

Clark Fork River Reach A Phases 3 and 4 Draft Data Summary Report

Clark Fork River Operable Unit Milltown Reservoir/Clark Fork River NPL Site Powell, Deer Lodge, Granite and Missoula Counties, Montana



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Executive Summary

This data summary Report (DSR) summarizes the results of the Reach A, Phase Phases 3 and 4 Floodplain Investigation. The document governing the Floodplain Investigation is the Draft Final Clark Fork Site Sampling and Analysis Plan (SAP) Addendum, Reach A, Phases 3 and 4 (CDM Smith, 2014). This SAP Addendum augmented and modified the comprehensive SAP (Sampling and Analysis Plan (SAP) Soils and Wastes Chemical Characterization for Remedial Design/Remedial Action, Clark Fork River Operable Unit Milltown Reservoir/Clark Fork River NPL Site, (CDM, 2009) with sampling objectives, methods and analytical procedures specific to collect data in support of a design for remedial action within Reach A, Phases 3 and 4 of the Clark Fork Site. Under this SAP Addendum, DEQ collected design level data concerning the nature and extent of soil contamination, thickness of contaminated materials, concentrations of contamination within the soil profile and depth to groundwater. Floodplain sampling activities began on October 26, 2014, and were completed on February 11, 2015.

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Section 1

Introduction

This Data Summary Report (DSR) for Phases 3 and 4 of the Clark Fork River Unit (CFROU) part of the Milltown Reservoir/Clark Fork River Superfund Site has been prepared for the Montana Department of Environmental Quality (DEQ) by the design consultants CDM Smith, Inc. (CDM Smith). The CFROU is part of the Milltown Reservoir/Clark Fork River Superfund Site (“Clark Fork Site” or “Site”) and includes the uppermost 120 miles of the Clark Fork River (CFR) between Warm Springs Ponds and Missoula, Montana. The Operable Unit is divided into three reaches (A, B, and C) as shown on Figure 1-1.

DEQ, as lead agency, oversees, manages, coordinates, designs, and implements the Remedial Action for the Clark Fork Site in consultation with the U.S. Environmental Protection Agency (USEPA). DEQ coordinates with the State of Montana Natural Resource Damage Program (NRDP) for the implementation and integration of restoration components into the work. Four primary functions of consultation and coordination among the agencies for the Clark Fork Site are to 1) understand and receive the information to be collected, 2) understand how that information is to be analyzed, 3) provide review and comment, and 4) maximize the use of the available resources and the environmental benefits for the Clark Fork Site in the successful and cost-effective completion of the work.

Remedial design data collection activities for the Clark Fork River Operable Unit (the “Clark Fork Site”) are being conducted under the guidance of the *Sampling and Analysis Plan (SAP) Soils and Wastes Chemical Characterization for Remedial Design/Remedial Action, Clark Fork River Operable Unit Milltown Reservoir/Clark Fork River NPL Site*, (CDM, 2009) hereinafter referred to as the “Comprehensive SAP”. The Comprehensive SAP includes the data quality objectives (DQOs) process, which is a series of planning steps based on scientific method that are designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended purpose. The DQO process was developed by the US Environmental Protection Agency (EPA) and published in the *Guidance on Systematic Planning using the Data Quality Objectives Process*, Publication No. EPA/240/B-06/001 (EPA, 2006). DEQ will address site-specific data collection through a SAP Addendum that describes field activities and laboratory methods for a particular property or group of properties. The *Clark Fork River Reach A Phases 3 and 4 Draft Sampling and Analysis Plan (SAP) Addendum* (CDM Smith, 2014) augments and modifies the comprehensive SAP with sampling objectives, methods and analytical procedures needed to collect data in support of a design for remedial action within CFR Reach A, Phases 3 & 4.

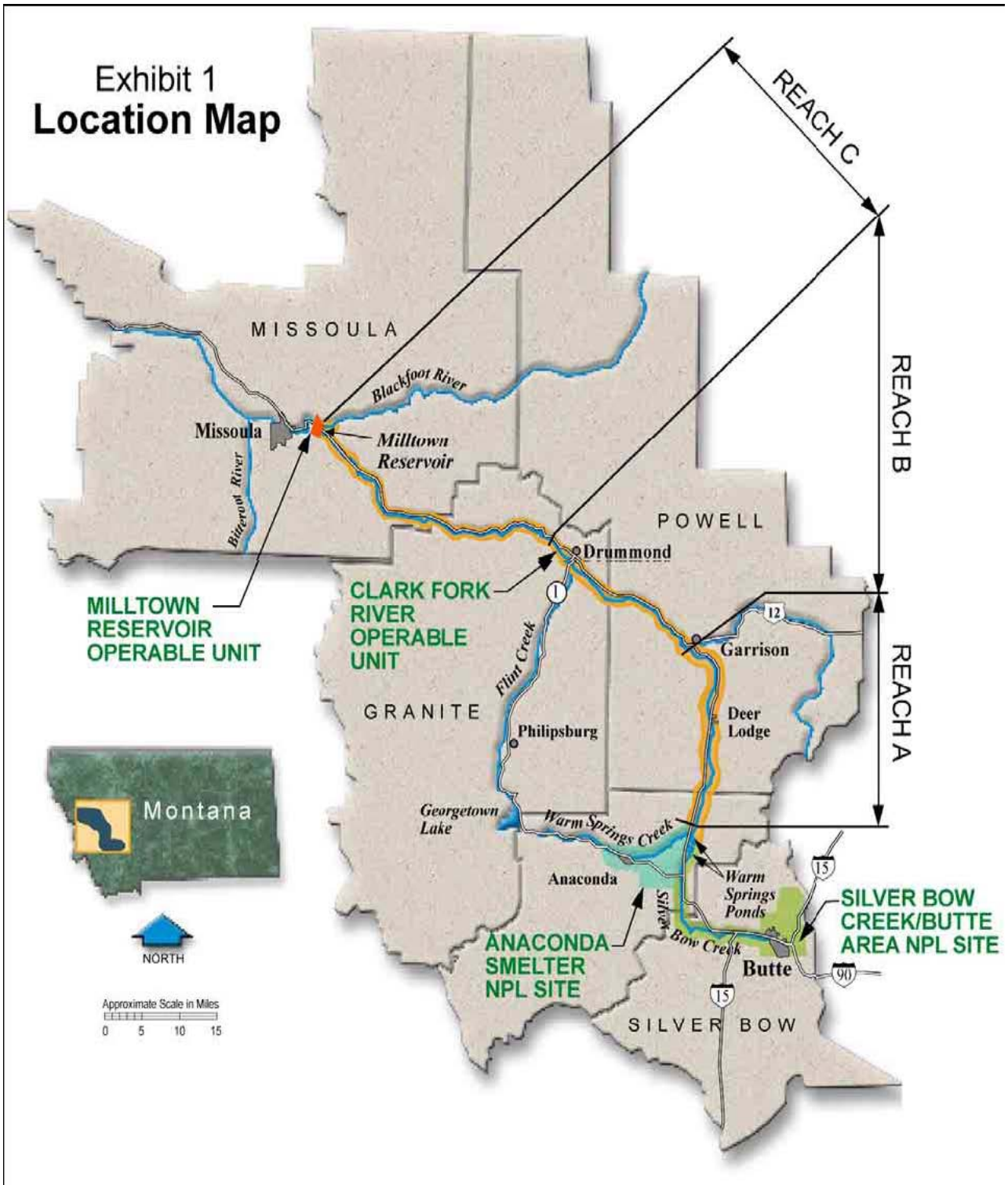


Figure 1-1. Clark Fork River Operable Unit Reaches.

1.1 Site Background

Heavy metals originating from historic mining activities, milling and smelting processes associated with the Anaconda Company operations in Butte and Anaconda have accumulated on the Clark Fork River stream banks and floodplain over a period of at least 100 years. The primary sources of contamination are tailings and contaminated sediments mixed with soils in the stream banks and floodplains, which erode during high flow events and enter the river and other surface waters. In addition to erosion, heavy metals are leached from the contaminated sediments and tailings directly into the groundwater and eventually to surface water. These contaminant transport pathways result in impacts to terrestrial and aquatic life along the Clark Fork River as described in the Record of Decision (ROD) for the CFROU (EPA/DEQ, 2004).

1.2 Purpose and Objectives

The overall objective of the tailings investigation summarized in this DSR is to support the designs of reconstructed river banks and floodplain modifications necessary for the remediation of Phases 3 and 4.

This DSR summarizes the locations, methods and procedures used to perform the tailings investigation, analysis and reporting. This investigation identified design level data concerning the nature and extent of soil contamination, thickness of contaminated materials, concentrations of contamination within the soil profile and depth to groundwater.

1.3 Site Location and Description

The CFROU is located within Deer Lodge, Granite, Powell, and Missoula Counties. The upstream boundary of the CFROU is located at the confluence of the old Silver Bow Creek channel with the reconstructed lower Mill-Willow bypass, just downstream of the Warm Springs Ponds. The original channel of the river upstream of this point was obliterated when the Warm Springs Ponds were built. The downstream boundary is the maximum high pool reservoir level (elevation 3265.5, NAVD 88) of the former Milltown Reservoir (eliminated by the removal of the Milltown Dam), just east of Missoula, Montana. Phases 3 and 4 are located just north of Phase 2 between Perkins Lane on the south and Galen Road on the north. The Phases 3 and 4 property is owned by the Lampert Ranch LP, Ms. Rosmarie Silzly, and the Deer Lodge River Ranch.

The Clark Fork Site is described in the 2004 ROD (EPA/DEQ, 2004):

The CFROU consists of surface water, stream bed sediments, tailings, impacted soils, groundwater, aquatic resources, terrestrial resources, irrigation ditches and related sediment depositions and contaminated property, and air located within and adjacent to the 100-year historic floodplain of the Clark Fork River. The OU extends from the confluence of the old Silver Bow Creek channel with the reconstructed lower Mill-Willow bypass, to the maximum Milltown Reservoir pool.

The Clark Fork Site has been divided into three reaches, with Reach A stretching from the confluence of the old Silver Bow Creek channel to the town of Garrison, Montana.

The Reach A, Phases 3 and 4 investigation consists of approximately 4 miles of stream channel and adjacent floodplain within Reach A, between Perkins Lane and Galen Road. Figure 1-2 shows the site-specific investigation areas. The abandoned Chicago Milwaukee railroad grade bisects the floodplain as it trends northward along the stream corridor (see Drawing A in Appendix F). In the upstream

portion of Phase 3, the river flows on the west side of the railroad grade, which forms a linear embankment on the floodplain. Half way through Phase 3, the river crosses the grade under an old railroad bridge which marks the original river location during the early 1900s when the Milwaukee Line was built as shown in Drawing B in Appendix F. Two bendways have cut off in Phase 4 since 1950; one relatively old cutoff at station 387+50, and another occurred since 2006 at station 437+50. There are eight acres of islands in Phase 4. Lost Creek enters Phase 4 at station 356+00 as shown in Drawing C in Appendix F.

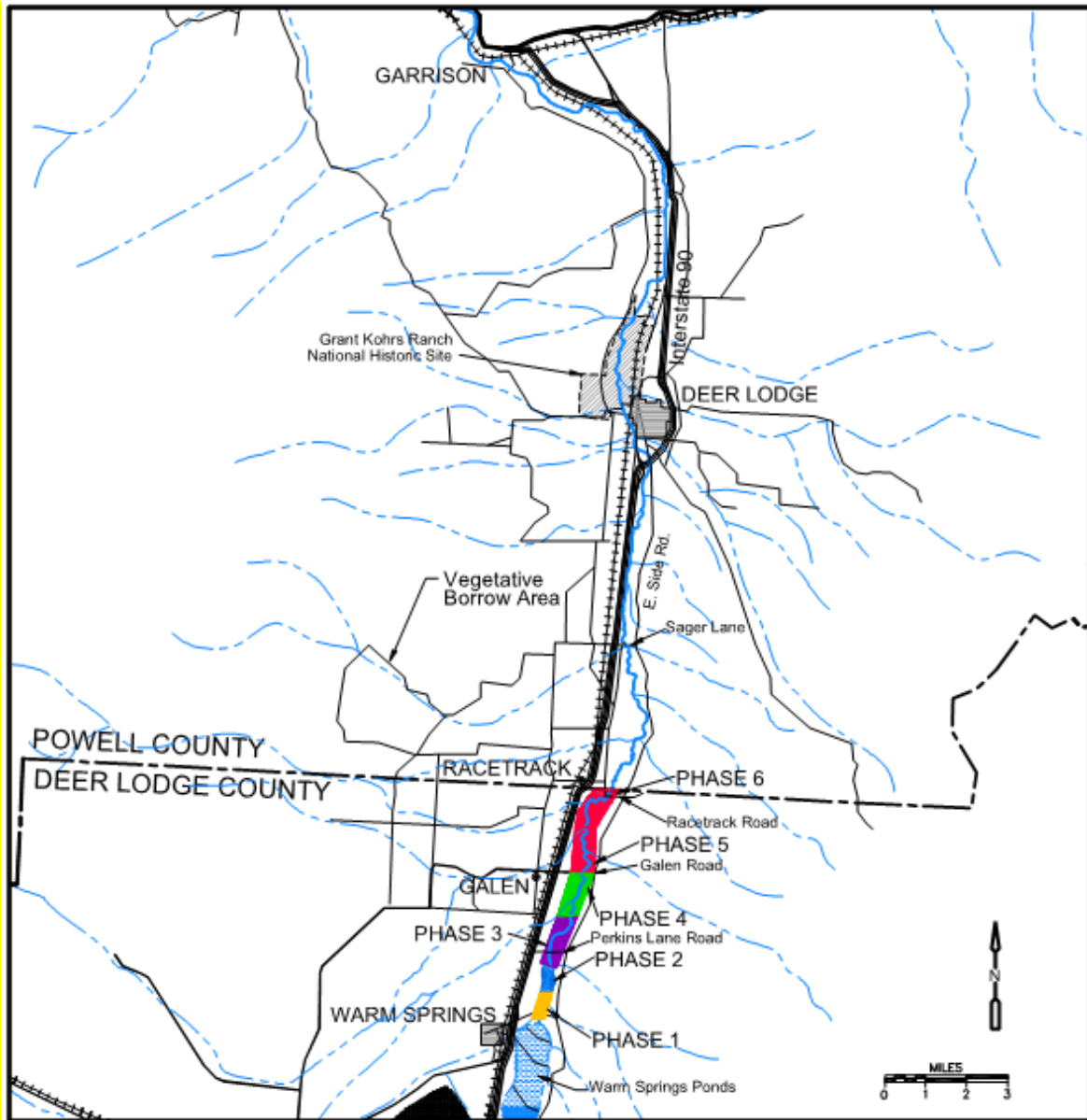


Figure 1-2. Reach A of the Clark Fork River Operable Unit.

Section 2

Sampling and Analysis Procedures

This section describes test pit sampling and analysis procedures used during remedial design sampling. Test pit excavation was performed using a track-mounted excavator to facilitate access. The resulting data are discussed in Section 3. The primary activities associated with the sampling and analysis included:

1. Utilities located.
2. Test pit locations identified, located and clearly marked.
3. Test pits excavated and (if necessary) dewatered;
4. Soil samples collected from the test pit excavations;
5. Samples screened using a field X-Ray fluorescence analyzer (XRF) for submittal to the laboratory;
6. Document approximate depth to groundwater (if present) in each of the test pits;
7. Test pits backfilled; and,
8. Remaining samples archived.

Soil sample collection methods and procedures are outlined below.

2.1 Sampling Approach

Test pit locations were spaced on a north-south, east-west grid with 125 foot centers. Additional sample locations were identified based on field XRF results and within historic channels and oxbows. Test pits samples were collected at 6-inch intervals the entire depth of the test pit, but only selected samples were submitted for laboratory analysis. The selected samples (generally three per test pit) were intended to bracket the transition from the sum of contaminants of concern (COC) (arsenic, cadmium, copper, lead, and zinc) of above 1,400 mg/kg to those that are below this level.

XRF field screening was used to determine which samples were submitted to the laboratory. Because XRF readings, when used as a screening tool, are less accurate than laboratory analysis using wet chemistry methods, allowance was made for potential underestimation of the sum of contaminant concentrations. Based on previous experience, when wet samples are analyzed with the XRF in the field, the readings can be as much as 30 percent less than the laboratory analysis of the sum of contaminants. Therefore, 1,000 mg/kg was used as the screening level in the field. The concentration of 1,000 mg/kg is about 30 percent less than removal criterion of 1,400 mg/kg.

A total of 958 test pits were completed in Phases 3 and 4 as follows:

- **Phase 3:** A total of 527 test pits were completed in Phase 3; 426 test pits were initially proposed, of which 407 were completed, 19 test pits were skipped and 120 test pits were added to better define the extent of contamination.
- **Phase 4:** A total of 431 test pits were completed in Phase 4; 345 test pits were initially proposed, of which 340 were completed, 5 test pits were skipped and 91 test pits were added to better define the extent of contamination.

Test pit locations are shown on Figures 1A through 1C. Test pit locations were surveyed by Brown and Associates prior to commencement of sampling activities.

Samples were collected in 6-inch intervals and screened in the field until one of the following conditions were met:

- Field XRF indicated that the sum of As + Cd + Cu + Pb + Zn concentrations (“total COC concentrations”) were below 1,000 mg/kg. For test pits completed after November 21, 2014, total COC concentrations below 1,000 mg/kg were required for two consecutive intervals (refer to Section 2.2).
- Coarse alluvium having a rock content of 60% or more (visual estimation) was encountered. These conditions greatly reduce the presence of contaminated materials.

2.2 Sample Identification

The sample identification scheme consisted of a numeric identifier for the specific project area (Phase 3 and Phase 4) followed by a 3-digit sample location number beginning with 001. The sample locations generally corresponded to the most upstream sampling location and increased numerically as the test pits progressed downstream. The sample location number was followed by four digits representing the top and bottom depth of the sampled interval (in inches).

The following are examples of sample identification codes:

Sample code: 3-008-0612

3 = Project Area No.

008 = Sample Site Location No. 8

0612 = Subsurface sample collected from a depth interval of 6 – 12 inches below ground surface

For the identification of the horizontal extent of contaminated soils, the test pit and sample identification protocol was modified. These points were located during the investigation and were not staked in advance. The approximate test pit location was determined by the field crew by measurement from the nearest staked test pit and a field direction was added relative to the nearest test pit identifier. For example, if the horizontal extent was staked 85 feet north of the test pit 03-008, the horizontal extent will be identified as 03-008N where the “N” indicates the cardinal direction from the original staked test pit.

For areas not conducive to grid sampling, the sample crew located the test pits based on observed conditions (such as historic oxbows or channels) as described above. In this case, the sampling crew marked and placed lath according to the scheme described above.

2.3 Test Pit Surveying

Prior to performing the field sampling, the initial test pit location for gridded areas were staked and labeled using survey-grade GPS methods. Once the sampling investigation was completed, the surveyor returned to the project areas and surveyed the actual location of all the test pits, the initial test pits and any additional test pit locations that were identified during the field activities.

Survey data collected included test pit designation, northing, easting and elevation. The accuracy of the survey was to within 1-foot horizontal and 0.1-foot vertical. Survey data were collected and presented in the Montana State Plane NAD 83 coordinate system international feet and elevations were based on North American Vertical Datum (NAVD 1988). The survey data are presented in Table B included in Appendix A.

2.4 Test Pit Excavation

All field activities were conducted under a Health and Safety Plan included in the Addendum SAP (CDM Smith, 2014). Test pits were excavated with a track-mounted excavator. The test pits were excavated preserving the test pit location and designation stake described in Section 2.2. The test pits was excavated to an average depth of four (4) feet. One wall of the test pit was prepared for evaluation and sampling as described in Section 2.6. Excavated materials were stockpiled a minimum of three (3) feet from the edge of the excavation. For pits deeper than four feet, side slopes of the three walls not logged were sloped at an approximate angle of 1.5:1 (H:V) to minimize the possibility of sloughing or cave-ins. In the event that groundwater intrusion affected either sample collection or worker safety, the test pits was dewatered using a centrifugal (trash) pump.

After excavation of each test pit, the general lithology of one of the test pit sidewalls was logged. A general soil log included depths of soil horizons, visual interpretation of the depth of contamination, and depth to groundwater. Photographs of the test pit wall and corresponding survey stake were taken. Visual and lithological information was recorded on field log sheets which are included on a DVD in Appendix B. Photos are included on a DVD in Appendix C.

2.5 Sampling Method

Sampling was conducted in accordance with the Clark Fork River Standard Operating Procedures included in the SAP Addendum (CDM Smith, 2014). Upon completion of the test pit excavation, the test pit sidewall was scraped clean of visual residue with a decontaminated shovel or trowel. Soil samples were collected continuously in 6-inch intervals along the vertical scraped wall, beginning at the base of the test pit, proceeding upward, and ending at the ground surface. Sampling in this fashion prevented the soil from falling down onto the lower layers to be sampled. The sampling intervals were measured from the ground surface. The samples were collected and homogenized in Ziploc plastic bags.

Soil samples were field analyzed with an XRF in accordance with EPA Method 6200 (EPA, 2007). EPA Method 6200 provides procedures for both direct readings and readings of a field prepared sample. Direct readings were used for screening purposes.

Some test pits were excavated to depths below groundwater elevation. If the amount of groundwater entering the test pit caused sidewall instability, sampling began as close to the base of the test pit as practical while dewatering the excavation. If it was evident through visual observation and field XRF measurements that impacted material extended below the depth of which the sloughing occurred, sampling was performed with the excavator bucket.

In order to determine the extent of contamination for slickens, tailings/impacted soils and preserve vegetation areas, the following sampling procedure was followed:

1. If a test pit located at the outer boundary of the test pit grid showed COC contamination above 1,000 mg/kg (XRF reading), an additional test pit (step-out) was marked in a cardinal direction. The additional test pit was typically located 125 feet from the outermost impacted test pit, with the distance occasionally adjusted due to changes in ground elevation or site obstacles.
2. The additional test pit was excavated, sampled, and field screened with an XRF using the procedures described above.
3. If COC concentrations were above 1,000 mg/kg (XRF readings) for the 12 to 18-inch or deeper intervals, additional step-out test pits were performed in the same general direction.
4. If COC concentrations were above 1,000 mg/kg for the 0 to 6 and 6 to 12-inch intervals, the total arsenic readings were evaluated. If arsenic levels in either sample interval exceeded 500 mg/kg (the Rancher/Farmer risk-based action level for the Clark Fork River OU of 620 mg/kg, plus a safety factor), then additional step-out pits were performed in the same general direction.
5. If the XRF arsenic readings were below 500 mg/kg and the total COC concentrations were above 1,000 mg/kg in the 0 to 6 and 6 to 12-inch intervals, the area was considered adequately characterized and no further step-out test pits were performed.

2.6 Selection of Samples for Laboratory Analysis

Upon completion of soil sampling from the test pits, samples were selected for analysis. Three 6-inch interval samples that bracketed the tailings/soil interface (one above the 6-inch interval where total COC's XRF readings were greater than 1,000 mg/kg and, two below) were submitted to Energy Laboratories, Inc. in Helena Montana for laboratory analysis. In the event that coarse alluvium was encountered at the maximum depth of the test pit and field XRF screen values were above the 1,000 mg/kg combined COC criteria, the two deepest samples were submitted for laboratory analysis.

The samples submitted to the laboratory were analyzed for total metals and saturated paste pH, as described in Section 2.9. All remaining samples were archived as described in Section 2.12 and were available for further laboratory analysis.

The laboratory results were then compared to the XRF reading and if the lower interval laboratory result was still above 1,400 mg/kg, the next lower sample interval was sent to the laboratory for analysis. This procedure was repeated until the lower sample result was below 1,400 mg/kg or the sample log indicated that alluvium was encountered at that interval.

2.7 Equipment Decontamination

All sampling equipment was decontaminated using a soap and tap water rinse prior to collecting each sample. Gross contamination was removed from any hand tools used to prepare the test pit sidewalls.

2.8 Field Documentation

All significant observations, measurements, relevant data and results were clearly documented in the field logbook in indelible ink according to the methods and procedures specified in CFRSSI SOP-G-4. This included the following:

- Lithologic logs of the test pits indicating material types (i.e., sand, silt), color, and other observations (i.e. presence of roots, wood, or debris) (The lithologic logs were recorded on separate log sheets and not in the field logbook);
- Presence of visually discernable impacted material;
- Results of XRF field screening;
- Depths from the ground surface to all soil horizons and total depth of the boring;
- Sample location descriptions and designations;
- Photographs of selected sample locations to aid data recording and documentation efforts; and,
- Abnormal occurrences and other relevant observations.

The lithologic logs, photographs, and field logs are included in Appendices B, C and D.

2.9 Laboratory Analysis

Samples were analyzed for parameters as presented in Table 2-1. Table 2-1 shows the parameters and the respective method of analysis. The samples were submitted to Energy Laboratory in Helena, Montana for analysis of saturated paste pH, arsenic, cadmium, copper, lead and zinc, the contaminants of concern (COC).

Table 2-1. Parameters for Laboratory Analysis Clark Fork River Operable Unit.

Parameter	Test	Method
Total Metals (As, Cu, Cd, Pb, Zn)	ICP-AES	EPA Contract Laboratory Program Statement of Work, Multi-Media, Multi Concentration, Inorganic Analytical Service for Superfund (ILM05.4)
pH	Saturated Paste Extract	USAD Handbook 60, Methods 2, 3a, CFRSSI SOP SS-09 modified ¹

¹ CFRSSI SOP-09 will be modified: pH will be determined using a minimum of 16-hour equilibration time and vacuum extraction of the saturated paste extract, rather than a 1:1 soil:water dilution.

2.10 Sample Handling

Upon completion of sampling activities at each location, the collected samples were packaged for shipping. For all samples analyzed, the sampler labeled the sample with an indelible marker, recorded the sample designation on a field XRF log sheet. The samples were later recorded on a chain-of-custody form as specified in CFRSSI SOP G-7. Sample labels clearly presented the sample designation,

date, and time. Sample designation labels were completed in the field, prior to transport of the samples to the analytical laboratory.

A copy of the chain-of-custody record accompanied the samples during shipment. It served as the laboratory request form and specified the type of analysis requested for each individual sample. The original form was maintained with the field notes and records. Copies of the chain-of-custodies are included with the laboratory data sheets in Appendix E.

2.11 Field Quality Control

Field quality control samples were collected as outlined in the *Sampling and Analysis Plan (SAP) soils and Wastes Chemical Characterization for Remedial Design/Remedial Action* (CDM, 2009).

- Field Blank Samples – analyzed at a frequency of at least 1 per 20 natural samples
- Cross Contamination Blank Samples – analyzed at a frequency of at least 1 per 50 natural samples, or minimum of one per week
- Field Duplicate Samples – analyzed at a frequency of 1 per 20 natural samples
- Matrix Spikes – analyzed at a frequency of 1 per 20 natural samples

Further discussion of field quality control sampling is provided in Section 3.

2.12 Sample Disposal and Archiving

The samples that were not submitted to the laboratory for analysis are stored in a storage facility, where they will remain there until further analysis is required, if any. If it is determined that the samples are no longer required, they will be disposed of at the site.

Section 3

Investigation Results

This section summarizes the data collected during the soil investigation conducted between October 26, 2014 and February 11, 2015. During this investigation data were collected to determine the nature and extent of soil contamination within the floodplain and banks of the Clark Fork River, Phases 3 and 4.

3.1 Laboratory Data Results

The laboratory results of those samples submitted for laboratory analysis are contained in the electronic database submitted to DEQ in an EQulS compatible format. The sample identification, test pit location, interval and elevation, saturated pH, and metal concentrations as well as laboratory qualifiers are presented in Appendix A, Table A. Table A also indicates if the sample interval passed or failed the COC concentration criteria of 1,400 mg/Kg. When alluvium was encountered, the test pit excavation was terminated because experience has shown that the COC concentration in alluvium is below the COC criteria. In these cases the lower end of the lowest interval was used to delineate the horizontal extend of contamination. Drawings A through C in Appendix F show the test pit location, test pit identification, and depth to the bottom of contamination (based on the 1,400 mg/kg criteria). Appendix A also includes Table B that presents the depth of contamination, elevation of the bottom of contamination, and elevation of groundwater observed during the sampling activities. In those cases where groundwater was not observed, a “NO” entry was made. Appendix B includes a DVD with the test pit boring logs and Appendix D includes copies of the field notes.

3.2 Deviations from the SAP

Deviations from the SAP (CDM Smith, 2014) are listed below.

1. Section 2.1 of the SAP stipulated sampling of test pits vertically until total contaminant concentrations in the sampling interval were less than 1,000 mg/kg (30 percent less than the removal criterion of 1,400 mg/kg). Based on initial sampling results, the difference between XRF readings and laboratory data at times exceeded the expected variance of 30 percent. Therefore, sampling in subsequent test pits was continued until two consecutive samples were less than 1,000 mg/kg.
2. Section 2.2 of the SAP states that additional test pits added to delineate the horizontal extent of contamination would be named by adding both the cardinal direction of the additional pit from the original pit, and the distance from the original pit. This naming procedure was modified to include only the cardinal direction and not the distance (i.e. an additional pit excavated 125 feet north of pit 3-008 would be named 3-008N). The distance from the original pit was recorded in the field logbook. Subsequent additional pits were designated with a number after the cardinal direction (i.e. a second additional pit north of 3-008 would be named 3-008N2. The purpose of this modification was to simplify the alphanumeric sample name in instances where multiple additional pits were excavated relative to an original pit.

3. Section 2.4 of the SAP stipulates to record visual and lithologic information in a field logbook. This information was instead recorded on test pit log field sheets to allow for separation of personnel logging test pits and personnel maintaining logbook control.
4. Section 2.6 of the SAP describes a procedure of taking surface XRF readings to determine additional step-out borings to define the horizontal extent of contamination. A modified procedure (described in detail in Section 2.5 of this document) was used to better define the vertical impacts in step-out borings, and account for impacted areas where contamination at the surface may be less than contamination in near-subsurface soils.
5. Proposed test pits 3-189, 3-209, and 3-213 were not completed because the locations were on islands that were inaccessible to the excavator. Nearby test pit data will be used during the design phase to determine vertical extent of contamination on these islands.
6. Numerous proposed test pits were not completed because the extent of contamination was adequately defined by adjacent test pits. A summary of test pits not completed is as follows:
 - **Phase 3:** 3-044, 3-154, 3-229, 3-249, 3-250, 3-251, 3-270, 3-271, 3-272, 3-290, 3-291, 3-306, 3-307, 3-308, 3-319, 3-320
 - **Phase 4:** 4-007, 4-300, 4-310, 4-311, 4-320

3.3 Quality Control

3.3.1 Field Blanks

Field blank samples were prepared by filling 250 ml containers with analyte-free water. Field blank identification numbers generally followed the naming convention, as discussed in Section 2.2, in which a field blank was used to identify all field blanks followed by a sequential digit of 01 through 144. A total of 144 field blank samples were obtained on the total sample set of 2,837 natural samples. This met the required collection frequency of one for every 20 natural samples. One cadmium result was above the laboratory Practical Quantitation Limit (PQL) at a concentration of 0.014 mg/L. This detected result in the field blank does not negatively impact the project quality objective. Field blank sample analyses are presented in Appendix G.

3.3.2 Cross Contamination Blank Samples

Cross contamination blank samples (rinsate blanks) were collected by pouring de-ionized water across decontaminated field sampling equipment (primarily stainless steel sampling bowls and spoons). Cross contamination blank identification numbers generally followed the previously discussed naming convention, as discussed in Section 2.2, in which a cross contamination blank was used to identify all cross contamination blank followed by a sequential digit of 01 through 58. Rinsate water was collected in a 250 ml container provided by the laboratory (sample water was preserved to a pH <2 with dilute nitric acid) and shipped in coolers containing ice sufficient to maintain the temperature of <5 degrees Celsius. A total of 58 cross contamination blanks were collected on the total sample set of 2,837 natural samples. This met the required collection frequency of one for every 50 natural samples. Results from a few cross contamination blanks exceeded laboratory PQLs for the COCs as follows: six results for arsenic ranging from 0.002 to 0.009 mg/L; 21 results for copper ranging from 0.002 to 0.033 mg/L; five results for lead ranging from 0.002 to 0.008 mg/L; and six results for zinc ranging from 0.01 to 0.03 mg/L. The results from the cross contamination blanks do

not negatively impact the project quality objectives. Cross contamination blank sample analyses are presented in Appendix G.

3.3.3 Field Duplicate Samples

Field duplicate samples were collected at a rate of one duplicate per 20 natural samples in the field. A total of 144 duplicate samples were collected on the total sample set of 2,837 natural samples which exceeds the requirement of 142 duplicates. The proper number of duplicate samples were collected in the field but only selected samples were sent to the laboratory for analysis, not always coinciding with the interval the duplicate sample was collected. In order to offset the number of duplicate samples, natural samples were split and analyzed by the laboratory. Duplicate samples were compared to COC results for their corresponding natural samples and the relative percent difference (RPD) was calculated when both values exceeded five-times the PQL, or absolute value difference (AVD) was calculated when one or both values were less than or equal to the five-times PQL. This analysis was performed in a Microsoft Excel spreadsheet and the results of the analysis are presented in Appendix G. If the RPD was greater than 35 percent or the AVD was greater than the PQL, the duplicate sample value was flagged in the color red in Appendix G. Table 3-1 presents the number and percentage of the duplicate samples that exceeded either the Relative Percent Difference (RPD) or Absolute Difference between Duplicates (AVD) for each constituent.

Table 3-1 Results of Duplicate Sample Comparisons

Constituent	Number of Exceedances	Percent Exceedance(1)
Arsenic	45	31.25%
Cadmium	43	29.86%
Copper	28	19.44%
Lead	65	45.14%
Zinc	39	27.08%
Saturated pH	0	0.00%

Note: (1) Percent based on 144 duplicate samples

The relatively large percentage of exceedances is not unusual for soil sampling although it is probably more severe than in some soil sampling investigations for two reasons:

1. The materials in the floodplain are very heterogeneous consisting of tailings, natural soils and mixed soils/tailings. Although duplicate samples were taken at the same depth as the natural samples, their slightly different positions could produce significantly different metals concentrations due to heterogeneity of the materials.
2. The duplicate comparison results indicate that there is some uncertainty associated with the concentrations of a particular constituent at a given sample depth. The remaining question is how much this uncertainty affected the determination of the extent of contamination. To ascertain this effect, the values of each duplicate sample and its corresponding natural sample were compared to the pass-fail criteria. This information is also presented in Appendix G. We then compared how many disagree (one passed and one failed). This analysis showed that 91 percent of the duplicate-natural sample pairs agree suggesting that the uncertainty in the actual constituents' concentrations had relatively little effect on our ability to determine the extent of contamination.

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Section 4

References

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