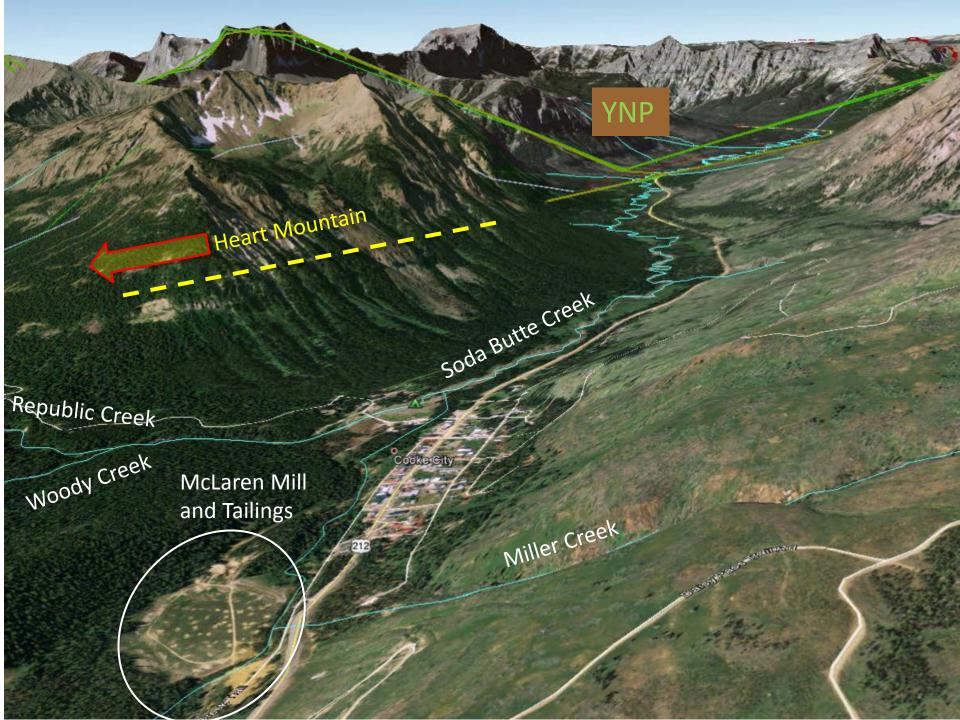
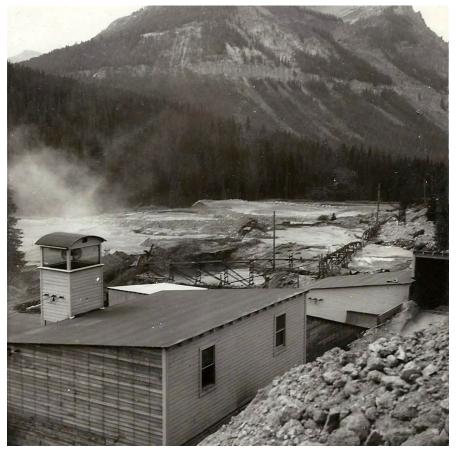
Groundwater Modeling Used to Design of a Tailings Impoundment Removal near Yellowstone National Park

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



McLaren Mill and Tailings and National Park Service Concerns



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

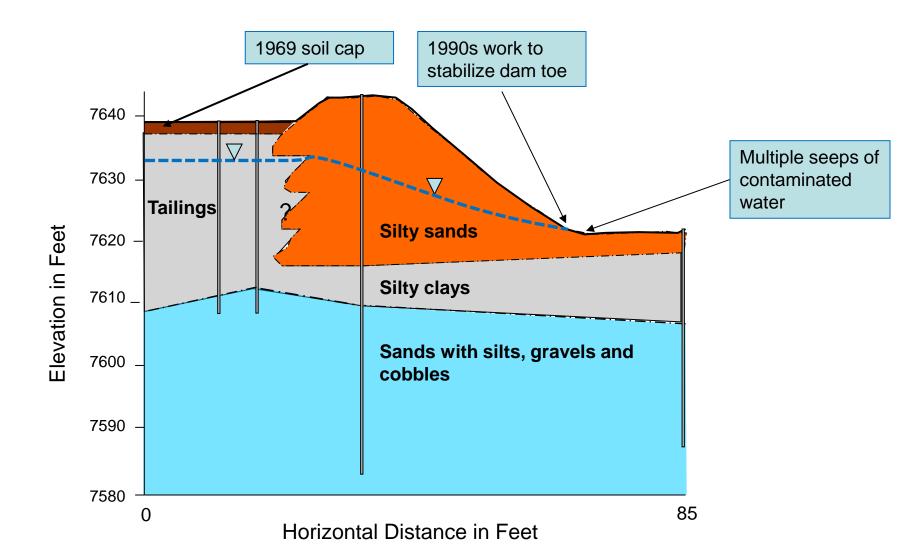
- 1933 1953: Approximately
 250,000 yd³ tailings in floodplain
- Memos to Chief Ranger describe annual inspections
 - water below Mill 'milky' in July and August
 - settling pond dyke 'leaking badly' (16 Jun 1949)
 - section of settling pond earthen
 wall 'washed out during heavy
 rain' (27 Jun 1950)
 - 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."

WATER QUALITY RESTORATION PLAN FOR THE COOKE CITY TMDL PLANNING AREA



September 23, 2002

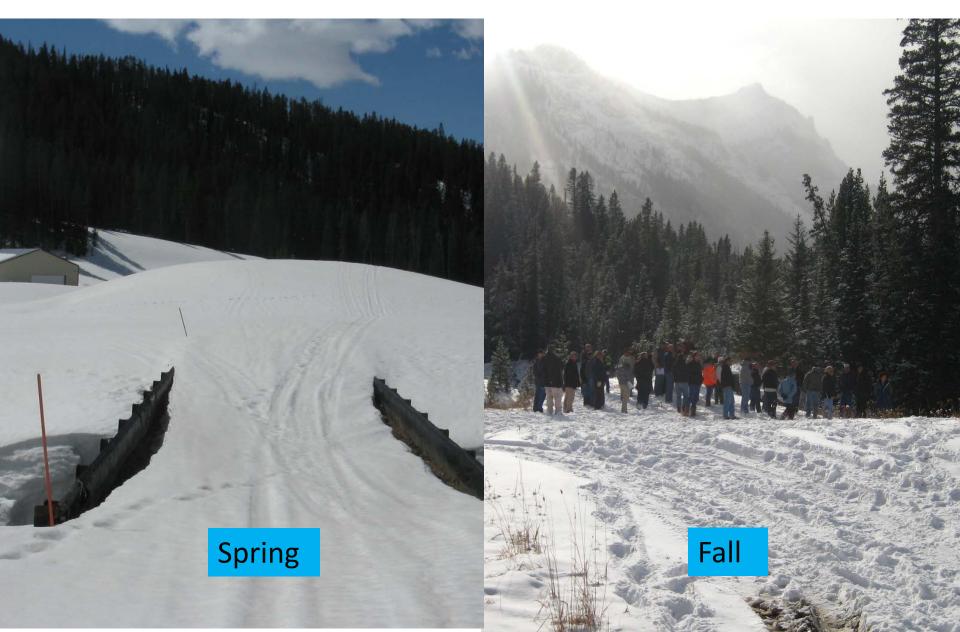


Yashan et al. 2002. Water Quality Restoration Plan for the Cooke City TMDL Planning Area. Montana Department of Environmental Quality. Helena, Montana. 208 pp. Published September 23, 2002.

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

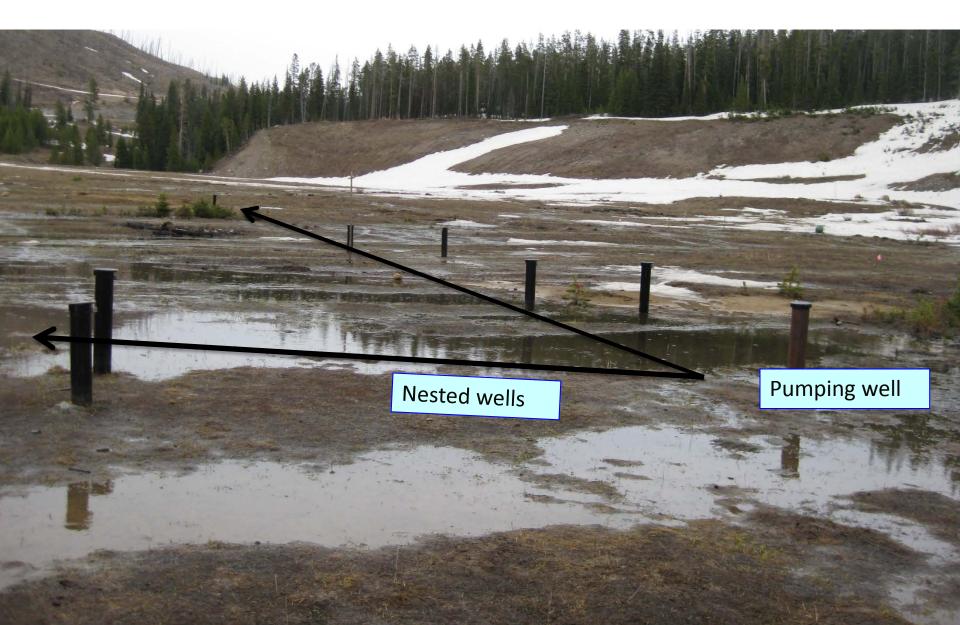
Artesian GW

07/11/2011

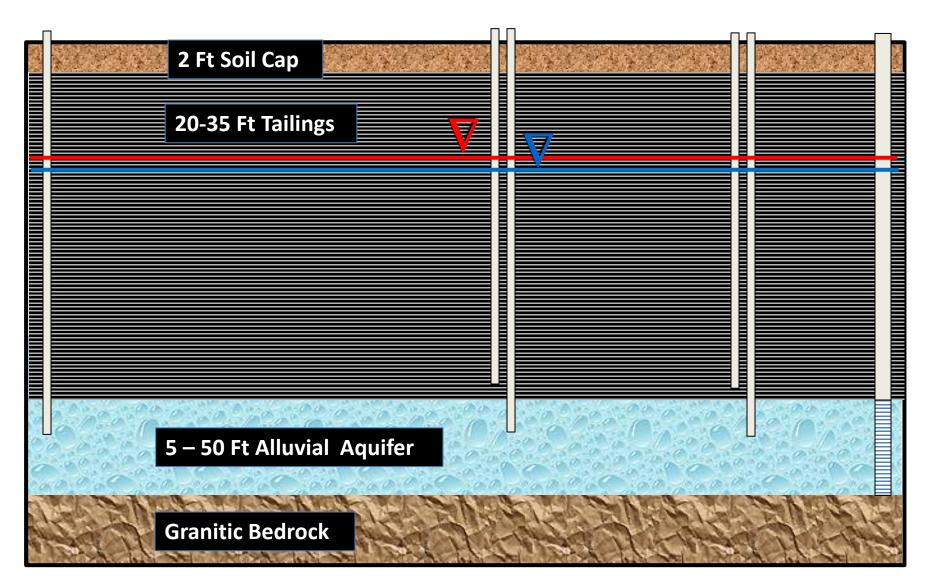
Tailings Stabilization (?)



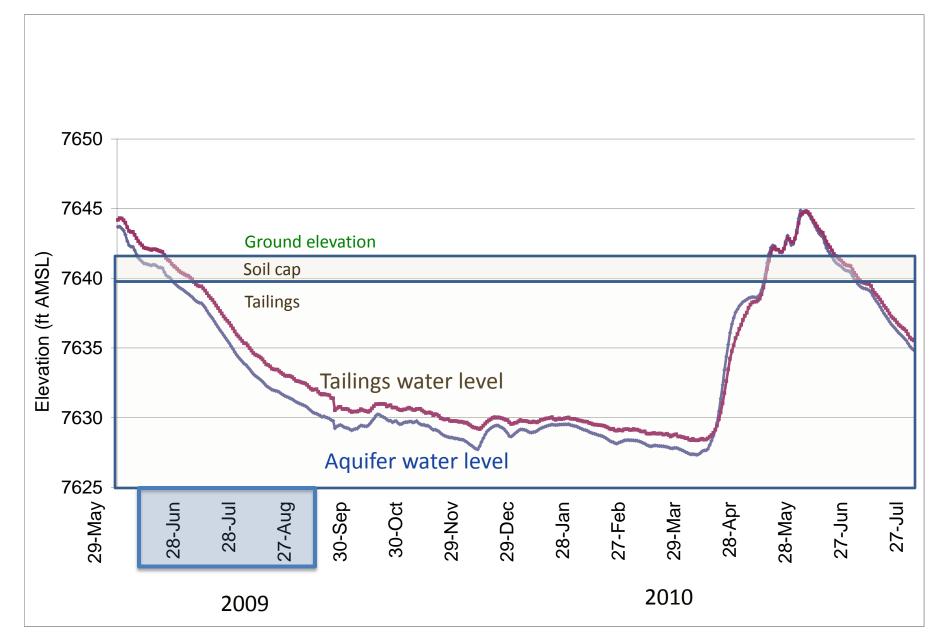
Design Investigations



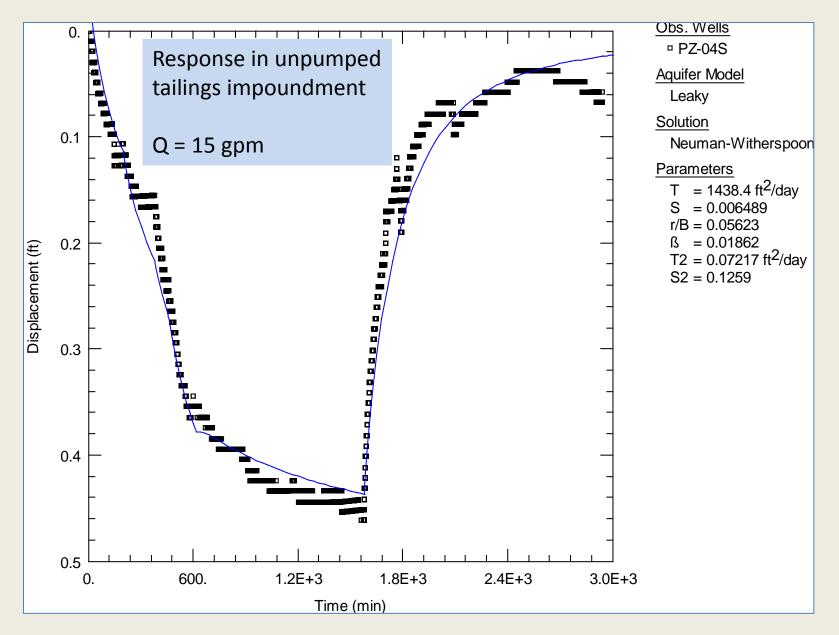
Groundwater System



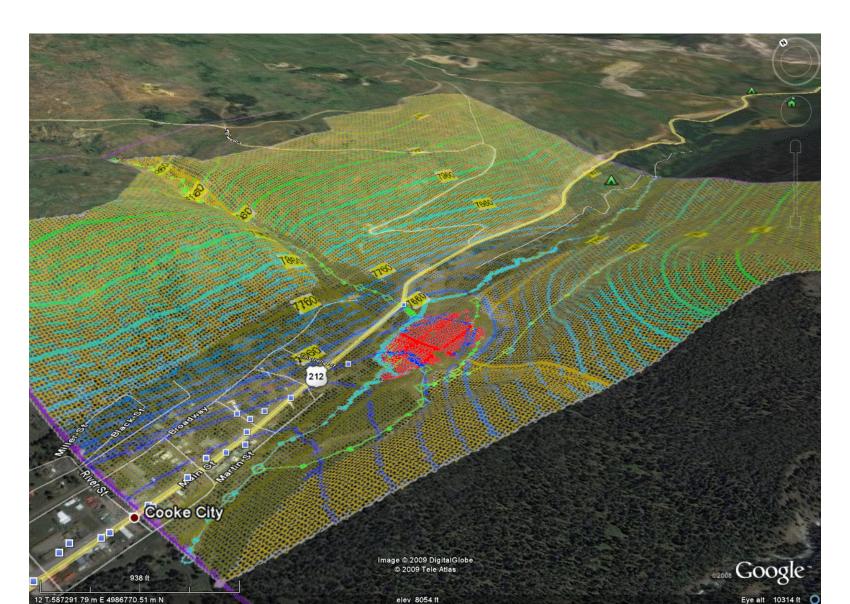
Seasonal Variability



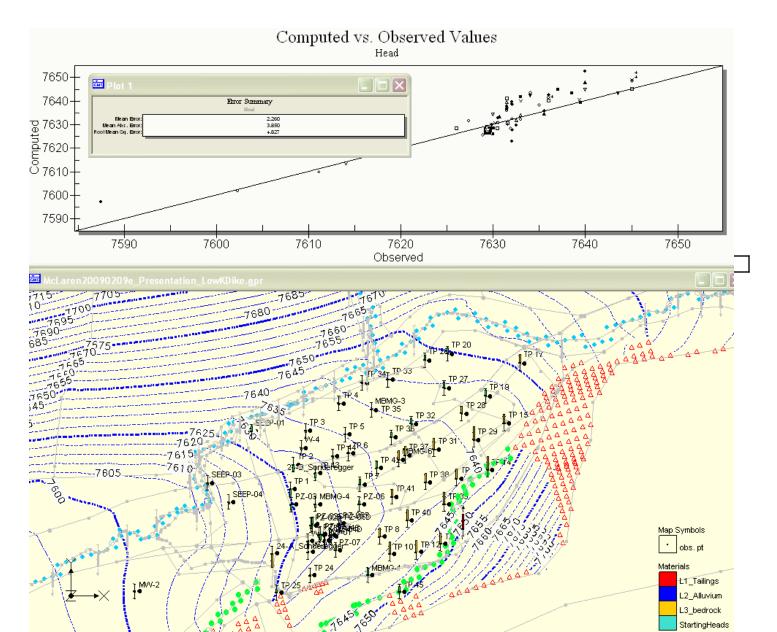
Pump Testing and Analysis



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

1

Photo taken July 11, 2012

FILLE

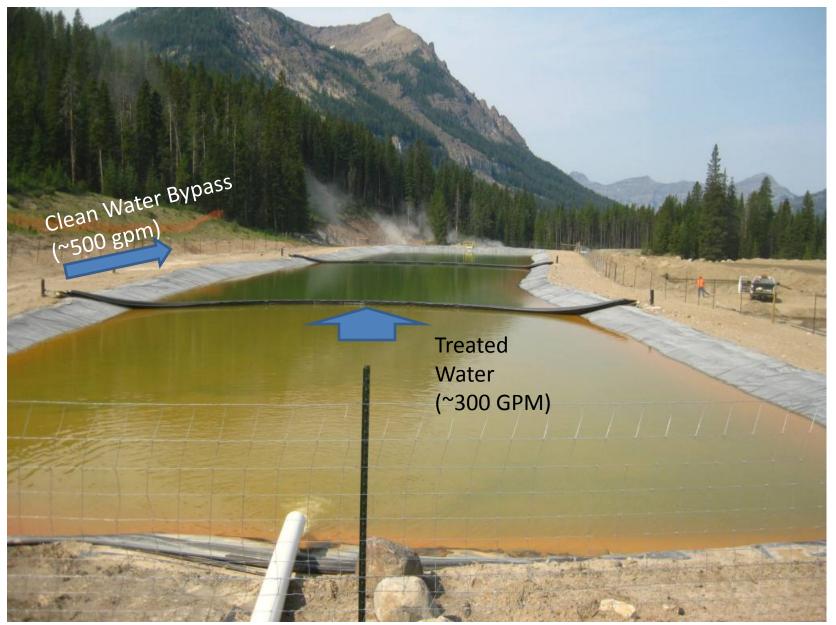
DEERE

Continued Pumping

Tailings (~500,00 Tons) Stabilized & Excavated

Static Groundwater Level

Water Balance











Basin Assessment

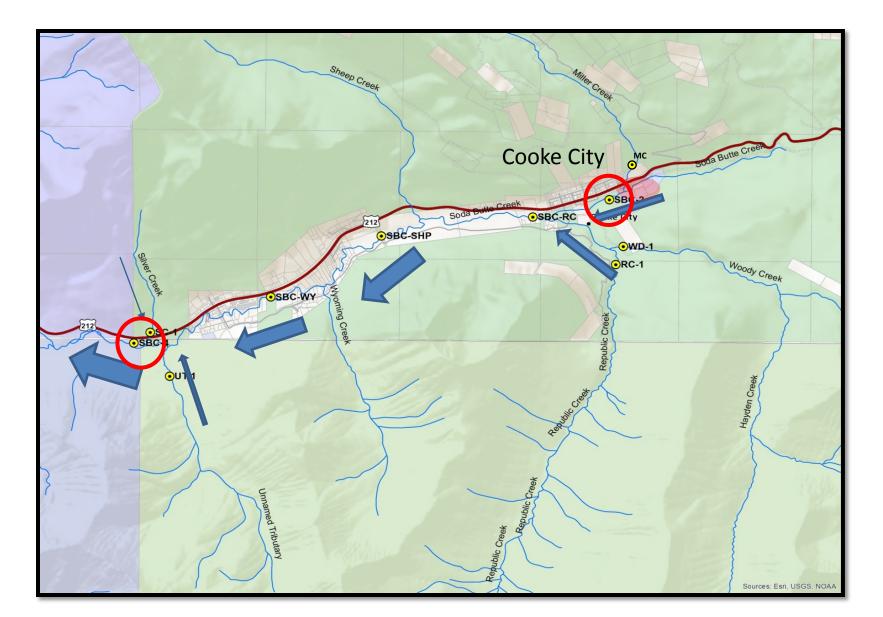
KGLT

Yellowstone National Park

- Water Quality Assessment
- Reevalution of Impairments to Soda Butte Creek



SBC WQ Study 2015 & 2016



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

April 14Image: part of the sector			
October 10 October 10 April 19 June 25 October 12 October 12 April 22 2002 July 1 October 9 April 23 2003 June 30 September 30 June 30 September 30 June 30 October 7 June 30 October 7 June 27 September 28 April 26 June 21 June 14 September 19 June 14 September 19 June 14 September 19 June 14 September 23 Juny 16 September 23 April 9 June 22	2000	April 14	
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		April 22	
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September 29	2009	April 9	
		June 22	
2010 April 6		September 29	
	2010	April 6	

USFS 2000 - 2010

31 Sampling Events20 Iron exceedances8 Copper exceedances1 Lead exceedance

DEQ/NPS 2015 - 2016

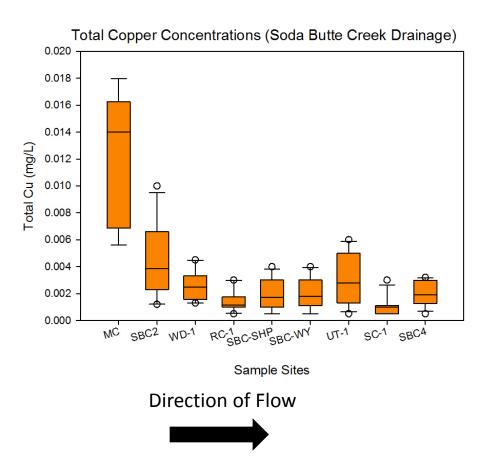
11 Sampling Events0 Iron exceedances1 Copper exceedance0 Lead exceedance

	June 28	
2015	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

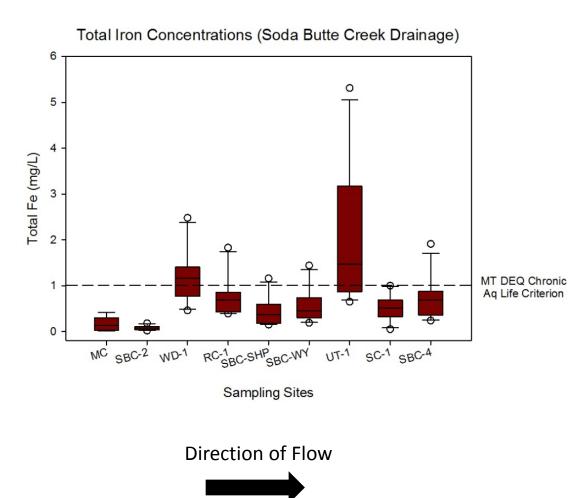
SBC WQ Study 2015 & 2016 Sample Results

- 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 <u>lowest</u> below former tailings site
- Highest [Fe] from two tributaries
- At YNP boundary generally below MT DEQ chronic aquatic life criterion



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

2000	April 14	
	July 7	
	October 10	
2001	April 19	
	June 25	
	October 12	
	April 24	
2002	July 1	
	October 8	1
	April 22	
2003	July 2	
	September 30	
	April 8	
2004	June 30	
	October 7	
	April 4	
2005	June 27	
	September 28	
	April 26	
2006	June 26	
	September 25	
	April 12	
2007	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 Events6 Iron exceedances3 Copper exceedances4 Lead exceedances

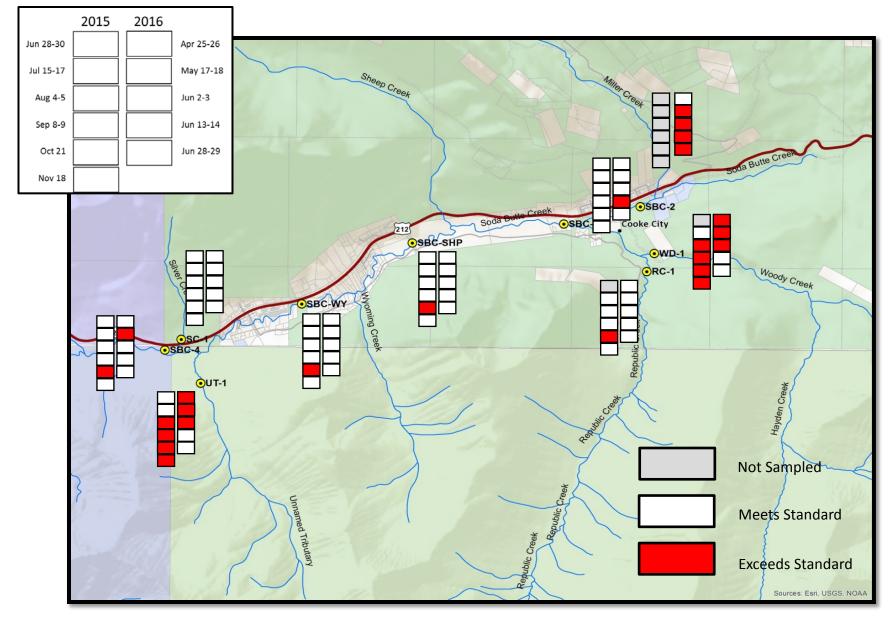
DEQ/NPS 2015 - 2016

11 Sampling Events2 Iron exceedances0 Copper exceedances0 Lead exceedances

	June 28	
2015	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 ³⁴

SBC WQ Study 2015 & 2016



Resource Restoration

Yellowstone Cutthroat Trout Conservation

- Montana Fish, Wildlife & Parks
- Wyoming Department of Game and Fish
- National Park Service
- Custer Gallatin National Forest
- Shoshone National Forest

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

