

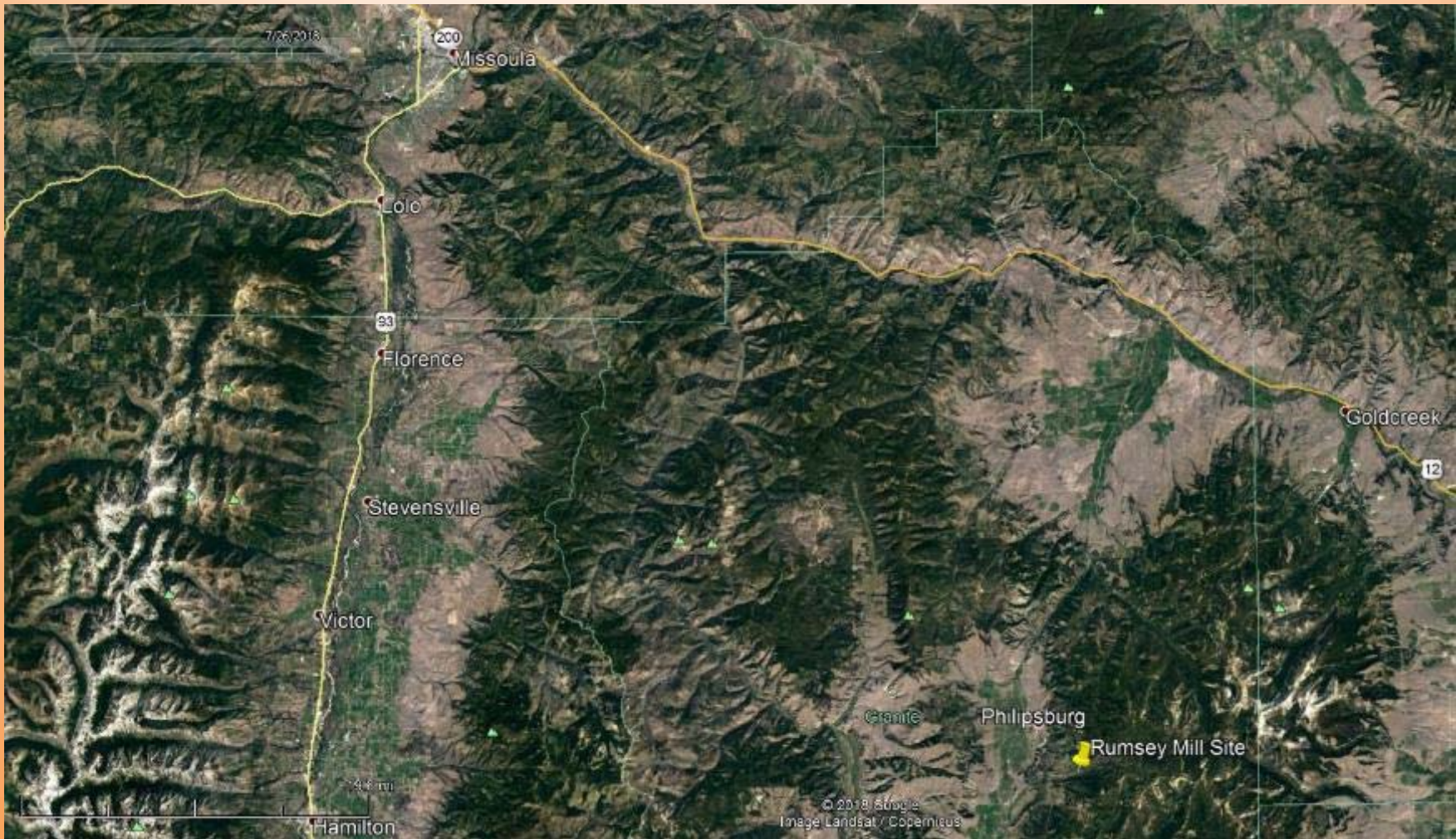


Rumsey Mill & Fred Burr Creek Site Characterization

Project Members

- Granite Headwaters Watershed Group
 - DNRC Grant
- Trout Unlimited
 - Project Coordination
- Landowners
- KC Harvey Environmental
 - Natural Resource and Technical Lead

Project Location



Site Background

- Fred Burr Creek
 - Tributary of Flint Creek and Clark Fork River
- Mill History
 - Milling silver ore circa 1890's
 - Mercury and metals in tailings
 - Non-acid forming
- Substantial Site Disturbance
 - Off site Re-processing (historic; 1930's – 1950's)
 - Pond and ditch construction (circa 1996/97)
 - Pond site reclamation (circa 2002/03)
 - Subdivision and Development (current)
 - Recent fire
 - Natural erosion of mill site area and streambanks

Site Background

– Key Previous Investigations

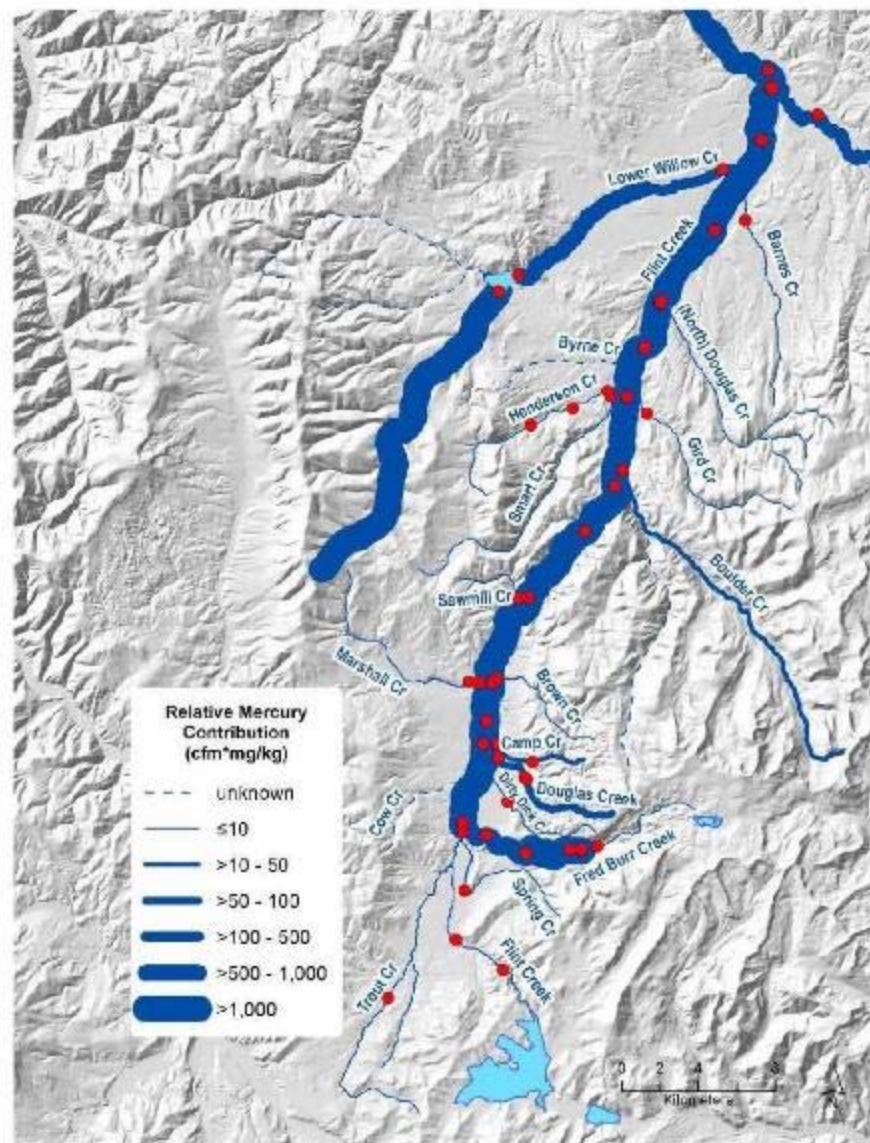
- Focused on Mill Site area and SW/Sediments
 - MDEQ
 - » AML program (circa 1995)
 - » SW and Sediments (circa 2015/16)
 - EPA (1997 – 2001)
 - » In response to 404 violation/pond construction
 - » SW, Sediments, Soils/Tailings
 - » Ecological Risk Assessment
 - Montana FWP (2014)
 - » BMI's
 - Private (2002)
 - » Reclamation of pond construction site
 - University of Montana (2014)
 - » Sediment Sampling

Existing Data Review

(Pre-2018 Field Investigation)

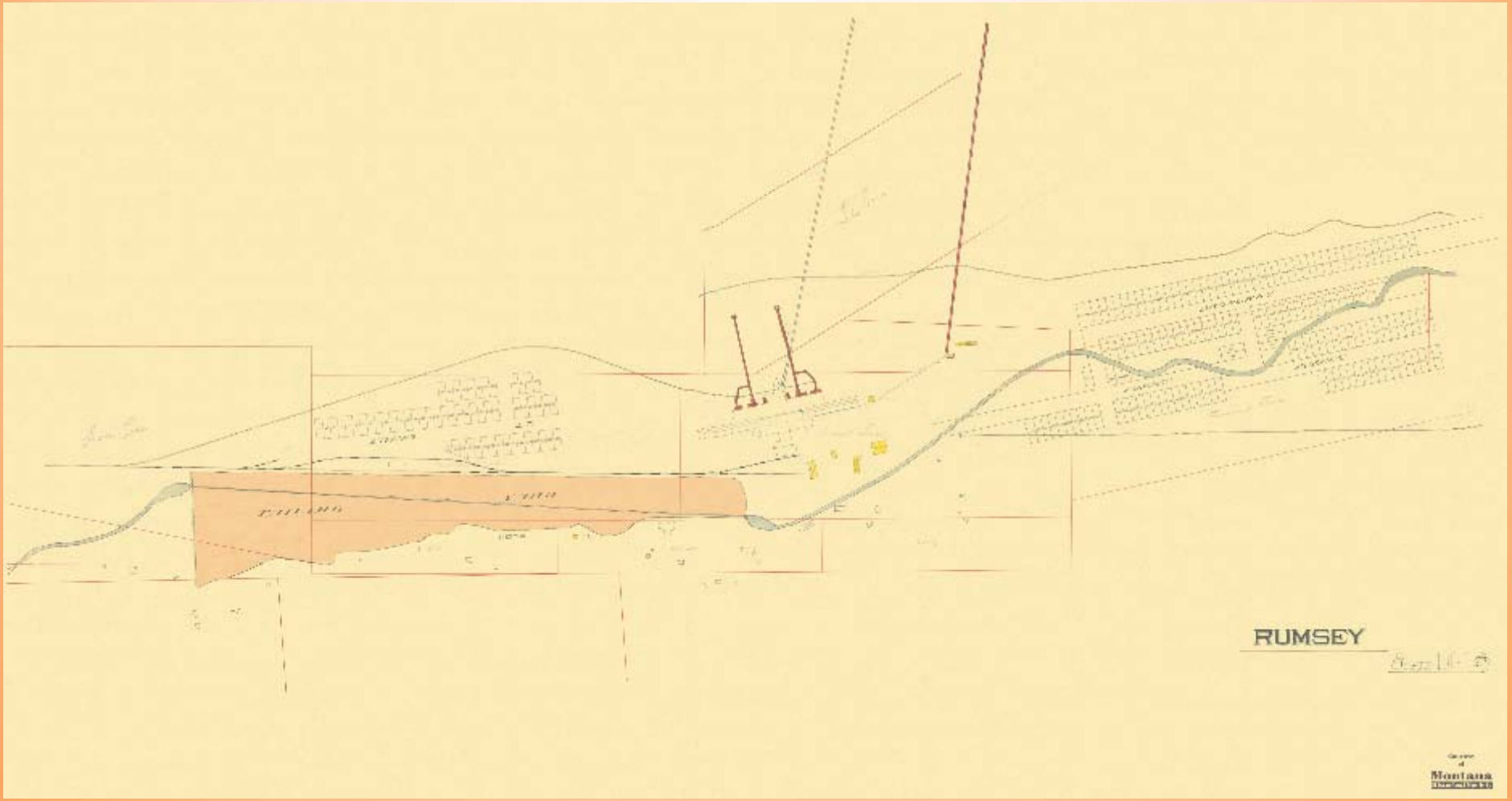
- Summary
 - Elevated mercury, arsenic and lead in surface water and sediments in Fred Burr Creek below mill site to Flint Creek
 - Elevated mercury, arsenic and lead in floodplain soils of Fred Burr Creek around mill site
 - Elevated mercury in BMI and fish in FBC and Flint Creek
 - Eco Risk Assessment - Benthic and terrestrial invertebrates and reference plants impacted
 - **Unknown level of soil contamination below historic mill/tailings location on Fred Burr Creek floodplain**

Figure 4. Estimated Relative Mercury Contribution of tributaries to Flint Creek. Red circles are sampling sites.



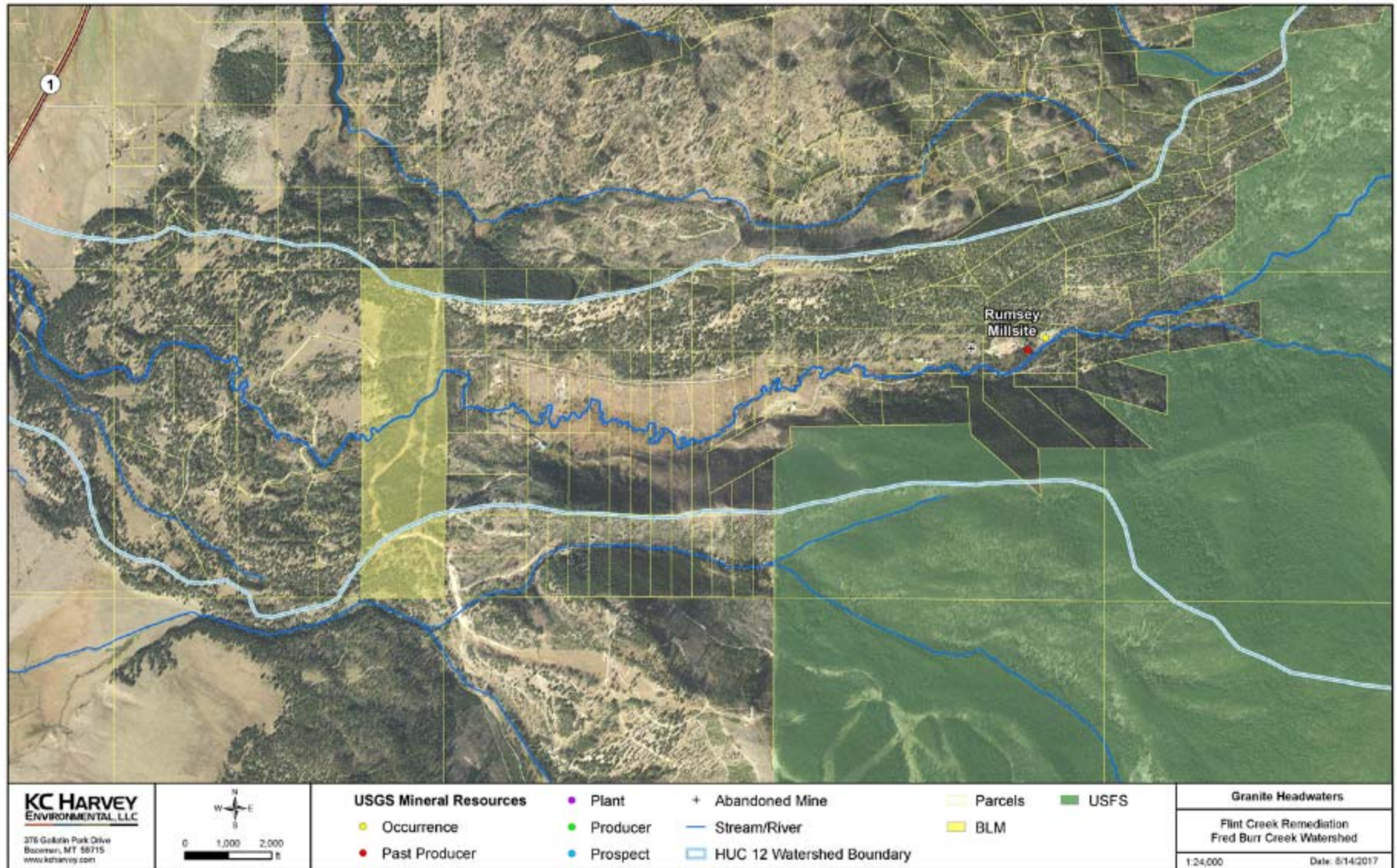


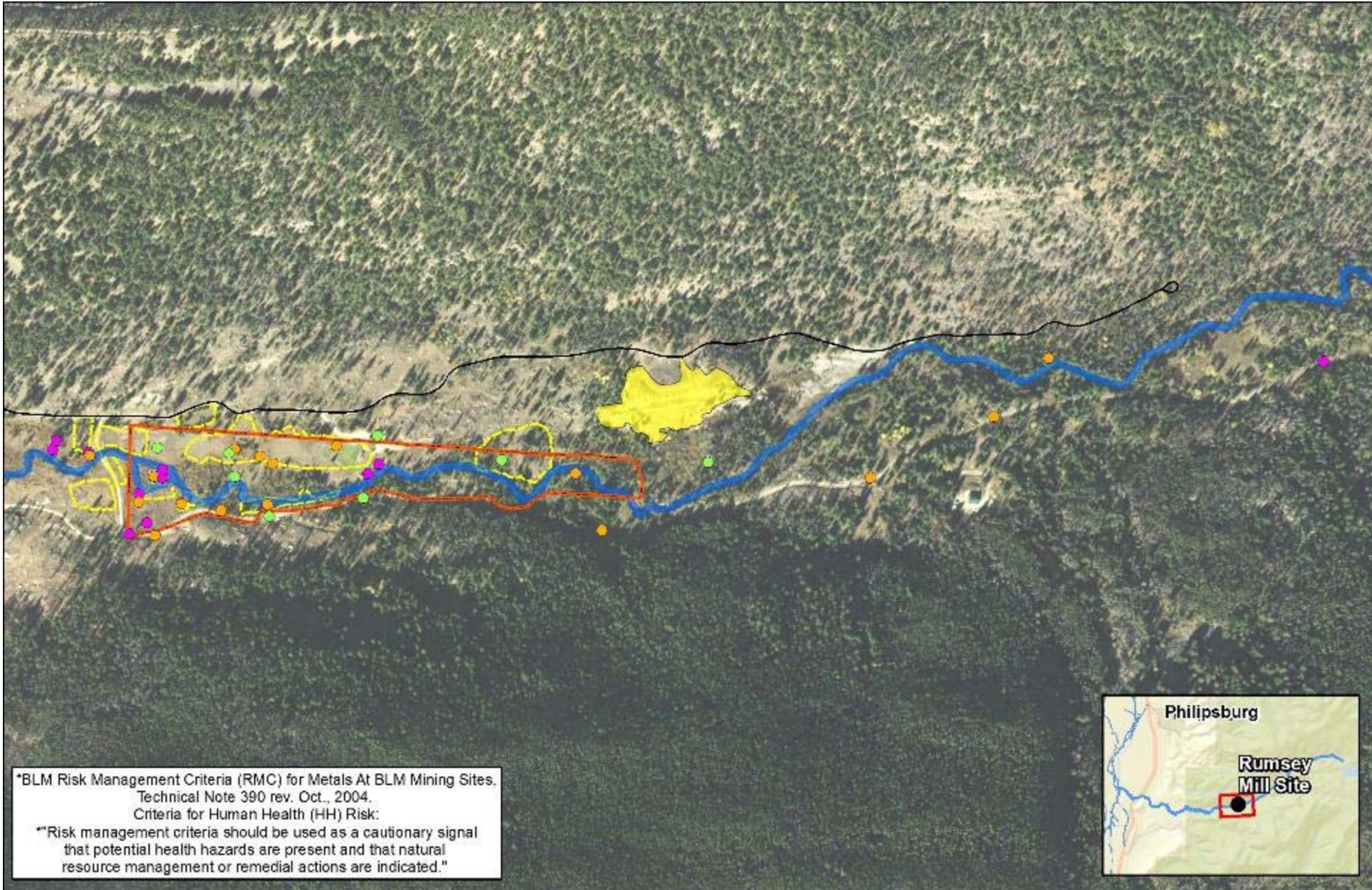
Rumsey Mill circa 1890's



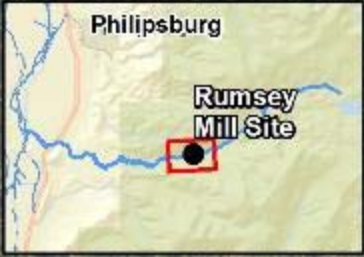
Historic Rumsey Mill Site (MBMG)

Parcel Map of Upper Fred Burr Creek



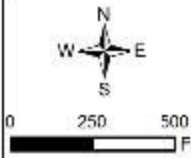


*BLM Risk Management Criteria (RMC) for Metals At BLM Mining Sites.
 Technical Note 390 rev. Oct., 2004.
 Criteria for Human Health (HH) Risk:
 "Risk management criteria should be used as a cautionary signal
 that potential health hazards are present and that natural
 resource management or remedial actions are indicated."



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Human Health Risk Management Criteria for Mercury in Soil (mg/kg)

- 0-2 (Below HH Risk Criteria)
- 2-40 (Resident Risk)
- 40 - 430 (Resident & Camper Risk)

- Mill Site
- Tailings Yard
- Reclaimed (2003)
- Road

* Potential risk based on BLM criteria

* Max 430 mg Hg/kg

**Granite Headwaters Watershed Group
 & Trout Unlimited**

Fred Burr Creek - Rumsey Mill Site
 Mercury Soil Sample Results - Detail Map

1:7,000

Date: September, 2017

Imagery: NAIP 2015

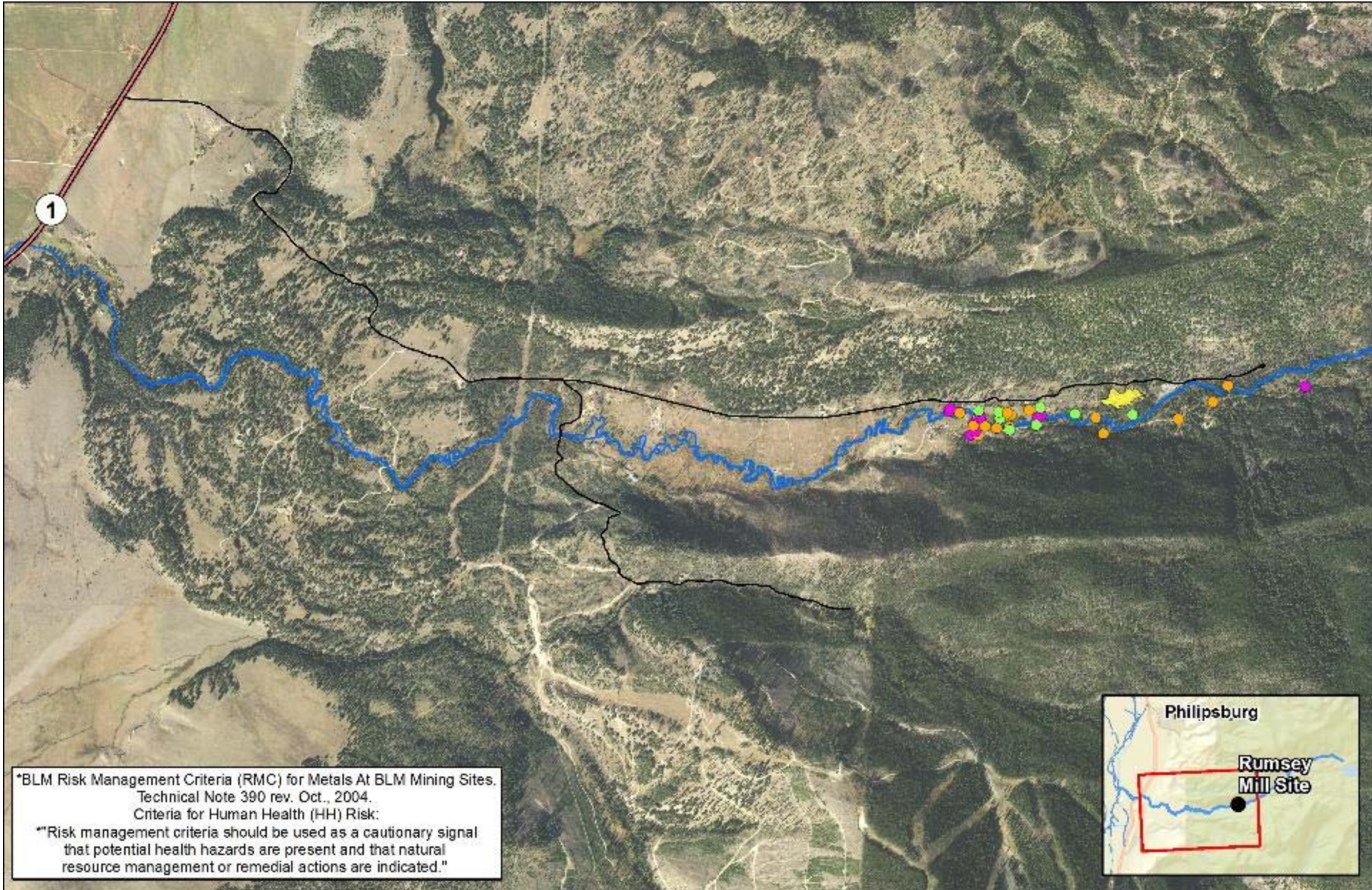


PHOTO 14



PHOTO 4

Reclaimed Bare/Tailings Areas (left) and Repository (right) (From LMRC and WET, 2003)

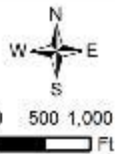


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Human Health Risk Management Criteria for Mercury in Soil (mg/kg)

- 0-2 (Below HH Risk Criteria)
- 2-40 (Resident Risk)
- 40 - 430 (Resident & Camper Risk)

* Potential risk based on BLM criteria

- Mill Site
- Creek
- Primary Road
- Road

* Max 430 mg Hg/kg

**Granite Headwaters Watershed Group
 & Trout Unlimited**

Fred Burr Creek - Rumsey Mill Site
 Mercury Soil Sample Results - Overview Map

1:25,000

Date: September, 2017

Imagery: NAIP 2015

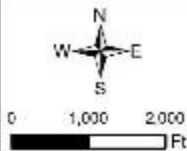


Green: Min, Avg, Max Elevation: 2208, 5629, 8448 ft
 Range Top: Distance: 7.85 mi Elev Gain/Loss: 1890 ft - 485 ft Max Slope: 63.3%, -6.4% Avg Slope: 5.4%, -2.0%



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- Mill Site
- Tailings Yard
- Moraine Crest
- Creek
- Primary Road
- Road

**Granite Headwaters Watershed Group
 & Trout Unlimited**

Fred Burr Creek - Rumsey Mill Site
 Elevation Profile

1:30,000

Date: September, 2017

Imagery: NAIP 2015

Upper Fred Burr Creek

Circa 2006



Google Earth

Image: USDA Farm Service Agency

2000 ft



2017 Data Gaps

- Extent (lateral and depth) of contamination
 - Limited to historic mill site area
 - Many historic land disturbances
- Sediment and Hg source to Creek
- Groundwater Quality and effects on Fred Burr Creek
- Roads/Construction materials
- Effect of recent flood flows (2017) on stream sediment chemistry

Field Investigation

- Objective: Define extent and degree of milling contamination in upper FBC
- Sampling and Analysis Plan
 - Focused soil/tailings sampling from soil pits in the upper (mill area) FBC floodplain (no access)
 - Soil/Tailings sampling from soil pits along transects between mill site and moraine crest
 - XRF analysis permits real time decision making and saves \$
 - Laboratory confirmation samples
 - Sediment sampling at select locations (similar to previous efforts)
 - Limited co-located surface water samples to correlate to stream sediment results
 - Groundwater observations/sampling to:
 - Note depth to GW in soil pits
 - Install piezometers for seasonal measurements of GW levels

Sampling Frequency

- Soil
 - 11 Hand-dug pits
 - 39 Mini excavator (larger)
 - 147 XRF samples from various depths
- Sediment
 - 5 samples from low-energy sections of FBC channel
- Surface Water (SW)
 - 4 samples co-located with sediment samples
- Groundwater (GW)
 - 6 piezometers installed in soil pits

QA/QC

- Soil
 - Daily accuracy and precision using NIST Hg standards
 - Daily cross-contamination blanks
 - 11 Field Duplicates
 - 20 sample splits for lab physical & chemical analyses
- Sediment
 - 1 Field Duplicate
 - All samples for lab analyses
 - All samples split for fine fraction (< 63um) analysis of Hg
- Surface Water (SW)
 - 1 Field Duplicate

Watershed-scale site map and sampling locations for the July 2018 field investigation at Fred Burr Creek.



<p>378 Gallatin Park Drive Bozeman, MT 59715 www.kcharvey.com</p>		<p>Watershed Map: Fred Burr Creek July 2018 Mercury (Hg) Sampling Results</p>	<ul style="list-style-type: none"> Surface water sample (mg/L Hg) Sediment sample - bulk (mg/kg-dry Hg) <p>NOTE: BLM Recreational Use Screening Level for Mercury in Soil is 40 (mg/kg & ppm)</p>	<p>Soil sample - bulk analytical (mg/kg Hg)</p> <ul style="list-style-type: none"> 0 - 10 10 - 40 40 - 100 100 - 200 200 - 500 	<p>Soil sample - bulk XRF (ppm Hg)</p> <ul style="list-style-type: none"> 0 - 10 10 - 40 40 - 100 100 - 200 200 - 500 	<p>Fred Burr Creek July 2018 Field Investigation</p> <p>1:15,000 Date: 10/3/2018</p>
				<p>U.S. Department of Agriculture Farm Service Agency Aerial Photography Field Office</p>		

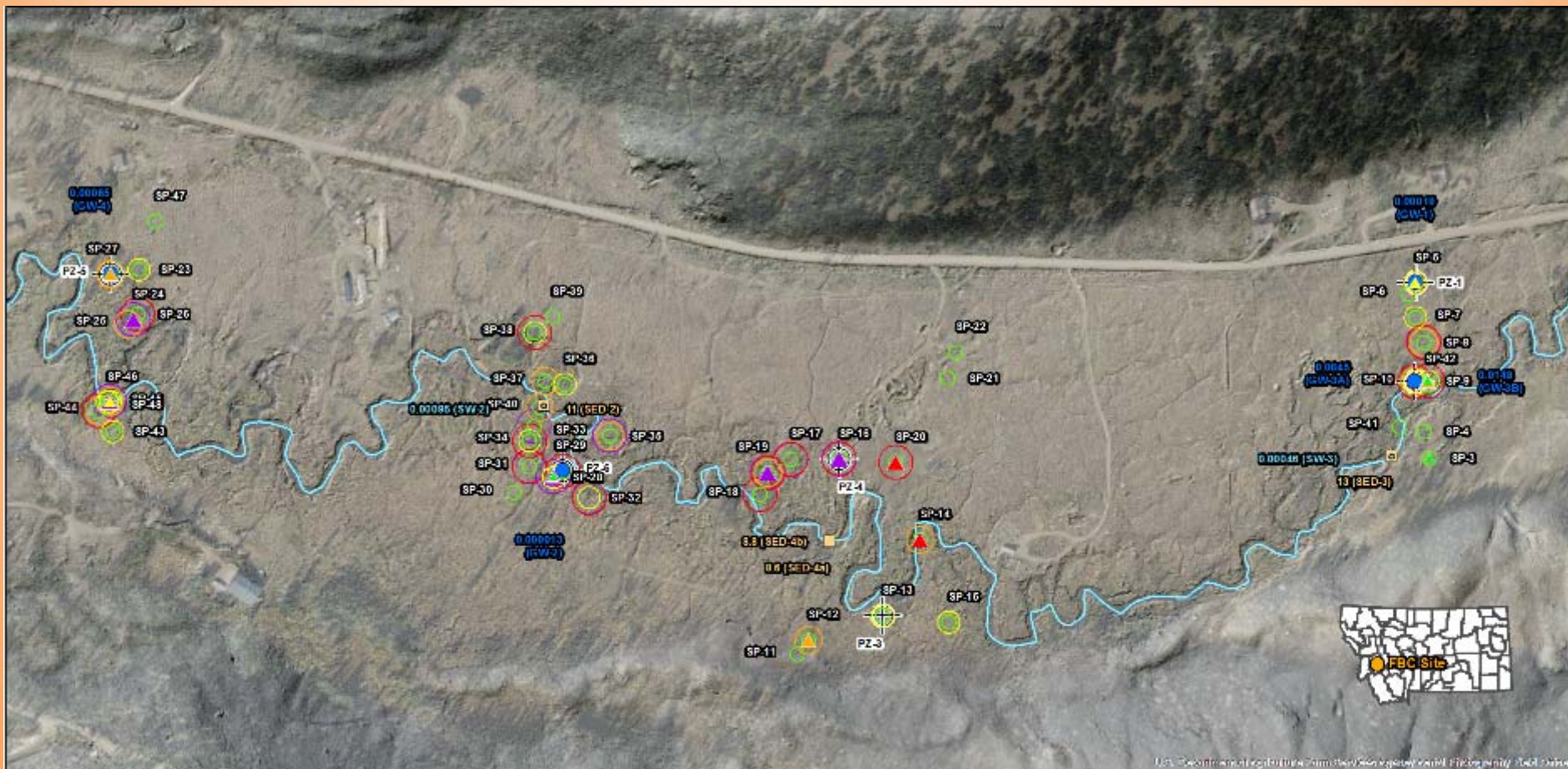
Fred Burr Creek bench (foreground) and floodplain looking SE



Typical excavator-dug soil pit during the July 23rd to 26th 2018 field investigation at Fred Burr Creek.

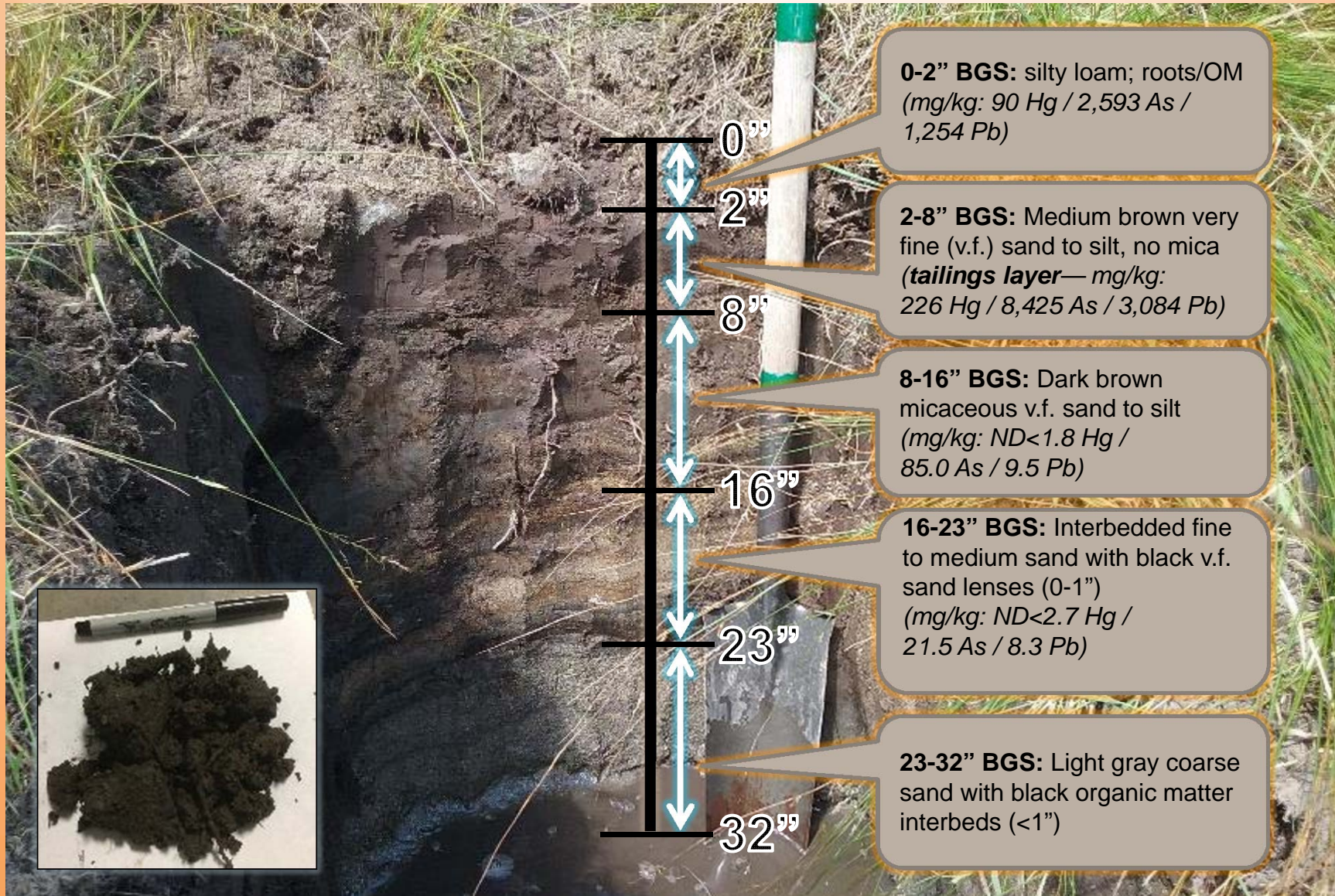


Sampling locations and results summary for July 2018 field investigation in upper Fred Burr Creek.

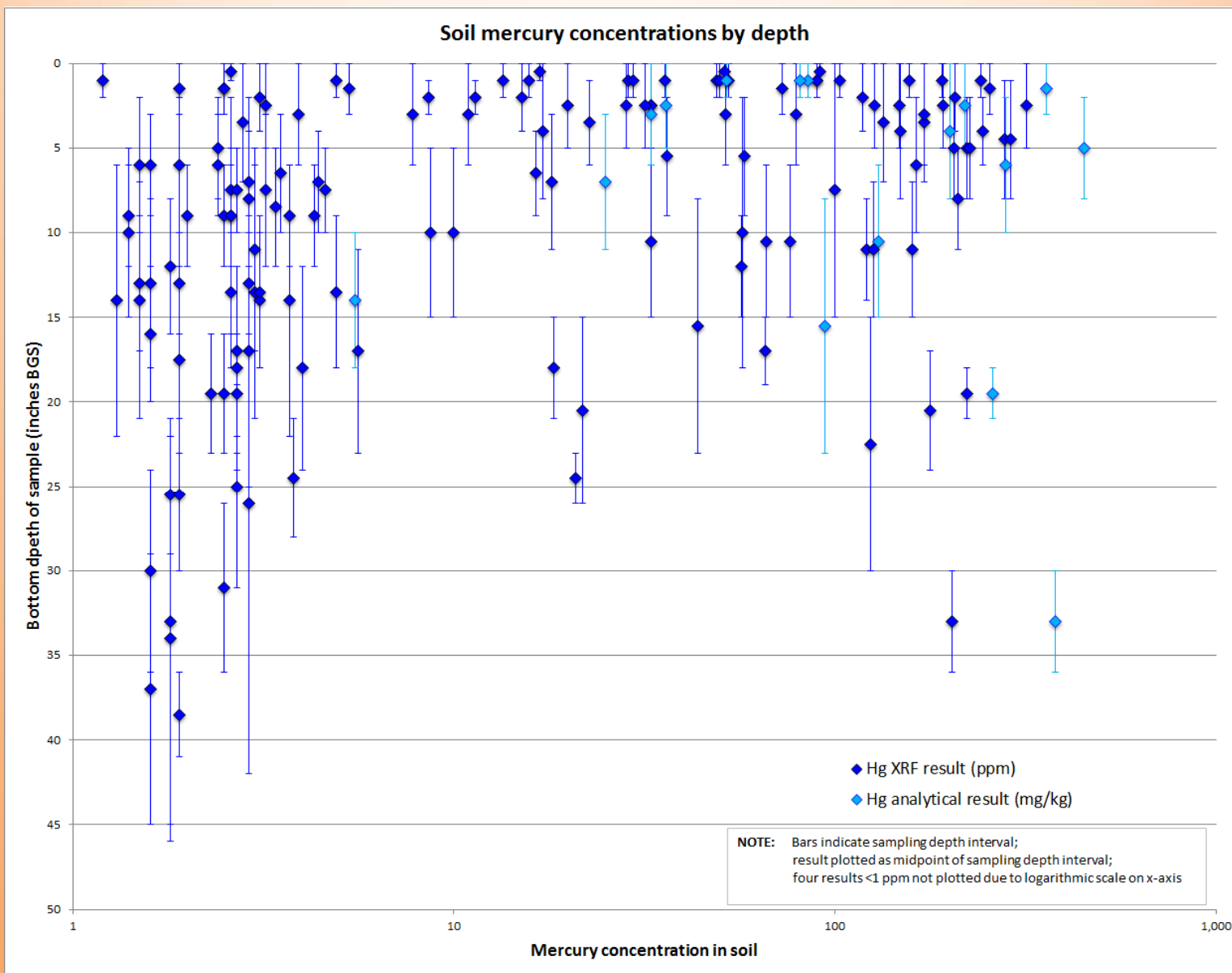


<p>KC HARVEY ENVIRONMENTAL, LLC 370 Daniels Park Drive Bloomington, UT 84301 www.kch Harvey.com</p>		<p>Fred Burr Creek July 2018 Mercury (Hg) Sampling Results</p>	<p>Soil sample - bulk analytical (mg/kg Hg)</p> <ul style="list-style-type: none"> 0 - 10 (Green circle) 10 - 40 (Yellow circle) 40 - 100 (Orange circle) 100 - 200 (Red circle) 200 - 500 (Purple circle) <p>Soil sample - bulk XRF (ppm Hg)</p> <ul style="list-style-type: none"> 0 - 10 (Light green circle) 10 - 40 (Yellow circle) 40 - 100 (Orange circle) 100 - 200 (Red circle) 200 - 500 (Purple circle) <p>NOTE: BLM Recreational Use Screening Level for Mercury is 40 (mg/kg & ppm)</p>	<ul style="list-style-type: none"> Surface water sample (mg/L Hg) Sediment sample - bulk (mg/kg-dry Hg) Groundwater sample (mg/L Hg) Piezometers Fred Burr Creek 	<p>Fred Burr Creek July 2018 Field Investigation</p> <p>12,300 Date: 8/30/2018</p>
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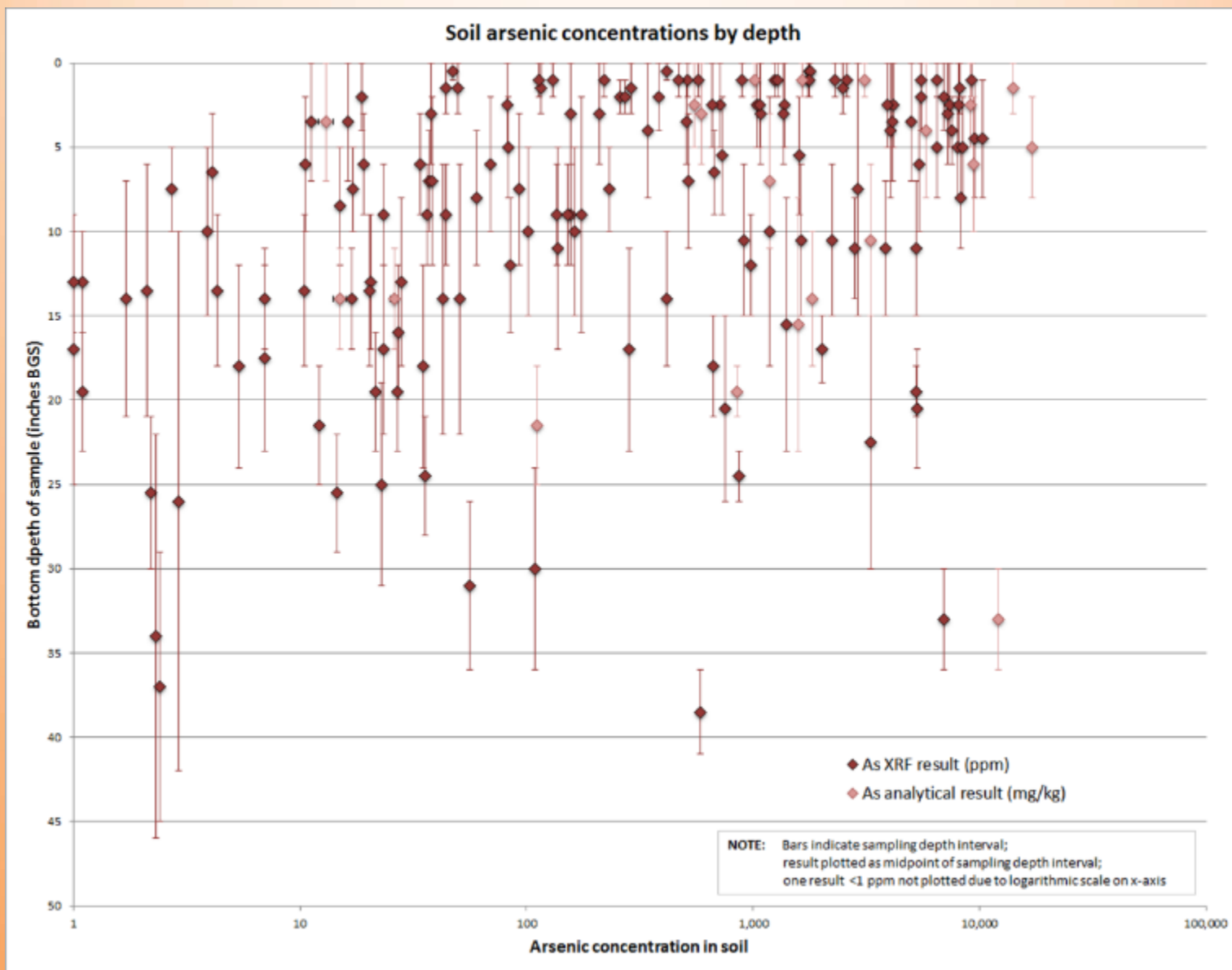
**Representative FBC soil profile and descriptions at sampling pit SP-8 (sharpshooter spade for scale).
Inset, lower left: close-up of tailings layer (2-8" BGS) found throughout FBC.**



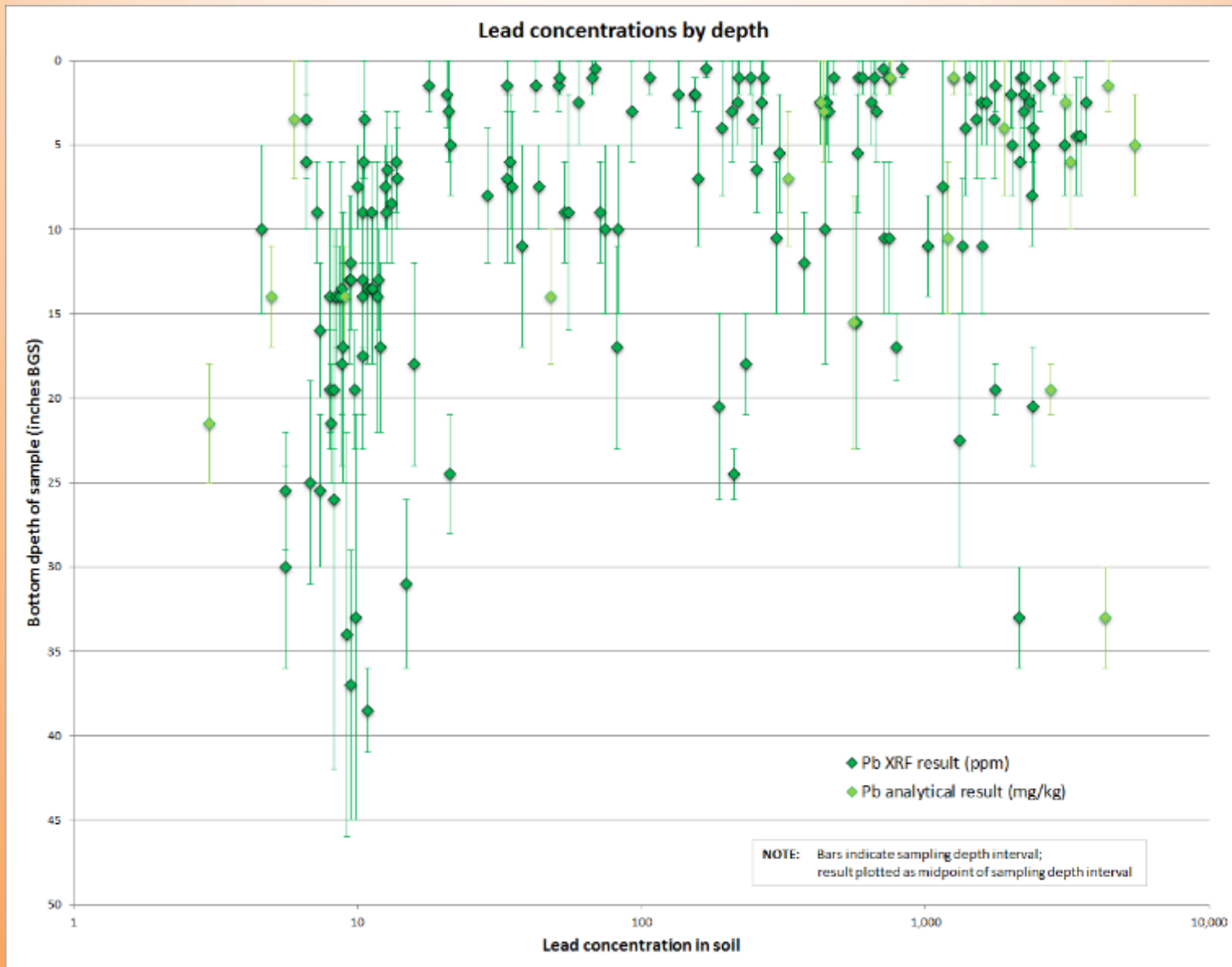
Mercury concentrations for laboratory and XRF analyses of soil samples collected in upper FBC watershed



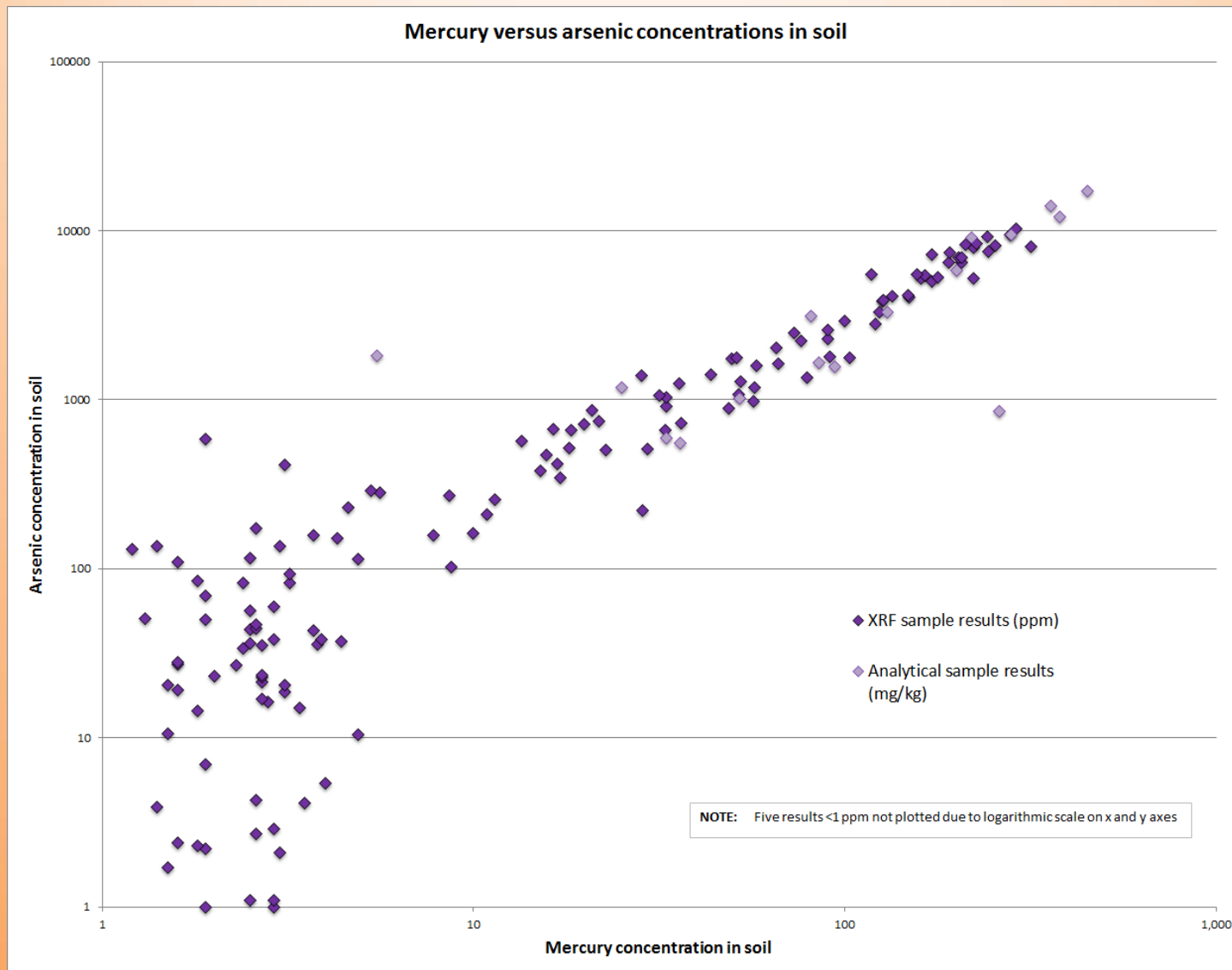
Arsenic concentrations for laboratory and XRF analyses of soil samples collected in upper FBC watershed



Lead concentrations for laboratory and XRF analyses of soil samples collected in upper FBC watershed



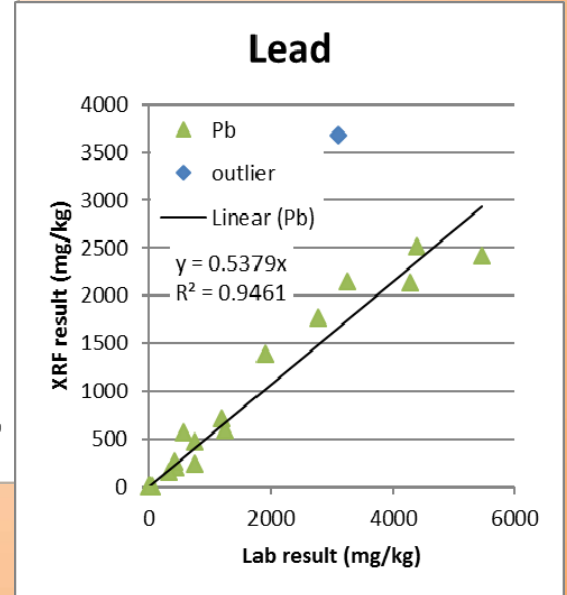
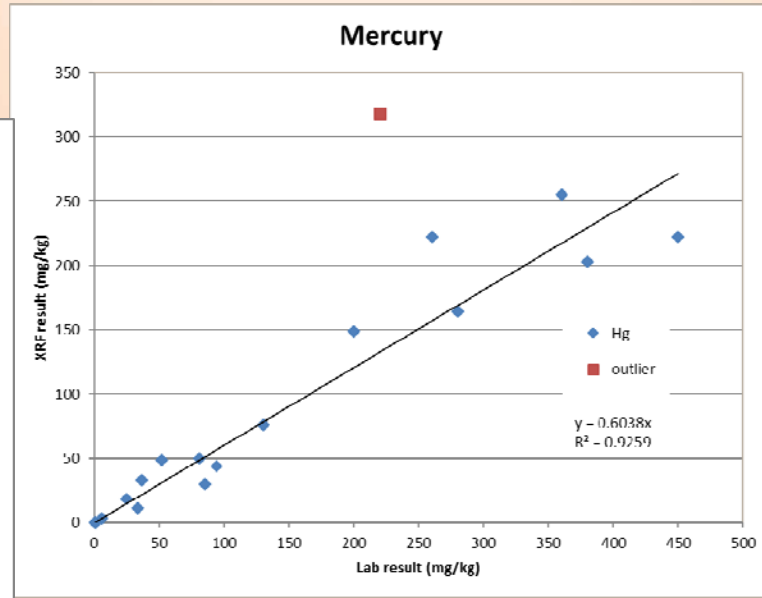
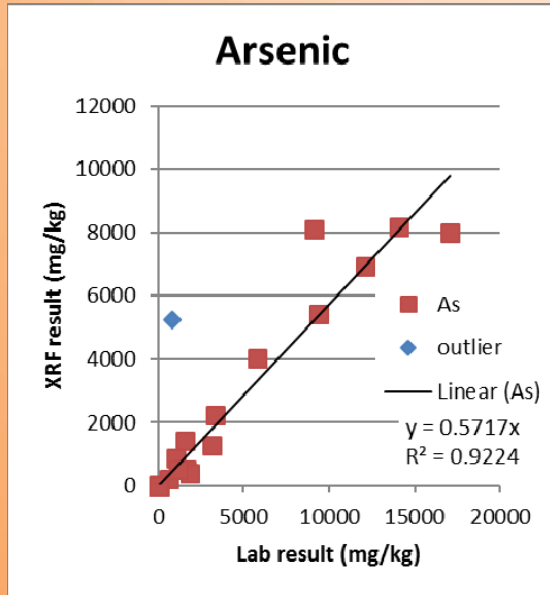
Mercury and arsenic concentrations for XRF and laboratory splits of soil samples collected in upper FBC watershed



Mercury and lead concentrations for XRF and laboratory splits of soil samples collected in upper FBC watershed



Sample Split Lab vs XRF Total Concentrations

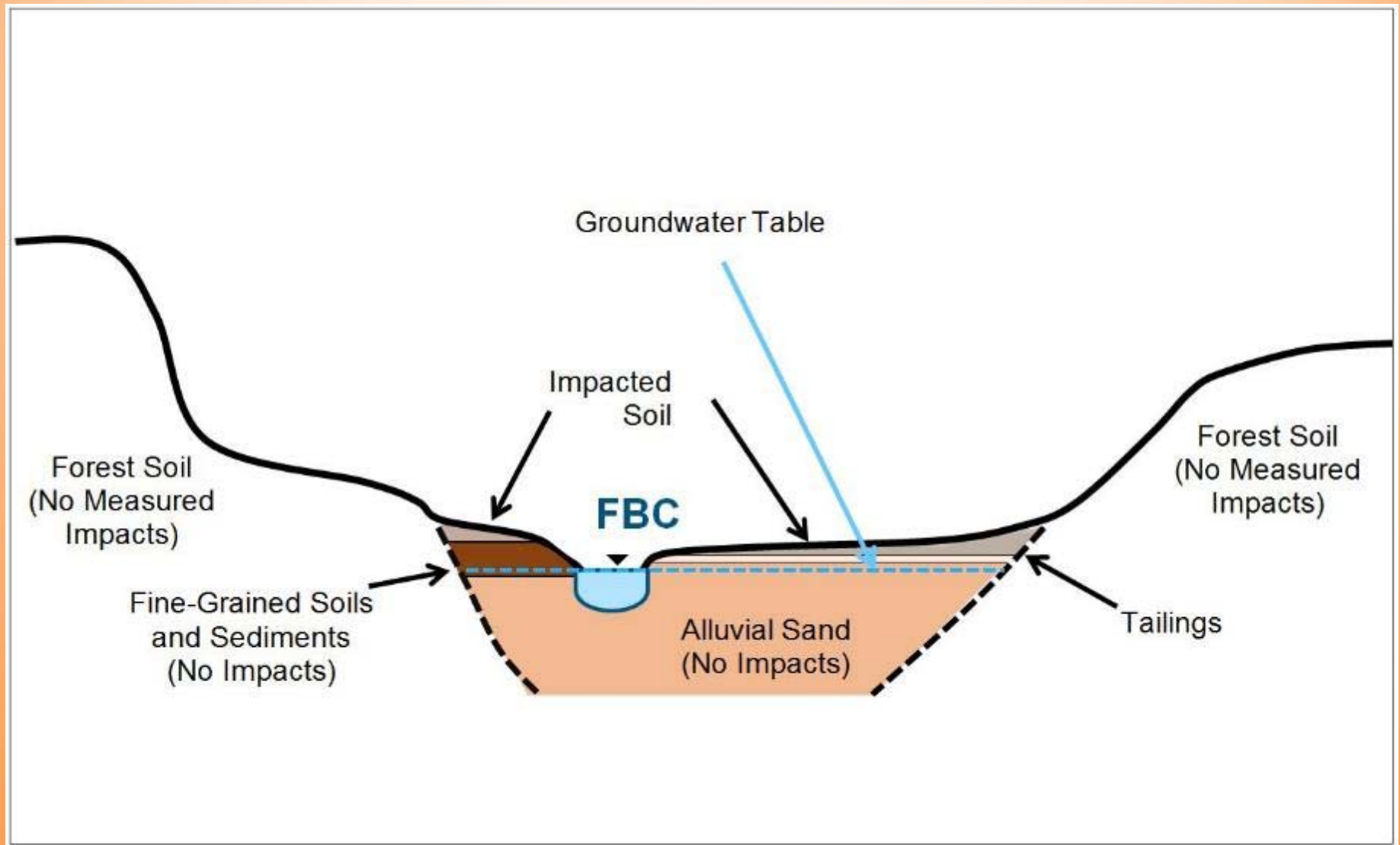


Results

- Soil

- Presence of tailings/impacted soils are primarily limited to the riparian corridor and lower terraces of the floodplain (average width approximately 250 feet)
- Impacted material ranged between approximately 0 and 25 inches BGS
 - Most impacts observed within the upper 12 to 15 inches
- Total mercury (Hg), arsenic (As) and lead (Pb) concentrations correlate strongly
- Mercury (Hg) and arsenic (As) are elevated, particularly in “tailings” layer
 - Mercury ranged between below detection to 450 mg/kg
 - Arsenic and lead ranged between below instrument detection and 17,100 mg/kg and 5,460, respectively
- Antimony concentrations (only 20 lab samples) were also elevated
 - Antimony ranged between below detection to 530 mg/kg
- Soils and sands immediately beneath tailings/impacted soils and above groundwater in most locations had relatively low to below detection limits for mercury, arsenic and lead

FBC floodplain cross-section schematic showing tailings, impacted, and non-impacted sediments and soils (not to scale).



Typical sediment sample location on Fred Burr Creek



Results

- Sediment

COC	Bulk Sample Range (mg/kg)	Fine (<63um) Fraction Range (mg/kg)
Mercury	8.6 - 21	25 - 64
Arsenic	78 - 398	401 - 1,840
Lead	36 - 132	172 - 572
Antimony	4 - 19	11 - 78

- Mercury, arsenic and lead concentrations were comparable with values observed in the recent MDEQ sediment sampling
- Splits of the fine fraction (silt <63um) of samples had mercury, arsenic, lead and antimony concentrations between 2 to 3, 4 to 10, 4 to 6 and 2 to 6 times greater than bulk samples, respectively.
- Recent overbank flood deposits similar to sediment Hg and metal concentrations
 - Implications for long-term impacts

Recent (2017) flood overbank deposits on Fred Burr floodplain



- Hg, As and Pb concentrations similar in overbank deposits and stream sediment

Results

- Surface Water

COC	Sample Range	MDEQ Aquatic Standard (chronic/acute)	MDEQ Human Health Standard
	(ug/l) (lead @ hardness = 25 mg/l)		
Mercury	0.18 – 0.95	0.91/1.7	0.05
Arsenic	13 - 25	150/340	10
Lead	0.8 – 3.7	0.545/13.98	15
Antimony	1.0 – 1.6	NA/NA	5.6

- Generally within the range observed in recent MDEQ sampling at similar locations

Results

- Groundwater

- Depth to GW ranged from 24-56” BGS in floodplain
- Analytical results are not conclusive, as groundwater was highly turbid at the time of sampling from *piezometers*

Select Agency Soil Screening and Risk Levels

COC	Receptor (*)	Soil Concentration (mg/kg)				# and % sample locations with 1 or more samples > EPA removal criteria	# and % surface sample locations with 1 or more samples > EPA removal criteria	# and % of total samples > EPA removal criteria
		BLM (1)	MDEQ (2)	EPA (3)	EPA (4)			
Mercury	Residential	2	1	11	33	27 (56%)	24 (50%)	52 (35%)
	Rec/Commercial (*)	40		46	140	17 (35%)	10 (21%)	23 (16%)
Arsenic	Residential	3	40	0.68	68	40 (83%)	39 (81%)	94 (64%)
	Rec/Commercial (*)	20		3	300	39 (81 %)	37 (77%)	70 (48%)
Lead	Residential	400	400	400	400	29 (60%)	26 (54%)	51 (35%)
	Rec/Commercial (*)	1000		800	800	21 (44%)	17 (35%)	34 (23%)
Antimony**	Residential	1	--	31	94	9 (45%)	4 (20%)	9 (45%)
	Rec/Commercial (*)	50	--	470	1400	0 (0%)	0 (0%)	0 (0%)

* - BLM Receptor is for recreational camper; EPA receptor is industrial/commercial worker

(1) - Bureau of Land Management - Risk Management Criteria for Metals at BLM Mining Sites (Tech note 390 October 2004)

(2) - Montana Department of Environmental Quality - Tier 1 Risk Based Corrective Actions for Petroleum Releases (2009)

(3) - EPA - Regional Soil Screening Levels at Superfund Sites - Generic SSL's (November 2018); TR (carcinogenic)=1E-6;THQ (non-carcinogenic)=1

(4) - EPA - Regional Removal Management Levels - Generic Values (November 2018); TR (carcinogenic)=1E-4;THQ (non-carcinogenic)=3

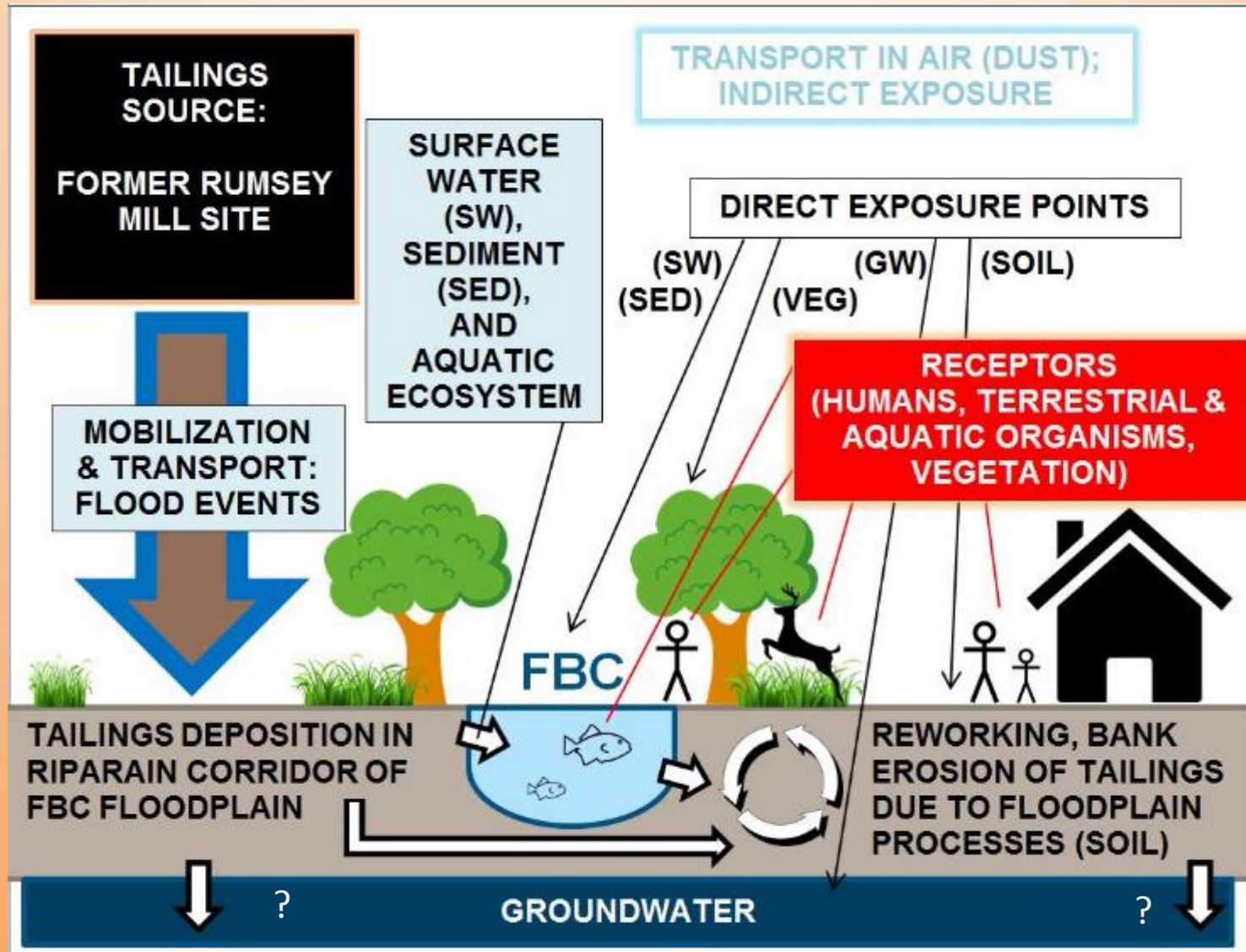
Screening Levels

- Sediment
 - Mercury
 - All samples exceeded EPA BTAG freshwater benchmarks (0.18 mg/kg)
 - Arsenic
 - All samples exceeded EPA BTAG freshwater benchmarks (1.8 mg/kg)
 - Lead
 - All samples exceeded EPA BTAG freshwater benchmarks (35.8 mg/kg)
 - Antimony
 - All samples exceeded EPA BTAG freshwater benchmarks (2 mg/kg)

Screening/Regulatory Levels

- Surface Water
 - Mercury
 - All samples exceeded MDEQ human health standard
 - A single sample exceeded MDEQ chronic aquatic standard
 - Arsenic
 - All samples exceeded MDEQ human health standard
 - Lead
 - All samples exceeded MDEQ chronic aquatic standard

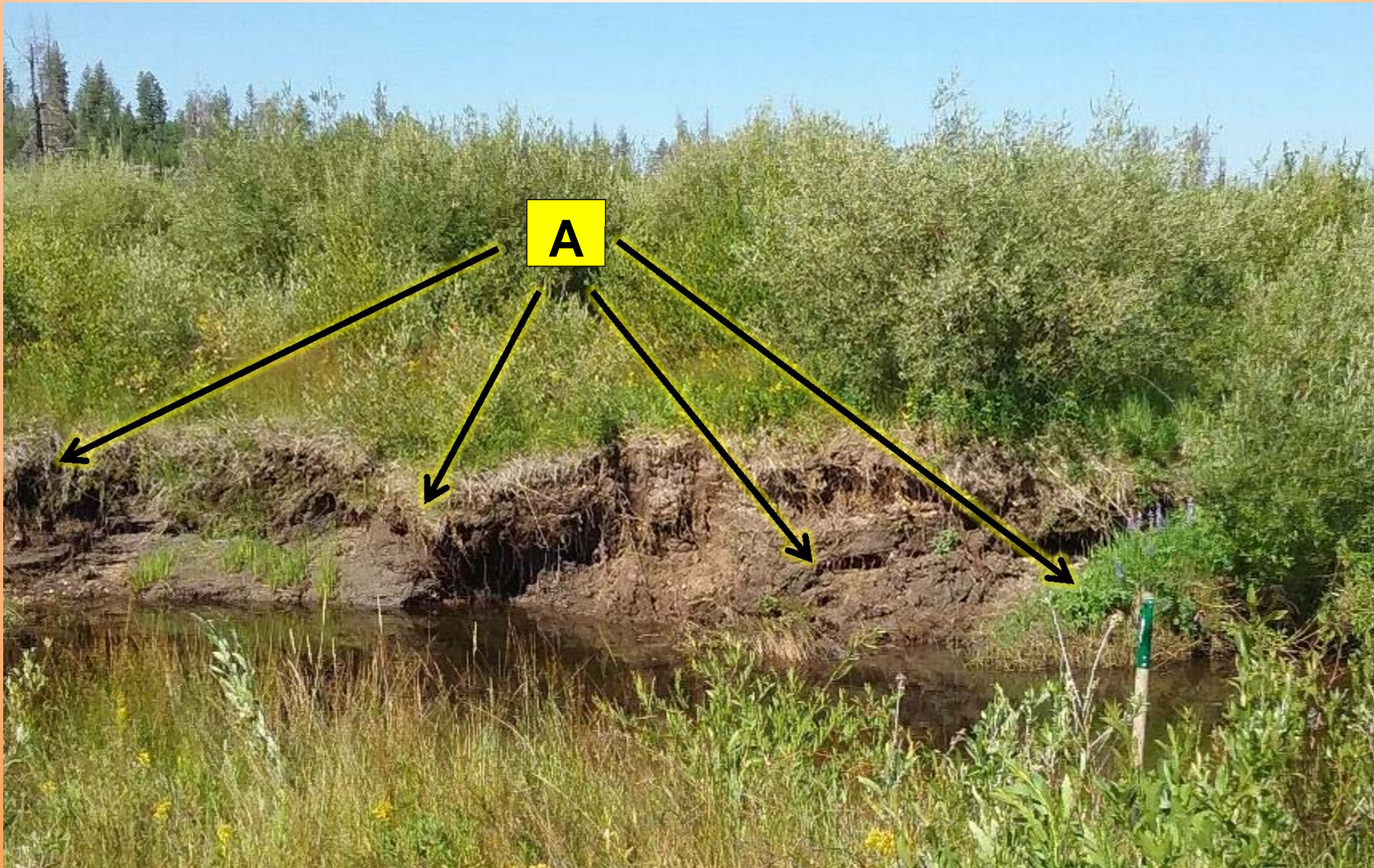
Conceptual Site Model schematic for potential tailings impacts and exposure pathways in the FBC floodplain.



Contaminant Transport/ Exposure Pathways

- Streambank erosion and fluvial processes
 - Likely substantial source of elevated Hg and metals in sediment and SW
- Groundwater
 - Large decrease (2 orders of magnitude) in Hg and metal concentrations in underlying soil/seds
Suggests limited movement via infiltration to GW
- Floodplain surface runoff is likely minimal
 - Floodplain has a low slope
 - Floodplain also well-vegetated, minimizing runoff/erosion
- Exposure due to ingestion or airborne soils likely minimal
 - Well-vegetated floodplain
 - Roads near mill site unknown
- Mill site characteristics are the primary unknowns
 - How much source material remains and where is it located?
 - What does runoff regime look like?
 - What is extent/degree of impacts in FBC floodplain near mill site?
 - Effect of disturbance on distribution
 - Road material contamination

Soil (A) slumping into FBC channel as a result of streambank erosion and undercutting near SP-37. Also note red top and willows on top of the river bank—the vegetation assemblage observed with tailings impacts in the FBC floodplain.



Data Gaps & Recommendations

- Determine nature and extent of contamination at mill site
- Any new information should contribute to a remediation plan and/or assessment of risk
 - Volume of impacted material in FBC floodplain/mill site
 - Estimate of streambank erosion rates
 - Groundwater pathway
 - Concentration of metals in vegetation
 - Methylmercury impacts
- Risk assessment
 - Human Health and Ecological
 - Based on contaminant exposure pathway and receptor

Next Steps

What We Are Doing Now

- Any new information should contribute to remediation planning and/or assessment of risk
- Develop volume estimate of tailings/impacted soils in floodplain using LiDAR, GIS and existing analytical data
- Sample domestic wells for Hg and metals
- Begin Preliminary Risk Assessment
- Refine Hg/metal source loading to FBC
 - Estimate bank migration rates and develop estimate of sediment input and Hg/metal loading to FBC
 - If warranted, install a few shallow monitoring wells to characterize floodplain GW quality