Reclamation Research Group, LLC
202 South Black Avenue, Suite 4
P.O. Box 6309, Bozeman, MT 59715
Phone: (406) 624-6571
Fax: (406) 551-2036

Technical Memorandum

To: Karen Ekstrom, CDM
From: Pam Blicker
Date: January 25, 2012
Re: Barker Hughesville Streamside Tailings and Campsite Investigation, Fall 2011

Abstract

The Barker-Hughesville Mining District Superfund Site (the Site) consists of approximately 9,600 acres in Cascade and Judith Basin Counties in located in west-central Montana, east of the town of Monarch. There are 11 drainages on the Site and 45 mine sites scattered within those drainages. The two major creeks within these drainages are Galena Creek and Lower Dry Fork Belt Creek (Dry Fork). A Streamside Tailings investigation was completed in the fall of 2011 that focused on identifying the presence and extent of mine waste transported down surface water drainages and re-deposited along floodplains. The reconnaissance and sampling of the streamside deposition material included both the floodplains and several campsites that are located along the streams. This memo summarizes the scope and preliminary findings from the visual reconnaissance and quantification of metal and metalloid concentrations in collected sediments and soils.

Ten drainages at the Site were investigated in September and October 2011. The streambed and floodplains of Upper Galena Creek, Otter Creek, Green Creek, Gold Run Creek, Galena Creek, and the upper 5 miles of the Lower Dry Fork of Belt Creek were investigated by walking the length of these drainages. The Upper Dry Fork of Belt Creek (Dry Fork), McKay Gulch, Spruce Creek and Silver Creek were inspected and sampled near their confluence with Galena Creek or the Dry Fork and at other selected locations along these creeks. Streamside tailings were visible along the majority of Upper Galena Creek and Galena Creek. Along the Dry Fork, below the confluence with Galena Creek, visible tailings became intermittent in the floodplain. Lenses of buried tailings were periodically visible in the cut banks of the Dry Fork between Galena Creek and the mouth of the Dry Fork. Overbank sediment deposits were common throughout the Dry Fork floodplain and frequently these deposits were several inches in depth. Ninety-three near surface soil samples were collected during the Streamside Tailings 2011 sampling event. Samples were collected at predetermined and opportunistic sampling locations within creek floodplains as well as numerous semi-developed campsites. Streamside and campsite samples generally consisted of fluvially deposited sediment located in the floodplain. Elevated concentrations of several elements were found in the soils including arsenic, cadmium, thallium, lead, zinc, and others. The distribution of contaminated soil within the Barker Hughesville CERCLA site is widespread and variable.

1.0 Introduction

There are 45 known abandoned mine sites with associated waste rock dumps, discharging mine adits, streamside tailings deposits, and tailing impoundments as well as the Block P Mill Tailings and Mine Waste Complex properties located within the boundaries of the Barker-Hughesville Mining District Superfund Site (the Site). The abandoned mine sites are mostly in the Upper Galena Creek and Galena Creek Drainages, near the historic town sites of Barker and Hughesville. Spring runoff and other precipitation events periodically contribute a significant amount of water to the drainages at the Site, occasionally resulting in the flow of water exceeding the capacity of the creek channels. Historic and recent overbank flow of water has deposited a considerable amount of sediment throughout the floodplain, particularly along Galena Creek and the Dry Fork.

The purpose of the Streamside Tailings Investigations was to assess the extent of contamination deposited in creek drainages at the Site. These creeks include Otter Creek, Green Creek, Upper Galena Creek, Silver Creek, Galena Creek, Gold Run, Upper Dry Fork of Belt Creek, Spruce Creek, McKay, and the Lower Dry Fork of Belt Creek (Dry Fork). Seventy-three streamside deposit samples were collected along the drainages. In addition to the creek drainage investigation, surface soils from numerous semi-developed campsites located adjacent the Dry Fork were assessed to evaluate health risks to recreationalists. Shallow soil samples were collected at 20 camping and recreational sites. Background or baseline soil samples were collected in four drainages, above the historic mining activities.

In September 2011, CDM contracted the Reclamation Research Group (RRG) to walk the length of the main drainages as a reconnaissance for streamside tailings deposits and to collect samples where appropriate to determine the extent of contamination. Sediment samples were analyzed for eight potential contaminates of concern (PCOC): arsenic, cadmium, copper, lead, manganese, mercury, thallium, and zinc. Areas of large sediment deposition and visible tailings were mapped.

2.0 Scope

This section includes original text (*italicized*) from the Sampling and Analysis Plan (SAP) describing the procedures and protocol that were prescribed prior to the field investigation. Due to site-specific field conditions, several deviations from the SAP were made during the investigation. The original text from the SAP is in italics and any deviations to these procedures are list below the SAP text.

> *Streamside sampling will occur systematically at regular intervals on some streams. Other streams will be sampled only at select locations, due to a lack of water or mine source areas. Composite samples will be collected from shallow materials on either side of transects that*

run perpendicular to and across the creeks being investigated. Data generated will be used as a screening evaluation to determine the downstream extent of contaminated streamside tailings, and to determine the potential human health and ecological impacts.

Systematic Streamside Samples

Streamside tailings sampling will include the following steps:

- *The length of all streams will be walked to the extent possible. Areas of major stream bank deposition will be noted on maps.*
  - Due to time constraints, not all streams were walked in their entirety. Field reconnaissance of creeks and floodplains are described below:
    - Otter Creek (Map 1): The upper portion of Otter Creek was walked and samples were collected at 2 locations. There were no visible tailings or impacted areas noted along the creek. The upper portion of this drainage is quite steep and deposition material was found only in the path of the intermittent flow of Otter Creek.
    - Green Creek (Map 1): Green Creek was visible from the adjacent road. This creek was walked, some of it from the road. Three samples were collected along Green Creek. There were no major areas of streambank deposition and no visible tailings or impacted areas to note along the creek.
    - Upper Galena Creek (Map 2): Upper Galena Creek was walked from the headwaters area to its confluence with Galena Creek. Flow above the historic mines is intermittent. Five samples were collected. This creek was not mapped because below the upper-most mine, the streambed and sediments appear contaminated the entire length of the creek. This drainage was steep so the major areas of deposition were generally restricted to the historic mines sites.
    - Silver Creek was not walked (Map 3). One sample was collected approximately 2,800 ft upstream from its confluence with Galena Creek.
    - Gold Run Creek (Map 4): Gold Run was walked from the confluence with Galena Creek to just above the waterfall and "Hughesville Project" (approximately 6,000 ft from confluence with Galena Creek). One sample was collected above the waterfall and one closer to the confluence. No areas of major deposition were noted.
    - Galena Creek (Maps 3-5). The entire length of this creek was walked. Major deposition along the floodplain prompted investigators to map the streambanks along the entire length of the creek as impacted or tailings. Twelve samples were collected along Galena Creek.

- Upper Dry Fork of Belt Creek (Map 5): This section the Dry Fork was not walked. Background samples were collected approximately 3,500 ft upstream from the confluence with Galena Creek. Two additional samples were collected upstream to the confluence with Galena Creek (300 and 600 ft upstream).

- Spruce Creek (Map 5): This creek was not walked. One sample was collected approximately 250 ft above the confluence with the Upper Dry Fork. Access was not granted for further inspection.

- McKay Gulch (Map 5): This intermittent creek was not walked. One sample was collected approximately 350 ft above the confluence with the Dry Fork. Access issues restricted sample collection to this single location. No areas of major deposition or contamination were noted.

- Lower Dry Fork of Belt Creek (Dry Fork) (Maps 5-13): The upper 5 miles of the Dry Fork were walked and mapped. The lower 6 miles were sampled at predetermined locations. Areas of major deposition and visible tailings were noted on maps.

■ *The systematic sampling locations have been plotted in advance and will be located by the field team, starting with the most downgradient of the locations.*

- Sampling and field reconnaissance started at the most up-gradient locations. The field team worked its way downstream, not upstream.

■ *The field team will sketch each sample location and make an attempt to visually estimate the extent of stream bank deposition. Sketches of the perimeter of the deposits will be made on the appropriate map in the map book, for digitization and calculation of area. If available, a handheld GPS may be used to collect spatial coordinates defining the perimeter. If possible, the field team may also measure the depth of the stream bank deposits by examination of cut banks.*

- Each sample location was sketched on the back of the field form and spatial coordinates were recorded using a Trimble GPS unit. Streambank deposits were generally too extensive to estimate size and/or depth. Many depositional areas continued along the streambank and floodplain for long distances. The time expended on mapping all deposits with a GPS would have been prohibitive and the resolution of field maps (aerial photos) was not sufficient to distinguish details of the landscape necessary for mapping smaller depositional areas. Notes and sketches were recorded on field forms and large depositional areas were drawn on the field maps.

■ *At each location, the field team will delineate a transect that extends on either side of the creek, such that four evenly spaced samples can be collected on each side of the creek. The spacing will be determined in the field and will be dependent on the width of the available sampling area and of the creek.*

- Both sides sampled: SST designation. In areas where it was possible to extend the transect across the creek, the number of samples locations on each side of the creek was dependent of the size of the floodplain. At the smaller intermittent tributaries, the area between high water marks was narrow and the creek bed was often dry. At these locations, the transect extended across the area and 4 evenly spaced samples were collected across the entire width of the narrow floodplain. These four samples were composited into one sample. At locations where the area between high water marks was larger, 4 samples were collected from each side of the creek (8 total) and composited into one sample.
- Both sides sampled: RST and LST designation. Transects did not always extend across the creek because of unfavorable topography and other site-specific circumstances. At these locations, if both sides of the creek were sampled, each side of the creek was sampled separately (designated as "RST" for right side and "LST" for left side). A transect was established from the creek bank, inland across the boundary of the "regular" floodplain. Four evenly spaced samples were then collected along the transect and composited into one sample
- One side sampled: RST or LST designation. At many locations, only one side of the creek was sampled (designated either "RST" for right side or "LST" for left side). A transect was established from the creek bank, inland across the boundary of the "regular" floodplain. Four evenly spaced samples were then collected along the transect and composited into one sample. These decisions were based on the presence or absence of sediment in the floodplain. Many locations did not have sediment deposition areas on both sides of the creek.

▪ *The four samples from each side of the creek will be collected using hand trowels from the 2- to 6-inch interval. They will be composited into a single sample in a zipper-top bag. At some locations, it may not be possible to collect a composite from both sides of the creek due to access issues (e.g., steep canyon walls or major debris piles).*

- These procedures were followed. Any deviations were noted in the field notebook and field forms.

▪ *The sampling locations proposed are based on accessibility and approximate distances downstream. On Dry Fork of Belt Creek, sample spacing is relatively dense for the first three miles below its confluence with Galena Creek and is approximately one sample per mile thereafter.*

- Some samples were collected several feet upstream or downstream from the proposed locations. These decisions were based on the presence/absence of depositional material.

- *GPS locations will be collected from the center of the sampled area*
    - GPS coordinates were recorded at the center of the transect.

Opportunistic Streamside Samples

Major areas of tailings deposition along the streamsides will be sampled when encountered, independent of the systematic streamside sampling. It is anticipated that this will entail up to 20 samples.

- A total of sixteen opportunistic streamside samples were collected. Three opportunistic campsite samples were collected for a totally of 19 opportunistic samples.

A major area of tailings deposition is defined as an area of 100 square feet or greater that can be categorized into one of the following three categories:

<u>*Exposed tailings*</u>***.*** *Visual evidence of tailings below high water mark. Overbank deposits have exposed tailings (less than 25 percent canopy cover, efflorescent metal salts may be visible, tufted hairgrass is present, if there is any live vegetation). Areas smaller than 100 feet may also be sampled at the discretion of the field team.*

- High water marks were difficult to determine due to recent and historic flooding events. Visible tailings were mapped anytime an area larger than 100 sq ft of exposed tailing was discovered. Buried tailings were noted when encountered but not mapped or sampled.
- Tailing deposits encountered at the Site generally did not have efflorescent salts or tufted hairgrass associated with them.
- Exposed tailings were identified by color, texture, field pH (Hellige Troug pH indicator solution), and vegetation condition (or lack of vegetation).

<u>*Impacted Areas*</u>***.*** *Visual evidence of tailings below high water mark. Overbank deposits have impacted soils and vegetation areas (canopy cover greater than 25 percent, small individual areas of exposed tailings indicating the degree of phytotoxicity is variable, efflorescent metal salts may or may not be visible, and tufted hairgrass present but has less than 1 percent of the canopy cover). Any area over 100 square feet in this category should be sampled at a rate of 50 percent (every other qualifying area that is encountered.*

- The "regular or normal" floodplain boundary was generally used to define sampling locations. Due to numerous overland flow events, it was often difficult to determine high water marks and floodplain boundaries.

- Impacted areas were not mapped individually. This was due to the complexity of determining if the impact was due to contamination, recent flooding, human recreational use, or depth of deposition due to historic and repeated flooding events.

- Generally, impacted areas were mapped as "depositional areas". Results from sediments sampled in these depositional areas should help determine if the areas are impacted by contamination.

Slightly Impacted Areas. *Visual evidence of tailings below high water mark. Overbank deposits have slightly impacted soils and vegetation areas (these areas would normally be well vegetated and display no visible evidence of tailings contamination except that the recent spring flows have deposited new sediment on top of the existing vegetation and the vegetation is re-establishing itself). Any area categorized as slightly impacted should be sampled at a rate of 25 percent (every fourth such area encountered).*

- Recent and historic spring flows have deposited new sediment on top of existing vegetation over large expanses of the Dry Fork and Galena Creek floodplains. This tended to be the rule in many areas as opposed to the exception. Many depositional areas were continuous and interconnected. Once the field reconnaissance began, it was determined that distinguishing boundaries between depositional areas was not possible in many areas. According to the definition, large portions of the Dry Fork floodplain could be considered slightly impacted due to expected depth of deposition. Samples were not collected solely based on the SAP's definition of Slightly Impacted due to site conditions and time constraints.

Each of the major tailings deposits described above will be sketched and divided into four quarters. Four aliquots will be collected from the 0- to 6-inch interval in each quarter and composited into a single sample representative of the pile.

- This protocol was followed for opportunistic streamside samples.

Campsite Samples

Campsites will be sampled to provide an indication of potential threat to human health. The sampling will focus on the most surficial layer, as flows:

- *Each campsite will be sketched and divided into four quarters.*

- *Four aliquots will be collected from the 0- to 2-inch interval in each quadrant and composited.*

- *Samples should be collected from areas of obvious use (e.g, near campfire rings, flat areas for tents, etc.)*

  - This sampling protocol was followed for all campsite samples.

3.0 Results and Discussion

3.1 Streamside Sampling

This section addresses site conditions at the time of the site investigation and preliminary data from the sampling and analysis campaign. The information is presented by tributary. Galena Creek and the Dry Fork are divided into upper and lower sections in this document.

The existing USGS 7.5 minute (1:24,000 scale) quadrangles that cover Daisy and Upper Galena Creeks (Barker and Mixes Baldy quadrangles - last updated in 1995) label the creek running through Sandra Croff's property as "Daisy Creek," and that is how all site reports and other documents (beginning in the early 1990s) have shown these streams. However, during the 2011 field sampling event, the landowner referred to the same creek as "Galena Creek." Subsequent research of the Bureau of Land Management's historic records showed that the names of the two creeks had indeed been mislabeled on the USGS maps. This can be seen on a map surveyed August 17th to 21st, 1897 by Harry V Wheeler, U.S. Deputy Mineral Surveyor. A plat of the claim of "Moulton Consolidated Mining Co." known as the "Belfont, Pioneer, Moulton and Harrison Lodes," with Mineral Survey Nos 3560,3561, 3562, and 3563 clearly shows the same area and has the creek labeled as "Galena". From this point forward, the maps for the Barker Hughesville Mining District Superfund site will be changed to reflect the 1897 naming. However, the during the 2011 field work the upper portion of Galena Creek was referred to as "Daisy Creek". Therefore, references to "Daisy Creek" in field notes and photos actually refer to the upper section of Galena Creek. In this document, "Upper Galena Creek" is used to reference Galena Creek from the headwaters to just above the Block P waste removal construction area.

Streamside Background Samples. Background soil samples were collected at five locations within the Site. Four streamside samples were collected and one campsite sample. The streamside samples were collected at the Upper Dry Fork of Belt Creek, Gold Run Creek, Spruce Creek and McKay Gulch (Table 1). The Upper Dry Fork sample was collected approximately 3,500 ft upstream from the confluence with the Galena and the Gold Run sample was collected over 1 mile upstream, above a large waterfall. The Spruce Creek and McKay Gulch background samples were collected upstream from their confluences with the Dry Fork (250 ft and 350 ft respectively). The average PCOC concentrations of these background samples are used in this document as a comparison to PCOC concentrations at streamside soil sample locations throughout the study site.

Table 1. Concentrations of PCOC in background streamside samples. Average levels shown are used for comparison purposes.

Local Background Sample Streamside Tailings	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
DF-SS024 Upper Dry Fork Streamside (2-6 in)	3.9	0.10	14.4	17.9	312	0.11	2.40	53.9
GR-SS02 Upper Green Creek Streamside (2-6 in)	27.3	0.52	5.3	108.0	1470	0.11	2.20	178.0
SC-SS01 Spruce Creek Streamside (2-6 in)	7.8	0.25	33.8	44.0	285	0.06	4.00	72.5
MK-SS01 McKay Gulch Streamside (2-6 in)	10.2	0.30	11.0	24.0	453	0.10	0.38	88.0
Average	**12.3**	**0.29**	**16.1**	**48.9**	**630**	**0.10**	**2.25**	**98.1**

Otter Creek. Otter Creek does not drain to Dry Fork Belt Creek, but to an adjacent watershed to the north (Map 1). Flow in the creek is intermittent; no water was present at the time of sampling. Two samples were collected along Otter Creek. Vegetation was diverse and appeared healthy at both sample sites. Sample OC-SS001 was collected approximately 200 ft below an open adit (Cape Nome Mine). Vegetation was diverse and appeared healthy in this area. Thallium, at 28.6 mg/kg, was over 12x greater than background concentrations and zinc was over 44x greater than background (Table 2). Lead was elevated at 798 mg/kg, but below the EPA screening level of 1200 mg/kg. Sample OC-SS002 was collected approximately 950 ft below the headwaters (top of pass). An open adit (Vista Mine) was located above this sample point as well as a small waste rock pile. Thallium was 9 mg/kg at this location, which is elevated. These two sample sites did not appear impacted; the creek bed was dry at the time of sampling. The elevated thallium level in the soil may be a concern.

Table 2. Concentrations of PCOC in Otter Creek streamside samples. Average levels of project background concentrations are shown for comparison purposes.

Otter Creek:	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
OC-SS01-BTA-SST-002006	50.1	2.6	36.3	798	924	0.06	28.6	4320
OC-SS02-NTA-SST-002006	66.8	1.1	21.8	570	624	0.03	9	202
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

Green Creek. Green Creek is located on the opposite side of the pass from Otter Creek and is a tributary to Galena Creek (Map 1). Three samples were collected along Green Creek (Map 1). A historic smelter site was located between Samples GN-SS03 (upper-most sample) and GN-SS002. Samples GN-SS02 and GN-SS01 were both collected below the historic smelter site and had elevated concentrations of lead and thallium (Table 3). Soil collected at GN-SS02 had a lead concentration of 1230 mg/kg and thallium at 17.2 mg/kg. These levels are both substantially greater than background concentrations. Soil thallium was quite high (26.9 mg/kg) at GN-SS01. Above the historic smelter site, the creek and floodplain do not appear to be impacted by mining activities. Below the smelter, the concentrations of PCOC increase. The creek is no longer bound by the road below GN-SS02 and water runs overland. The creek was dry at the time the sample was collected; however, soils in this area were damp. Vegetation was robust and healthy and the creek bed did not appear impacted.

Table 3. Concentrations of PCOC in Green Creek streamside samples. Average levels of project background concentrations are shown for comparison purposes.

Green Creek:	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
GN-SS01-NTA-SST-002006	60.1	2	189	192	1980	0.02	26.9	439
GN-SS02-NTA-SST-002006	86	5.3	101	1230	1610	0.11	17.2	1440
GN-SS03-NTA-SST-002006	20.3	0.56	9.1	137	642	0.02	4.5	130
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

Upper Galena Creek: Five historic mines were operated in the Upper Galena Creek drainage (Map 2). Sample DC-SS005 was located furthest up the drainage and DC-SS001 was located closest to the mouth of the creek. The creek runs adjacent to several historic mine sites and cuts through tailings and waste rock piles. This creek appears to be negatively impacted by mining activities from just below the headwaters to the mouth. Sample DC-SS005 was positioned above all of the tailing piles and just down gradient from the headwaters. This sample had a lead concentration of 1300 mg/kg (Table 4). Below the Tiger Mine, the streambed and banks of Upper Galena Creek become visibly impacted by mine waste contamination. Seeps from underground workings are actively contributing water to the creek. Samples collected at the lower four sample points all had elevated concentrations of cadmium, copper, lead, manganese, and zinc (Table 4). Arsenic concentrations were all less than 65 mg/kg, which is much lower than the majority of samples collected along Galena Creek and the Lower Dry Fork.

Table 4. Concentrations of PCOC in Upper Galena Creek streamside samples. Average levels of project background concentrations are shown for comparison purposes.

Upper Galena Creek	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
DC-SS05-NTA-SST-002006	37.3	1.6	25.2	1300	3130	0.14	0.29	541
DC-SS04-NTA-SST-002006	60.1	16.8	264	12900	5790	0.18	0.84	5680
DC-SS03-NTA-SST-002006	59.7	10.2	275	12000	4600	0.28	0.76	3460
DC-SS02-NTA-SST-002006	43.5	7.3	340	4400	5040	0.14	0.91	1740
DC-SS01-NTA-LST-002006	62.7	15.5	1190	3880	14000	0.17	2.6	2600
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

Silver Creek. Silver Creek was not walked. Investigators were escorted through the Block P Removal Construction Area and parked their vehicle near the sample point. The sample site was located upgradient of the side channel that drains the Wright and Edwards mines (Map 3). Water was flowing at a trickle at the sample point. The vegetation in this area was robust and the area did not appear impacted by mining contamination. Soil manganese and zinc concentrations were the most enriched of the PCOC in the soil at this site as compared to background (Table 5).

Silver Creek was visually inspected at its confluence with Galena Creek. Silver Creek appeared heavily impacted in this area. Tailings were visible and noted; no samples were collected.
It is unknown at this time where Silver Creek becomes impacted, but somewhere between the sample point and the mouth, the creek entrains mine wastes.

Table 5. Concentrations of PCOC in Silver Creek streamside samples. Average levels of project background concentrations are shown for comparison purposes.

Silver Creek:	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
SV-SS01-NTA-SST-002006	19.2	3	39.7	88	2640	0.06	4.5	688
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

*Used as a background sample.

Gold Run. Over one mile (approximately 6,000 ft) of Gold Creek was investigated by walking the streambank (Map 4). The uppermost sample, GR-SS02, was used as a background sample. This sample was collected above the large waterfall and debris pile thought to be part of the Hughesville Project. The entire area investigated did not appear to be negatively impacted by mining activities. Vegetation was robust and diverse and fish were visible in the creek. Sample GR-SS01 was collected approximately 1,000 ft upstream from the confluence with Galena Creek. Results from both samples sites did not indicated that the area is impacted or has enriched concentrations of PCOCs (Table 6).

Table 6. Concentrations of PCOC in Gold Run Creek streamside samples. Average levels of project background concentrations are shown for comparison purposes.

Gold Run Creek:	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
GR-SS01-NTA-RST-002006	17.3	0.49	10.8	73.4	756	0.05	0.63	149
GR-SS02-BTA-SST-002006*	27.3	0.52	5.3	108	1470	0.11	2.2	178
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

*Used as a background sample.

Galena Creek. The investigation of Galena Creek began just below the Block P waste removal construction area, at the confluence of Silver Creek with Galena Creek (Maps 3 – 5). Galena Creek was heavily impacted by historic mining activities and the upper portion of the creek bisects tailing and waste piles. The visible signs of impact within the floodplain were inconsistent; some areas were barren while other areas supported variable degrees of vegetation. The diversity of the plant communities appeared to be less than that of neighboring plant communities and ground cover was often sparse. Signs of major overbank flow of water caused by spring snowmelt and other significant precipitation events were obvious along the creek. Galena Creek had deeply cut banks in many sections; these cut banks often displayed lenses of tailings. Other areas along the floodplain were wider and visible tailings were present several feet from the creek bed. Concentrations of PCOC were considerably elevated as compared to background samples (Table 7). Maps 3-5 show tailings and depositional area polygons. One tailings polygon was mapped to include the entire length of the creek that was investigated. The depositional areas are likely impacted, but it was difficult to define with certainty the nature of the impact. The depth of the depositional material at some locations would have a negative impact on vegetation, regardless of contamination levels. Young conifers were common throughout the floodplain and willows and water birch were present along the stained creek banks in many locations. The plant communities in the depositional areas generally appeared stressed, which could be caused from flooding events, elevated PCOCs, or both.

Data collected from streambank soils adjacent to Galena were plotted in order starting upstream and moving downstream. These data are included in Appendix A and show slight trends from upstream to downstream. Arsenic, lead, mercury and thallium soil concentrations were generally greater upstream and decreased as the samples locations moved downstream. Whereas cadmium, manganese and zinc soil concentrations tended to increase at downstream sample locations. Manganese levels increase below GL-SS007 while cadmium and zinc begin to increase below GL-SS004. An historic mine was located between GL-SS004 and GL-SS003, which may explain the increases in cadmium and zinc.

Table 7. Concentrations of PCOC in Galena Creek streamside samples. Average levels s of project background concentrations are shown for comparison purposes.

Galena Creek	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
GL-SS09-NTA-SST-002006	373	6.9	125	3310	681	0.37	4.8	1240
GL-SS01R-NTA-LST-000006*	756	7.1	428	34600	29.9	1.8	11.5	1500
GL-SS08-NTA-SST-002006	511	2	197	3760	700	0.53	6.4	516
GL-SS07-NTA-LST-002006	316	0.86	104	3670	931	0.49	2.9	272
GL-SS06-NTA-SST-002006	505	4.6	194	4880	3070	0.36	3.6	447
GL-SS05-NTA-SST-002006	289	2.7	100	1880	1930	0.14	3.1	488
GL-SS02R-NTA-SST-000006	209	2.9	154	1710	3300	0.08	3.5	490
GL-SS04-NTA-SST-002006	190	2.8	79.9	1490	1790	0.09	2.4	400
GL-SS03-NTA-SST-002006	223	12.7	155	1490	1950	0.19	2.4	3270
GL-SS02R-NTA-RST-002006	109	9	49.1	3010	1440	0.03	0.84	1220
GL-SS03R-NTA-LST-000006	207	6.4	104	1540	1960	0.11	2.9	1030
GL-SS01-NTA-SST-002006	182	14.6	418	1070	4790	0.05	2.4	1960
Galena Creek Average*	283.1*	5.95*	152*	2528*	2049*	0.22*	6.3*	1030*
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

* Galena Creek Averages do not include sample GL-SS01 (tailing sample)

Sample GL-SS001 was collected just above the mouth of Galena Creek, at its confluence with the Dry Fork. A large depositional areas lies between the road and the creek, the sample collected in this area had enriched concentrations of cadmium (14.6 mg/kg), copper (418 mg/kg), and manganese (4790 mg/kg). There is a pull-off from the main road and the area appeared to be used by recreationalists.

Table 8 displays the enrichment factors of the samples collected along Galena Creek. The enrichment factor was calculated by dividing the lowest, highest and average sample concentration of each PCOC by the average background concentration. All samples from Galena Creek, with the exception of GL-SS01R, were used for these calculations. Sample GL-SS01R was omitted from the calculations because this sample consisted of tailings. A transect was not established at this location, a composite sample of an area with exposed tailings was collected, therefore it was excluded.

Enrichment of arsenic, cadmium, copper and lead was quite substantial at many locations along Galena Creek. The average enrichment factor for arsenic and cadmium was over 20x background and for lead, that factor went up to over 50x background

Table 8. Range of enrichment factors for PCOCs from samples collected along Galena Creek.

PCOC	Enrichment Factors*		
	Low	**High**	**Average**
Arsenic	8.9	41.5	23.0
Cadmium	3.0	50.3	20.5
Copper	3.0	26.0	9.5
Lead	21.8	99.6	51.6
Manganese	1.1	7.6	3.3
Mercury	0.0	5.3	2.2
Thallium	0.1	1.0	0.5
Zinc	2.8	33.4	10.5

*Enrichment factor = sample concentration / average background concentration
Sample GL-SS01R was omitted from enrichment factor calculations because this sample was a tailings sample, not streamside.

Despite the visible tailings and orange staining along the length of Galena Creek, average enrichment factors for cadmium, manganese and thallium were lower along Galena Creek than the Lower Dry Fork (Table 9). Soil lead appears to be substantially enriched along the Galena as compared to background and the concentrations of the other creeks. Appendix C displays data from the three largest creeks at the Site. This data is plotted from the top of the watershed downstream to the mouth of the Dry Fork of Belt Creek, in order of sample location.

Table 9. Average enrichment factors for PCOCs from samples collected along the Dry Fork of Belt Creek and Galena Creek.

PCOC	Enrichment Factors	
	Average Dry Fork	**Average Galena**
Arsenic	17.1	23.0
Cadmium	38.5	20.5
Copper	8.3	9.5
Lead	22.4	51.6
Manganese	6.2	3.3
Mercury	1.3	2.2
Thallium	0.9	0.5
Zinc	19.3	10.5

Upper Dry Fork of Belt Creek. This section of the Dry Fork of Belt Creek was not walked. A background sample was collected upstream, approximately 3,500 ft from the confluence with Galena Creek and three more streamside samples were collected nearer to the confluence (Map 5). Fish were visible in the water and the area did not appear negatively impacted by mining. The creek bed and floodplain did not show signs of mining impact until the confluence with Galena Creek. At the confluence, an obvious change occurred, including clouding of the water. The two soil samples that were collected upstream but closer to the confluence did not have elevated levels of PCOC. Two opportunistic samples were also collected (opportunistic samples are followed by the letter "R"). Sample DF-SS01R was from a drainage channel that directed water from the historic mill site (now a repository), under the road and into the Upper Dry Fork. Sample DF-SS01R had enriched levels of arsenic, cadmium, copper, manganese and zinc as compared to the other samples collected along the Upper Dry Fork and the average background concentrations from the Site (Table 10). The land drained by the channel once housed a mill. During cleanup activities in 2006, a repository was constructed at the old mill site. The channel leading from this repository/historic mill area was stained orange and vegetated with redtop grass (*Agrostis gigantea*) at the time of the investigation. Sample DF-SS02R was also an opportunistic sample, this sample was collected at the confluence of the Upper Dry Fork and Galena Creek. The sample location was on the opposite side of the Dry Fork as mouth of Galena Creek. The difference in water clarity was apparent at this sample site, clear water flowed on the left bank (sample location) while cloudy water poured into the Dry Fork from Galena Creek (right side).

Table 10 Concentrations of PCOC in Upper Dry Fork of Belt Creek streamside samples. Average levels of project background concentrations are shown for comparison purposes.

Upper Dry Fork of Belt Creek	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
DF-SS024-BTA-SST-002006*	3.9	0.1	14.4	17.9	312	0.11	2.4	53.9
DF-SS023-NTA-RST-002006	4.5	0.19	20.7	30.2	151	0.03	4.1	78.4
DF-SS01R-NTA-SST-000004	58.9	6.3	495	105	2520	0.05	0.75	2200
DF-SS022-BTA-RST-002006	4.6	0.4	13.1	26.4	835	0.11	2	113
DF-SS02R-NTA-LST-000006	9.8	1.3	34.1	71.9	614	0.09	2.4	242
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

*Used as a background sample

Spruce Creek. This creek was not walked. One sample was collected approximately 250 ft above the confluence with the Upper Dry Fork (Map 5). This sample was used as a background sample. Access was not granted for inspection further up the drainage. The PCOC concentrations from this site are generally below the average background for the Site (Table 11).

Table 11. Concentrations of PCOC in Spruce Creek streamside sample. Average levels of project background concentrations are shown for comparison purposes.

Spruce Creek:	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
SC-SS01-NTA-SST-002006*	7.8	0.25	33.8	44	285	0.06	4	72.5
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

*Used as a background sample

McKay Gulch. This intermittent creek was not walked. One sample was collected approximately 350 ft above its confluence with the Dry Fork (Map 5, Table 12). Access issues restricted investigation of the creek further upstream. No areas of major deposition or contamination were noted. This location was used as a background site.

Table 12. Concentrations of PCOC in McKay Gulch streamside sample. Average levels of project background concentrations are shown for comparison purposes.

McKay Gulch Creek:	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
MK-SS01-NTA-SST-002006*	10.2	0.3	11	24	453	0.1	0.38	88
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

*Used as a background sample

Dry Fork of Belt Creek. The upper five miles of this creek were walked (Maps 5-10). The lower six miles were not inspected except for the areas surrounding sample locations (Maps 10-13). In this lower reach, samples were collected systematically at approximate 1-mile intervals. Along the upper approximately five miles below the confluence with Galena Creek, samples were collected at pre-determined locations and opportunistic locations. Large depositional areas and tailings were mapped. Opportunistic sample locations were dependent on the professional judgment of the inspection team and generally occurred in large sections of depositional material.

Beginning just below the confluence with Galena creek, the Dry Fork enters a canyon. The streamsides were narrow and steep. The depositional areas were frequent, but generally small. Cobbles were present along the creek banks at most depositional areas. As you moved away from the creek bed, the ground was often blanketed with orange-tinted sand. Vegetation was usually present, but stressed in some areas due to several inches of sand over surface soil. Some of these areas appeared as fresh deposits (this year) while other depositional areas had lichen growing on the cobbles and appeared several years old.   The orange-tinted sand was sampled at DF-SS03R, DF-SS04R, and DF-SS05R. Out of the 41 samples collected along the Dry Fork, sample DF-SS05R ranked in the top 10 for the highest concentrations for all PCOC (Table 12). Soil sample DF0SS03R had arsenic, copper, lead and thallium concentrations that ranked in the top ten highest. This indicates that the orange-tinted sand deposited along this section was contaminated by mine waste.

Sample DF-SS06R was an opportunistic sample collected just before the creek bed opens up and the gradient becomes more gradual. Material was collected from the floodplain in an area of visible tailings. This sample had very high levels of lead (26,200 mg/kg), arsenic (1190 mg/kg), copper (676 mg/kg), thallium (18.7 mg/kg), and zinc (7060 mg/kg). The concentrations of arsenic, cadmium, manganese, thallium and zinc are considerably higher in these tailings than the concentrations from the tailings sample collected along Galena Creek. Data from this sample were not used to calculate the range of PCOC enrichment.

Once the floodplain became wider, the depositional areas become much larger along the Dry Fork. This occurred just below the missile silo location and continued for approximately 3 miles downstream to just below DF-SS009. The Dry Fork has flowed out of its banks many times in the past and some depositional areas are vast and deep. The creek channel has also changed course in several sections and was braided. Depositional areas were mapped; however, it was not possible to sample all of these areas. Down gradient from sample location DF-SS10R to the mouth, the creek was not mapped.

Reclamation activities occurred in the area of samples DF-SS016 and DF-SS017, which were located approximately 250 ft downstream from the missile silo. Details of the reclamation activities were not known to inspectors, but the area was referred to as the “Bender Tailings Removal Area”. The plant community here differed significantly from the surrounding plant communities. The reclaimed areas were level and contained areas of standing water. Willows were becoming established in the wet areas, the rest of the reclaimed areas were dominated by redtop. Lenses of visible tailings were present in the cut banks of the creek. Below the reclaimed area, a large depositional area was located on the left bank. The area covered approximately 100,000 sq ft. The area was forested however the ground cover was sparse. This is likely due to the depth of the sand deposited over the surface of the ground. Some areas had sand over 8" deep. It did not appear that the deposit was disturbed during spring run-off of 2011, the deposition appeared more than one year old. Arsenic, cadmium, copper, lead, manganese and zinc soil concentrations were considerably enriched in this area.

Between sample locations DF-SS011R and DF-SS013 (Map 7), the right bank floodplain was visibly impacted by tailings. Lenses of buried tailings were visible in the creek bank in some areas. The depth of the buried tailings was quite variable. In the floodplain, a shovel was used to dig shallow pits as the inspectors walked through the area; at many locations tailings were visible within the top 6-8 inches of the surface. Inspectors used a field pH indicator solution to check the pH of the material; the solution consistently indicated a depressed pH. The impacted area is represented by a large white polygon on Map 7. This area is heavily used by recreationalists. Several fire pits and campsites were spread out throughout the area, as well as paths for ATV travel.

Down gradient from DF-SS013, the large depositional areas continue, however tailings were not as evident as above this location. Tailings were periodically seen in the cut banks of the creek, generally buried at depths greater than 6 inches. The creek becomes braided and meandered through small side channels in many locations. Most of the PCOC remain enriched in the samples collected in this section. Below DF-SS009, the creek narrows and the depositional areas become much smaller than upstream. Cadmium and zinc soil levels remain elevated throughout this section.

Down gradient from DF-SS10R, the creek and floodplain were not walked. Samples were collected at pre-determined locations; no opportunistic samples were collected downstream from DF-SS10R. When compared to background concentrations, the PCOC remained enriched the entire length of the Lower Dry Fork (downstream from Galena Creek). Samples DF-SS003 and DF-SS001 were surprisingly enriched. DF-SS003 had concentrations of cadmium, copper, manganese, mercury, thallium and zinc that ranked in the top 10 (out of 41) most contaminated samples along the Dry Fork. Sample DF-SS001 (closest to mouth of the Dry Fork) had concentrations of cadmium, manganese and zinc that also rated in the top 10 of the most enriched samples.

Table 13. Concentrations of PCOC in Dry Fork of Belt Creek streamside sample. Average levels of project background concentrations are shown for comparison purposes. The top 10 highest concentrations for each PCOC are shaded.

Dry Fork of Belt Creek	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
DF-SS021-NTA-LST-002006	177	11.1	165	1110	2020	0.21	2	1660
DF-SS021-NTA-RST-002006	176	8.1	96.8	1130	2140	0.09	1.9	1220
DF-SS03R-NTA-RST-000006	319	8.6	175	1630	4750	0.11	3.6	1330
DF-SS04R-NTA-LST-000006	133	8.3	90.2	775	2240	0.03	1.3	1900
DF-SS020-NTA-RST-002006	212	9.3	160	1050	3530	0.12	2	1560
DF-SS020-NTA-LST-002006	109	8.7	141	593	3680	0.05	1.5	1430
DF-SS019-NTA-LST-002006	278	11.1	159	1550	6070	0.09	2.7	1790
DF-SS05R-NTA-LST-002006	299	15.5	238	1600	6070	0.15	3.2	2420
DF-SS06R-NTA-SST-000006*	1190	35.7	676	26200	61.5	0.11	18.7	7060
DF-SS018-NTA-RST-002006	143	8.1	103	696	3460	0.05	1.8	1330
DF-SS018-NTA-LST-002006	966	16.3	191	4170	759	0.45	6.1	1550
DF-SS017-NTA-RST-000002	171	11.6	131	752	2220	0.08	1.6	1290
DF-SS016-NTA-RST-000002	151	10	155	806	2790	0.05	1.6	1510
DF-SS015-NTA-RST-002006	295	18.2	216	1510	6790	0.15	3.6	2590
DF-SS015-NTA-LST-002006	281	16.3	186	1520	4770	0.13	2.2	2260
DF-SS11R-NTA-RST-002006	276	7.3	141	1470	3990	0.15	2.5	1170
DF-SS014-NTA-RST-002006	310	9	234	4480	3020	0.56	5.8	1680
DF-SS014-NTA-LST-002006	591	3.6	170	3320	2430	0.5	4.1	523
DF-SS013-NTA-RST-002006	247	11.8	135	947	3240	0.09	1.9	1840
DF-SS013-NTA-LST-002006	172	14.8	124	600	2930	0.09	1.6	2790
DF-SS012-NTA-RST-002006	187	14.7	151	882	4030	0.09	2.2	2430
DF-SS012-NTA-LST-002006	107	8.2	75	515	2430	0.03	0.95	1440
DF-SS07R-NTA-RST-002006	187	12.5	146	925	5190	0.1	2.4	1940
DF-SS011-NTA-RST-002006	255	18.7	204	1300	5090	0.17	2.5	2550
DF-SS011-NTA-LST-002006	157	18.3	163	898	6820	0.06	2.4	3070
DF-SS12R-NTA-RST-002006	122	9	79.1	586	2420	0.05	1.3	1600
DF-SS010-NTA-RST-002006	105	12	126	523	3860	0.05	1.2	2080
DF-SS010-NTA-LST-002006	85.7	4.5	33.8	196	5970	0.03	2	790
DF-SS08R-NTA-RST-002006	133	11	104	671	4430	0.08	1.6	1890
DF-SS09R-NTA-LST-002006	698	2.6	191	2680	3570	0.54	4.6	534
DF-SS009-NTA-RST-002006	72.3	6.8	54.3	460	1900	0.03	0.81	1290
DF-SS009-NTA-LST-002006	89.9	8.3	72.1	400	3090	0.04	1.1	1530
DF-SS008-NTA-RST-002006	196	14.8	117	867	2740	0.08	1.1	2620
DF-SS10R-NTA-LST-002006	71.1	7.6	66.1	308	2230	0.03	0.9	1410
DF-SS007-NTA-RST-002006	40.7	6.1	47	275	3630	0.09	0.66	1280
DF-SS006-NTA-RST-002006	42.9	4.7	33.1	161	1960	0.09	0.53	944
DF-SS005-NTA-RST-002006	38.3	5.6	40.7	145	2400	0.09	0.61	1210

Dry Fork of Belt Creek	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
DF-SS004-NTA-RST-002006	147	12.8	139	630	4170	0.1	1.3	2320
DF-SS003-NTA-LST-002006	222	35.9	299	952	13400	0.15	3.4	7630
DF-SS002-NTA-RST-002006	13.6	6.8	43.8	219	3050	0.02	1.9	1390
DF-SS001-NTA-RST-002006	144	18	159	628	6190	0.08	2	3870
Dry Fork Averages*	210.5	11.2	133.9	1098.3	3886.7	0.13	2.16	1891.5
Project Background Averages	12.3	0.29	16.1	49	630	0.10	2.3	98

* Galena Creek Averages do not include sample GL-SS01 (tailing sample)

Table 14 displays the range of enrichment factors for the samples collected along the Dry Fork. The average enrichment factors for Galena Creek are also displayed. The enrichment factor was calculated by dividing the lowest, highest and average Dry Fork sample concentration of each PCOC by the average background concentration. All samples from the lower Dry Fork, with the exception of DF-SS06R, were used for these calculations. Sample DF-SS06R was omitted from the calculations because this sample consisted of tailings. A transect was not established at this location, a composite sample of an area with exposed tailings was collected, therefore it was excluded.

The average soil elemental enrichment factors for cadmium, manganese, and zinc were greater on the Dry Fork than on the heavily impacted Galena Creek. Lead was, on average, higher along the Galena than the Dry Fork.

Table 14. Range of enrichment factors for PCOCs from samples collected along the Dry Fork of Belt Creek and the averages for the Dry Fork and Galena Creek.

PCOC	Enrichment Factors*			
	Low Dry Fork	High Dry Fork	Average Dry Fork	Average Galena
Arsenic	1.1	78.5	17.1	23.0
Cadmium	9.0	123.8	38.5	20.5
Copper	2.1	18.6	8.3	9.5
Lead	3.0	91.4	22.4	51.6
Manganese	1.2	21.3	6.2	3.3
Mercury	0.2	5.6	1.3	2.2
Thallium	0.2	2.7	0.9	0.5
Zinc	5.3	77.9	19.3	10.5

*Enrichment factor = sample concentration / average background concentration
Sample DF-SS06R was omitted from enrichment factor calculations because this sample was a tailings sample, not streamside.

It might seem logical that the concentrations of PCOC would be lower in samples collected further down gradient from the obvious sources of contamination (historic mines). However, this doesn't appear to be the case on the Dry Fork. Sample concentrations of PCOC were plotted in order by location, starting upstream and moving downstream (Appendix B). There does not appear to be a discernable pattern. The sample location furthest downstream (DF-SS001) has elevated concentrations of several PCOC which are higher than PCOC concentrations from several upstream locations.

Appendix C displays all the data from the three major creeks at the Site. Data is plotted in order of sample location, from the most up-gradient location (headwaters of Upper Galena Creek) downstream along Galena Creek and then the Upper Dry Fork. The last sample point displayed in located closest to the confluence of Dry Fork of Belt Creek and Belt Creek, near the town of Monarch.

3.2 Campsite Sampling

The Dry Fork Belt Creek drainage has numerous semi-developed campsites along the county road, with many of these campsites being directly adjacent to the creek. During the high runoff in 2011, it was evident that high water had overflowed many of these campsites. Shallow soils at these campgrounds were sampled primarily for evaluation of human health risks, because of their frequent recreational usage. The most heavily used portion of each campsite was visually divided into four sections. In each section a surface samples were collected from 0 – 2 inches, these four samples were then composited into one sample.

Campsite Background Sample. One campsite background sample was collected at a large campsite adjacent to the Upper Dry Fork, approximately 3,500 ft upstream from its confluence with Galena Creek (Map 5). This site was located above the known sources of contamination. The PCOC concentrations at the DF-CG019 campsite were similar to the average concentrations of the streamside background samples (Table 15).

Table 15. Background sample at campground adjacent to the upper Dry Fork of Belt Creek.

Local Background Sample Campground Site	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
DF-CG019 Upper Dry Fork Campground (0-2 in)	12.5	0.50	52.50	145.0	464	0.04	2.70	260.0
Streamside Background Average	12.3	0.29	16.1	49	630	0.10	2.3	98

Campsites. Campsite sample locations were generally adjacent to the creek and near the main road. Many were located in a close proximity to bridges. Table 16 lists the PCOC concentrations for each campsite. Table 17 shows the enrichment factors for each PCOC, all campsite samples, with the exception of the background sample, were used for the calculations in Table 17.

Table 16. Concentrations of PCOC in campground soil samples.

Campgrounds	Arsenic mg/kg	Cadmium mg/kg	Copper mg/kg	Lead mg/kg	Manganese mg/kg	Mercury mg/kg	Thallium mg/kg	Zinc mg/kg
DF-CG019-BTA-CMP-000002*	12.5	0.5	52.5	145	464	0.04	1.1	260
GL-CG018-BTA-CMP-000002	183	7.9	132	1020	1950	0.06	0.75	1170
DF-CG01R-BTA-CMP-000002	62.1	8.2	102	422	3050	0.03	0.55	1020
DF-CG017-NTA-CMP-002002	20.9	1.5	37.1	199	588	0.02	0.24	346
DF-CG03R-NTA-CMP-000002	244	15.6	248	1340	5490	0.08	0.28	1880
DF-CG02R-NTA-CMP-000002	544	2.6	235	6680	273	0.66	0.81	651
DF-CG016-NTA-CMP-000002	583	10.2	233	2510	2790	0.42	0.21	1410
DF-CG015-NTA-CMP-000002	121	10.3	94.5	606	2910	0.06	0.85	1700
DF-CG014-NTA-CMP-000002	30.5	2.4	35.8	158	1090	0.04	0.26	525
DF-CG013-NTA-CMP-000002	77.8	7.3	58.7	355	2390	0.03	1.2	1390
DF-CG012-NTA-CMP-000002	20.8	2.4	36.1	145	1230	0.1	4.3	634
DF-CG011-NTA-CMP-000002	71.5	6.5	67	366	2350	0.02	5.7	1270
DF-CG010-NTA-CMP-000002	13.2	0.79	64.1	101	939	0.02	2.2	415
DF-CG007-NTA-CMP-000002	68.6	7.7	59.9	325	1990	0.04	0.94	1420
DF-CG006-NTA-CMP-000002	36.1	5.7	40.1	218	2340	0.02	0.54	1250
DF-CG004-NTA-CMP-000002	15.5	1.1	34.9	194	621	0.03	2.7	238
DF-CG005-NTA-CMP-000002	60.2	7	55.4	278	2000	0.03	1.6	1380
DF-CG003-NTA-CMP-000002	154	8.7	96.1	669	2510	0.08	0.63	1520
DF-CG002-NTA-CMP-000002	41.9	7.6	54	188	2810	0.01	0.6	1590
DF-CG001-NTA-CMP-000002	29.8	6.6	47.2	151	2600	0.11	0.23	1410

*Background sample

Sample DF-CG02R (Map 7) was collected at a popular recreation and camping area along the Dry Fork. This soil had very enriched concentrations of arsenic, copper, lead and mercury. Surface tailings were visible throughout this area and at adjacent campsites. Samples DF-CG016 (Map 8) and DF-CG03R (Map 7) also had substantially enriched concentrations of contaminants. These three samples are located in an area of very large sediment depositions and are some of the most heavily used recreational areas along the creek.

Table 17. Range of enrichment factors for PCOCs from samples collected at campsites along the Dry Fork of Belt Creek.

	Enrichment Factors*		
PCOC	**Low**	**High**	**Average**
Arsenic	1.1	46.7	10.0
Cadmium	1.6	31.2	12.6
Copper	0.7	4.7	1.7
Lead	1.9	46.0	5.8
Manganese	0.6	11.9	4.5
Mercury	0.3	16.5	2.5
Thallium	0.2	5.2	1.2
Zinc	0.9	7.2	4.3

Several popular campsites had enriched concentrations of PCOCs as compared to the background sample. The two highest arsenic enrichment values were over 40x background concentrations (samples DF-CG02R and DF-CG016). Cadmium was over 10 mg/kg (10x background) at 12 out of 20 sample locations. Lead was also elevated with concentrations exceeding 1,000 mg/kg at four locations.

4.0 Conclusions

Historic mining activities have negatively impacted Daisy, Galena, and the Lower Dry Fork of Belt Creek at the Barker Hughesville CERCLA site in Montana. The smaller tributaries, including Green Creek, Gold Run Creek, Upper Dry Fork, Spruce Creek and McKay Gulch did not show visible signs of being negatively impacted by historic mining. Otter Creek is not a tributary, but was inspected during the sampling event. Otter Creek had elevated thallium and zinc just below the Cape Nome mine. Green Creek had enriched concentrations of thallium and lead, but these values are not exceedingly high as compared to samples along Daisy, Galena and the Dry Fork. Silver Creek was visibly impacted down-gradient, near the mouth of the creek. The sample site adjacent to Silver Creek was did not appear impacted but had slightly enriched concentrations of PCOC.

Table 18 displays the number and percent of streamside sites sampled that were elevated. For this table, the term "elevated" is used to represent data with PCOC concentrations of greater than 5x the background levels, with the exception of arsenic and lead. The designation of elevated arsenic (400 mg/kg) and lead (1,000 mg/kg) concentrations are based on the action levels set at the Upper Ten Mile Creek Mining Site in Montana (EPA/ROD/R08-02/068 2002). This site is a CERCLA site and is similar to the Barker Hughesville Site in that it includes a sparsely populated drainage basin that includes abandoned and inactive mine sites.

Table 18. Distribution of soil samples with elevated concentrations of PCOC in project area (excluding campsite samples).

Project Streamside Data	Number	Percent
As > 400 mg/kg	7	10%
Cd > 5x background	61	88%
Cu > 5x background	48	70%
Pb > 1000 mg/kg	33	48%
Mn > 5x background	28	41%
Hg > 5x background	4	6%
Tl > 5x background	2	3%
Zn > 5x background	56	81%

Upper Galena Creek and Galena Creek appear impacted and flow through tailing and waste rock piles. Because the impact is obvious, it was not difficult to map tailings and impacted areas.

Data collected from sample sites adjacent to these two creeks show considerable levels of enrichment of the majority of PCOCs.

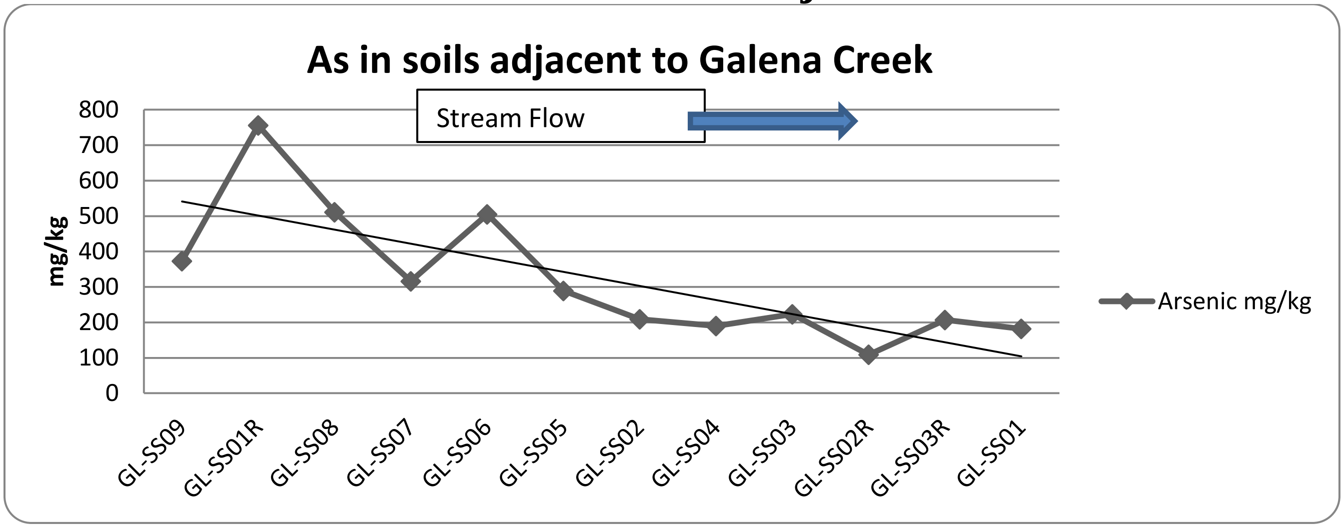
The Lower Dry Fork of Belt Creek (below Galena Creek) has varying degrees of visible impacts. It is difficult to visually determine if the impacts are due to historic flooding events, elevated concentrations of contaminants or both. There are many large depositional areas along the Dry Fork and many of these areas have sand deposited several inches deep. Most of samples collected in these areas had enriched levels of PCOC. The extent of contamination was difficult to determine during the investigation. Time constraint did not allow extensive study of these areas. The enrichment of PCOC was variable along the Dry Fork. However all samples had levels of PCOC that were enriched over background, and the sample collected at the most down-gradient site was substantially enriched in cadmium, manganese and zinc. The Dry Fork merits additional study to determine the extent of contamination along this drainage.

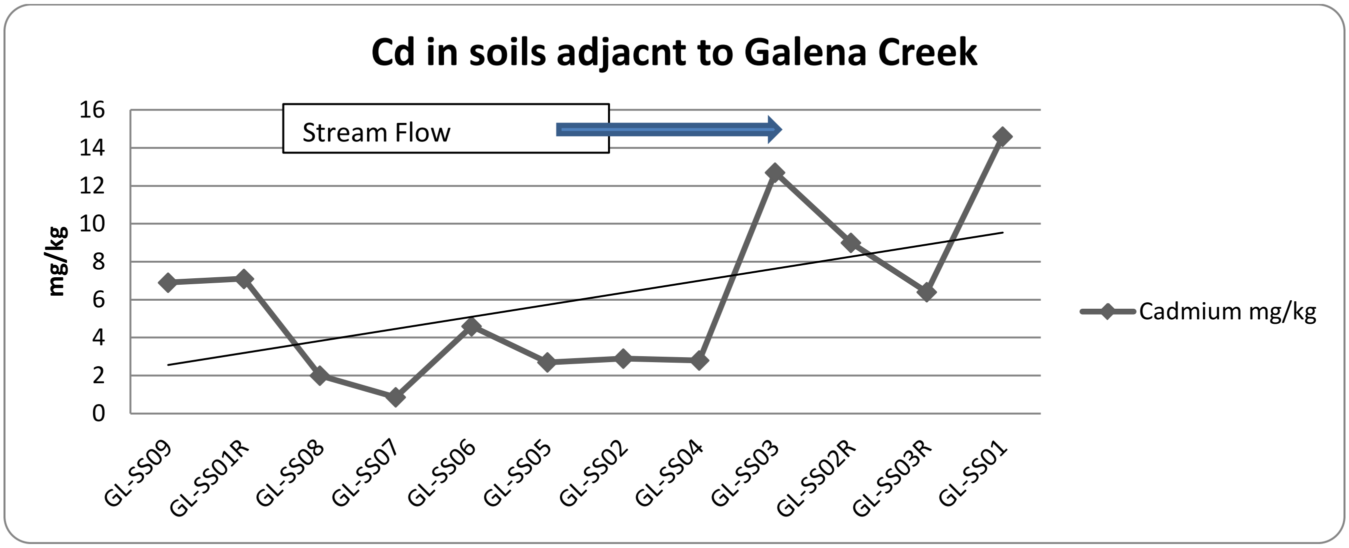
Enriched concentrations of PCOC were present from the top of Upper Galena Creek, down Galena Creek and then along the Dry Fork. This data is shown in Appendix C. Overall, the concentration of lead appears to gradual decrease, however the concentrations of the seven remaining PCOC are variable throughout the three major creeks in the watershed. There doesn't appear to be a discernable pattern.

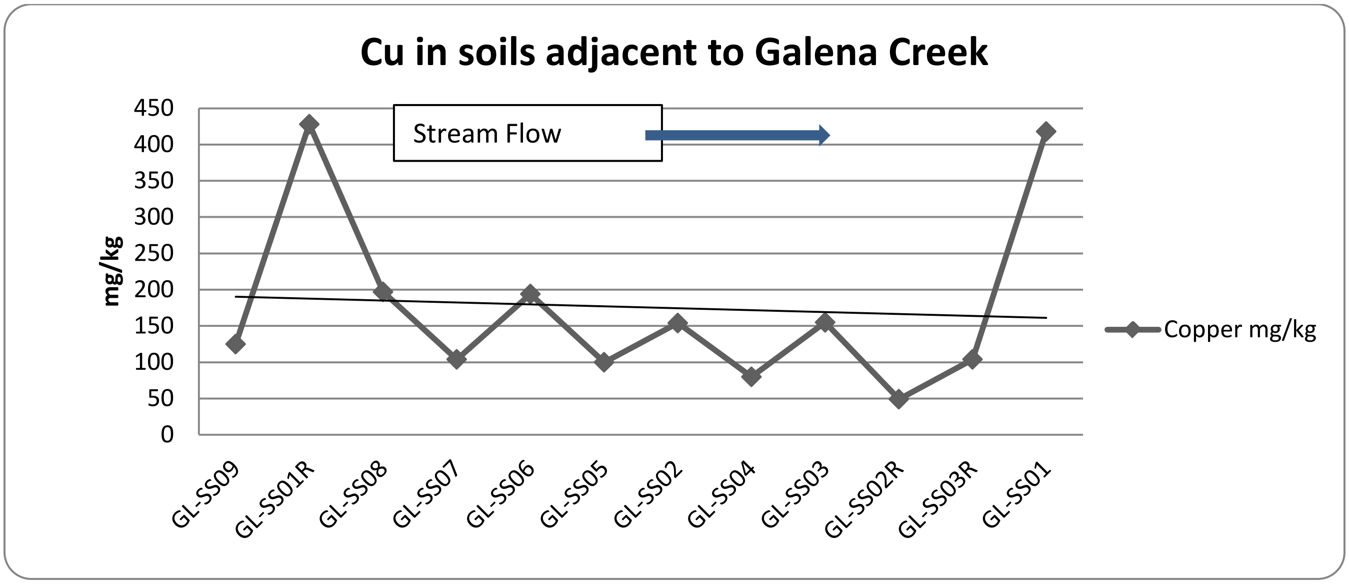
Screening levels for contaminants have not yet been determined for the Barker Hughesville CERCLA site. Data from the 2011 streamside tailings sampling event indicated that the majority of sites sampled had PCOC concentrations several times higher than background concentrations. Once screening levels have been selected for the PCOCs at this Site, campsite date should be screened again to determine risk to recreationalists.

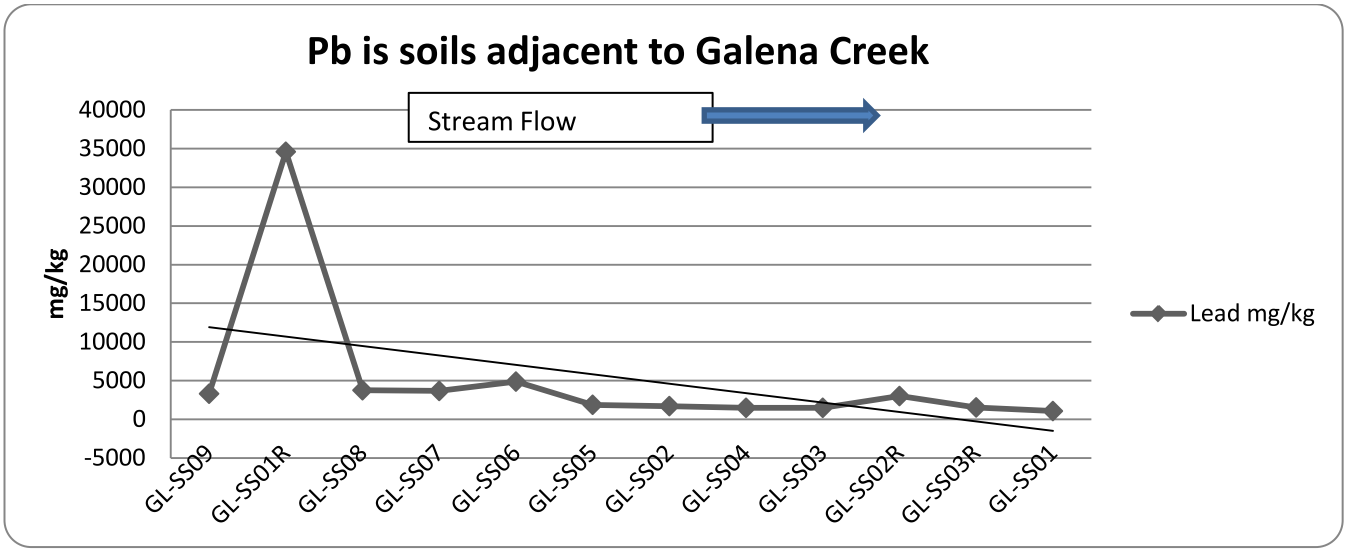
Appendix A: Concentrations of PCOC in Soils Adjacent to Galena Creek

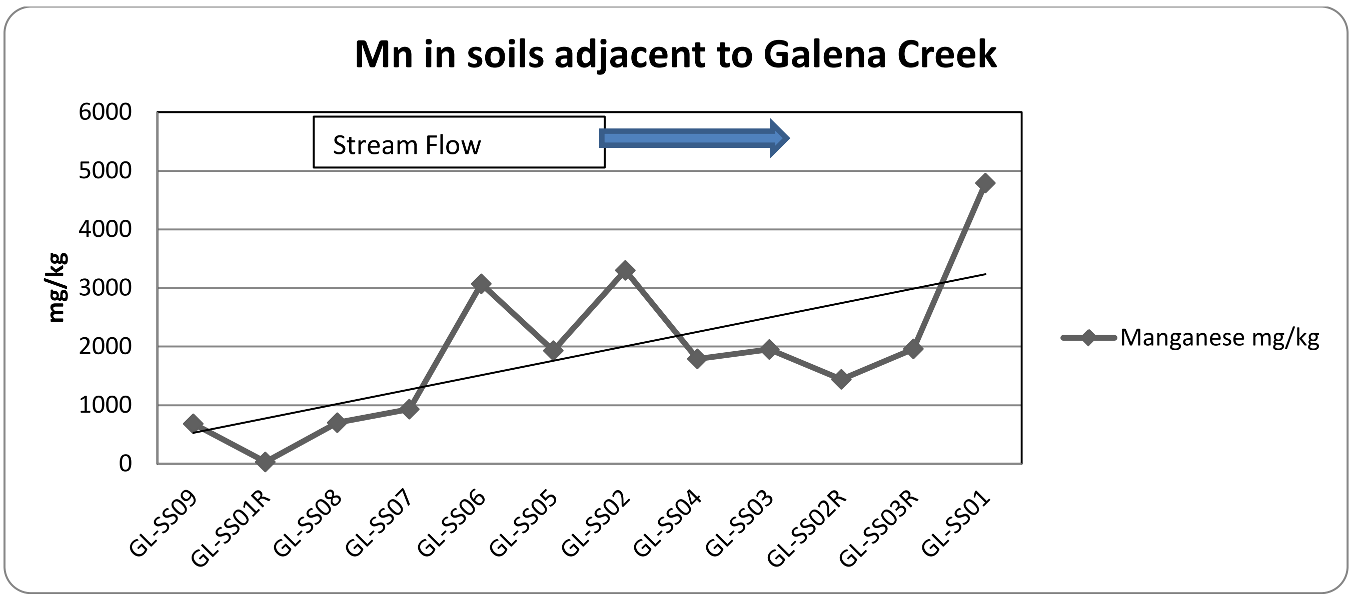
Concentrations of PCOC in soils adjacent to Galena Creek

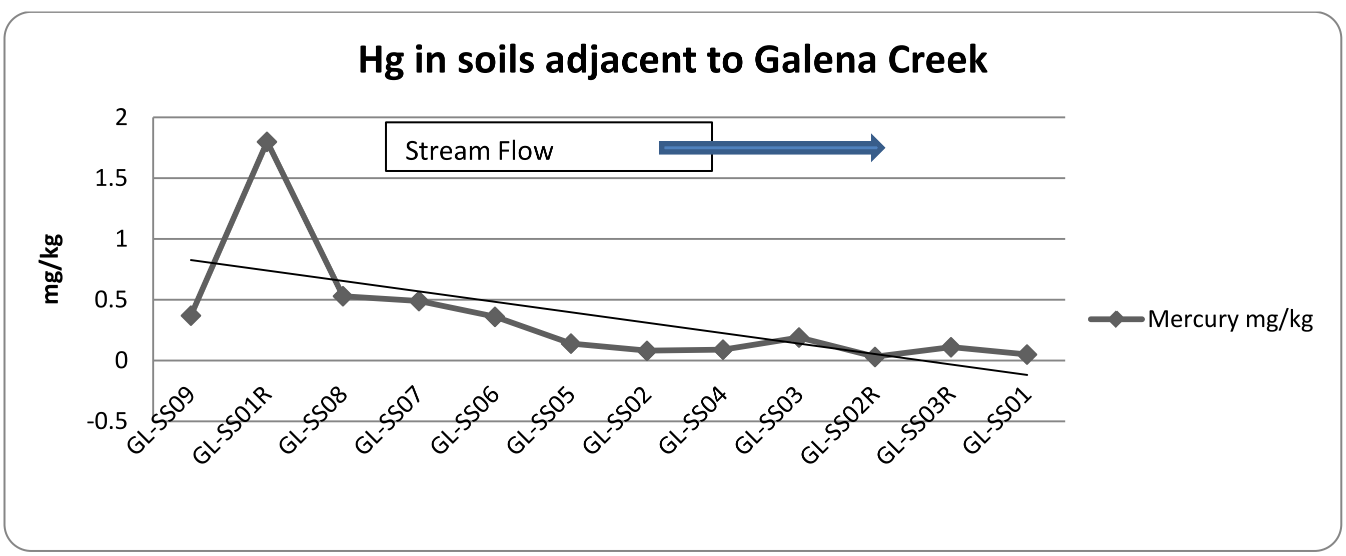


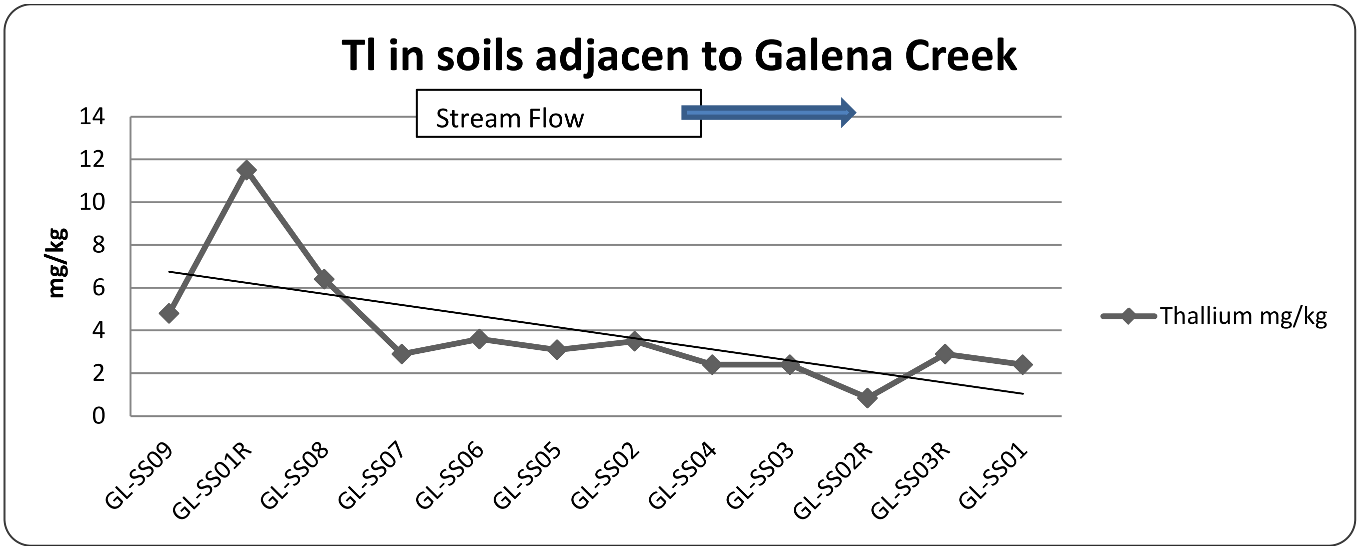


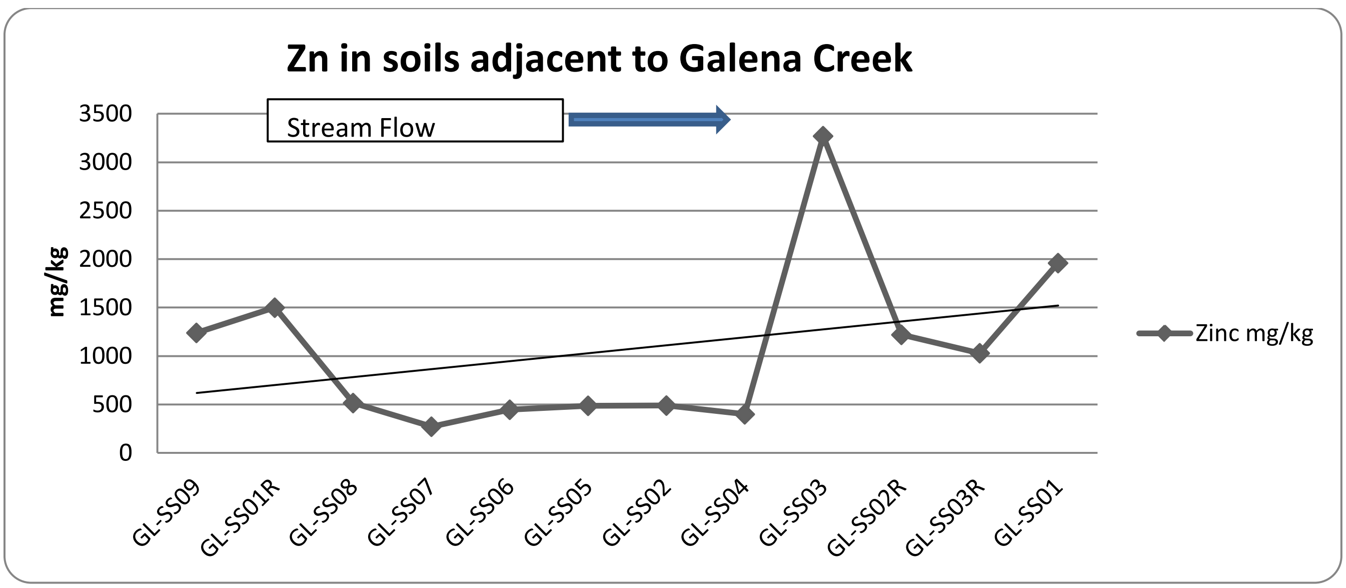



Pb is soils adjacent to Galena Creek
Stream Flow
mg/kg
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
GL-SS09
GL-SS01R
GL-SS08
GL-SS07
GL-SS06
GL-SS05
GL-SS02
GL-SS04
GL-SS03
GL-SS02R
GL-SS03R
GL-SS01
Lead mg/kg


Mn in soils adjacent to Galena Creek
Stream Flow
mg/kg
6000
5000
4000
3000
2000
1000
0
GL-SS09
GL-SS01R
GL-SS08
GL-SS07
GL-SS06
GL-SS05
GL-SS02
GL-SS04
GL-SS03
GL-SS02R
GL-SS03R
GL-SS01
Manganese mg/kg

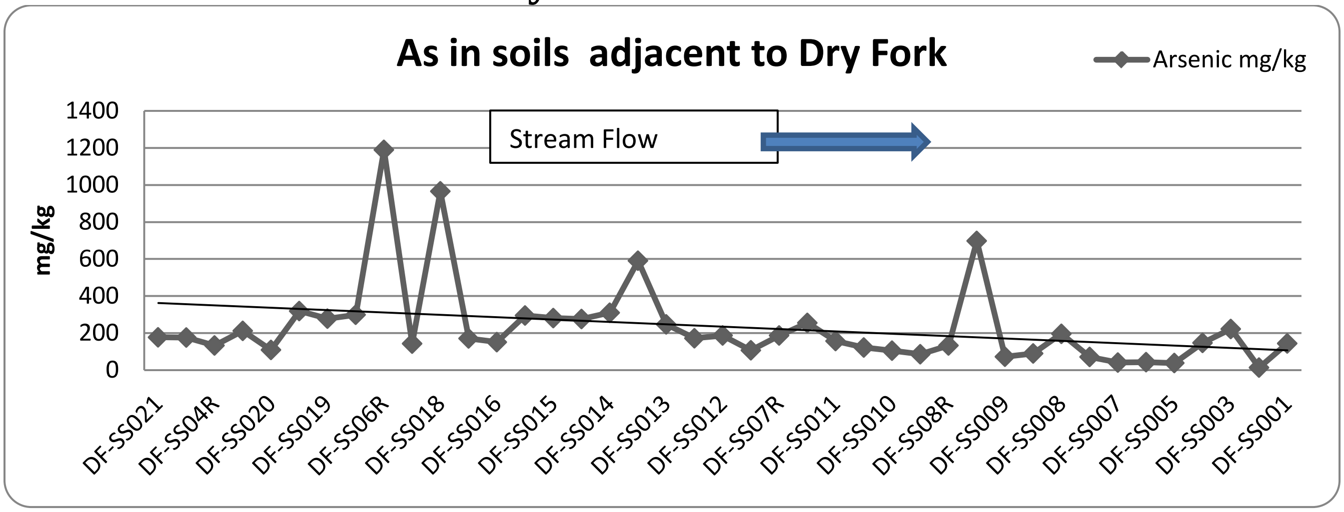

Hg in soils adjacent to Galena Creek
Stream Flow
mg/kg
2
1.5
1
0.5
0
-0.5
GL-SS09
GL-SS01R
GL-SS08
GL-SS07
GL-SS06
GL-SS05
GL-SS02
GL-SS04
GL-SS03
GL-SS02R
GL-SS03R
GL-SS01
Mercury mg/kg

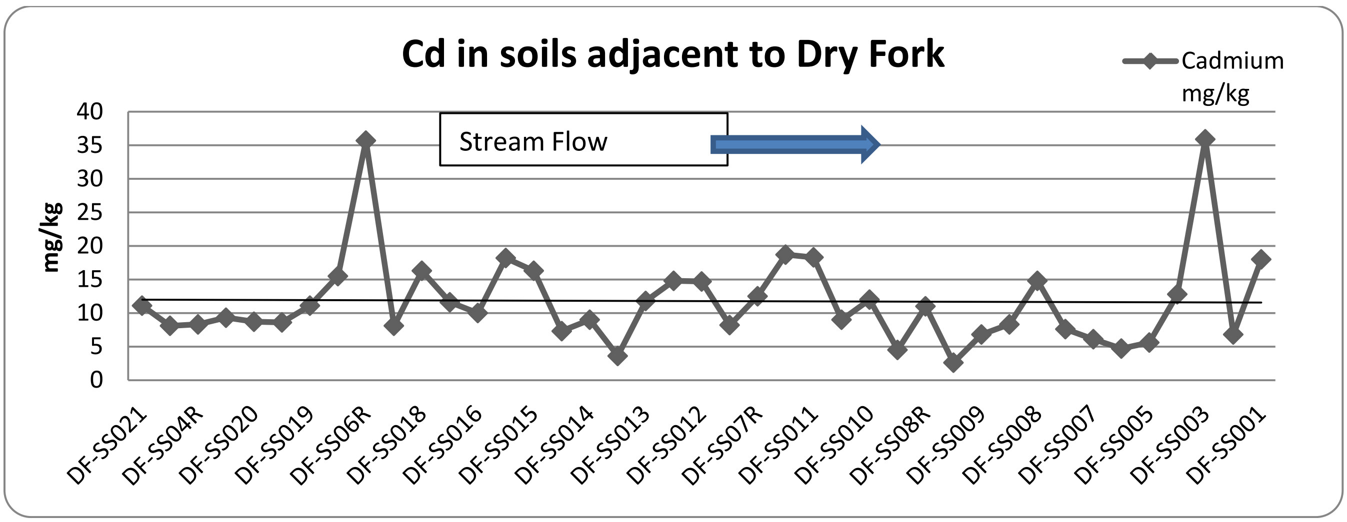

Tl in soils adjacen to Galena Creek
Stream Flow
14
12
10
8
6
4
2
0
mg/kg
Thallium mg/kg
GL-SS09
GL-SS01R
GL-SS08
GL-SS07
GL-SS06
GL-SS05
GL-SS02
GL-SS04
GL-SS03
GL-SS02R
GL-SS03R
GL-SS01

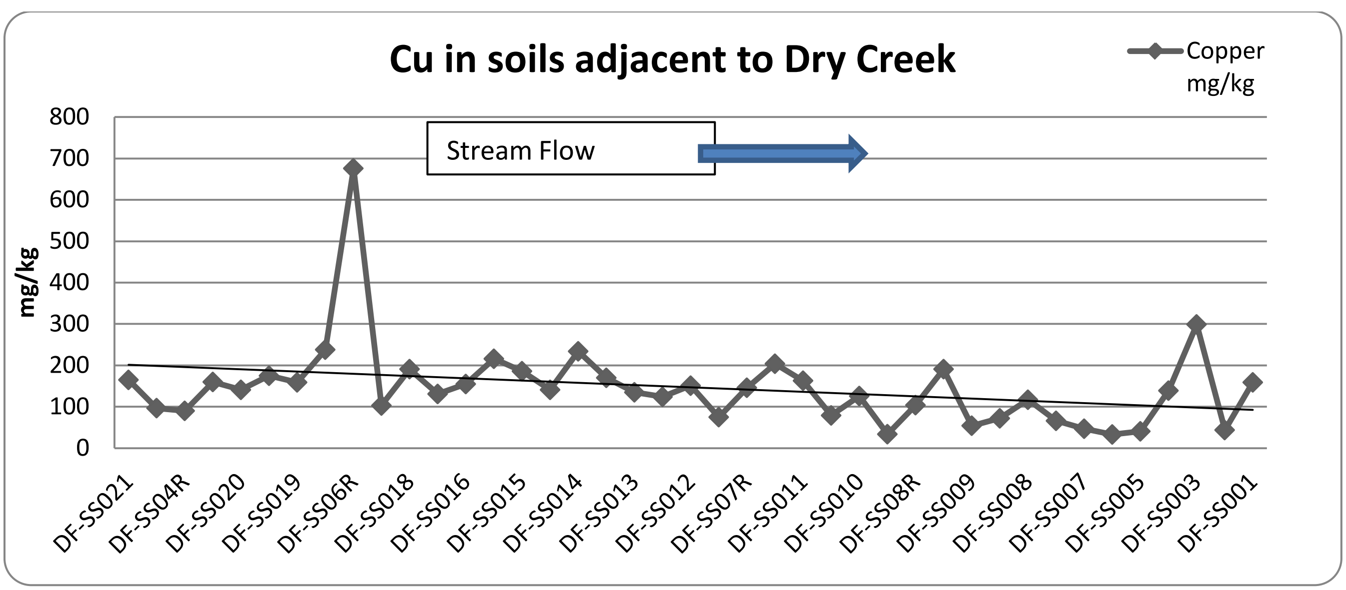

Zn in soils adjacent to Galena Creek
Stream Flow
3500
3000
2500
2000
1500
1000
500
0
mg/kg
Zinc mg/kg
GL-SS09
GL-SS01R
GL-SS08
GL-SS07
GL-SS06
GL-SS05
GL-SS02
GL-SS04
GL-SS03
GL-SS02R
GL-SS03R
GL-SS01

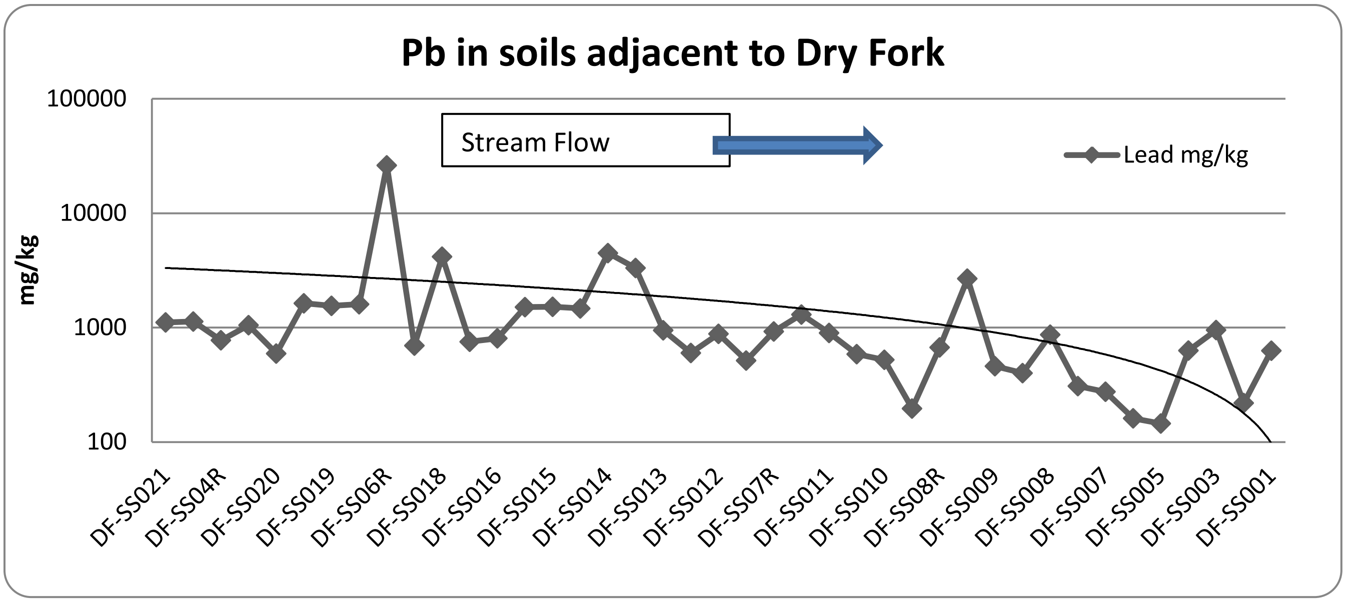
Appendix B: Concentrations of PCOC in Soils Adjacent to the Dry Fork of Belt Creek

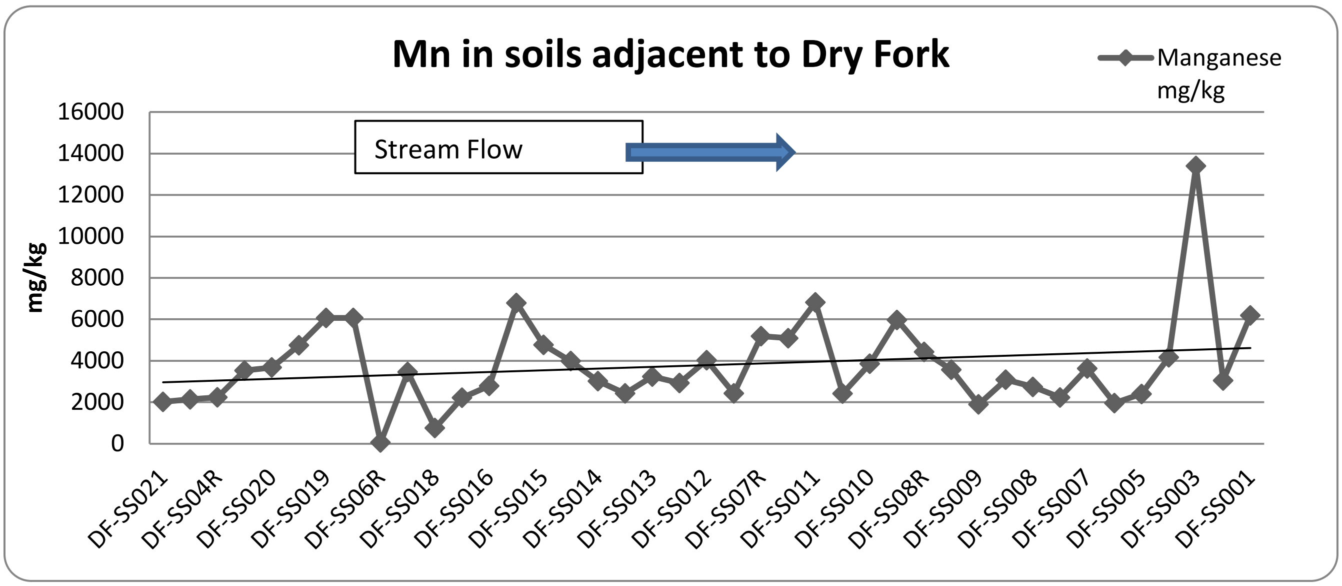
Concentrations of PCOC in soils adjacent to the lower section of the Dry Fork of Belt Creek

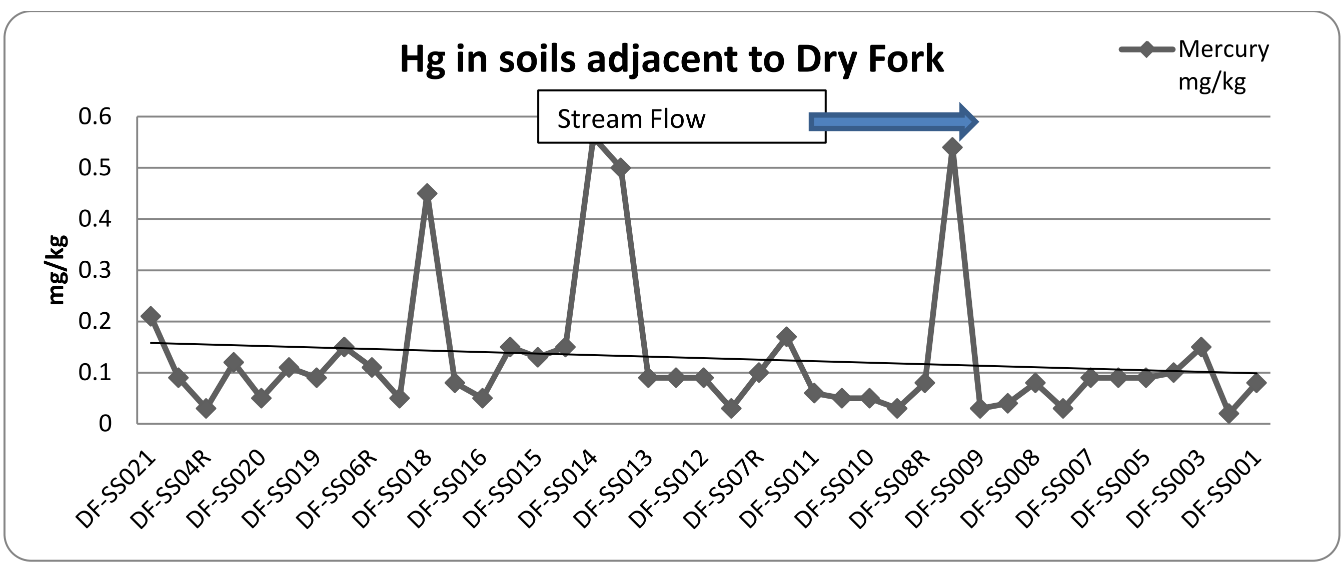


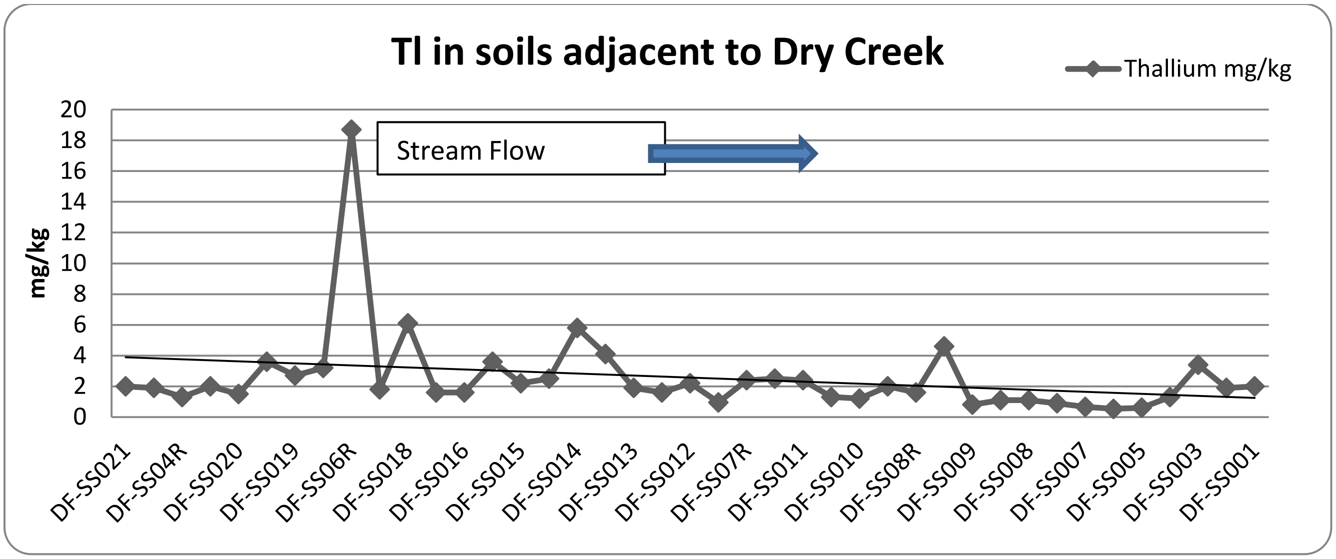


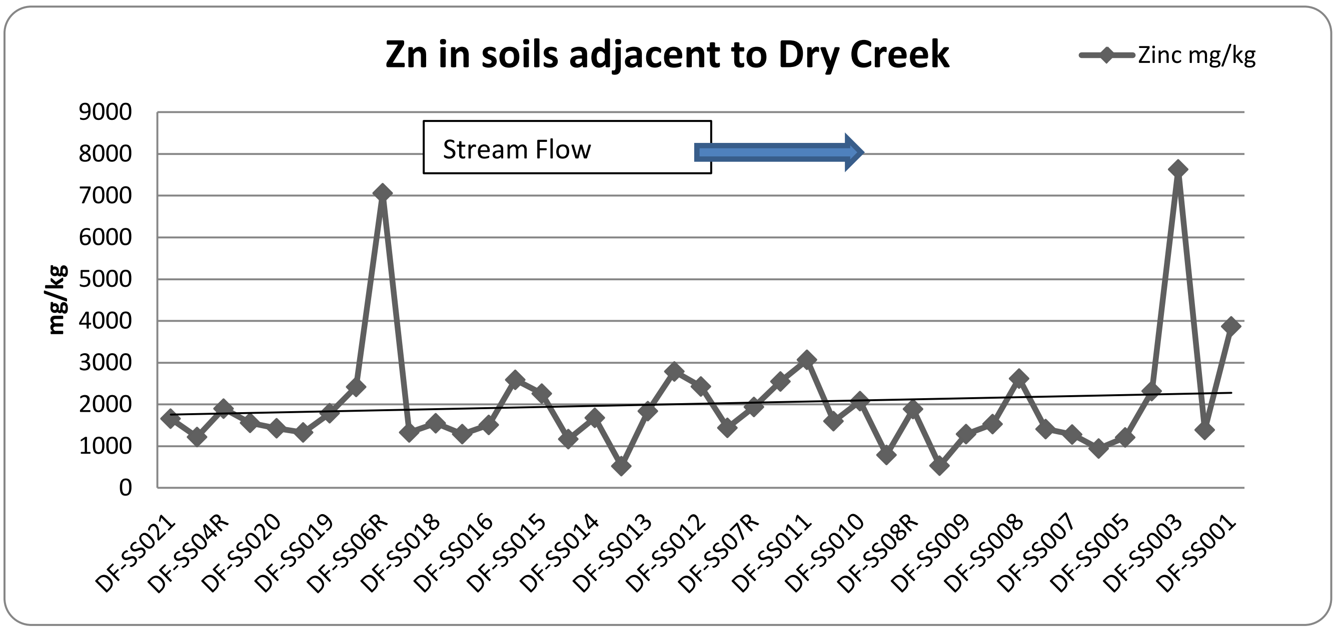



Pb in soils adjacent to Dry Fork
Stream Flow
Lead mg/kg
mg/kg
100000
10000
1000
100
DF-SS021
DF-SS04R
DF-SS020
DF-SS019
DF-SS06R
DF-SS018
DF-SS016
DF-SS015
DF-SS014
DF-SS013
DF-SS012
DF-SS07R
DF-SS011
DF-SS010
DF-SS08R
DF-SS009
DF-SS008
DF-SS007
DF-SS005
DF-SS003
DF-SS001


Mn in soils adjacent to Dry Fork
Manganese mg/kg
Stream Flow
mg/kg
16000
14000
12000
10000
8000
6000
4000
2000
0
DF-SS021
DF-SS04R
DF-SS020
DF-SS019
DF-SS06R
DF-SS018
DF-SS016
DF-SS015
DF-SS014
DF-SS013
DF-SS012
DF-SS07R
DF-SS011
DF-SS010
DF-SS08R
DF-SS009
DF-SS008
DF-SS007
DF-SS005
DF-SS003
DF-SS001

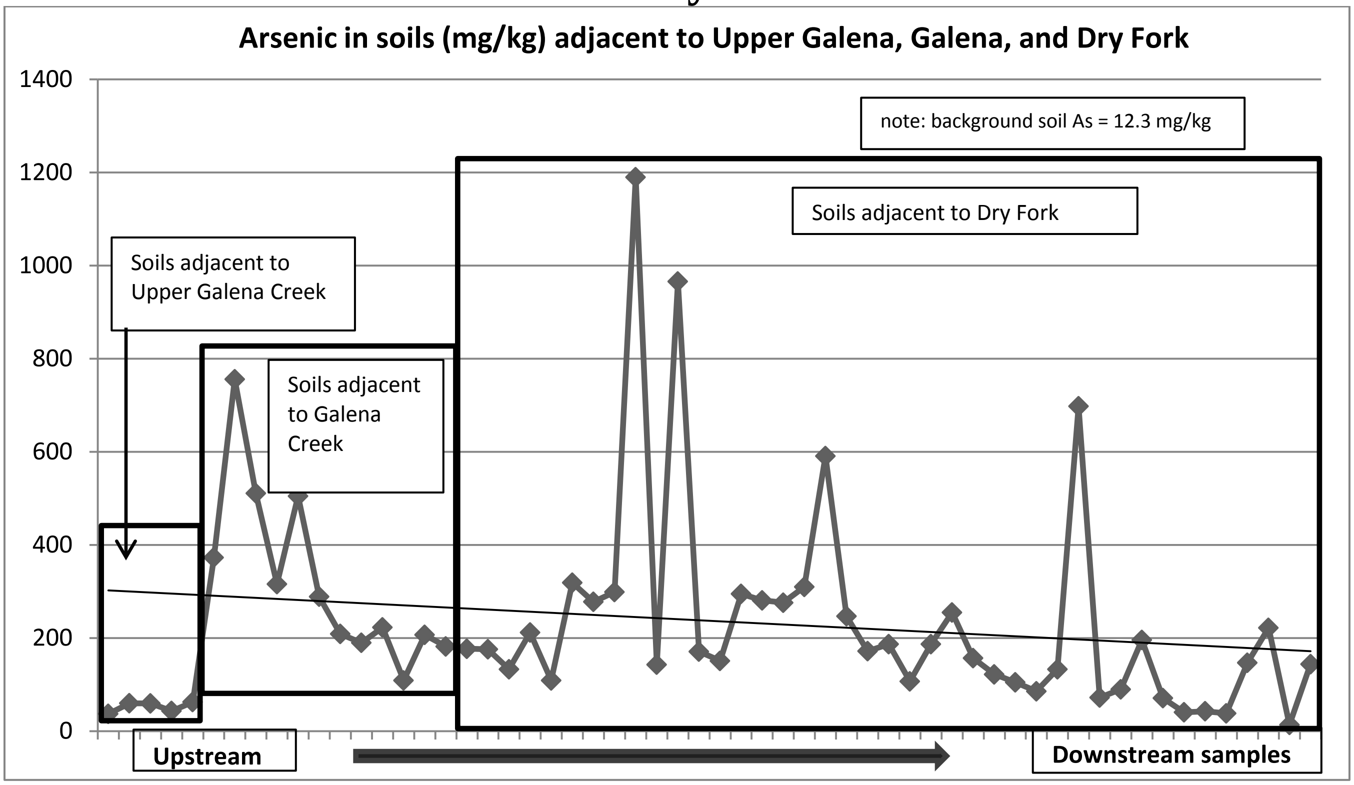

Hg in soils adjacent to Dry Fork
Mercury mg/kg
Stream Flow
mg/kg
0.6
0.5
0.4
0.3
0.2
0.1
0
DF-SS021
DF-SS04R
DF-SS020
DF-SS019
DF-SS06R
DF-SS018
DF-SS016
DF-SS015
DF-SS014
DF-SS013
DF-SS012
DF-SS07R
DF-SS011
DF-SS010
DF-SS08R
DF-SS009
DF-SS008
DF-SS007
DF-SS005
DF-SS003
DF-SS001

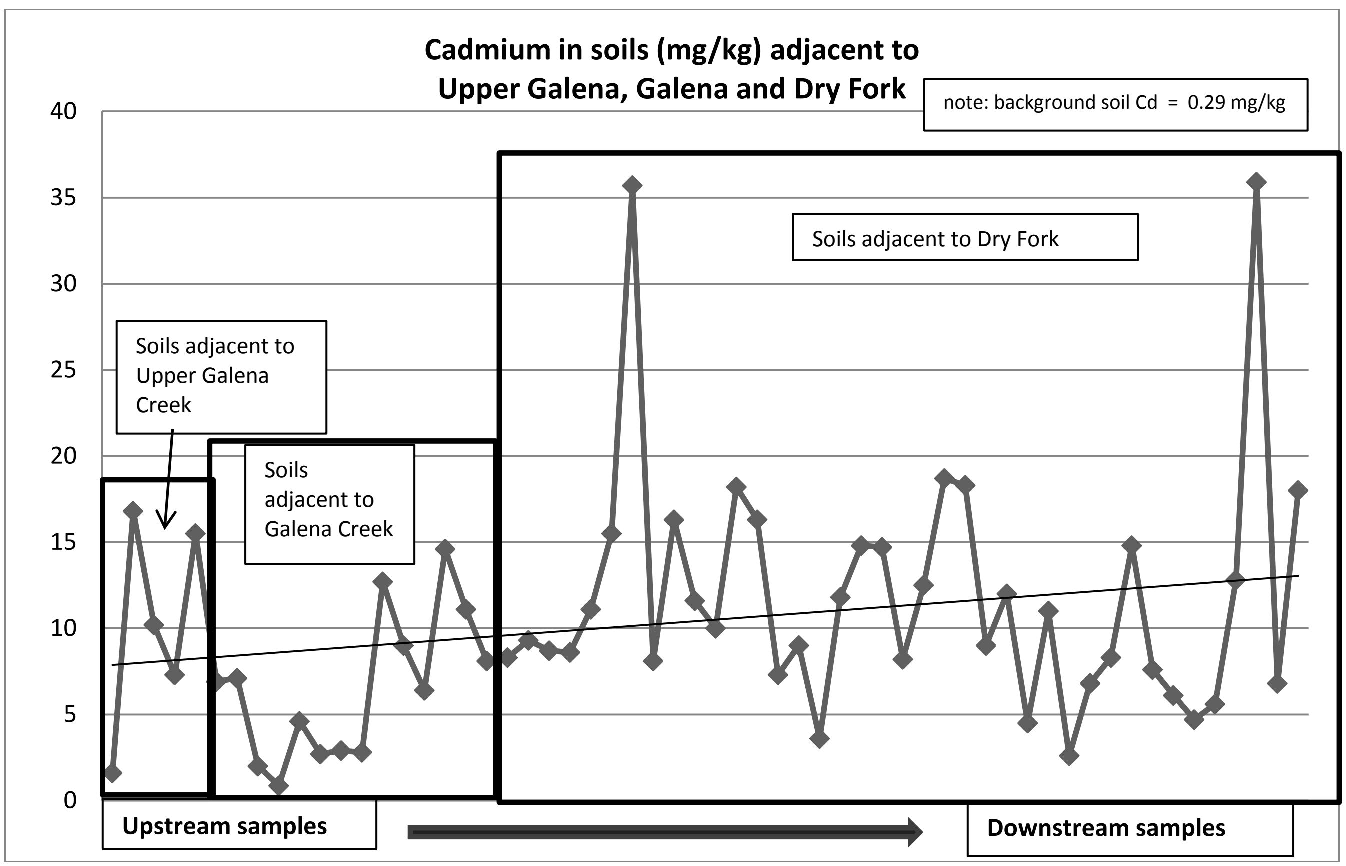

Tl in soils adjacent to Dry Creek
Thallium mg/kg
Stream Flow
mg/kg
20
18
16
14
12
10
8
6
4
2
0
DF-SS021
DF-SS04R
DF-SS020
DF-SS019
DF-SS06R
DF-SS018
DF-SS016
DF-SS015
DF-SS014
DF-SS013
DF-SS012
DF-SS07R
DF-SS011
DF-SS010
DF-SS08R
DF-SS009
DF-SS008
DF-SS007
DF-SS005
DF-SS003
DF-SS001

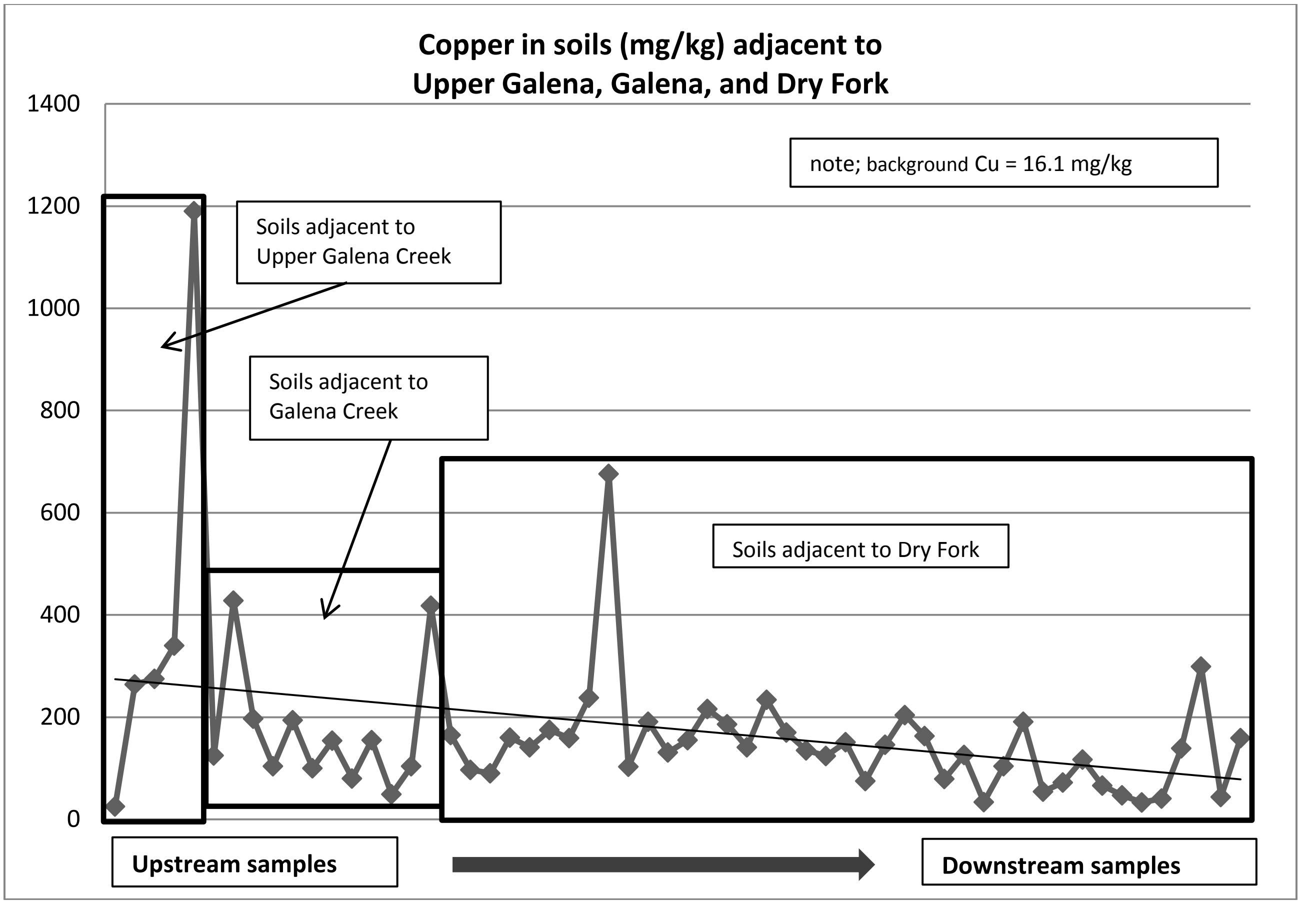

Zn in soils adjacent to Dry Creek
Zinc mg/kg
Stream Flow
mg/kg
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
DF-SS021
DF-SS04R
DF-SS020
DF-SS019
DF-SS06R
DF-SS018
DF-SS016
DF-SS015
DF-SS014
DF-SS013
DF-SS012
DF-SS07R
DF-SS011
DF-SS010
DF-SS08R
DF-SS009
DF-SS008
DF-SS007
DF-SS005
DF-SS003
DF-SS001

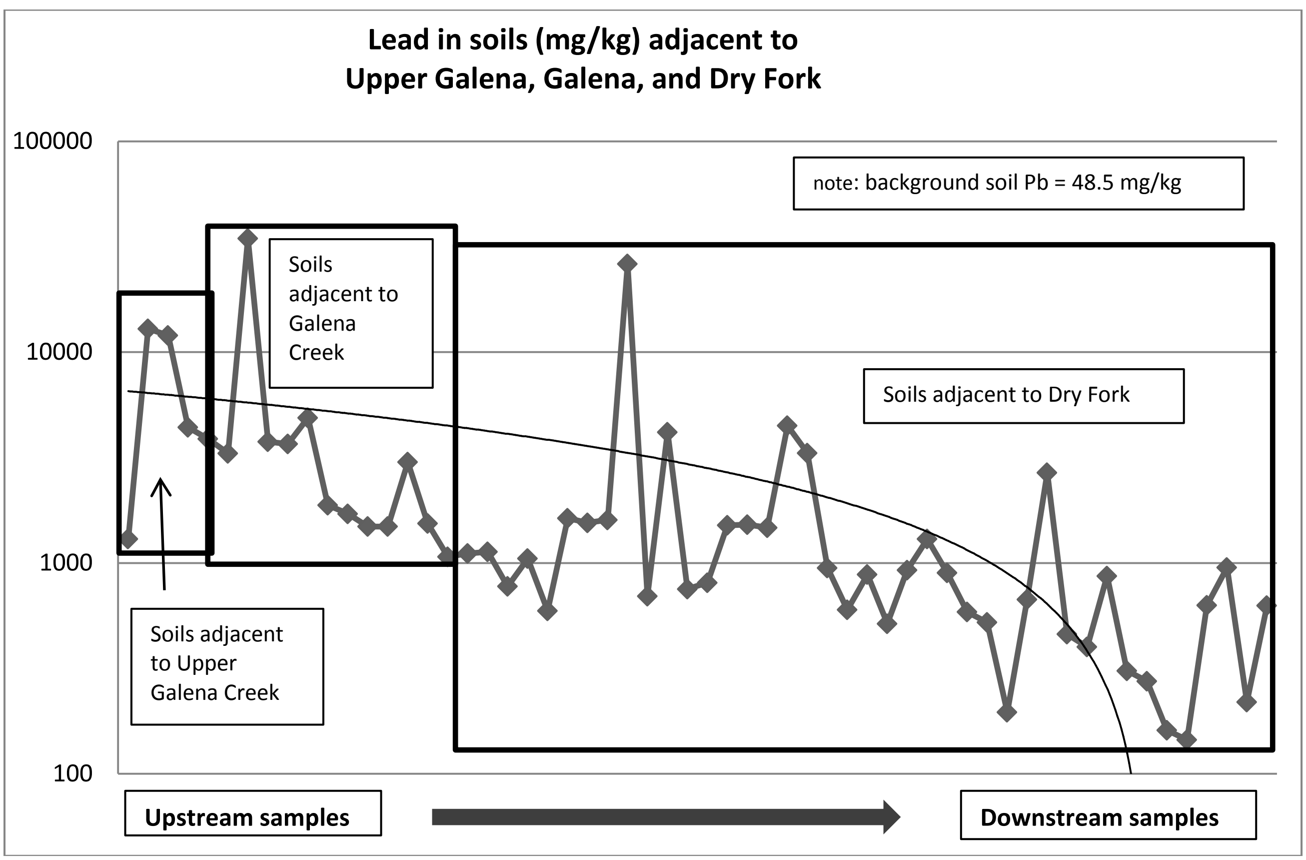
Appendix C: Concentrations of PCOC in Soils Adjacent to Upper Galena Creek, Galena Creek and the Dry Fork of Belt Creek

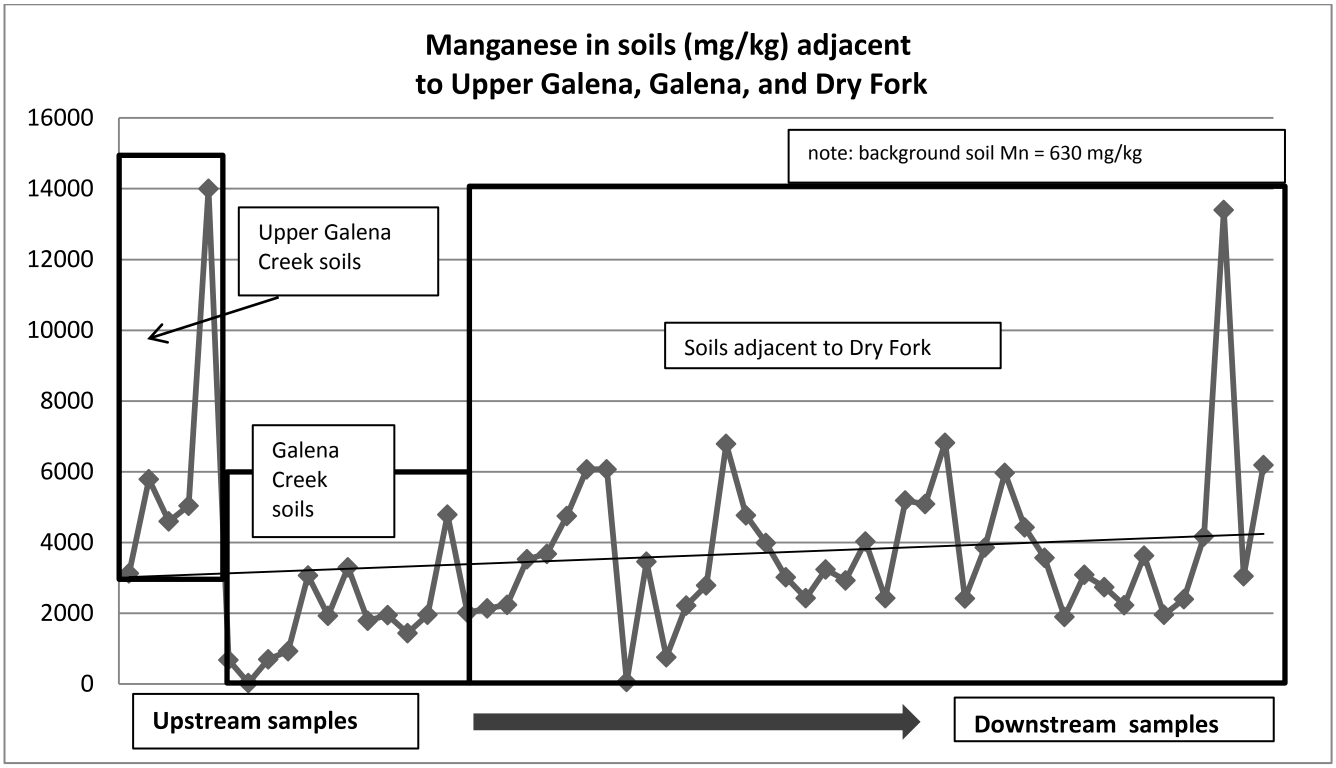
Concentrations of PCOC in soils adjacent to Upper Galena, Galena and Dry Fork Creek

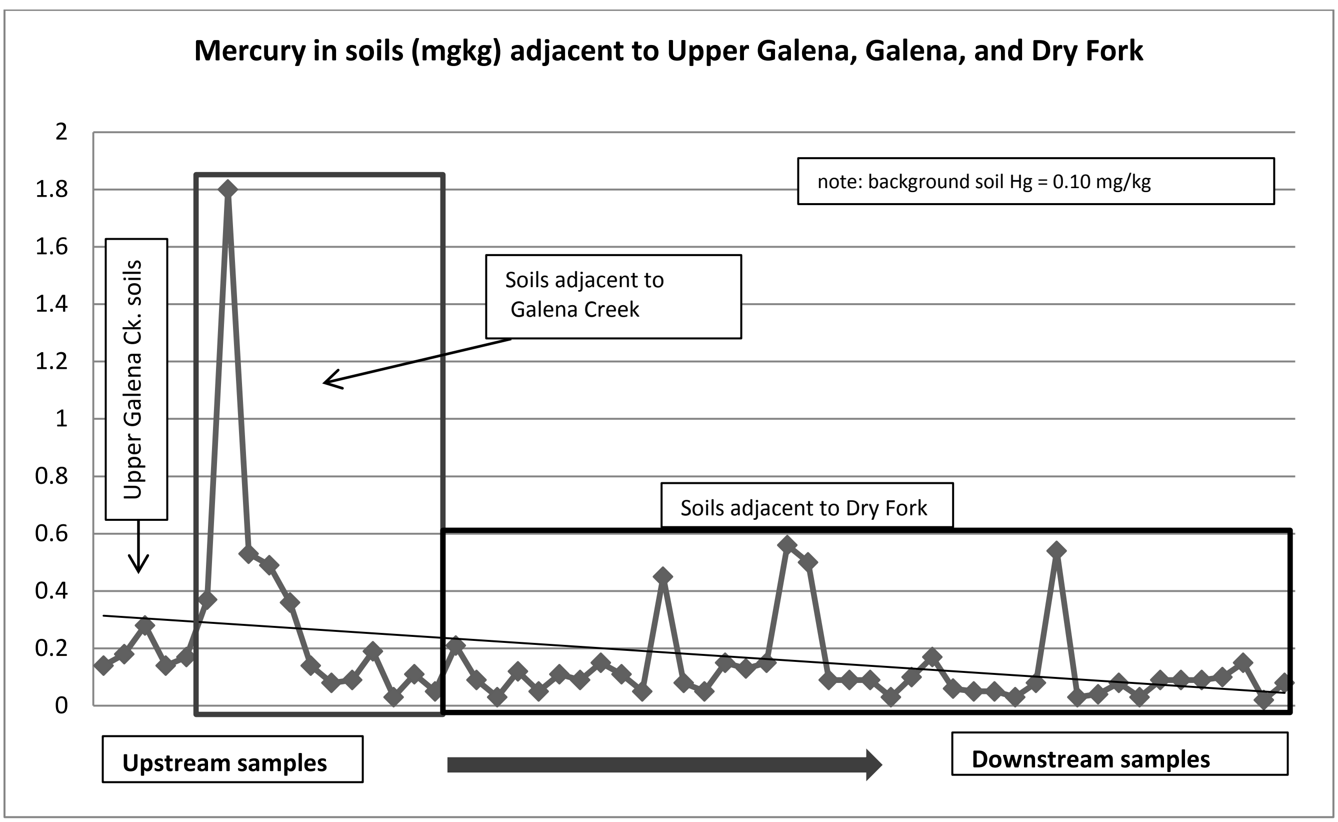


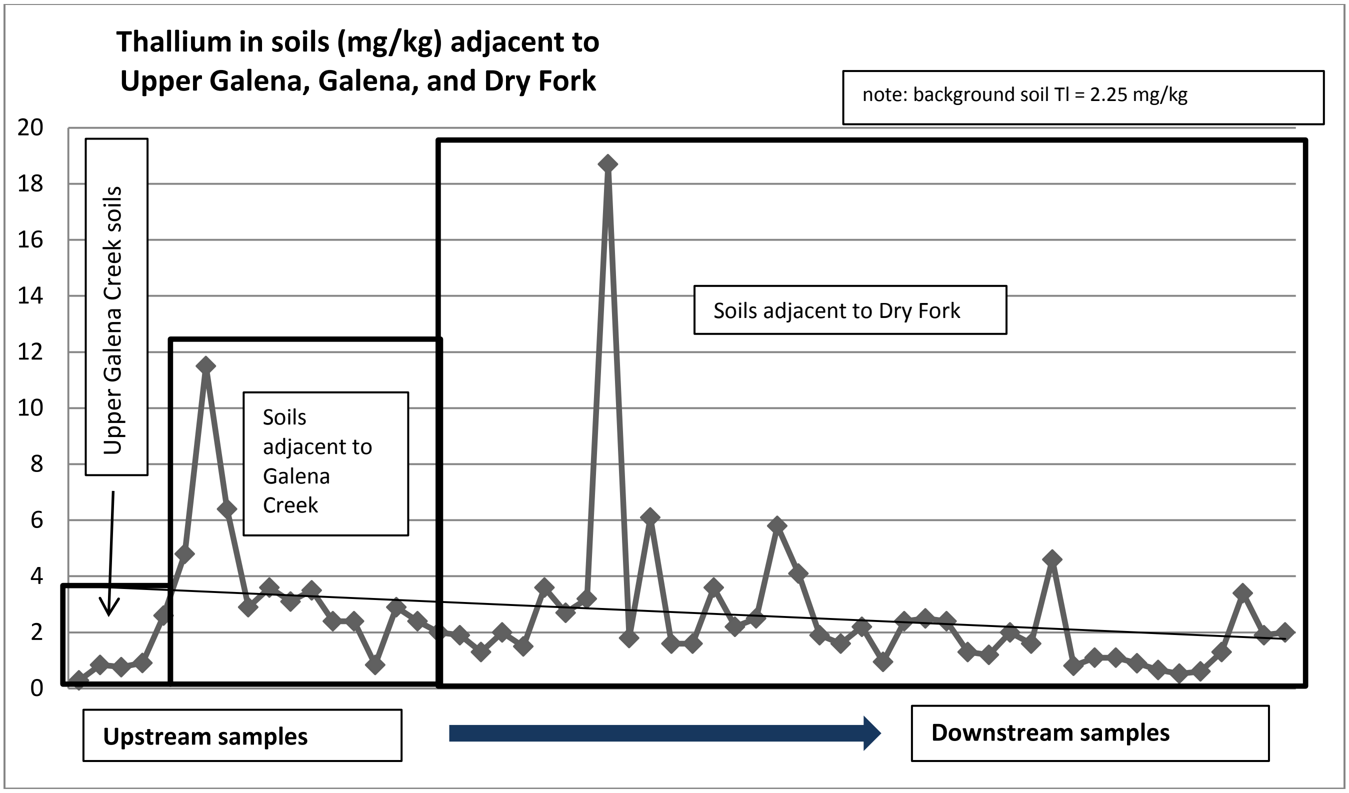


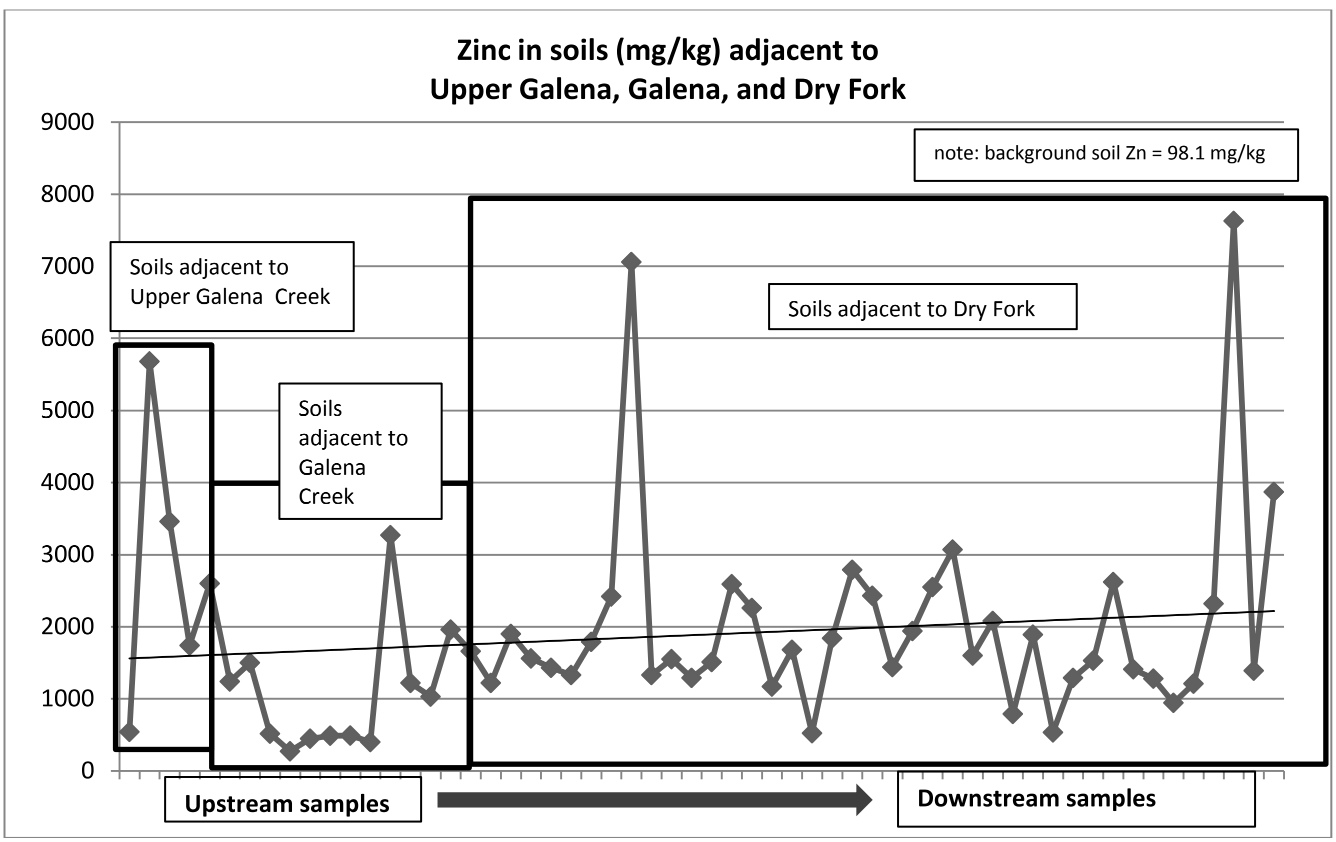

Copper in soils (mg/kg) adjacent to
Upper Galena, Galena, and Dry Fork
1400
1200
1000
800
600
400
200
0
note; background Cu = 16.1 mg/kg
Soils adjacent to Upper Galena Creek
Soils adjacent to Galena Creek
Soils adjacent to Dry Fork
Upstream samples
Downstream samples

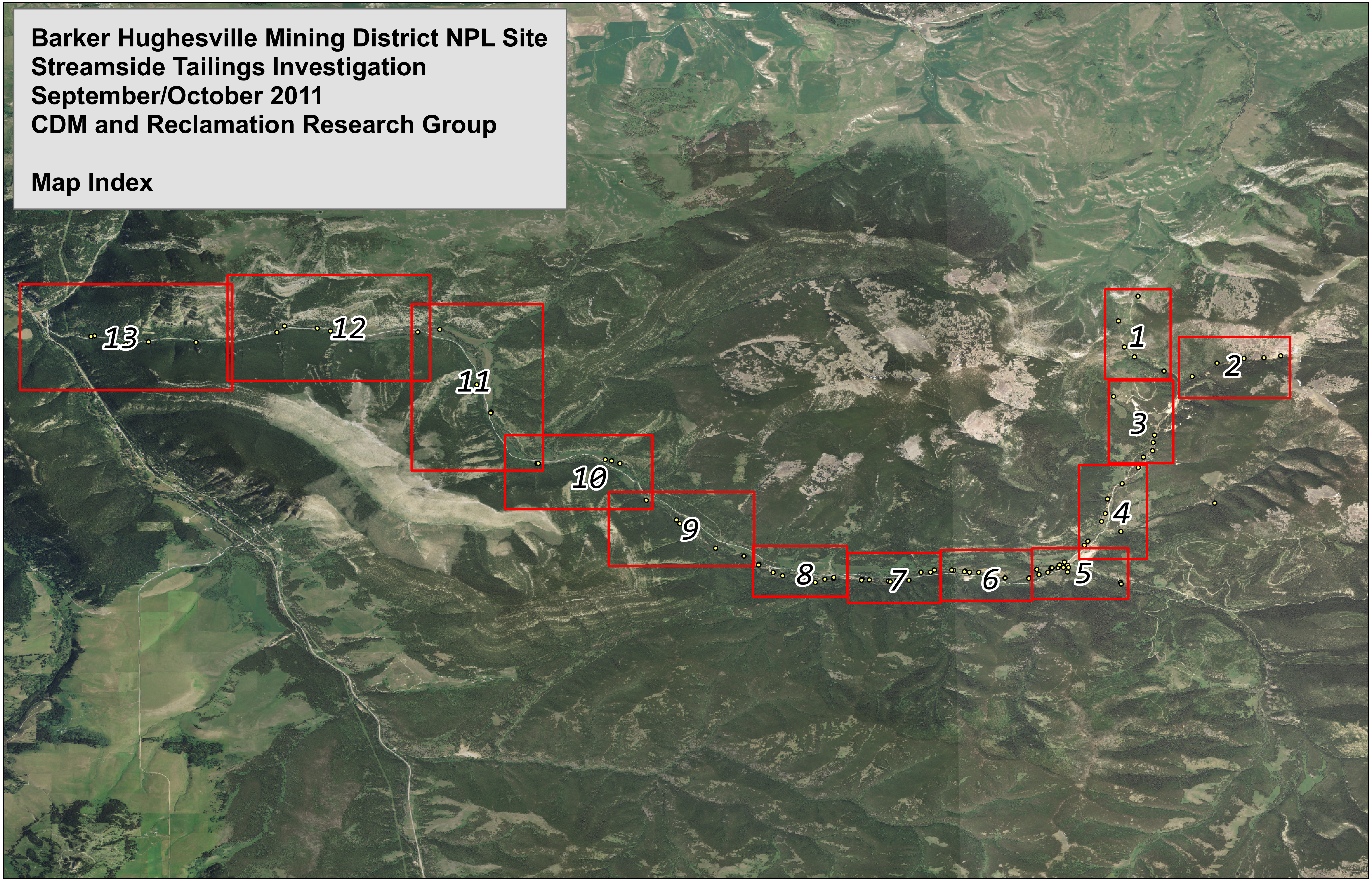

Lead in soils (mg/kg) adjacent to
Upper Galena, Galena, and Dry Fork
100000
10000
1000
100
note: background soil Pb = 48.5 mg/kg
Soils adjacent to Galena Creek
Soils adjacent to Dry Fork
Soils adjacent to Upper Galena Creek
Upstream samples
Downstream samples


Manganese in soils (mg/kg) adjacent
to Upper Galena, Galena, and Dry Fork
16000
14000
12000
10000
8000
6000
4000
2000
0
note: background soil Mn = 630 mg/kg
Upper Galena Creek soils
Soils adjacent to Dry Fork
Galena Creek soils
Upstream samples
Downstream samples


Mercury in soils (mgkg) adjacent to Upper Galena, Galena, and Dry Fork
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
note: background soil Hg = 0.10 mg/kg
Upper Galena Ck. soils
Soils adjacent to Galena Creek
Soils adjacent to Dry Fork
Upstream samples
Downstream samples

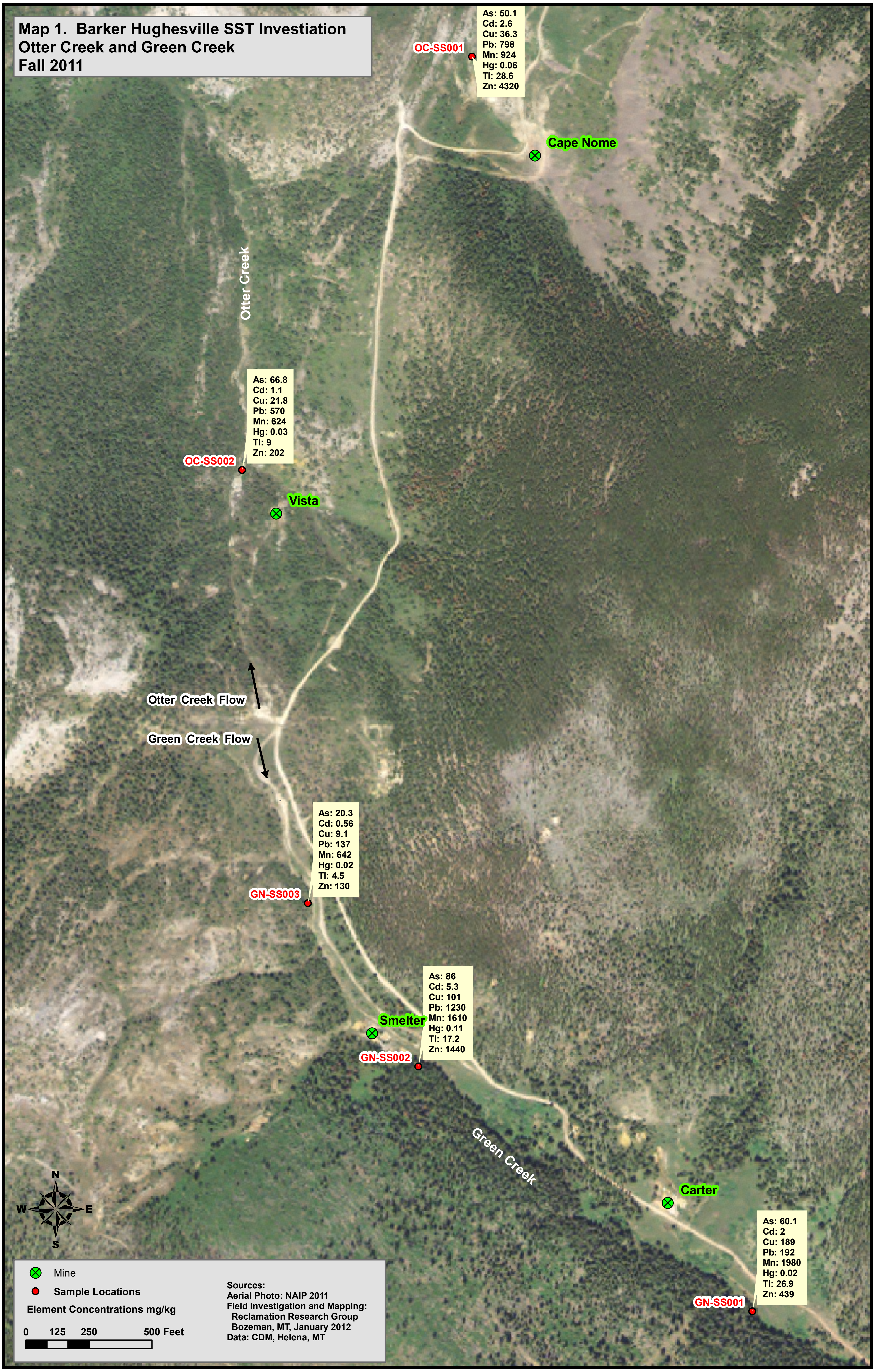

Thallium in soils (mg/kg) adjacent to Upper Galena, Galena, and Dry Fork
note: background soil Tl = 2.25 mg/kg
20
18
16
14
12
10
8
6
4
2
0
Upper Galena Creek soils
Soils adjacent to Galena Creek
Soils adjacent to Dry Fork
Upstream samples
Downstream samples

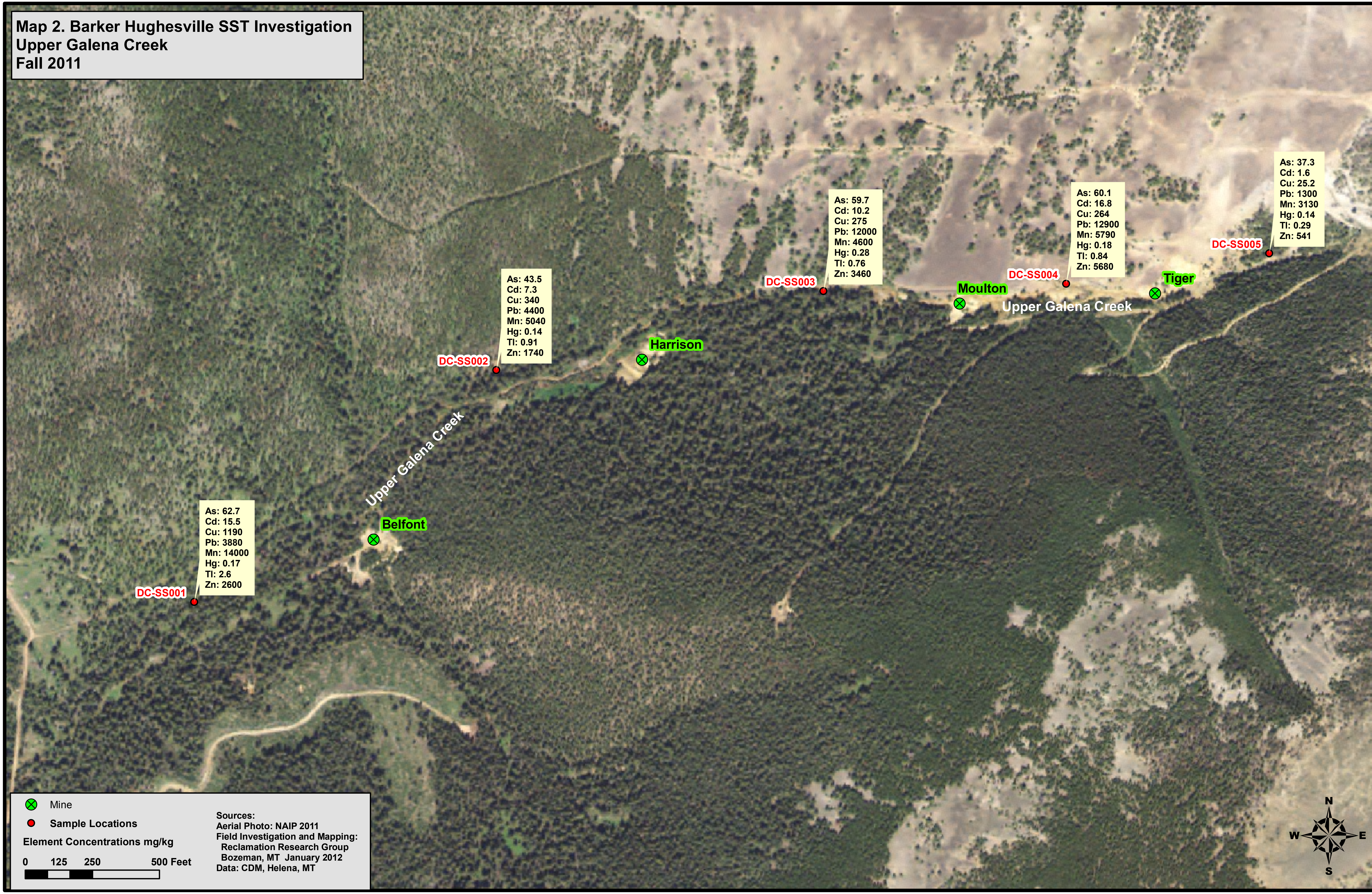

Zinc in soils (mg/kg) adjacent to Upper Galena, Galena, and Dry Fork
note: background soil Zn = 98.1 mg/kg
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Soils adjacent to Upper Galena Creek
Soils adjacent to Galena Creek
Soils adjacent to Dry Fork
Upstream samples
Downstream samples


Barker Hughesville Mining District NPL Site
Streamside Tailings Investigation
September/October 2011
CDM and Reclamation Research Group

Map Index
1
2
3
4
5
6
7
8
9
10
11
12
13

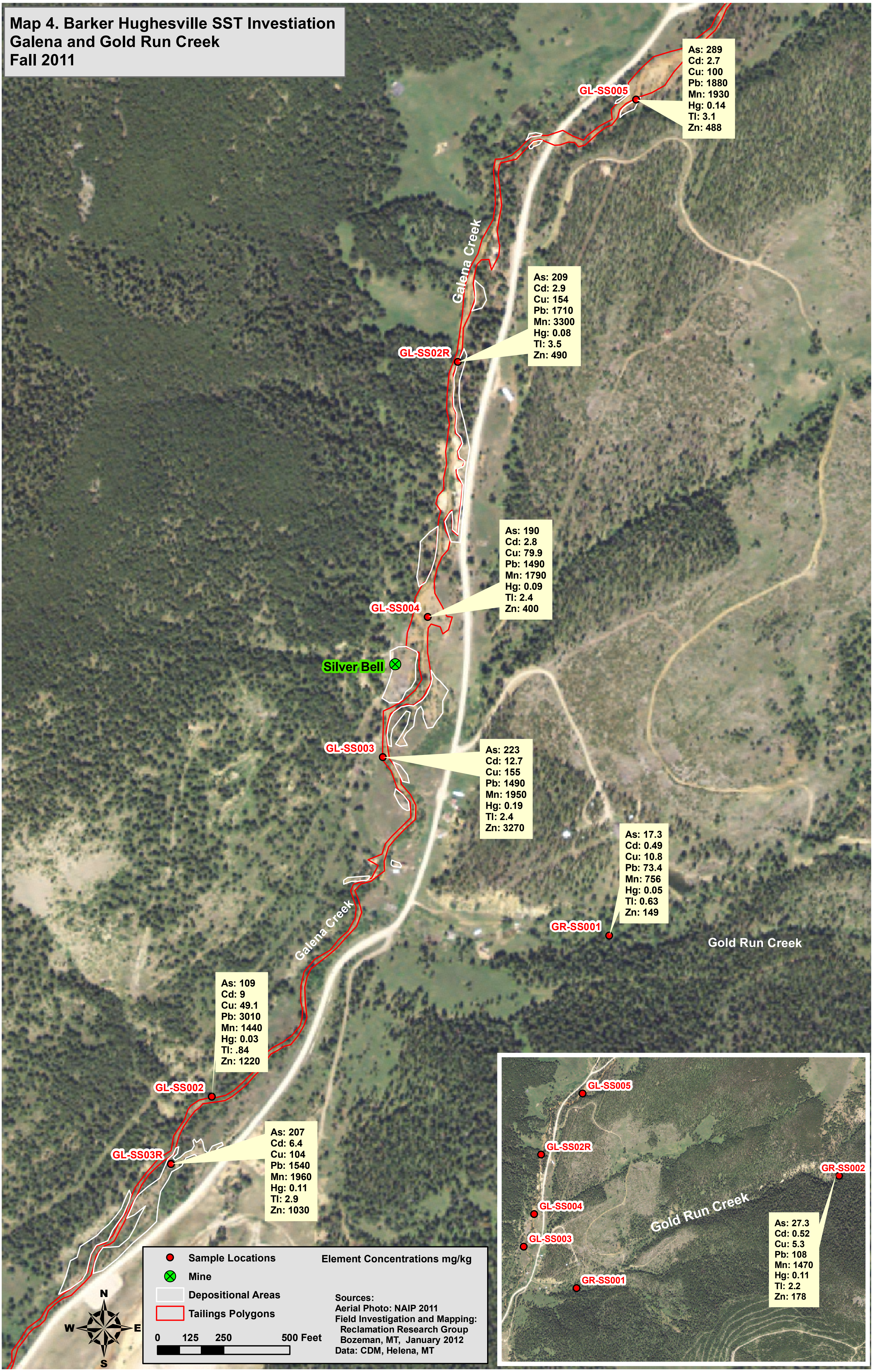
Map 1. Barker Hughesville SST Investiation
Otter Creek and Green Creek
Fall 2011

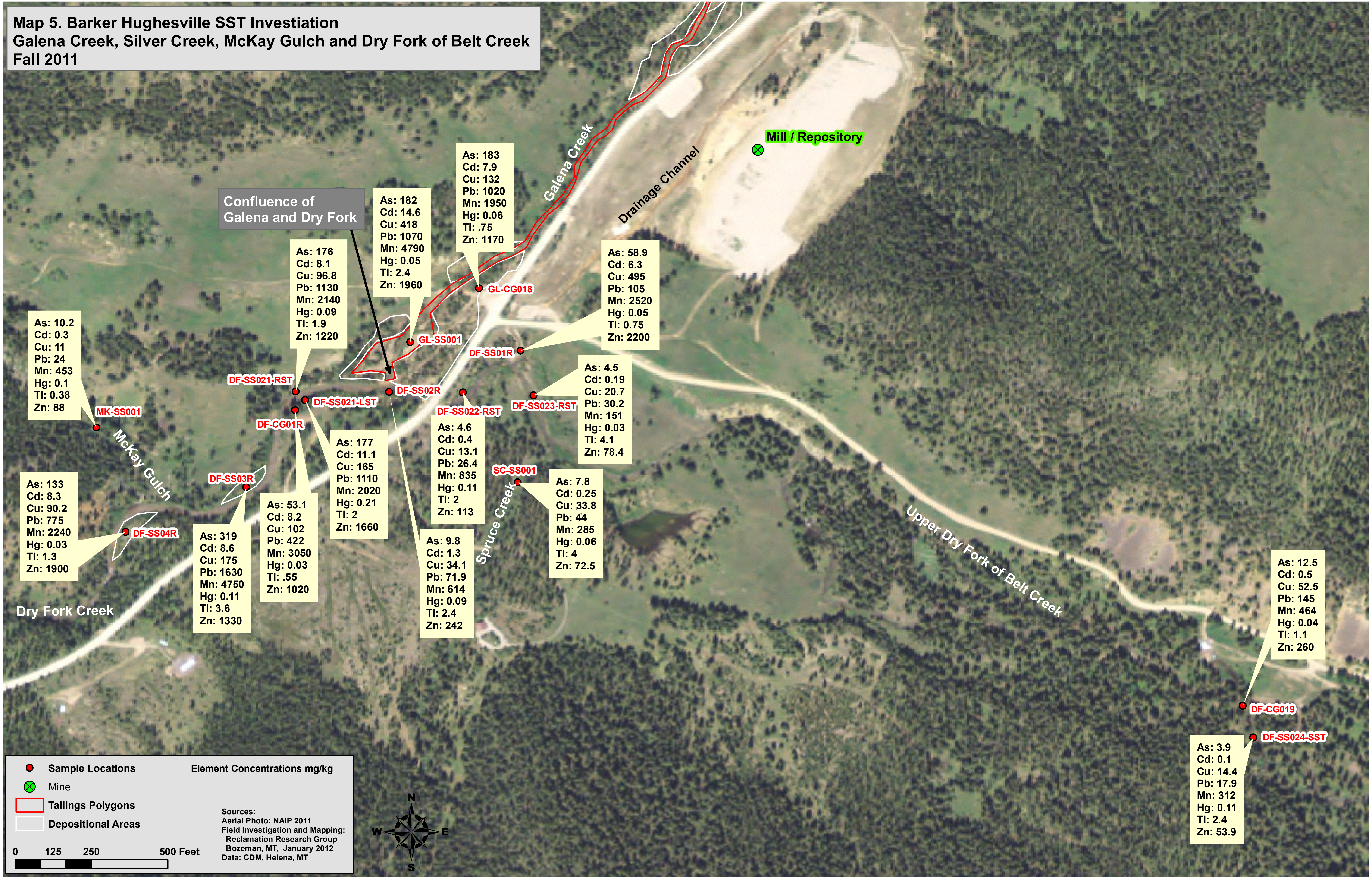


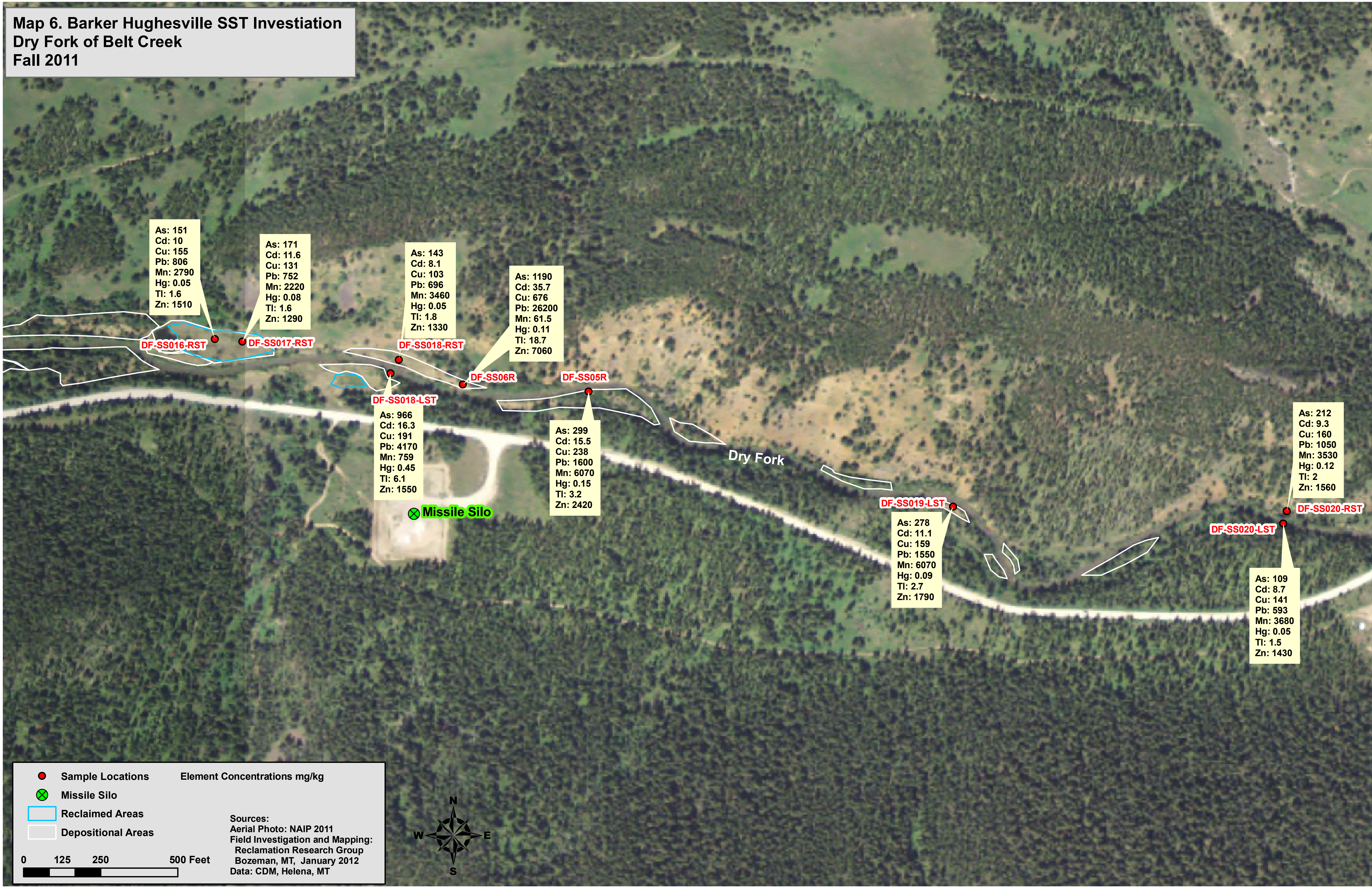

Map 2. Barker Hughesville SST Investigation
Upper Galena Creek
Fall 2011
As: 62.7
Cd: 15.5
Cu: 1190
Pb: 3880
Mn: 14000
Hg: 0.17
Tl: 2.6
Zn: 2600
DC-SS001
Belfont
Upper Galena Creek
As: 43.5
Cd: 7.3
Cu: 340
Pb: 4400
Mn: 5040
Hg: 0.14
Tl: 0.91
Zn: 1740
DC-SS002
Harrison
As: 59.7
Cd: 10.2
Cu: 275
Pb: 12000
Mn: 4600
Hg: 0.28
Tl: 0.76
Zn: 3460
DC-SS003
Moulton
Upper Galena Creek
As: 60.1
Cd: 16.8
Cu: 264
Pb: 12900
Mn: 5790
Hg: 0.18
Tl: 0.84
Zn: 5680
DC-SS004
Tiger
As: 37.3
Cd: 1.6
Cu: 25.2
Pb: 1300
Mn: 3130
Hg: 0.14
Tl: 0.29
Zn: 541
DC-SS005
Mine
Sample Locations
Element Concentrations mg/kg
0 125 250 500 Feet
Sources:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT January 2012
Data: CDM, Helena, MT
N
W
E
S

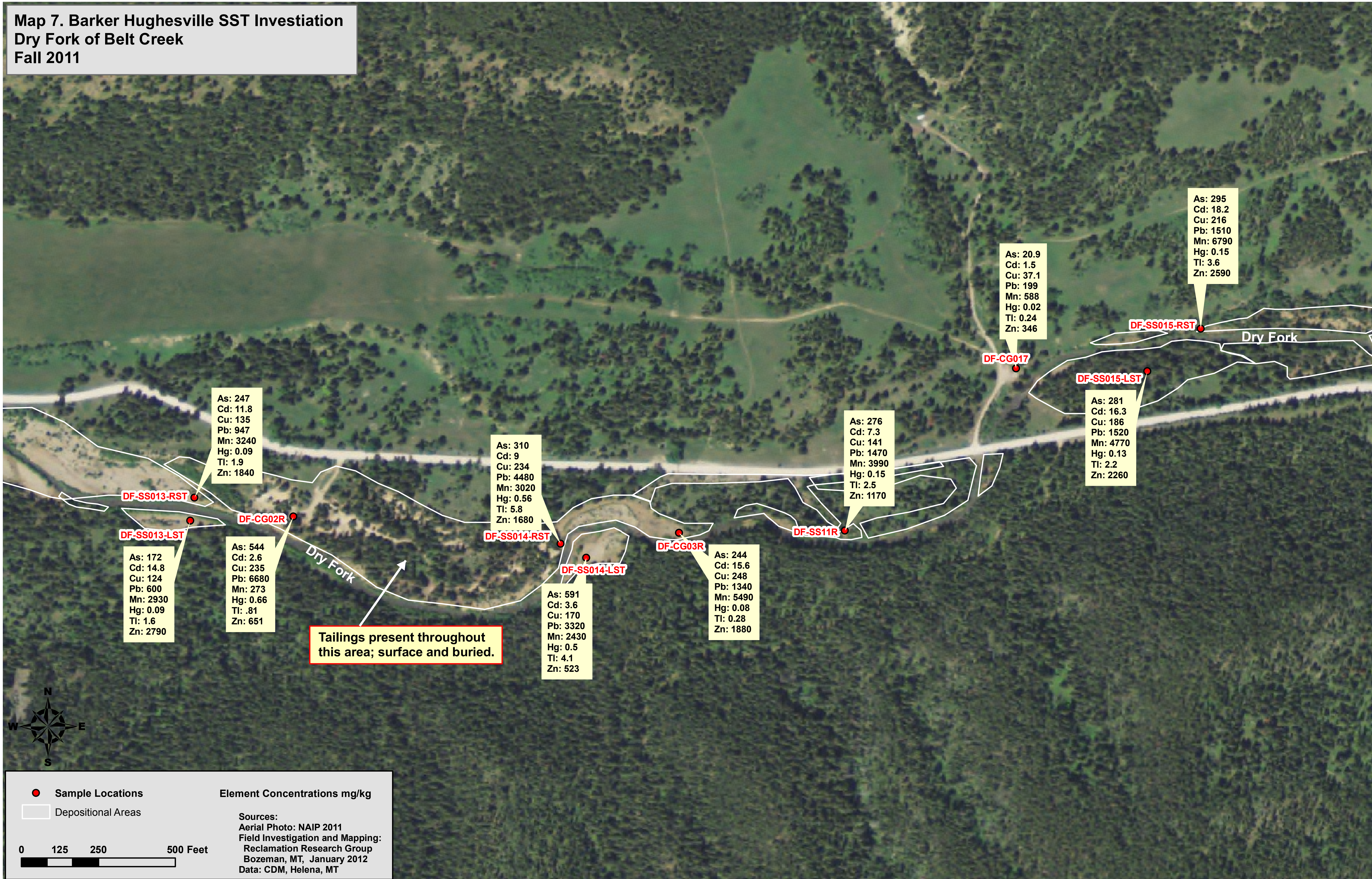

Map 3. Barker Hughesville SST Investiation
Upper Silver Creek and Galena Creek
Fall 2011
SV-SS001
As: 19.2
Cd: 3
Cu: 39.7
Pb: 88
Mn: 2640
Hg: 0.06
Tl: 4.5
Zn: 688
Block P
Removal Work
Silver Creek
Belt Patent
Galena Creek
Sinclair
Liberty
Marcelline
Danny T
As: 373
Cd: 6.9
Cu: 125
Pb: 3310
Mn: 678
Hg: 0.37
Tl: 4.8
Zn: 1240
GL-SS009
As: 756
Cd: 7.1
Cu: 428
Pb: 34600
Mn: 29.9
Hg: 1.8
Tl: 11.5
Zn: 1500
GL-SS01R
Galena Creek
Lucky Strike
GL-SS08
As: 511
Cd: 2
Cu: 197
Pb: 3760
Mn: 700
Hg: 0.53
Tl: 6.4
Zn: 516
As: 316
Cd: .86
Cu: 104
Pb: 3670
Mn: 931
Hg: 0.49
Tl: 2.9
Zn: 272
GL-SS007
N
W
E
S
Magnolia
As: 505
Cd: 4.6
Cu: 194
Pb: 4880
Mn: 3070
Hg: 0.36
Tl: 3.6
Zn: 447
GL-SS006
Sample Locations
Mine
Depositional Areas
Tailings Polygons
Element Concentrations mg/kg
Source:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT, January 2012
Data: CDM, Helena, MT
0 125 250 500 Feet

Map 4. Barker Hughesville SST Investiation Galena and Gold Run Creek Fall 2011

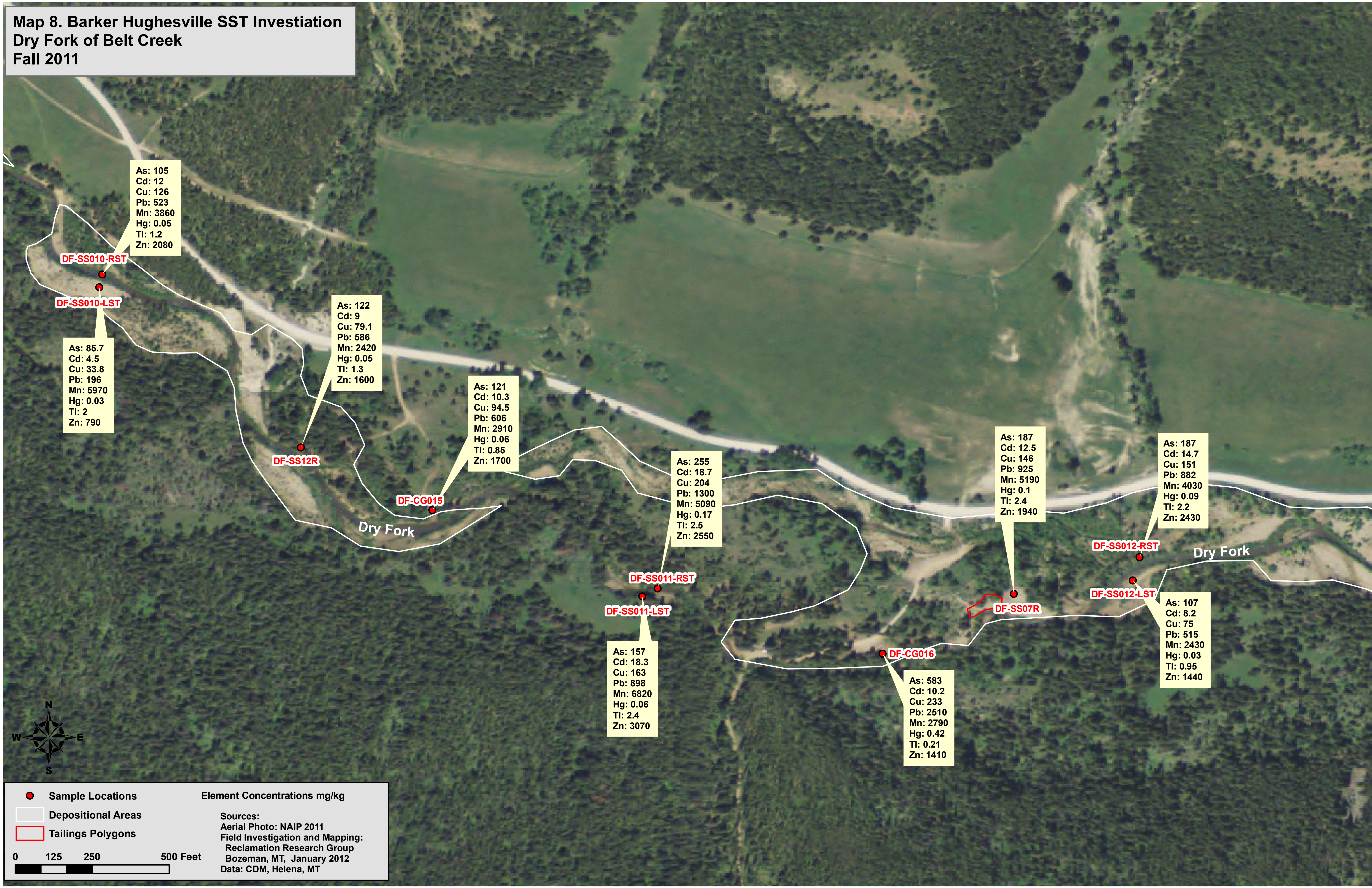



Map 5. Barker Hughesville SST Investiation
Galena Creek, Silver Creek, McKay Gulch and Dry Fork of Belt Creek
Fall 2011
Confluence of Galena and Dry Fork
Mill / Repository
Galena Creek
Drainage Channel
McKay Gulch
Spruce Creek
Dry Fork Creek
Upper Dry Fork of Belt Creek
GL-CG018
As: 183 Cd: 7.9 Cu: 132 Pb: 1020 Mn: 1950 Hg: 0.06 Tl: .75 Zn: 1170
GL-SS001
As: 182 Cd: 14.6 Cu: 418 Pb: 1070 Mn: 4790 Hg: 0.05 Tl: 2.4 Zn: 1960
DF-SS021-RST
As: 176 Cd: 8.1 Cu: 96.8 Pb: 1130 Mn: 2140 Hg: 0.09 Tl: 1.9 Zn: 1220
MK-SS001
As: 10.2 Cd: 0.3 Cu: 11 Pb: 24 Mn: 453 Hg: 0.1 Tl: 0.38 Zn: 88
DF-SS01R
As: 58.9 Cd: 6.3 Cu: 495 Pb: 105 Mn: 2520 Hg: 0.05 Tl: 0.75 Zn: 2200
DF-SS023-RST
As: 4.5 Cd: 0.19 Cu: 20.7 Pb: 30.2 Mn: 151 Hg: 0.03 Tl: 4.1 Zn: 78.4
DF-SS022-RST
As: 4.6 Cd: 0.4 Cu: 13.1 Pb: 26.4 Mn: 835 Hg: 0.11 Tl: 2 Zn: 113
DF-SS02R
As: 9.8 Cd: 1.3 Cu: 34.1 Pb: 71.9 Mn: 614 Hg: 0.09 Tl: 2.4 Zn: 242
DF-SS021-LST
As: 177 Cd: 11.1 Cu: 165 Pb: 1110 Mn: 2020 Hg: 0.21 Tl: 2 Zn: 1660
DF-CG01R
As: 53.1 Cd: 8.2 Cu: 102 Pb: 422 Mn: 3050 Hg: 0.03 Tl: .55 Zn: 1020
DF-SS03R
As: 319 Cd: 8.6 Cu: 175 Pb: 1630 Mn: 4750 Hg: 0.11 Tl: 3.6 Zn: 1330
DF-SS04R
As: 133 Cd: 8.3 Cu: 90.2 Pb: 775 Mn: 2240 Hg: 0.03 Tl: 1.3 Zn: 1900
SC-SS001
As: 7.8 Cd: 0.25 Cu: 33.8 Pb: 44 Mn: 285 Hg: 0.06 Tl: 4 Zn: 72.5
DF-CG019
As: 12.5 Cd: 0.5 Cu: 52.5 Pb: 145 Mn: 464 Hg: 0.04 Tl: 1.1 Zn: 260
DF-SS024-SST
As: 3.9 Cd: 0.1 Cu: 14.4 Pb: 17.9 Mn: 312 Hg: 0.11 Tl: 2.4 Zn: 53.9
Sample Locations
Mine
Tailings Polygons
Depositional Areas
Element Concentrations mg/kg
0 125 250 500 Feet
Sources:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT, January 2012
Data: CDM, Helena, MT
N W E S

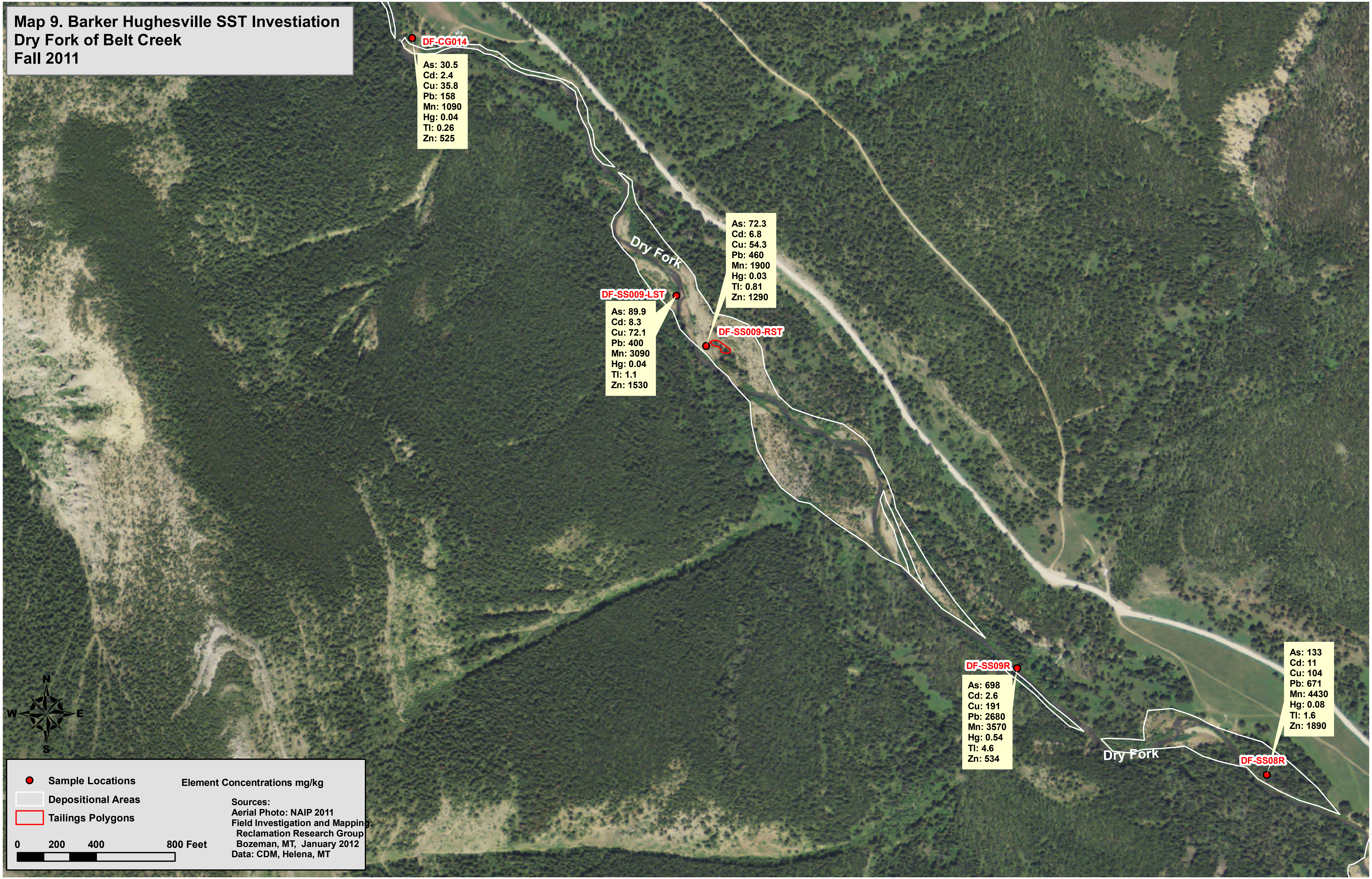

Map 6. Barker Hughesville SST Investiation
Dry Fork of Belt Creek
Fall 2011
As: 151
Cd: 10
Cu: 155
Pb: 806
Mn: 2790
Hg: 0.05
Tl: 1.6
Zn: 1510
DF-SS016-RST
As: 171
Cd: 11.6
Cu: 131
Pb: 752
Mn: 2220
Hg: 0.08
Tl: 1.6
Zn: 1290
DF-SS017-RST
As: 143
Cd: 8.1
Cu: 103
Pb: 696
Mn: 3460
Hg: 0.05
Tl: 1.8
Zn: 1330
DF-SS018-RST
As: 1190
Cd: 35.7
Cu: 676
Pb: 26200
Mn: 61.5
Hg: 0.11
Tl: 18.7
Zn: 7060
DF-SS06R
DF-SS05R
As: 299
Cd: 15.5
Cu: 238
Pb: 1600
Mn: 6070
Hg: 0.15
Tl: 3.2
Zn: 2420
DF-SS018-LST
As: 966
Cd: 16.3
Cu: 191
Pb: 4170
Mn: 759
Hg: 0.45
Tl: 6.1
Zn: 1550
Missile Silo
Dry Fork
DF-SS019-LST
As: 278
Cd: 11.1
Cu: 159
Pb: 1550
Mn: 6070
Hg: 0.09
Tl: 2.7
Zn: 1790
As: 212
Cd: 9.3
Cu: 160
Pb: 1050
Mn: 3530
Hg: 0.12
Tl: 2
Zn: 1560
DF-SS020-RST
DF-SS020-LST
As: 109
Cd: 8.7
Cu: 141
Pb: 593
Mn: 3680
Hg: 0.05
Tl: 1.5
Zn: 1430
Sample Locations
Missile Silo
Reclaimed Areas
Depositional Areas
Element Concentrations mg/kg
Sources:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT, January 2012
Data: CDM, Helena, MT
0 125 250 500 Feet
N
W
E
S

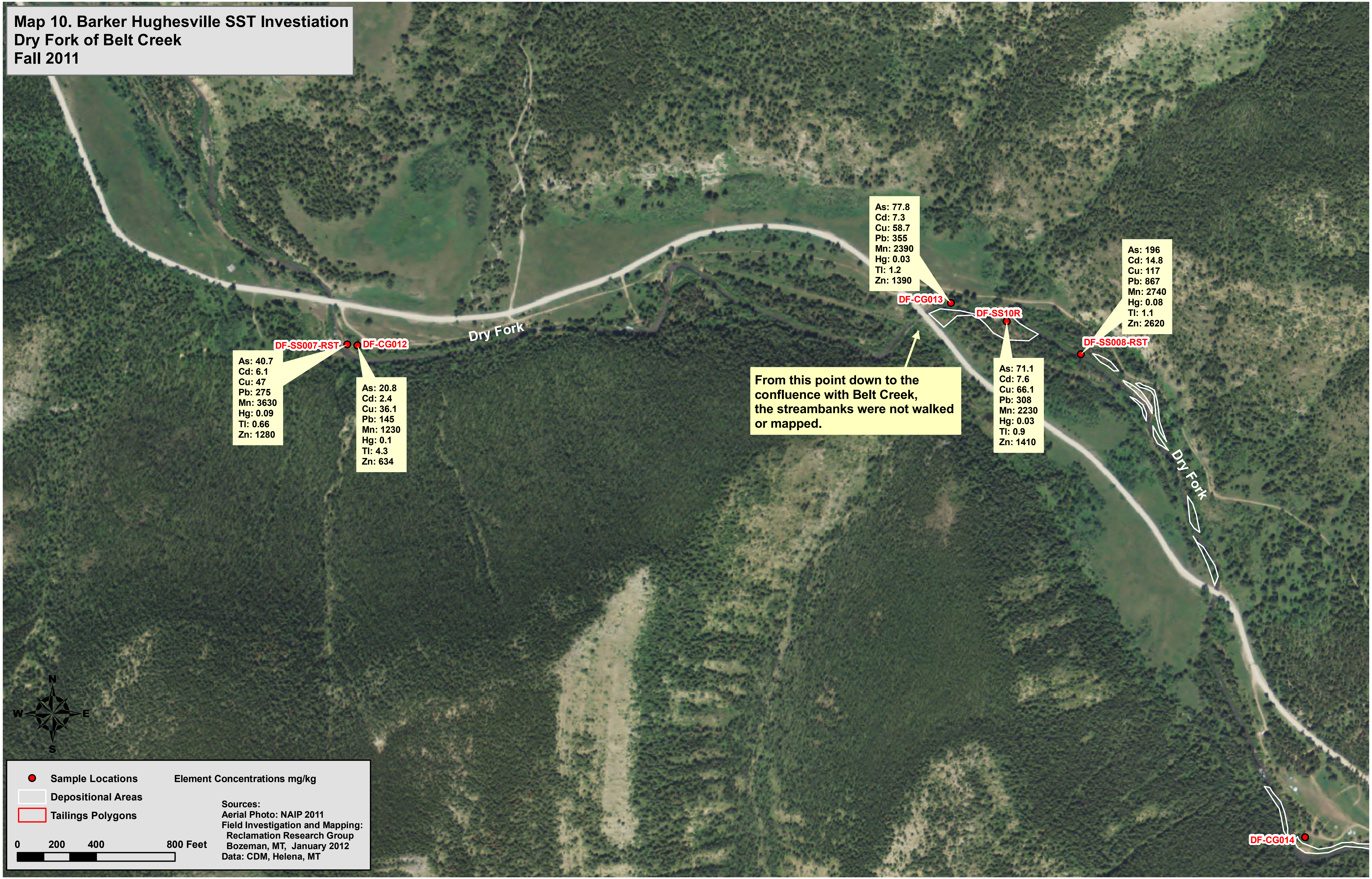


Map 7. Barker Hughesville SST Investiation
Dry Fork of Belt Creek
Fall 2011
As: 20.9 Cd: 1.5 Cu: 37.1 Pb: 199 Mn: 588 Hg: 0.02 Tl: 0.24 Zn: 346
DF-CG017
As: 295 Cd: 18.2 Cu: 216 Pb: 1510 Mn: 6790 Hg: 0.15 Tl: 3.6 Zn: 2590
DF-SS015-RST
Dry Fork
DF-SS015-LST
As: 281 Cd: 16.3 Cu: 186 Pb: 1520 Mn: 4770 Hg: 0.13 Tl: 2.2 Zn: 2260
As: 247 Cd: 11.8 Cu: 135 Pb: 947 Mn: 3240 Hg: 0.09 Tl: 1.9 Zn: 1840
DF-SS013-RST
DF-SS013-LST
As: 172 Cd: 14.8 Cu: 124 Pb: 600 Mn: 2930 Hg: 0.09 Tl: 1.6 Zn: 2790
DF-CG02R
As: 544 Cd: 2.6 Cu: 235 Pb: 6680 Mn: 273 Hg: 0.66 Tl: .81 Zn: 651
Dry Fork
As: 310 Cd: 9 Cu: 234 Pb: 4480 Mn: 3020 Hg: 0.56 Tl: 5.8 Zn: 1680
DF-SS014-RST
DF-SS014-LST
As: 591 Cd: 3.6 Cu: 170 Pb: 3320 Mn: 2430 Hg: 0.5 Tl: 4.1 Zn: 523
DF-CG03R
As: 244 Cd: 15.6 Cu: 248 Pb: 1340 Mn: 5490 Hg: 0.08 Tl: 0.28 Zn: 1880
As: 276 Cd: 7.3 Cu: 141 Pb: 1470 Mn: 3990 Hg: 0.15 Tl: 2.5 Zn: 1170
DF-SS11R
Tailings present throughout this area; surface and buried.
N
W
E
S
Sample Locations
Depositional Areas
Element Concentrations mg/kg
0 125 250 500 Feet
Sources:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT, January 2012
Data: CDM, Helena, MT

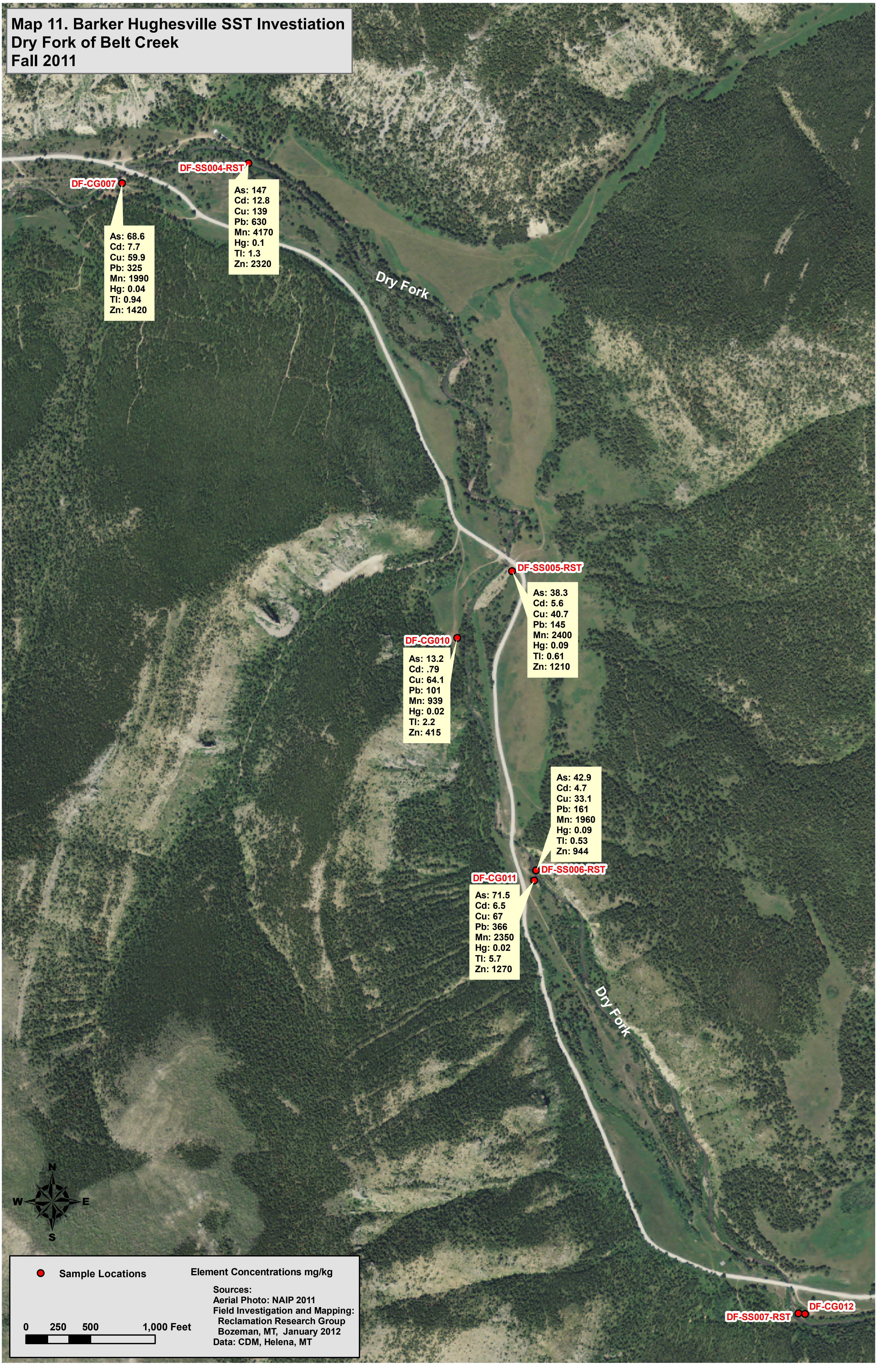

Map 8. Barker Hughesville SST Investiation
Dry Fork of Belt Creek
Fall 2011
DF-SS010-RST
As: 105
Cd: 12
Cu: 126
Pb: 523
Mn: 3860
Hg: 0.05
Tl: 1.2
Zn: 2080
DF-SS010-LST
As: 85.7
Cd: 4.5
Cu: 33.8
Pb: 196
Mn: 5970
Hg: 0.03
Tl: 2
Zn: 790
DF-SS12R
As: 122
Cd: 9
Cu: 79.1
Pb: 586
Mn: 2420
Hg: 0.05
Tl: 1.3
Zn: 1600
DF-CG015
As: 121
Cd: 10.3
Cu: 94.5
Pb: 606
Mn: 2910
Hg: 0.06
Tl: 0.85
Zn: 1700
Dry Fork
DF-SS011-RST
As: 255
Cd: 18.7
Cu: 204
Pb: 1300
Mn: 5090
Hg: 0.17
Tl: 2.5
Zn: 2550
DF-SS011-LST
As: 157
Cd: 18.3
Cu: 163
Pb: 898
Mn: 6820
Hg: 0.06
Tl: 2.4
Zn: 3070
DF-CG016
As: 583
Cd: 10.2
Cu: 233
Pb: 2510
Mn: 2790
Hg: 0.42
Tl: 0.21
Zn: 1410
DF-SS07R
As: 187
Cd: 12.5
Cu: 146
Pb: 925
Mn: 5190
Hg: 0.1
Tl: 2.4
Zn: 1940
DF-SS012-RST
As: 187
Cd: 14.7
Cu: 151
Pb: 882
Mn: 4030
Hg: 0.09
Tl: 2.2
Zn: 2430
DF-SS012-LST
As: 107
Cd: 8.2
Cu: 75
Pb: 515
Mn: 2430
Hg: 0.03
Tl: 0.95
Zn: 1440
Dry Fork
N
W
E
S
Sample Locations
Depositional Areas
Tailings Polygons
0
125
250
500 Feet
Element Concentrations mg/kg
Sources:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT, January 2012
Data: CDM, Helena, MT

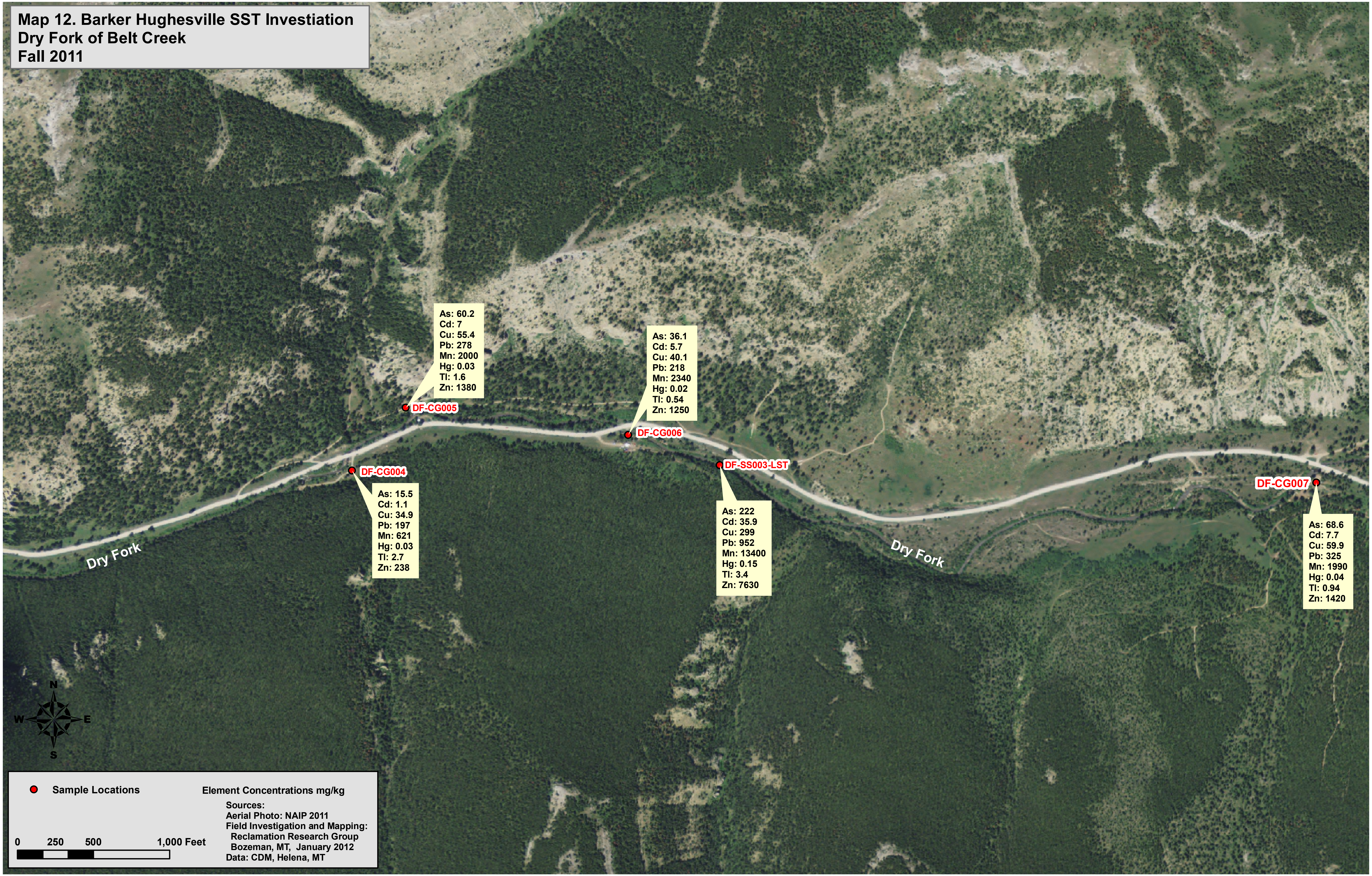
Map 9. Barker Hughesville SST Investiation
Dry Fork of Belt Creek
Fall 2011

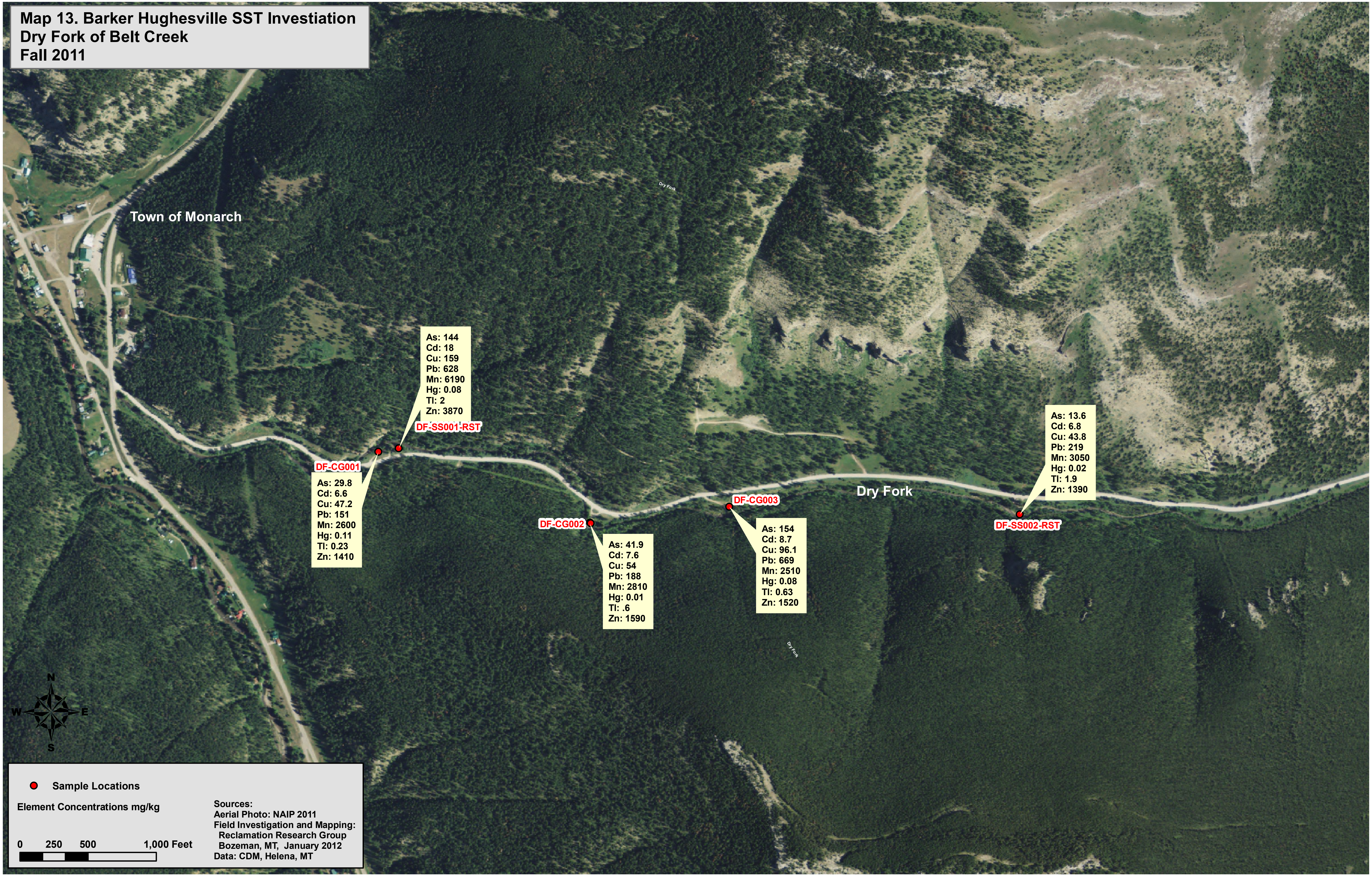




Map 10. Barker Hughesville SST Investiation
Dry Fork of Belt Creek
Fall 2011


Map 11. Barker Hughesville SST Investiation
Dry Fork of Belt Creek
Fall 2011
DF-CG007
As: 68.6
Cd: 7.7
Cu: 59.9
Pb: 325
Mn: 1990
Hg: 0.04
Tl: 0.94
Zn: 1420
DF-SS004-RST
As: 147
Cd: 12.8
Cu: 139
Pb: 630
Mn: 4170
Hg: 0.1
Tl: 1.3
Zn: 2320
Dry Fork
DF-SS005-RST
As: 38.3
Cd: 5.6
Cu: 40.7
Pb: 145
Mn: 2400
Hg: 0.09
Tl: 0.61
Zn: 1210
DF-CG010
As: 13.2
Cd: .79
Cu: 64.1
Pb: 101
Mn: 939
Hg: 0.02
Tl: 2.2
Zn: 415
As: 42.9
Cd: 4.7
Cu: 33.1
Pb: 161
Mn: 1960
Hg: 0.09
Tl: 0.53
Zn: 944
DF-SS006-RST
DF-CG011
As: 71.5
Cd: 6.5
Cu: 67
Pb: 366
Mn: 2350
Hg: 0.02
Tl: 5.7
Zn: 1270
Dry Fork
N
W
E
S
DF-SS007-RST
DF-CG012
Sample Locations
Element Concentrations mg/kg
Sources:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT, January 2012
Data: CDM, Helena, MT
0 250 500 1,000 Feet


Map 12. Barker Hughesville SST Investiation
Dry Fork of Belt Creek
Fall 2011
As: 60.2
Cd: 7
Cu: 55.4
Pb: 278
Mn: 2000
Hg: 0.03
Tl: 1.6
Zn: 1380
DF-CG005
As: 36.1
Cd: 5.7
Cu: 40.1
Pb: 218
Mn: 2340
Hg: 0.02
Tl: 0.54
Zn: 1250
DF-CG006
DF-CG004
As: 15.5
Cd: 1.1
Cu: 34.9
Pb: 197
Mn: 621
Hg: 0.03
Tl: 2.7
Zn: 238
DF-SS003-LST
As: 222
Cd: 35.9
Cu: 299
Pb: 952
Mn: 13400
Hg: 0.15
Tl: 3.4
Zn: 7630
DF-CG007
As: 68.6
Cd: 7.7
Cu: 59.9
Pb: 325
Mn: 1990
Hg: 0.04
Tl: 0.94
Zn: 1420
Dry Fork
Dry Fork
N
W
E
S
Sample Locations
Element Concentrations mg/kg
Sources:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT, January 2012
Data: CDM, Helena, MT
0 250 500 1,000 Feet


Map 13. Barker Hughesville SST Investiation
Dry Fork of Belt Creek
Fall 2011
Town of Monarch
As: 144
Cd: 18
Cu: 159
Pb: 628
Mn: 6190
Hg: 0.08
Tl: 2
Zn: 3870
DF-SS001-RST
DF-CG001
As: 29.8
Cd: 6.6
Cu: 47.2
Pb: 151
Mn: 2600
Hg: 0.11
Tl: 0.23
Zn: 1410
DF-CG002
As: 41.9
Cd: 7.6
Cu: 54
Pb: 188
Mn: 2810
Hg: 0.01
Tl: .6
Zn: 1590
DF-CG003
As: 154
Cd: 8.7
Cu: 96.1
Pb: 669
Mn: 2510
Hg: 0.08
Tl: 0.63
Zn: 1520
Dry Fork
As: 13.6
Cd: 6.8
Cu: 43.8
Pb: 219
Mn: 3050
Hg: 0.02
Tl: 1.9
Zn: 1390
DF-SS002-RST
N
W
E
S
Sample Locations
Element Concentrations mg/kg
0 250 500 1,000 Feet
Sources:
Aerial Photo: NAIP 2011
Field Investigation and Mapping:
Reclamation Research Group
Bozeman, MT, January 2012
Data: CDM, Helena, MT