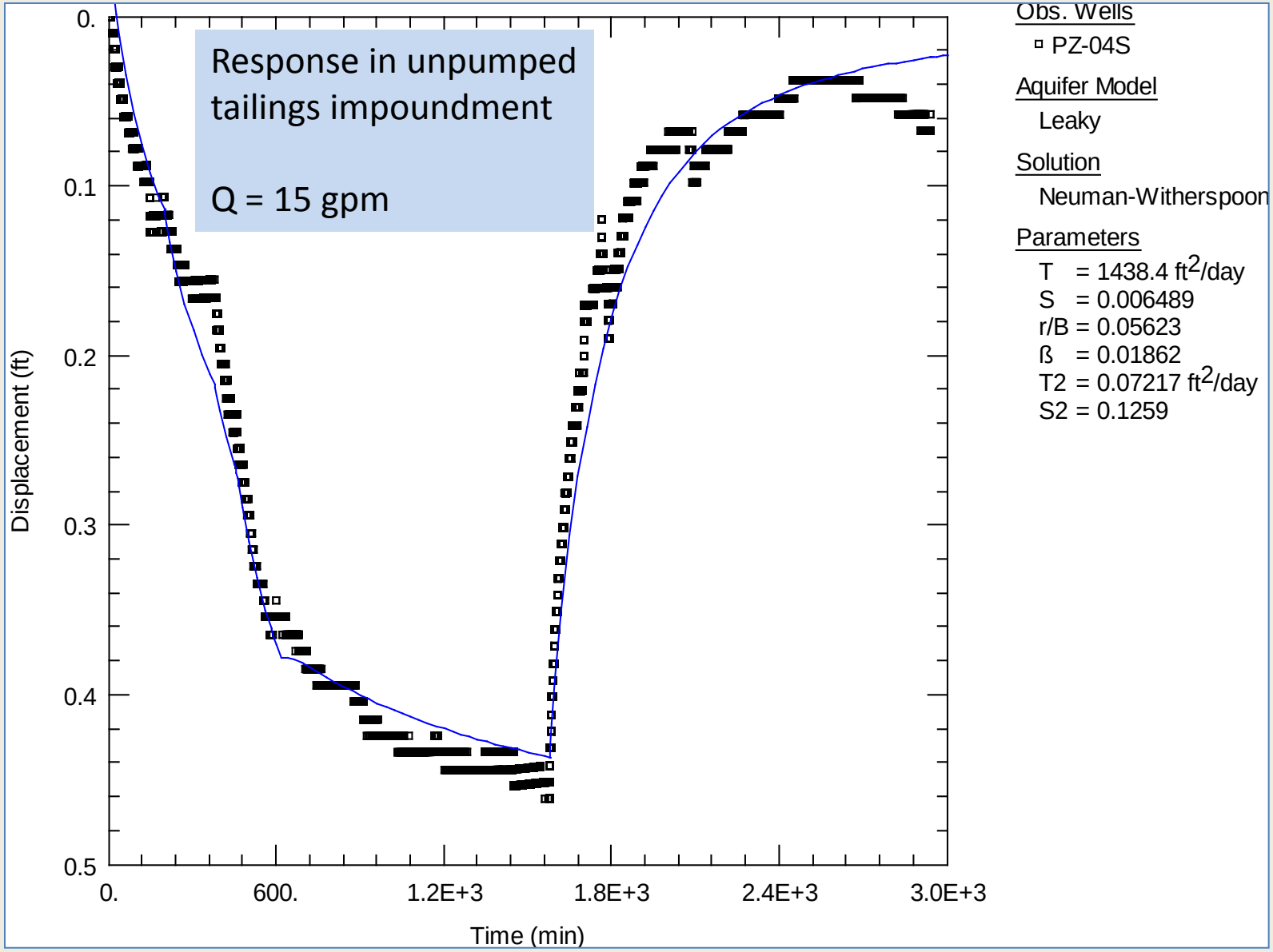
Groundwater System



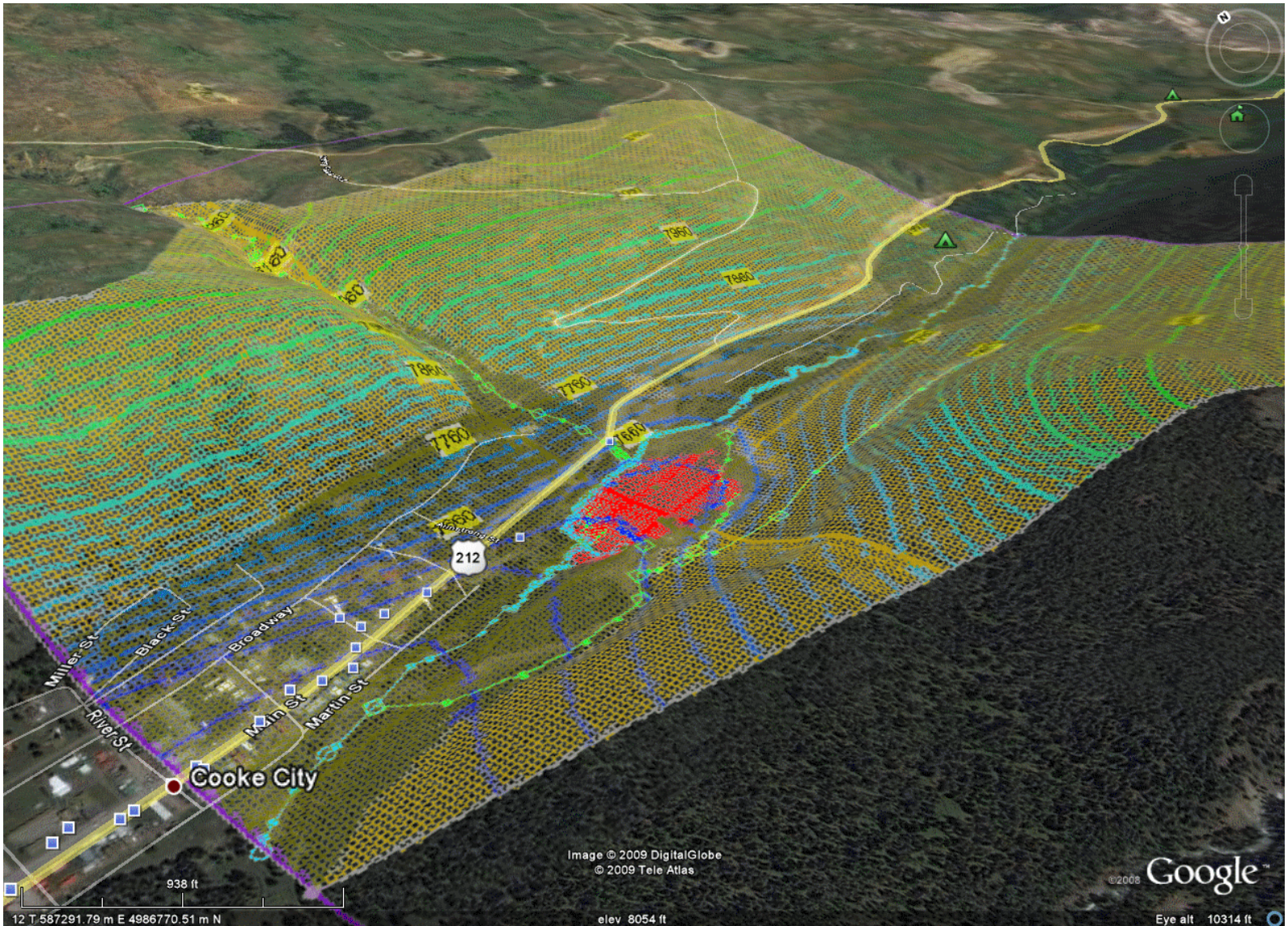
Seasonal Variability



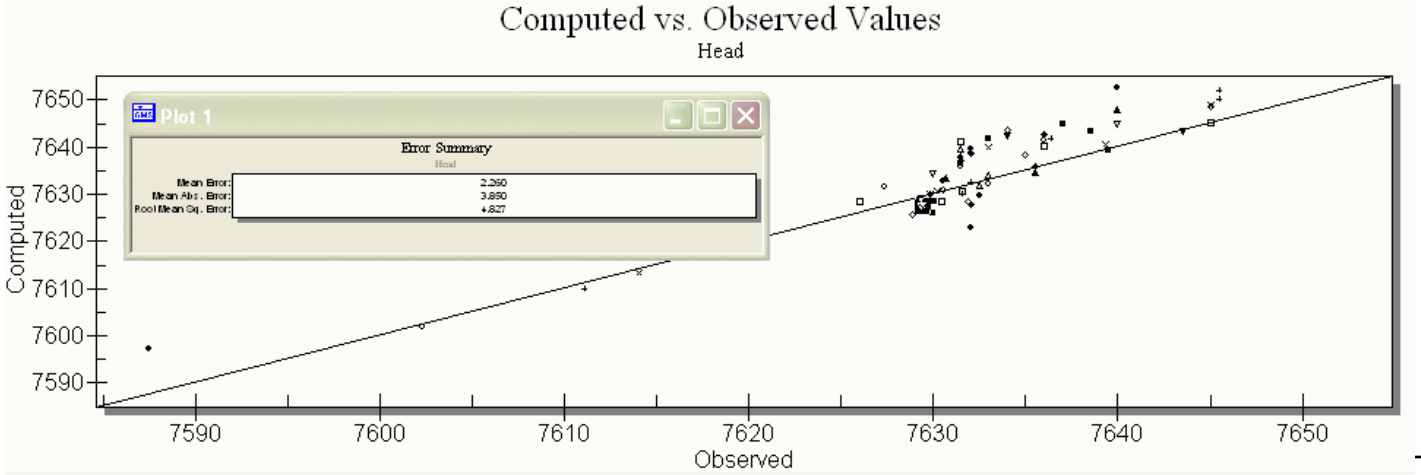
Pump Testing and Analysis

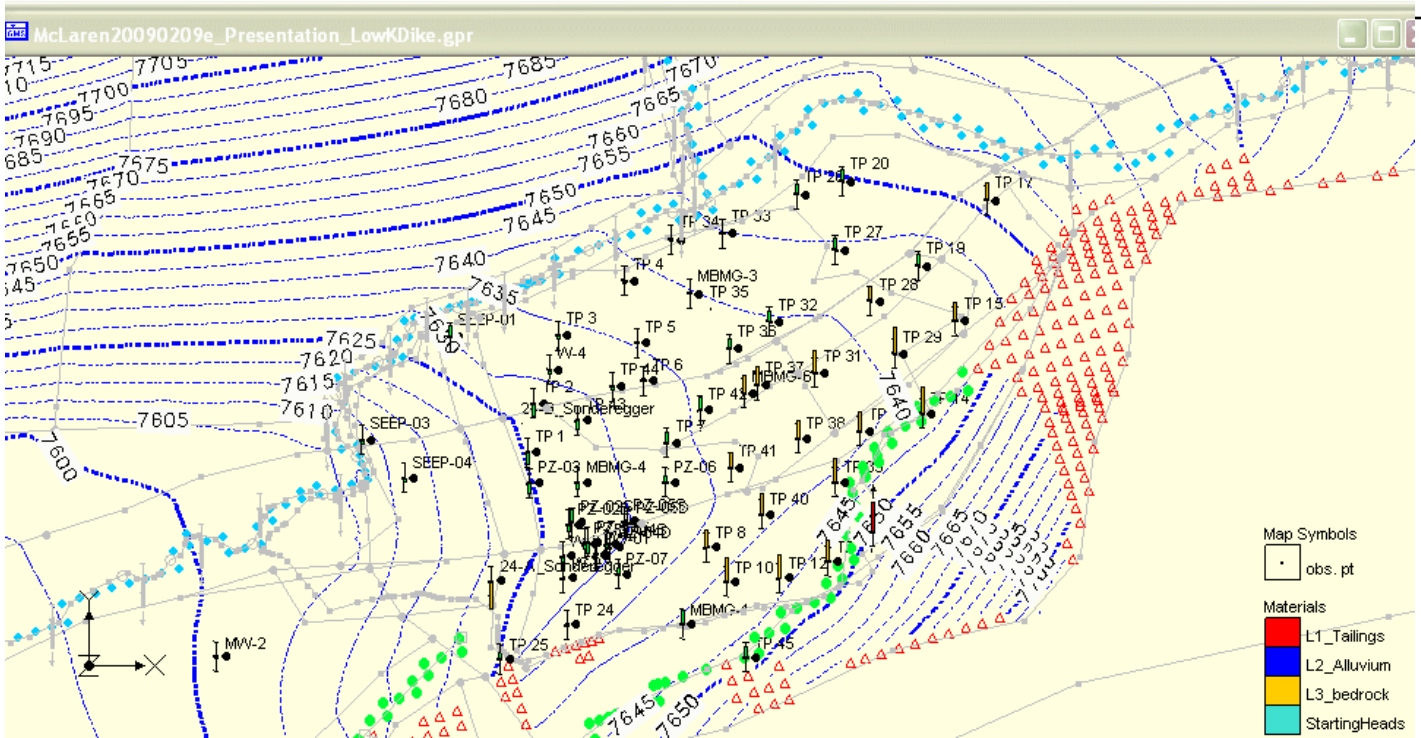


MODFLOW Modeling



Model Calibration





Modeling Results

- Approximately 800 GPM extraction rate required to drop water table to base of tailings impoundment
- Winter pumping desirable to dampen spring surge
- Additional pumping under the tailings required during the summer

Tailings Excavation

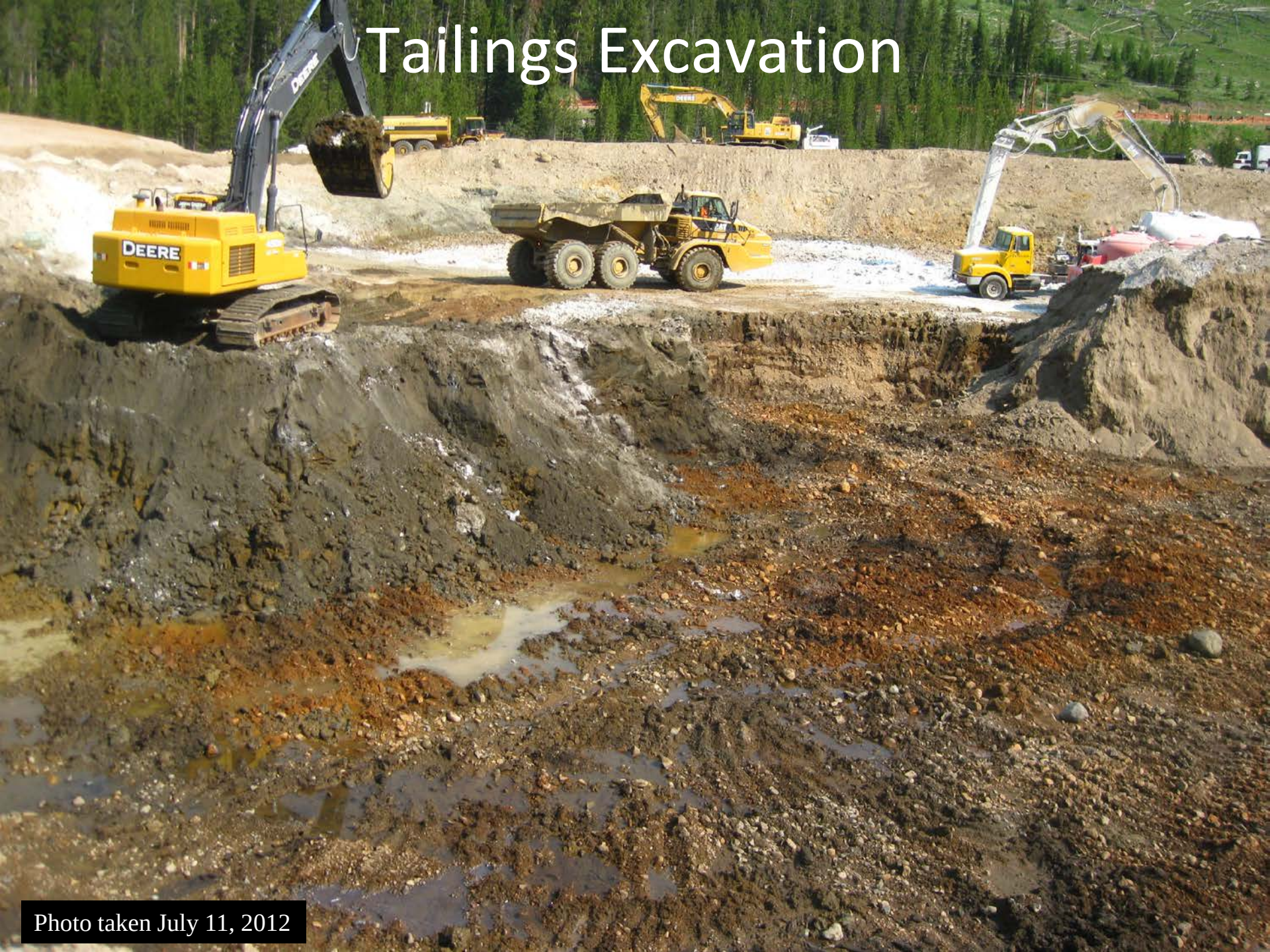
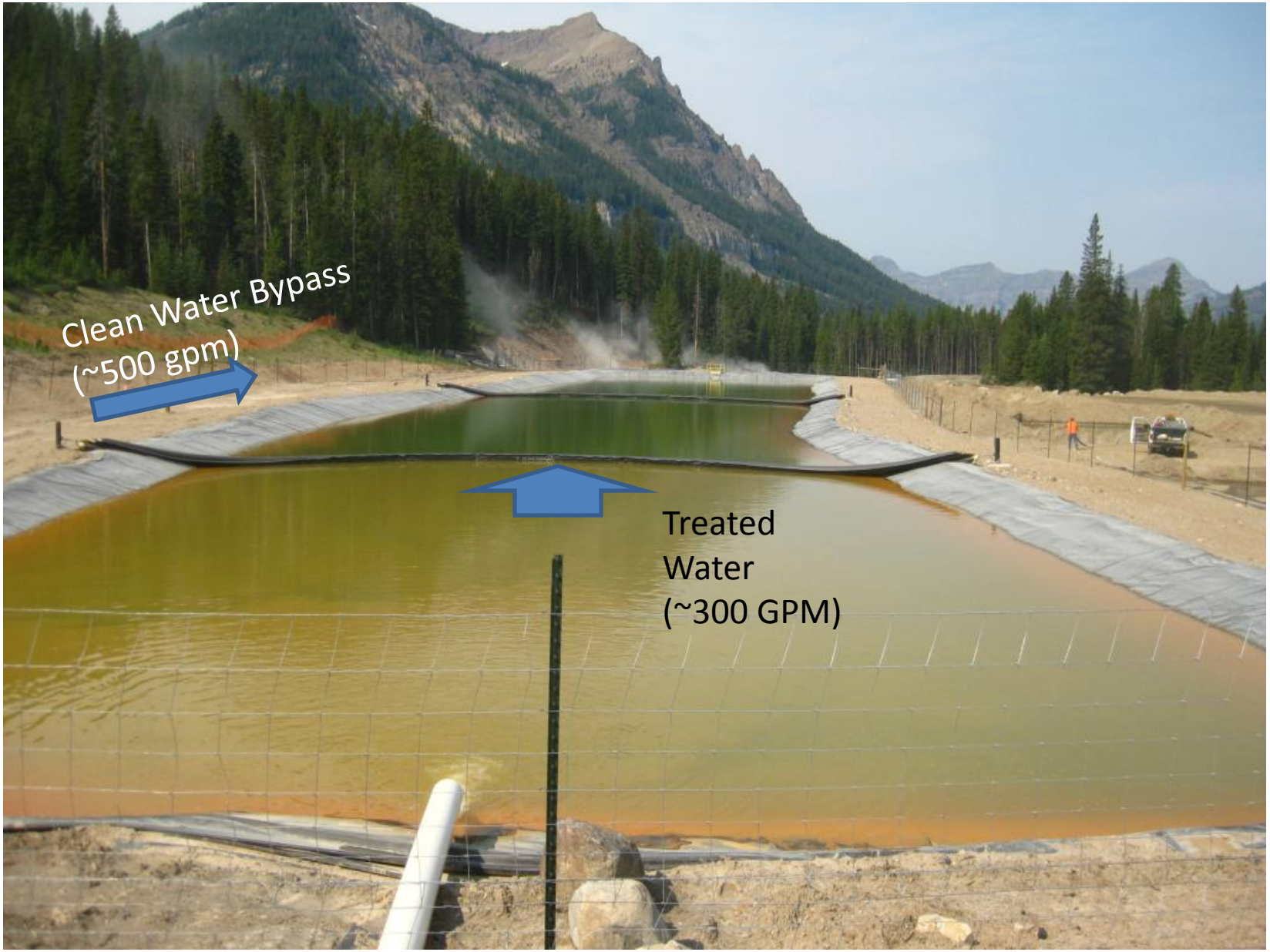


Photo taken July 11, 2012

Continued Pumping

Tailings (~500,00 Tons) Stabilized & Excavated

Water Balance




2008


2013

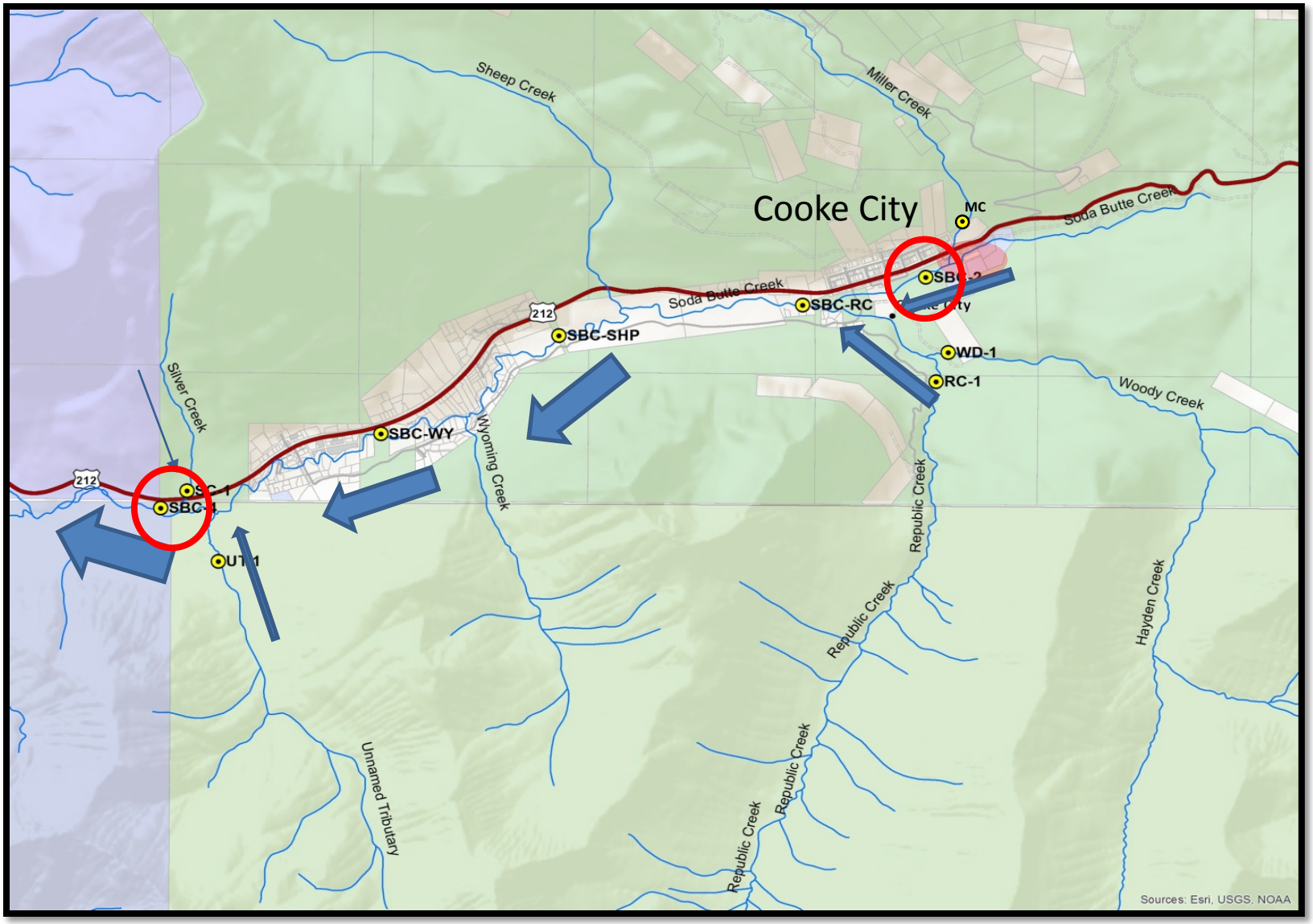
2016

Basin Assessment

Yellowstone National Park
- Water Quality Assessment
- Reevalution of Impairments to Soda Butte Creek

May 2016

SBC WQ Study 2015 & 2016



SBC-2: Water Quality vs. DEQ-7 Standards

2000	April 14	
	July 7	
	October 10	
2001	April 19	
	June 25	
	October 12	
2002	April 22	
	July 1	
	October 9	
2003	April 23	
	June 30	
	September 30	
2004	April 7	
	June 30	
	October 7	
2005	April 4	
	June 27	
	September 28	
2006	April 26	
	June 26	
	September 25	
2007	April 12	
	June 14	
	September 19	
2008	April 15	
	July 16	
	September 23	
2009	April 9	
	June 22	
	September 29	
2010	April 6	

USFS 2000 – 2010

31 Sampling Events

20 Iron exceedances

8 Copper exceedances

1 Lead exceedance

DEQ/NPS 2015 – 2016

11 Sampling Events

0 Iron exceedances

1 Copper exceedance

0 Lead exceedance

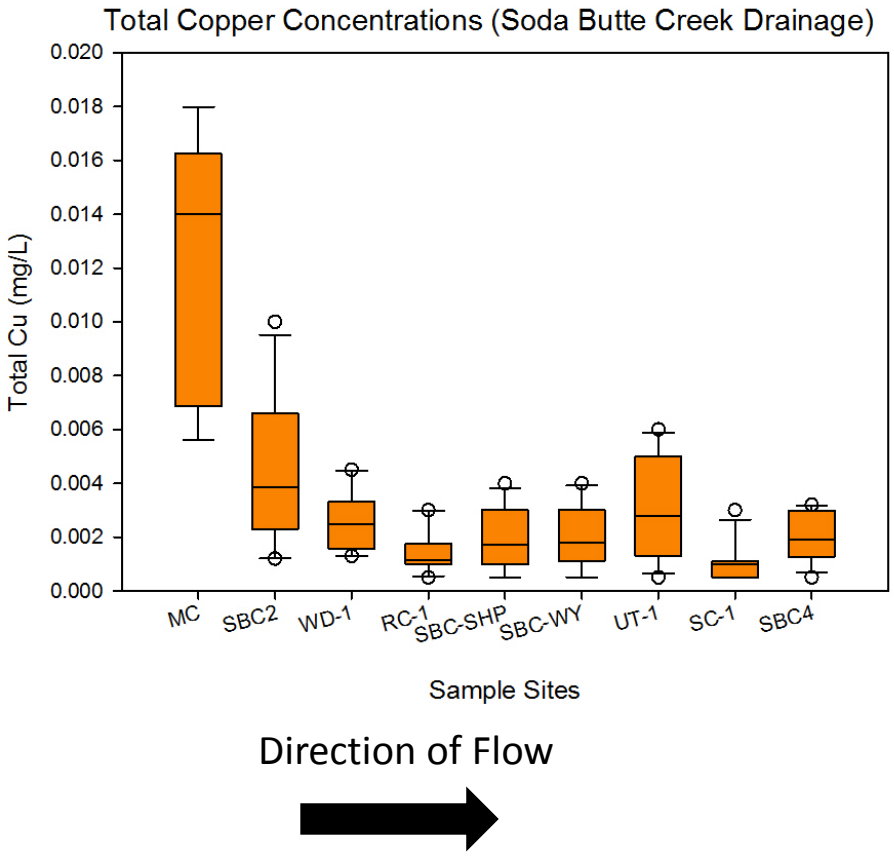
2015	June 28	
	July 15	
	August 4	
	September 9	
	October 21	
	November 18	
2016	April 25	
	May 17	
	June 2	
	June 13	
	June 28	

SBC-2 is located downstream of the McLaren Tailings project

McLaren Tailings reclamation project began June 2010

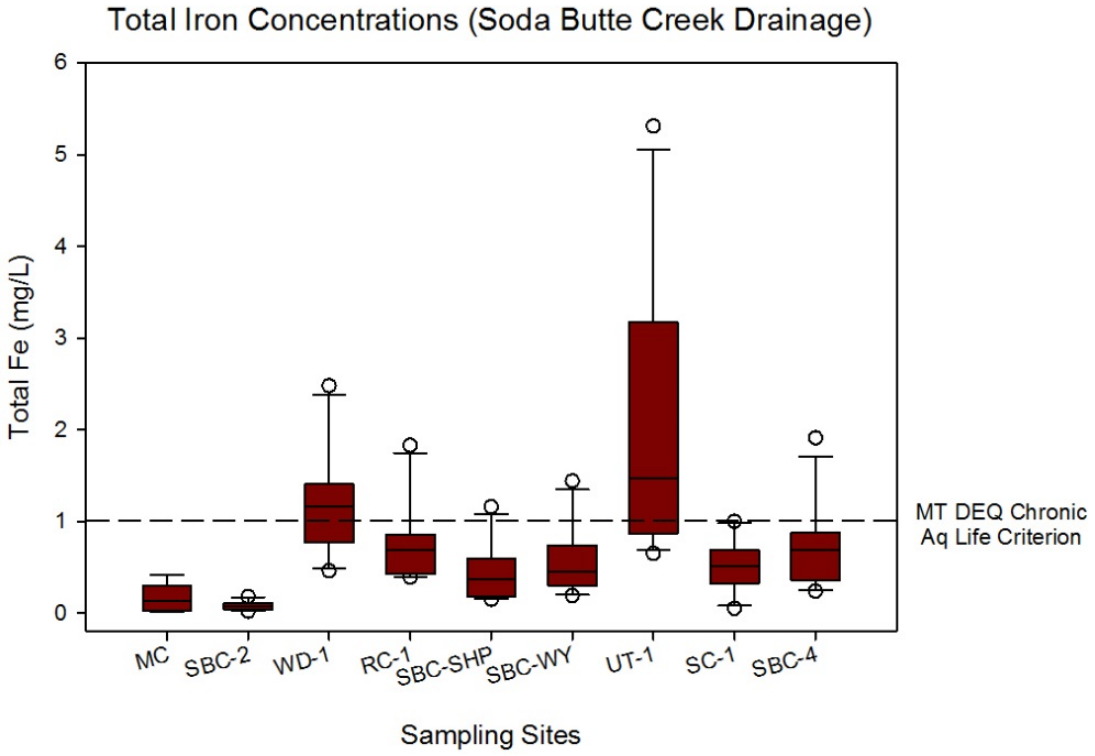
SBC WQ Study 2015 & 2016 Sample Results

- Cu levels in SBC variable but mostly below MT criterion
- Exception is **Miller Creek** where [Cu] are 2 to 3X higher
- At YNP boundary Cu below WQ Standards



SBC WQ Study 2015 & 2016 Sample Results

- Fe levels lowest below former tailings site
- Highest [Fe] from two tributaries
- At YNP boundary generally below MT DEQ **chronic** aquatic life criterion



Direction of Flow

SBC-4: Water Quality vs. DEQ-7 Standards

2000	April 14	
	July 7	
	October 10	
2001	April 19	
	June 25	
	October 12	
2002	April 24	
	July 1	
	October 8	
2003	April 22	
	July 2	
	September 30	
2004	April 8	
	June 30	
	October 7	
2005	April 4	
	June 27	
	September 28	
2006	April 26	
	June 26	
	September 25	
2007	April 12	
	June 14	
	September 19	
2008	April 15	
	July 16	
	September 23	
2009	April 9	
	June 22	
	September 29	
2010	April 6	

USFS 2000 – 2010

31 Sampling Events

6 Iron exceedances

3 Copper exceedances

4 Lead exceedances

DEQ/NPS 2015 – 2016

11 Sampling Events

2 Iron exceedances

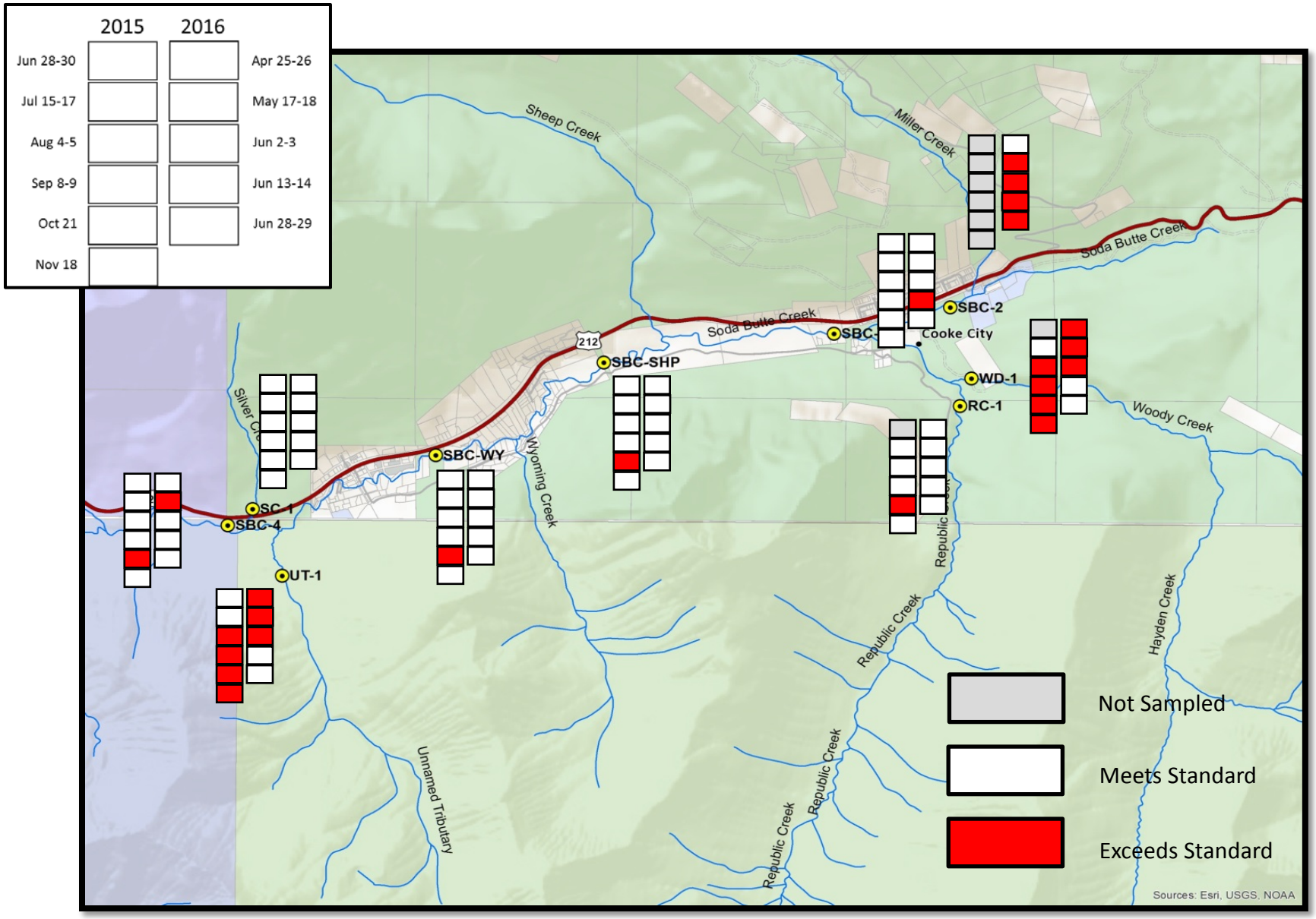
0 Copper exceedances

0 Lead exceedances

2015	June 28	
	July 15	
	August 4	
	September 9	
	October 21	
	November 18	
2016	April 25	
	May 17	
	June 2	
	June 13	
	June 28	

SBC-4 is located upstream of YNP northeast entrance station

SBC WQ Study 2015 & 2016



Resource Restoration

Summary

- Montana is evaluating delisting of metals impairments to Soda Butte Creek
- Reclamation project is a milestone for the Greater Yellowstone ecosystem
- Design investigations critical to project success
- Support provided by OSMRE throughout project design and reclamation

Questions