COEUR D'ALENE RIVER BASIN

Water Year 2013 BEMP Sediment Sampling Data Summary

PREPARED FOR

United States Environmental Protection Agency
Region X
Seattle, Washington

PREPARED BY

CH2MHILL

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Report

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Prepared for

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Prepared by

CH2MHILL®

Contents

Section **Page**

Acronyms and Abbreviations....v

1.0 Introduction....1-1
1.1 Purpose and Objectives....1-1
1.2 Sampling Program....1-1
1.2.1 Suspended Sediment Program....1-2
1.2.2 Depositional Sediment Program....1-3

2.0 Hydrologic Conditions....2-1
2.1 Precipitation....2-1
2.2 Hydrology....2-1

3.0 Suspended Sediment Data....3-1
3.1 Suspended Sediment Field Observations....3-1
3.2 Suspended Sediment Laboratory Analyses....3-1
3.3 Suspended Sediment Results....3-1
3.3.1 Suspended Sediment Concentration....3-1
3.3.2 Metals Concentration....3-2
3.3.3 Total Lead Flux....3-2

4.0 Depositional Sediment Data....4-1
4.1 Depositional Sediment Field Observations....4-1
4.2 Depositional Sediment Laboratory Analysis....4-1
4.3 Depositional Sediment Results....4-1
4.3.1 Depositional Sediment Particle Size Distribution....4-1
4.3.2 Depositional Sediment Metals Concentration....4-2

5.0 Conclusions....5-1

6.0 References....6-1

Appendixes

A Photo Log
B Deviation Forms
C Analytical Data and Data Validation Reports

Tables

1-1 Sediment Monitoring Program
2-1 Summary of the Flood Peaks in the Coeur d’Alene River Basin
3-1 Suspended Sediment Sample Metals Concentrations by Size Fraction – April 6-7, 2013
3-2 Suspended Sediment Sampling Field Observations
4-1 Depositional Sediment Sampling Field Observations
4-2 Depositional Sediment Particle Size Distribution Results – Post-Spring Runoff
4-3 Depositional Sediment Average Particle Size Distribution by Reach
4-4 Depositional Sediment Total Organic Carbon Concentrations
4-5 Depositional Sediment Metals Concentrations by Size Fraction

Figures

1-1 Sediment Monitoring Program

2-1 WY2012 Hydrograph
3-1 WY2010 through WY2013 Suspended Sediment Concentration
3-2 WY2013 Suspended Sediment Concentration
3-3 Relationship Between SSC and Discharge
3-4 Suspended Sediment Particle Size Distribution
3-5 WY2010 through WY2013 Suspended Sediment Bulk Lead Concentration
3-6 WY2013 Suspended Sediment Bulk Lead Concentration
3-7 Suspended Sediment Bulk Lead Concentration Over Time
3-8 Relationship Between Lead Concentration and Discharge
3-9 Relationship Between SSC and Lead Concentration
3-10 WY2011 through WY2013 Estimated Lead Loading Rate
3-11 WY2013 Estimated Lead Loading Rate
4-1 Summary of Deposition and Erosion at Depositional Sediment Sampling Stations
4-2 Depositional Sediment Sample Particle Size Distribution
4-3 WY2011 through WY2013 Lead Distribution in Depositional Sediment Samples
4-4 Depositional Sediment Sample Lead Concentration by Size Fraction
4-5 Bulk Lead Results in Depositional Samples Over Time
5-1 WY2013 Lead Results by Sample Type
5-2 WY 2010 through WY2013 Lead Results by Sample Type

Acronyms and Abbreviations

µm	micrometer(s)
ARI	Analytical Resources, Inc.
ASTM	ASTM International
BEMP	Basin Environmental Monitoring Plan
CDR	Coeur d'Alene River
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
cfs	cubic feet per second
cm	centimeter(s)
COEC	contaminant of ecological concern
DQO	data quality objective
EcoRA	Ecological Risk Assessment
EPA	U.S. Environmental Protection Agency
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeter(s)
NFCDR	North Fork of the Coeur d'Alene River
NRCS	Natural Resources Conservation Service
NRFC	Northwest River Forecast Center
NWS	National Weather Service
PSEP	Puget Sound Estuarine Protocols
QAPP	*Quality Assurance Project Plan*
ROD	*Record of Decision – Bunker Hill Mining and Metallurgical Complex Operable Unit 3*
SFCDR	South Fork of the Coeur d'Alene River
SPAF	Sample Plan Alteration Form
SSC	suspended sediment concentration
SVL	SVL Analytical, Inc.
SWE	snow water equivalent
TOC	total organic carbon
USGS	U.S. Geological Survey
WY	water year

1.0 Introduction

The purpose of this report is to summarize the 2013 sediment sampling data and analysis, conducted under the Coeur d'Alene River *Basin Environmental Monitoring Plan* (BEMP) – *Bunker Hill Mining and Metallurgical Complex Operable Unit 3* (U.S. Environmental Protection Agency [EPA], 2004), as updated by the BEMP *Quality Assurance Project Plan* (QAPP) (CH2M HILL, 2010) and BEMP Sample Plan Alteration Form (SPAF) (CH2M HILL, 2012a). The BEMP was established under the *Record of Decision – Bunker Hill Mining and Metallurgical Complex Operable Unit 3* (ROD) (EPA, 2002) and includes annual sampling of suspended and depositional sediment to assess long-term status and trends of metals concentration in sediments and to establish a baseline and evaluate the effectiveness of remedial actions. Revisions to the BEMP were made in 2011 and 2012, including modification of sample collection methods and the addition of sampling stations. The sampling data reported in this report were collected in accordance with the BEMP *Quality Assurance Project Plan Addendum* (CH2M HILL, 2011) and BEMP SPAF (CH2M HILL, 2012a).

1.1 Purpose and Objectives

This report presents sediment data collected during water year (WY) 2013 (between October 1, 2012 and September 30, 2013). It supplements data reported previously in the *WY2012 BEMP Sediment Sampling Data Summary* (CH2M HILL, 2013). Similar reports will be prepared annually to support evaluations of sediment and contaminant transport. The information presented in this report is intended to support short- and long-term data needs for remedial actions in the Coeur d'Alene River Basin. Specifically, the sediment data will be used to accomplish the following:

- Assess status and trends of metals concentration in sediment over time
- Enhance the understanding of sediment fate and transport processes
- Assess changes in the characteristics of sediment and sediment transport over time
- Provide data for use in sediment transport models that are being developed for the Lower Basin of the Coeur d'Alene River

Collectively, these data will help support the selection, design, implementation, and effectiveness evaluations of remedial actions addressing contamination throughout the Coeur d'Alene River Basin. The data may also be used in conjunction with other environmental investigations to support restoration activities or other watershed objectives in the Lower Basin.

This report is organized by data type and presents data from the current water year together with previously collected data. Further evaluation of multiple years of data will be performed separately to meet a variety of project objectives; during the recurring 5-year reviews, as required under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA); and for ongoing analysis and modeling of sediment transport processes in the Coeur d'Alene River Basin. The BEMP program employs an adaptive management approach to data collection, consisting of annual program reviews that may support revision of sampling and laboratory procedures to ensure that data quality objectives (DQOs) continue to be met in the future.

1.2 Sampling Program

WY2013 sediment sampling was conducted in accordance the BEMP – *Bunker Hill Mining and Metallurgical Complex Operable Unit 3* (U.S. Environmental Protection Agency [EPA], 2004), as updated by the BEMP *Quality Assurance Project Plan* (QAPP) (CH2M HILL, 2010) and BEMP Sample Plan Alteration Form (SPAF) (CH2M HILL, 2012a). BEMP sediment sampling in the Coeur d'Alene River Basin includes the collection of two types of sediment samples: sediment suspended in the water column (suspended sediment) and sediment deposited on banks near the river channel and in off-channel lake or wetland areas (depositional sediment). Sampling stations for suspended and depositional sediment are located on the South Fork of the Coeur d'Alene River (SFCDR) and Canyon Creek and Ninemile Creek (two tributaries of the SFCDR), the North Fork of the Coeur d'Alene River

(NFCDR), the main stem of the Coeur d'Alene River (CDR), as well as on the Spokane River downstream of Coeur d'Alene Lake (Figure 1-1). For the purposes of this report, the Upper Basin of the Coeur d'Alene River is defined as the SFCDR watershed, and the Lower Basin includes the main stem of the river and its tributaries between the confluence of the NFCDR and SFCDR and Coeur d'Alene Lake. For sampling purposes, the stations at the mouths of the NFCDR and SFCDR are considered part of the Lower Basin because they are direct inputs to the Lower Basin. Table 1-1 summarizes sampling station locations and the sampling performed at each station during WY2013.

1.2.1 Suspended Sediment Program

Suspended sediment sampling is conducted to obtain data on the amount and characteristics of sediment being transported at a given time and location in the river system. Suspended sediment is typically reported as suspended sediment concentration (SSC) in milligrams of sediment per liter of water (mg/L), which can be used in conjunction with event-specific discharge to calculate the sediment discharge rate, or sediment flux (also known as "load"). The BEMP sediment program includes 12 locations for the collection of suspended sediment samples in the Upper and Lower Basins of the Coeur d'Alene River.

As shown in Figure 1-1, six suspended sediment sampling locations (or stations) are located in the Upper Basin: SFCDR near Shoshone Park, mouth of Ninemile Creek, mouth of Canyon Creek, SFCDR near Wallace, SFCDR near Smelterville, and SFCDR near Elizabeth Park. The Shoshone Park station is located upstream of most historical mining activities and is used to assess "background" metals concentrations. The Ninemile Creek and Canyon Creek stations are used to measure the concentrations and characteristics of sediment entering the SFCDR from these two tributaries, where some of the most extensive mining practices and tailings discharges occurred. The Wallace station was added in WY2012 to measure suspended sediment in the SFCDR immediately downstream of these tributaries. The Smelterville and Elizabeth Park stations provide spatial coverage of suspended sediment sampling stations in the SFCDR.

Six suspended sediment sampling locations are located in (or are considered, for sampling purposes, to be part of) the Lower Basin: SFCDR near Pinehurst (mouth of the SFCDR), NFCDR near Enaville (mouth of the NFCDR), CDR near Cataldo, mouth of Latour Creek (a tributary), CDR near Rose Lake, and CDR near Harrison. The Pinehurst and Enaville stations are used to measure the characteristics of sediment entering the Lower Basin from the SFCDR and NFCDR. Latour Creek is the largest tributary discharging directly into the Lower Basin. The Harrison station provides data on sediment characteristics discharging from the Coeur d'Alene River into Coeur d'Alene Lake.

The current BEMP (CH2M HILL, 2011 and 2012a) includes resources for up to four suspended sediment sampling events per year, to coincide with high-flow events when greater amounts of sediment are eroded (or mobilized) and transported in the river system. The BEMP identifies the possibility of high flows occurring from early winter through the spring runoff season. High flows are generally defined as those above flood stage (approximately 20,000 cubic feet per second [cfs]) at U.S. Geological Survey (USGS) gage number 12413500, located on the CDR at Cataldo. The number and magnitude of flood events vary from year to year, but years having more than four discrete events with flows greater than flood stage are uncommon. As outlined in the BEMP, the timing and location of high-flow suspended sediment sampling coincides, where feasible, with surface water quality sampling conducted by USGS in support of the BEMP (EPA, 2004).

Suspended sediment sampling for the BEMP is conducted using standard USGS depth-integrated sampling procedures to sample isokinetically[1] with the equal discharge or equal width increment methods (USGS, 1999a). Two types of sampling devices were used to collect depth-integrated samples of suspended sediment. A crane-operated sampler (D-96A1) was used for larger streams and where bridge crossings allowed its use, while a smaller, hand-held sampler (DH-81) was used for smaller streams. D-96A1 samplers are lowered and raised through the water column at transit rates specific to the depth and velocity measured at each of at least five

[1] The USGS revised criteria for isokinetic sampling using bag samplers (i.e., D-96A1) in the memorandum *Guidelines for FISP Bag Sampler Intake Efficiency Tests and Operational Velocities* (USGS, 2013). Revisions are applicable when sand is present in suspension, and consist of a temperature specific minimum stream velocity for isokinetic sampling. Specific to BEMP sampling, when water temperature is less than 10 degrees Celsius, the minimum velocity for isokinetic sampling is 3.7 feet per second. Additionally, the USGS recommends a sampler efficiency of 75-125% when sand is present.

sampling points along a transect (referred to as a vertical) to obtain samples representative of the vertically averaged sediment concentration throughout the entire cross section of the river. Samples are analyzed for SSC and metals concentration (when sufficient mass is obtained).

The sampling devices are designed to operate efficiently (isokinetic sampling) at stream velocities of 3.7 (when water temperature is less than 10 degrees Celsius and typical of BEMP winter/spring conditions) to 6 feet per second (D-96A1) and 1.5 to 7 feet per second (DH-81). Sampling outside of these ranges may result in a sampling efficiency outside the recommended range (75-125 percent) and subsequent bias error of the SSC data, depending on the presence of particles greater than 63 microns (i.e., sand). Other factors affecting sampler efficiency include water temperature, nozzle design, sampler orientation relative to the flow, and sample volume relative to that of the container (USGS, 2013). Some of the WY2013 suspended sediment samples were collected at velocities outside the specified range for the sampler. High river velocities (greater than 6 feet per second) at sampling locations (typically bridge crossings) were an issue primarily in the Upper Basin and at the Enaville station, where steeper gradients and a constrained channel create higher flow rates. Low river velocities (below 3.7 feet per second) were measured at all Rose Lake and Harrison sampling verticals and at a portion of Cataldo and Pinehurst sampling verticals. Sampler efficiency tests were conducted at the lower velocity verticals at Pinehurst and Cataldo. Test results indicate non-isokinetic sampling at an efficiency of 60-70 percent and the potential to bias the sand component high.

Sediment concentration is measured by ASTM International (ASTM) Method 3977B (ASTM, 2007a). Analysis is performed for seven metals (arsenic, cadmium, copper, lead, mercury, silver, and zinc) determined by the Ecological Risk Assessment (EcoRA) (EPA, 2002) to be contaminants of ecological concern (COECs) in sediment. Arsenic, cadmium, copper, lead, silver, and zinc concentrations are evaluated using EPA Methods 200.7/EPA7475; mercury concentration is evaluated using EPA Method 245.5M. Although all metals results are included in this report, lead results are of particular interest because lead is the primary risk driver for human and ecological health in the Lower Basin.

If sufficient sediment sample mass is available, analyses of the mass of separate particle size fractions and the concentrations of metals in each size fraction may be conducted for two discrete size fraction categories: clay and silt (<63 micrometers [μm]) and fine sand (63 to 250 μm). Metals analyses are performed on bulk sediment samples as well.[2] Particle size is an important factor in the dynamics of sediment erosion and transport, as well as in the depositional patterns of sediment particles and the concentrations of metals they contain.

1.2.2 Depositional Sediment Program

Depositional sediment sampling is conducted from within-bank areas and floodplain locations to provide data on the amount and characteristics of sediment deposited by high-flow events. The resulting data are indicative of the physical and chemical characteristics of sediment deposited after a given high-flow event and can be used to assess potential risk to human and ecological receptors in these areas. Depositional sediment samples are collected annually following the spring runoff, but samples may also be collected following large winter floods to assess the characteristics of sediment from such events (before the deposited material is disturbed by subsequent flooding).

Five near-channel depositional sampling stations are located in the Upper Basin (Shoshone Park, mouth of Canyon Creek, mouth of Ninemile Creek, Smelterville, and Elizabeth Park) (Table 1-1). As with suspended sediment sampling, the sampling stations at Ninemile Creek and Canyon Creek are used to measure the physical and chemical characteristics of sediment entering the SFCDR from two of the most contaminated tributaries. Sampling stations in the Lower Basin include 10 within-bank or near-channel locations (Pinehurst [SFCDR below Pine Creek], Enaville, Cataldo, Cataldo Dredge Site, Dudley East, Dudley, Bull Run Bridge, Rose Lake, Black Rock Trailhead, and Harrison). The Pinehurst station is used to measure physical and chemical characteristics of sediment from the SFCDR, and the Enaville station is used to measure characteristics of sediment from the NFCDR. The Cataldo

[2] Metals analyses for bulk samples are performed in accordance with EPA Method 200.7, which requires screening of the sample and analysis of all material passing a 4.75-millimeter (mm) mesh. Therefore, bulk sample results are representative of material ≤4.75 mm (gravel), which typically includes all the grains in suspension.

Dredge Site, Dudley East, and Bull Run Bridge stations were added to the depositional sediment monitoring network for WY2012, as documented in the SPAF (CH2M HILL, 2012).

Six off-channel locations are used to assess sediment deposition rates and characteristics in shallow lakes and wetlands (Lane Marsh, Killarney Lake, Strobl Marsh, Rainy Hill, Bare Marsh, and Anderson Lake). These stations provide data on material deposited in wildlife habitat areas and can be used as a measure of sedimentation rates and risk characteristics associated with specific flood events. One additional near-channel depositional sampling station is located downstream of Coeur d'Alene Lake and Post Falls Dam on the Spokane River (Figure 1-1). This sampling location is used to assess the physical and chemical characteristics of sediment carried beyond Coeur d'Alene Lake.

Depositional samples are collected using one of two methods, depending on whether they are "near-channel" or "off-channel" areas. At near-channel locations, stakes (with rulers attached) are installed during low water conditions in the fall. The amount of sediment deposition or erosion near each stake is measured after the flood waters recede. The sediment sample is collected only to the elevation of the surface as measured the previous autumn so that the samples collected contain only newly deposited material. In off-channel areas, "tiles" of plywood or ceramic are staked to the ground and the depth of material deposited on these tiles is recorded before sediment is collected for analysis. As with suspended sediment samples, depositional samples are analyzed for particle size distribution and concentrations of the COEC metals. Metals analyses are conducted for each defined size fraction (as discussed for suspended samples), if sufficient sample mass is available.

2.0 Hydrologic Conditions

Mean daily peak discharges of the three largest flood events in the Coeur d'Alene River Basin during WY2013 are summarized in Table 2-1. Elevated discharge in the winter and early spring typically results from heavy rain, or from rain falling on accumulated low-elevation snow. WY2013 was characterized by a series of relatively small (<10,000 cfs), short duration "rain-on-snow" events between mid-March and mid-May 2013. Spring peak discharge is commonly a longer duration event because it is primarily driven by snowmelt from higher elevations and typically occurs between late April and early June. The peak discharge at Harrison for WY2013 occurred April 7, 2013 with a peak flow of 14,100 cfs.

2.1 Precipitation

Rainfall and snowpack are significant variables in determining the magnitude and timing of major discharge events in the basin. The mean annual precipitation observed at the National Weather Service (NWS) Kellogg Station (Station 104831) in the Upper Basin is approximately 33.87 inches based on the 1981–2010 period of record, with a low of 19.08 inches in 1952 and a high of 47.99 inches in 1996 (Western Regional Climate Center, 2012). Much of this precipitation occurs as snow in the Coeur d'Alene River Basin, typically from November through April.

Annual precipitation for WY2013 recorded at the NWS Kellogg Station in the Upper Basin was 35.57 inches, approximately 1.7 inches more than the historical average. The snow water equivalent (SWE) for WY2013, as recorded by the Natural Resources Conservation Service (NRCS) at Lookout Ski Resort (located in the SFCDR headwaters), peaked on March 26, 2013, at 23.2 inches.

2.2 Hydrology

Seven real-time USGS gauging stations are located throughout the Coeur d'Alene River Basin. A single runoff event was sampled in WY2013, April 6-7, 2013. The locations and peak daily discharge rates for the gauging stations are shown in Table 2-1. The runoff event did not achieve flood stage at Cataldo and was slightly less than a 2-year recurrence interval flow. The hydrograph for WY2013 is shown in Figure 2-1, which also shows the timing of the suspended sediment sampling events for stations with USGS gauges.

3.0 Suspended Sediment Data

3.1 Suspended Sediment Field Observations

Suspended sediment sampling was conducted during a single high-flow event in WY2013. Samples were collected close to the highest flows occurring during the season on April 6-7, 2013. Sampling objectives are to collect samples at all stations as close to peak flow as is logistically possible with available resources. Figure 2-1 shows the timing of sampling relative to the hydrograph. Given the short during of the flood peak, three Lower Basin stations (Cataldo, and Harrison, Rose Lake), two representative stations in the SFCDR (Pinehurst and Shoshone Park), the NFCDR station (Enaville) and tributary stations (Canyon Creek and Ninemile Creek) were sampled. Latour Creek was not sampled during WY2013 because previous sampling at higher flows resulted in suspended sediment mass too low for metals analysis.

Suspended sediment concentration results by station location are shown in Figures 3-1 (which includes data from WY2010 through WY2013) and 3-2 (which shows data only from WY2013). Table 3-1 presents SSC and metals concentrations by size fractions for all the samples collected during the WY2013 sampling events. Field measurements and observations are presented in Table 3-2. Photographs of suspended sampling stations are provided in Appendix A.

Suspended sediment sampling was conducted in accordance with the standard USGS methods specified in the QAPP Addendum (CH2M HILL, 2011) to the extent feasible. However, challenges were encountered during some events at some stations, and deviations from the BEMP QAPP and associated addendums (CH2M HILL 2004; 2010, 2011, 2012a) are presented in Table 3-2 and described in Appendix B.

3.2 Suspended Sediment Laboratory Analyses

Suspended sediment samples were processed and analyzed by SVL Analytical, Inc. (SVL) of Kellogg, Idaho. Each suspended sediment sample consisted of 15 to 20 gallons of water. Samples were transported to the laboratory in decontaminated 5-gallon rigid polyethylene containers. Determination of SSC was made in accordance with ASTM Method 3977B (ASTM, 2007a). Analysis for metals content (excluding mercury) was performed using EPA Method 200.7 (EPA, 1982). Mercury analysis was performed using 245.5M/EPA7475. Samples were sieved to obtain the mass of material in each size classification and to provide material for metals analysis by size classification. However, samples were not analyzed for full particle size distribution as planned because inadequate sample mass was available to perform all the separate analytical procedures. Laboratory data were validated and both the laboratory reports and data validation reports are provided in Appendix C.

3.3 Suspended Sediment Results

Bulk and size-specific SSC and metals concentrations were measured for all samples collected during WY2013. Results are presented in Table 3-1.

3.3.1 Suspended Sediment Concentration

Bulk and size-specific SSC were measured for all suspended sediment samples. Figure 3-1 presents the bulk SSC results from WY2010 through WY2013, and Figure 3-2 presents bulk SSC results for WY2013 only. The highest recorded SSC recorded to date under the BEMP, by a factor of more than 2, was measured at Harrison during the January 2011 flood. This was also the largest discharge (Q) (Q = 33,000 cfs at Cataldo and Q = 20,700 cfs at Harrison) measured since implementation of the suspended sediment program. During WY2013, the highest SSC was measured at Harrison on April 7, 2013, WY2012 (Q = 19,000 cfs at Cataldo and Q = 12,800 cfs at Harrison).

SSC in the Lower Basin is generally lowest at Cataldo, below the confluence of the NFCDR and SFCDR. These data are assumed to reflect the mostly cobbled riverbed between the confluence and Cataldo, which supplies little local sediment capable of being suspended. Downstream of Cataldo, SSC increases downstream at Rose Lake, with the highest SSC observed at Harrison, near the mouth of the river.

The relationship between SSC and discharge appears to be site specific and influenced by several factors, including flood type and location on the hydrograph (rising limb, peak, or falling limb). The BEMP data set attempts to control for these factors by collecting suspended sediment samples during spring runoff season at the hydrograph peak (or as close to peak as practicable). Figure 3-3 presents the relationship between SSC and discharge at four stations: Pinehurst (SFCDR), Enaville (NFCDR), Cataldo (approximately 5 miles downstream from the confluence of the SFCDR and NFCDR), and Harrison (mouth of the main stem). The BEMP data set shows strong to moderate positive correlations between SSC and discharge for samples collected at Pinehurst ($R^2 = 0.72$), Enaville ($R^2 = 0.84$), Cataldo ($R^2 = 0.85$), and Harrison ($R^2 = 0.54$) (Figure 3-3).

Figure 3-4 presents particle size distribution for suspended sediment samples collected in WY2013. Particles are generally in the fine (silt/clay) and fine sand size ranges.

3.3.2 Metals Concentration

Bulk and size-specific metals concentrations were measured for all samples collected during the April 6-7, 2013 suspended sediment sampling event in WY2013. Results are presented in Table 3-1. Lead presents the greatest risk to ecological and human receptors in the Coeur d'Alene River Basin, and this report therefore focuses on lead data.

Figure 3-5 presents bulk lead results for WY2010, WY2011, and WY2012. Figure 3-6 presents bulk lead results for WY2013 only. The highest concentration of lead in 2011 suspended sediment sampling was measured in Ninemile Creek, an Upper Basin tributary to the SFCDR.

Within the Upper Basin, Shoshone Park (located upstream of historical mining operations) has consistently showed low metals concentrations. Samples collected at the mouths of Ninemile and Canyon Creeks, where extensive mining and milling occurred, have consistently contained high metals concentrations. To date, the average metals concentrations within the SFCDR stations downstream of Canyon Creek have remained relatively stable, ranging from 2,143 milligrams per kilogram (mg/kg) at Smelterville to 2,820 mg/kg at Elizabeth Park. During WY2013, suspended sediment samples were not obtained at Elizabeth Park and Smelterville; however, the lead concentration at Pinehurst was similar to previous sampling results.

Within the Lower Basin, average lead concentrations have ranged from 1,045 mg/kg at Cataldo to 3,515 mg/kg at Harrison. WY2013Lead concentrations measured in WY2013 at Lower Basin stations were both above and below average, depending on the station; results for Harrison and Rose Lake were well above average, while concentrations of lead at Cataldo were below average. Downstream of Cataldo, lead concentrations increase in the downstream direction, reflecting mobilization of contaminated sediment stored within the CDR bed and banks. At Harrison, metals concentrations approach values typical of the SFCDR. This general pattern of increasing contaminant concentrations through the Lower Basin appears to occur independently of the flow rate and corresponds with the longitudinal SSC patterns. Although the downstream increase in Lower Basin lead concentrations is generally consistent from one event to another, the absolute value of the lead concentrations has varied by individual sampling events.

Lead concentrations are consistently highest at Harrison, relative to Cataldo (Figure 3-7). Suspended sediment lead concentrations are variable by individual sampling event but appear to be relatively stable (Figures 3-7, 3-8, and 3-9). Evaluations of trends will be explored as the BEMP data set expands each water year.

3.3.3 Total Lead Flux

The lead flux (or discharge rate, also known as "load") was calculated for each station. Lead flux is the product of the lead content in suspended sediment, the SSC, and the discharge rate of water and is expressed as tons of lead per day. Note that the discharge is estimated from the time of sampling (based on discharge measurements collected concurrently with sampling or from stream gage data obtained from the USGS). It is important to note that flux combines SSC and lead data obtained during the several hour period of sediment sampling with daily average flow rates (when USGS gage data are used). Thus, the calculation assumes that the flow at the time of sampling is approximately equal to the mean flow rate during the day that the sample was collected. In other words, the actual computed flux is the product of instantaneous measurements of SSC and lead and the mean daily flow rate. Lead loading is consistently highest at the Harrison station, driven by higher values of both SSC and lead concentrations relative to upstream stations (Figure 3-10 and 3-11).

4.0 Depositional Sediment Data

4.1 Depositional Sediment Field Observations

Depositional sediment sampling (described previously) was conducted as soon as practicable after floodwaters receded at each sampling station. On May 14 and 15, 2013, samples were collected in low-elevation Upper Basin stations (Elizabeth Park, Smelterville, and Pinehurst), Lower Basin stations (Cataldo Dredge Site, Dudley East, CDR near Bull Run Bridge, Dudley, Rose Lake, and Harrison), and some off-channel stations (Strobl Marsh and Lane Marsh). On June 14, 2013, samples were collected from the NFCDR station (Enaville), two Lower Basin station (Cataldo and Black Rock Trailhead), and the remaining Upper Basin stations (Shoshone Park, Ninemile Creek, and Canyon Creek). On June 17, 2013, samples were collected from the Spokane River station.

Table 4-1 presents field observations at each of the depositional stake and tile locations, and Figure 4-1 presents the amount of deposition or erosion observed at each station. Some sediment deposition or erosion was apparent at each of the depositional sampling stations, and sample recovery was conducted at each. Net erosion was documented at several Upper Basin stations, including Pinehurst and Elizabeth Park. In previous years, net deposition has been observed at the Harrison station; however in WY2013, net erosion was observed, with nearly 6 centimeters (cm) of erosion recorded at three of four stakes.

Photographs of each depositional sampling station are provided in Appendix A. There were no significant deviations from the BEMP QAPP Addendum (CH2M HILL, 2011) or Sampling Plan Alteration Form (CH2M HILL, 2012).

4.2 Depositional Sediment Laboratory Analysis

Analysis for particle size distribution was performed by Analytical Resources, Inc. (ARI) of Tukwila, Washington. Particle size distribution analysis was conducted by ASTM D422 (ASTM 2007c), with a modification to include a 63-µm sieve (ASTM No. 230); all sample material passing through the 75-µm sieve (ASTM No. 200) was passed through a 63-µm sieve (ASTM No. 230), and hydrometer analysis was conducted on sample mass passing through the 63-µm sieve. This modification was made so particle size results were consistent with size-specific metals results. Data validation was conducted by CH2M HILL, and the validation results are provided in Appendix C.

Total organic carbon (TOC) analysis was also conducted according to Puget Sound Estuarine Protocols (PSEP) at two off-channel depositional sampling locations, and one in-channel location (Spokane River) where field observations indicated significant organic material in sediment samples.

Metals analyses (including mercury) were performed by the EPA Region 10 Manchester Environmental Laboratory on bulk, silt/clay, and fine sand sized fractions. Data validation was conducted by CH2M HILL, and the validation results are provided in Appendix C.

4.3 Depositional Sediment Results

4.3.1 Depositional Sediment Particle Size Distribution

Table 4-2 and Figure 4-2 present the particle size distribution results for depositional samples collected in WY2013. In general, a higher proportion of coarse- and medium-grained sediment was observed in the SFCDR and NFCDR stations, compared with the stations in the Lower Basin. This observation is consistent with the steeper gradients and higher stream velocities in the upper reaches; however, the grain size of sediment deposited at each stake location may be affected as much by local hydraulics around the stake as by reach-scale characteristics. Samples collected in off-channel Lower Basin stations did not yield adequate sample mass for grain size analysis (Table 4-3).

Table 4-4 presents the TOC results for samples collected at Strobl Marsh, Lane Marsh, and Spokane River. The highest TOC, 16.0 percent, was observed at Lane Marsh.

4.3.2 Depositional Sediment Metals Concentrations

Bulk and size-specific metals concentrations were measured for all samples collected from depositional sediment sampling in WY2013 (Table 4-5). Figure 4-3 presents bulk lead results to date. A similar longitudinal pattern of lead concentrations was observed for each of the depositional sampling events to date.

Low concentrations of lead (believed to be representative of background concentrations) are consistently measured at Shoshone Park, upstream from most of the historical mining activity. Lead concentrations increase downstream of Ninemile and Canyon Creek tributaries and are highest in the SFCDR at Elizabeth Park.

Within the Lower Basin, lead concentrations are slightly lower at Cataldo than on the SFCDR at Pinehurst—though not as much as might be expected based on the assumed dilution from the NFCDR—then increase in the downstream direction to concentrations at or above those observed on the SFCDR. This increase in lead concentrations is generally consistent with the pattern in the suspended sediment data. The depositional sampling stations added in WY 2012 (Cataldo Dredge Site, Dudley East, and Bull Run) suggest that this increase occurs over a relatively short distance (approximately 3 river miles) between the Cataldo Dredge Site and Dudley East. Lead concentrations remain relatively high between Dudley and Black Rock Trailhead.

There are no near-channel depositional sampling stations for nearly 20 miles, between Black Rock Trailhead and Harrison. However, there are four off-channel sampling stations in this stretch of the Lower Basin, two of which (Lane Marsh and Strobl Marsh), were sampled in WY2013. Lead concentrations in off-channel areas appear highly variable by sampling event and by station. Historically, the highest off-channel bulk lead concentrations have been detected at Rainy Hill and Anderson Lake. Downstream of these off-channel sampling stations, at Harrison, near-channel lead concentrations have been somewhat lower relative to upstream concentrations.

Figure 4-4 presents the size-specific metals results for depositional samples. Higher concentrations of lead were detected in the finer fractions for the in-channel samples collected throughout the Lower Basin. However, this same pattern is not evident for the off-channel samples, in which the three size-specific metals concentrations seem to be approximately the same.

Figure 4-5 shows metals concentrations in depositional samples over time. Over the four years of BEMP depositional data collection, lead concentrations appear relatively stable, with few exceptions (Figure 4-5). For a given site, the pattern of metals in near-channel or in-channel depositional areas does not show a clear trend; however, the metals concentrations from the January 2011 event show substantial departures from the overall pattern. In some locations, the January 2011 data show lead enrichment compared with the overall average; in other locations, the January 2011 data are less contaminated.

5.0 Conclusions

As stated in Section 1.0, the purpose of this report is to document field activities and analytical results for the BEMP sediment sampling program. The report includes historical data (since 2010) and data from WY2013. Suspended and depositional sediment data will be used to support project objectives, analyze status and trends, and support understanding of sediment transport dynamics. In addition, these data will be used to support modeling of sediment transport processes in the Coeur d'Alene River Basin. Data will also be used for 5-year reviews of remedy effectiveness as required by CERCLA.

WY2013 was characterized by generally low to average flow conditions throughout most of the winter. The BEMP program sampled one moderate flow event in April that was slightly below flood stage. Depositional sediment sampling was conducted following the spring runoff.

The following conclusions provide a general summary of the data collected for WY2013. :

- Consistent with previous sampling results, the lowest concentrations of lead in suspended and depositional sediment samples were observed at the upstream Shoshone Park station. Lead concentrations detected at Shoshone Park were characteristic of river sediment upstream of significant historical mining impacts and are considered to represent approximate background conditions. Metal concentrations in suspended and depositional sediment from the mouth of the NFCDR near Enaville also showed relatively little impact from mining activity.
- The highest concentrations of lead in suspended sediment in the WY2013 dataset was observed at Ninemile Creek (5,770 mg/kg), with the second highest concentrations of lead observed at Harrison (4,290 mg/kg) (Figure 5-1). The highest concentrations of lead in depositional sediment in the WY2013 data set were at Dudley East (4,230 mg/kg) (Figure 5-1). These data area were also provided in the context of data from previous years in Figure 5-2.
- The highest lead load was observed at Harrison (approximately 23 tons/day on April 7, 2013) (Figure 3-11). This value is largely attributable to higher SSC values, coupled with higher lead concentrations and flow at the mouth of the river.
- Compared with both upstream and downstream samples, lead concentrations were relatively low in the depositional and suspended sediment samples collected at the Cataldo station. These concentrations were lower than those upstream on the SFCDR but higher than those on the NFCDR. The relatively low lead concentrations near Cataldo appear to be the result of dilution of SFCDR sediment with cleaner sediment from the NFCDR and the cobbled river bottom in this reach, which does not store significant amounts of sediment from historical releases. Downstream of Cataldo, lead concentrations in both suspended and depositional sediment increased to levels above SFCDR levels—indicating that lead is being mobilized from within the CDR channel.
- New depositional sampling stations were sampled for the second time in WY2013. Results indicate that concentrations of lead immediately downstream of the Cataldo Dredge Site are similar to Cataldo. However, about 1 river mile downstream of the Dudley Scour Hole concentrations of lead in depositional sediment increase rapidly. This pattern supports the conceptual model of recruitment of previously deposited sediment from the riverbed (and, to a lesser degree, riverbanks) that contains higher concentrations of metals and subsequent downstream transport and deposition of this sediment.

6.0 References

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Tables

TABLE 1-1
Sediment Monitoring Program
WY2013 BEMP Sediment Sampling Data Summary

Station Location Description	BEMP Station ID	Analysis			Sample Date(s)
Suspended		**MET**	**PSD**	**SSC**	
SFCDR above Canyon Creek at Shoshone Park	SF-BSED-S-001	x	--	x	4/6/13
Mouth of Canyon Creek at CDA Trail Bridge	CC-BSED-S-002	x	--	x	4/6/13
Mouth of Ninemile Creek at Culvert	NM-BSED-S-005	x	--	x	4/6/13
SFCDR at Wallace	SF-BSED-S-201	--	--	--	--
SFCDR near Elizabeth Park at Park Road Bridge	SF-BSED-S-006	--	--	--	--
SFCDR near Smelterville at Theater Bridge	SF-BSED-S-007	--	--	--	--
SFCDR near Pinehurst (below Pine Creek)	SF-BSED-S-009	x	--	x	4/6/13
NFCDR near Enaville at Old River Road Bridge	LC-BSED-S-010	x	--	x	4/6/13
CDR near Cataldo at Riverview Road Bridge	LC-BSED-S-011	x	--	x	4/6/13
Latour Creek at East Dudley Road Bridge	LC-BSED-S-013	--	--	--	--
Rose Lake at Bull Run Road Bridge	LC-BSED-S-012	x	--	x	4/7/13
CDR near Harrison at Springston Bridge	LC-BSED-S-014	x	--	x	4/7/13
Depositional		**MET**	**PSD**	**TOC**	
SFCDR above Canyon Creek at Shoshone Park	SF-BSED-D-001	x	x	--	6/14/13
Mouth of Canyon Creek	CC-BSED-D-002	x	x	--	6/14/13
Mouth of Ninemile Creek	NM-BSED-D-005	x	x	--	6/14/13
SFCDR near Elizabeth Park	SF-BSED-D-006	x	x	--	5/15/13
SFCDR near Smelterville	SF-BSED-D-007	x	x	--	5/15/13
SFCDR near Pinehurst	SF-BSED-D-009	x	x	--	5/15/13
NFCDR near Enaville above Confluence	NF-BSED-D-010	x	x	--	6/14/13
CDR near Cataldo below Confluence	LC-BSED-D-011	x	x	--	6/14/13
Cataldo Dredge Site	LC-BSED-D-201	x	x	--	5/15/13
Dudley East	LC-BSED-D-202	x	x	--	5/15/13
CDR Near Bull Run Bridge	LC-BSED-D-203	x	x	--	5/14/13
Dudley	LC-BSED-D-101	x	x	--	5/14/13
Black Rock Trailhead	LC-BSED-D-102	x	x	--	6/14/13
Rose Lake	LC-BSED-D-012	x	x	--	5/14/13
Lane Marsh	LC-BSED-D-103	x	--	x	5/14/13
Strobl Marsh	LC-BSED-D-104	x	--	x	5/14/13
Killarney Lake	LC-BSED-D-105	--	--	--	--
Rainy Hill	LC-BSED-D-106	--	--	--	--
Bare Marsh	LC-BSED-D-107	--	--	--	--
Anderson Lake	LC-BSED-D-108	--	--	--	--
CDR near Harrison	LC-BSED-D-014	x	x	--	5/14/13
Spokane River near Stateline	SR-BSED-D-109	x	--	x	6/17/13

NOTES:
MET = Metals: arsenic, cadmium, copper, lead, mercury, silver, and zinc concentrations within bulk (≤4,750 micrometers [µm]), fine sand (63-250 µm), and silt/clay (<63 µm) fractions.
PSD = particle size distribution
SSC = suspended sediment concentration
TOC = total organic carbon (samples submitted for TOC when field observations indicated significant organic material in sediment sample)
-- = sample planned but not collected
NFCDR = North Fork Coeur d'Alene River
SFCDR = South Fork Coeur d'Alene River
CDR = Coeur d'Alene River

TABLE 2-1
Summary of the Flood Peaks in the Coeur d'Alene River Basin
WY2013 BEMP Sediment Sampling Data Summary

Location	USGS Gage Station	WY 2013			Historical Average Peak Flow (cfs)	Period of Record
		Flow (cfs)	Date of Peak	Date of Suspended Sediment Sampling		
Shoshone Park	--	NM [2]	NM [1]	4/6/13	--	--
Canyon Creek	12413125	153	4/6/13	4/6/13	458	1999 – 2012
Ninemile Creek	12413130	NM [2]	NM [1]	4/6/13	147	1999 – 2012
Wallace	--	NS	NS	NS	--	--
SFCDR at Elizabeth Park	12413210	1,720	4/6/13	NS	2,467	1987 – 2012
SFCDR near Pinehurst	12413470	2,690	4/6/13	4/6/13	4,339	1988 – 2012
NFCDR at Enaville	12413000	14,700	4/7/13	4/6/13	18,364	1912 – 2012
CDR at Cataldo	12413500	19,000	4/7/13	4/6/13	22,354	1911 – 2012
Latour Creek	--	NS	NS	NS	--	--
CDR at Rose Lake	--	NM [1]	NM [1]	4/7/13	--	--
CDR at Harrison	12413860	13,900	4/7/13	4/7/13	15,091	2004 – 2012

NOTES:
Instantaneous (15-minute) peak flow, unless otherwise indicated with an asterisk (*).
CDR = Coeur d'Alene River
cfs = cubic feet per second
NFCDR = North Fork Coeur d'Alene River
NM = not measured
NS = not sampled
SFCDR = South Fork Coeur d'Alene River
USGS = U.S. Geological Survey
-- = information unavailable
[1] Not measured because station was colocated with a USGS gage and EDIs were predetermined.
[2] Not measured due to health and safety concerns.

TABLE 3-1
Suspended Sediment Sample Metals Concentrations by Size Fraction– April 6 and 7, 2013, Sampling Event
WY2013 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Sample Date	Real-time Flow (cfs)	Bulk SSC (mg/L)	Size Fraction	Metals (mg/kg)						
						Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
PRG: [a]						*222*	*173*	*2,157*	*530*	*2.5*	*NA*	*519*
SF-BSED-S-001	Shoshone Park	04/06/13	NM [2]	10	Bulk [b]	25.6 J	16.6	386	**608**	--	1.7 J	**637**
CC-BSED-S-002	Mouth of Canyon Creek	04/06/13	149 [1]	2	Bulk [b]	--	--	--	--	--	--	--
NM-BSED-S-005	Mouth of Ninemile Creek	04/06/13	NM [2]	6	Bulk [b]	31.8	38.6	322	**5,770**	--	8.1	**6,380**
SF-BSED-S-201	SFCDR at Wallace	*Station Not Sampled*										
SF-BSED-S-006	SFCDR at Elizabeth Park	*Station Not Sampled*										
SF-BSED-S-007	SFCDR at Smelterville	*Station Not Sampled*										
SF-BSED-S-009	SFCDR near Pinehurst	04/06/13	3,074	33	Bulk [b]	60	135	111	**2,340**	2	7	**2,540**
LC-BSED-S-010	NFCDR at Enaville	04/06/13	NM [3]	83	Silt/clay	17	58	73	238	0	1 J	350
					Fine sand	11.5	15.2	46.3	318	0.27	0.3 J	231
					Bulk	13.5	46.4	30.8	123	0.28	0.4 J	279
LC-BSED-S-011	CDR at Cataldo	04/06/13	17,300 [1]	44	Silt/clay	37	26	1,160	**874**	1	2	**2,030**
					Fine sand	26.3	21.4	112	**1,080**	--	2.7	**818**
					Bulk	34.5	26.8	47.2	**784**	0.73	2.4	**881**
LC-BSED-S-013	Latour Creek	*Station Not Sampled*										
LC-BSED-S-012	CDR at Rose Lake	04/07/13	NM [1]	53	Silt/clay	77.1	24.3	728	**3,550**	**2.6**	9.1	**3,930**
					Fine sand	92.8	57.1	211	**4,830**	**4.3**	19	**8,640**
					Bulk	63.8	29.2	106	**3,320**	**3.3**	10	**4,000**
LC-BSED-S-014	CDR near Harrison	04/07/13	NM [1]	158	Silt/clay	154	27.2	140	**5,050**	**3.1**	15	**4,190**
					Fine sand	78.3	29.8	106	**3,880**	**3.4**	13	**4,130**
					Bulk	90.5	26.3	112	**4,290**	**3.1**	14	**3,950**

NOTES:
-- = inadequate sample mass
[1] Not measured because station was colocated with a USGS gage and EDIs were predetermined.
[2] Not measured due to health and safety concerns
[3] Discharge measurement equipment malfunction
[a] Preliminary Remediation Goal (PRG) Ecological Risk Assessment Population/LOAEL-Based Values for Sediment (mg/kg) Protective for Aquatic Birds and Mammals (EPA, 2001)
[b] Only bulk analysis conducted due to insufficient sample mass for size-specific analysis
Bold concentrations indicate exceedance of PRG
Bulk = ≤4,750 micrometers (μm)
CDR = Coeur d'Alene River
cfs = cubic feet per second
EDI = Equal Discharge Increment
Fine sand = 63-250 μm
J = estimated value
LOAEL = lowest observed adverse effect level
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
NA = not applicable
NFCDR = North Fork Coeur d'Alene River
NM = not measured
SFCDR = South Fork Coeur d'Alene River
Silt/clay = <63 micrometers

TABLE 3-2
Suspended Sediment Sampling Field Observations
WY2013 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Event	Sampling Date	Maximum Depth (ft)	Maximum Velocity (ft/sec)	Discharge (cfs)	Comments
SF-BSED-S-001	Shoshone Park	Spring Peak Runoff	4/6/2013	NM [2]	NM [2]	NM [2]	
CC-BSED-S-002	Mouth of Canyon Creek	Spring Peak Runoff	4/6/2013	NM [1]	NM [1]	149 [1]	
NM-BSED-S-005	Mouth of Ninemile Creek	Spring Peak Runoff	4/6/2013	NM [2]	NM [2]	NM [2]	
SF-BSED-S-201	SFCDR at Wallace	Spring Peak Runoff	NA	NA	NA	NA	Wallace Station not sampled this event.
SF-BSED-S-006	SFCDR at Elizabeth Park	Spring Peak Runoff	NA	NA	NA	NA	Elizabeth Park Station not sampled this event.
SF-BSED-S-007	SFCDR at Smelterville	Spring Peak Runoff	NA	NA	NA	NA	Smelterville Station not sampled this event.
SF-BSED-S-009	SFCDR near Pinehurst	Spring Peak Runoff	4/6/2013	8.4	6.44	3,074	
LC-BSED-S-010	NFCDR at Enaville	Spring Peak Runoff	4/6/2013	--	NM [3]	NM [3]	
LC-BSED-S-011	CDR at Cataldo	Spring Peak Runoff	4/6/2013	21.4	5.089	17,300 [1]	
LC-BSED-S-013	Latour Creek	Spring Peak Runoff	NA	NA	NA	NA	Latour Creek Station not sampled this event.
LC-BSED-S-012	CDR at Rose Lake	Spring Peak Runoff	4/7/2013	51	3.48	NM [1]	
LC-BSED-S-014	CDR near Harrison	Spring Peak Runoff	4/7/2013	33.5	3.59	NM [1]	

NOTES:
-- = inaccurate depth measurements due to high velocity
CDR = Coeur d'Alene River
cfs = cubic feet per second
EDI = Equal Discharge Increment
EWI = Equal Width Increment
ft/sec = feet per second
NA = not applicable
NM = not measured

[1] Not measured because station was colocated with a USGS gage and EDIs were predetermined.
[2] Not measured due to health and safety concerns.
[3] Discharge measurement equipment malfunction.

TABLE 4-1
Depositional Sediment Sampling Field Observations
WY2013 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Stake/Tile ID (S/T Number)	Deposition (+) or Erosion (-) (cm)	Sample Date	Field Observations
NEAR-CHANNEL LOCATIONS					
SF-BSED-D-001	Shoshone Park	S1	0.3	6/14/2013	Depositional area observed to extend from S1 to S2. A sharp contact was present between the recent material and existing organics/material. Material consisted of a well graded sand with trace fines and trace fine gravel. Deposition also present at S2, consisting of silt atop moss and the existing coarse bed material. Sample predominantly material from S1 and S2. Limited sample volume at S3 (200 ml). Sample submitted for particle size and metals analysis.
		S2	0.3		
		S3	0.2		
CC-BSED-D-002	Mouth of Canyon Creek	S1	0.5	6/14/2013	Deposition observed at S1 and between S1 and S3 consisting of mounds/zones downstream of vegetation and other features. This material consisted of a well graded sand with trace fine gravel. The thickness of deposition ranged from 1.0-3.0 cm, but the predominant measurement was 2.0 cm. No sample was collected at S1. Although deposition measured, no new deposition was atop the existing moss and dead vegetation surrounding the stake. Sample submitted for particle size and metals analysis.
		S2	Stake horizontal at installed location		
		S3	Stake pulled out and leaning		
NM-BSED-D-005	Mouth of Ninemile Creek	S1	1.2	6/14/2013	Deposition at S2 consisted of 2" gravel with no fines. Sample was not collected at S2 because the measured deposition may be suspect. Areas for deposition are small and all available material was sampled at S1 and S3. The sample consisted of 60% from S1 and 40% from S3. A well graded sand with silt and trace gravel was present near S1. Deposition near or at S3 consisted of a poorly graded pea sized gravel with trace sand and trace fines. Sample submitted for particle size and metals analysis.
		S2	0.3		
		S3	0.7		
SF-BSED-D-006	Elizabeth Park	S1	-0.6	5/15/2013	Significant deposition and erosion across the site. Deposition consisted of mounding downstream of vegetation and other features and movement of bed material at the northeastern portion of the site. The grain size of newly deposited material is highly variable consisting of mounds of fine sand in the observed lower velocity areas to coarse sand/gravel in the observed higher velocity areas. Some areas at the sourthern end of the site had a very thin layer of fines on the surface indicating pooling of water. Due to the variability at the site, sample was collected opportunistically from across the site using 30 subsamples of equal volume. Sample consisted of a fine and medium sand with trace fines and trace gravel. Sample submitted for particle size and metals analysis.
		S2	-3.3		
		S3	2.4		
		S4	3.5		
		S5	-0.9		
		S6	-4.2		
SF-BSED-D-007	Smelterville	S1	0.1	5/15/2013	Deposition measured and observed at S1 and S3. Measurement at S3 is suspect due to moss around the stake. The grain size of newly deposited material was similar at S1 and S3 consisting of a silt with fine sand. The depositional areas had a very thin layer of fines on the surface indicating pooling of water. The sample consisted of 60% from S4 and 40% from S1. Sample submitted for particle size and metals analysis.
		S2	-0.7		
		S3	0.2		
		S4	0.6		
SF-BSED-D-009	Pinehurst	S1	0.0	5/15/2013	No deposition measured or observed at the site. High water inundated S1 and S2 and the channel that runs parallel with S3 and S4. The southern portion of the site appears to be a high velocity area and S1 and S2 should be relocated to the northern portion of the site. Sample collected from the vicinity of S3 and S4. Sample submitted for particle size and metals analysis.
		S2	Inundated		
		S3	-1.5		
		S4	0.0		
LC-BSED-D-010	Enaville	S1	1.6	6/14/2013	Sample collected from the vicinity of S1 and S3 consisting of a fine sand with trace fines. Sample consisted of a poorly graded fine sand with trace silt. Due to availabiliy of material to sample at each stake, the sample consisted of about 50% from S1 and 50% from S3. Sample submitted for particle size and metals analysis.
		S2	-0.2		
		S3	2.9		
		S4	-0.1		
		S5	>-1.0		
		S6	-0.5		
LC-BSED-D-011	Cataldo	S1	0.1	6/14/2013	Sample collected from recent deposition at S1, S2, and S4. Material at S2 and S4 consisted of a thin and flaky, poorly graded sand w/silt layer overlying a loose, poorly graded fine sand with trace fines. Sample submitted for particle size and metals analysis.
		S2	0.4		
		S3	Stake broken at base and lying on ground		
		S4	0.5		
LC-BSED-D-201	Cataldo Dredge Site	S1	0.7	5/15/2013	Most deposition occurred at the bank edge. The high water mark extended just beyond the edge and overbank deposits measured and observed in this zone. Sample collected near stakes S1, S2, and S3 did not provide sufficient volume. Other overbank deposits opportunistically sampled to obtain sufficient volume. The grain size of deposition was similar at the site consisting of a brown fine sand with trace silt. Sample submitted for particle size and metals analysis.
		S2	0.5		
		S3	1.1		
		S4	0.0		
		S5	--		
		S6	0.0		
LC-BSED-D-202	Dudley East	S1	-0.2	5/15/2013	Deposition observed along the shoreline between S4 and S6 with the predominant thickness of 0.1 cm. Material consisted of silt with fine sand and organics. The high water mark did not inundate S1, S2, and S3. Sample submitted for particle size and metals analysis.
		S2	0.0		
		S3	0.0		
		S4	0.1		
		S5	Inundated		
		S6	0.5		
LC-BSED-D-101	Dudley	S1	0.0	5/14/2013	The high water mark at the site was at about the bank edge. The stakes were not inundated and no overbank deposits were observed. Equivalent sample volume was collected in the vicinity of each stake. Sample submitted for particle size and metals analysis.
		S2	0.0		
		S3	0.0		

TABLE 4-1
Depositional Sediment Sampling Field Observations
WY2013 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Stake/Tile ID (S/T Number)	Deposition (+) or Erosion (-) (cm)	Sample Date	Field Observations
NEAR-CHANNEL LOCATIONS					
LC-BSED-D-203	Bull Run Bridge	S1	-0.5	5/14/2013	The high water mark appeared to inundate all stakes. However, depositional material was only measured and observed at S2, S3, and S5. Material at S2 and S5 consisted of a fine sandy silt and material at S3 consisted of a silty fine sand overlying a sandy silt. Depositional material was limited so all available material was sampled and consisted of about 10% from S2, 45% from S3, and 45% from S5. Sample submitted for particle size and metals analysis.
		S2	0.1		
		S3	0.7		
		S4	-0.4		
		S5	0.6		
		S6	Inundated		
LC-BSED-D-012	Rose Lake	S1	-1.6	5/14/2013	The high water mark appeared to inundate all stakes. Ripple marks and the dead vegetation line were apparent. Because erosion was measured at all stakes, equal sample volume was collected in the vicinity of each stake. The sample consisted of a fine sand w/trace fines. Sample submitted for particle size and metals analysis.
		S2	-0.3		
		S3	-2.7		
		S4	-0.7		
LC-BSED-D-102	Black Rock Trailhead	S1	-1.5	6/14/2013	The high water mark appeared to inundate S4 and S5. The deposition at these stakes was sampled and consisted of a fine sand with trace silt. Depositional material was limited so all available material was sampled and consisted of about 50% from S4 and 50% from S5. Sample submitted for particle size and metals analysis.
		S2	-3.0		
		S3	-0.2		
		S4	1.0		
		S5	2.2		
LC-BSED-D-014	Harrison	S1	>-13.2	5/14/2013	Significant erosion of the shelf deposited in the spring of 2012 was observed. Equal sample volume was collected from the vicinity of each stake. The material sampled is a tan fine sand with trace silt.
		S2	-0.5		
		S3	Bank eroded. Stake lying in water about 15 feet from installation.		
		S4	-2.6		
SR-BSED-D-109	Spokane River near Stateline	--	--	6/17/2013	The site was heavily vegetated with grasses resulting in difficult identificatin of deposition. Deposition was identified at one area (20' x 10') of cobbles with no vegetation growth. The thickness of deposition was predominantly 1.0 mm at this area. Sample was collected from depositional material atop the cobbles and existing moss and consisted of a fine sand with silt. The depositional mounds observed in prior years were not observed at the site.
		--	--		
		--	--		
OFF-CHANNEL LOCATIONS					
LC-BSED-D-103	Lane Marsh	T1	<0.1	5/14/2013	Four tiles were inundated during sample collection. Deposition was observed on four tiles consisting of a silt/clay, but was intermixed with an orange/tan organic muck and decaying vegetation. Tiles were carefully removed for sample collection. The vegetation was removed from the tiles and all organic material/sediment from the four tiles was containerized into a 32 oz bottle.
		T2	<0.1		
		T3	<0.1		
		T4	<0.1		
		T5	0.0		
LC-BSED-D-104	Strobl Marsh	T1	0.3	5/14/2013	All tiles were inundated during the peak runoff event. Deposition was observed on two of the tiles, but was primarily an orange/tan organic muck with some fines. All organic material/sediment from the five tiles was cotnainerized into a 32 oz bottle.
		T2	0.3		
		T3	0.0		
		T4	0.0		
		T5	0.0		
LC-BSED-D-105	Killarney Lake	T1	--	No Sample	No depositional material was observed on the five tiles. The tiles were inundated in 6 inches to 2 feet of water. No sample was collected.
		T2	--		
		T3	--		
		T4	--		
		T5	--		
LC-BSED-D-106	Rainy Hill	T1	--	No Sample	Four ceramic tiles were placed at the site. Two tiles were missing and the other two were moved. No deposition was observed on the moved tiles or on the adjacent land. No sample was collected. Tiles have not been disturbed at this site during previous years.
		T2	--		
		T3	--		
		T4	--		
LC-BSED-D-107	Bare Marsh	T1	--	No Sample	The tiles were not inundated during the peak runoff event. Thus, no deposition was present on the tiles and no sample was collected.
		T2	--		
		T3	--		
		T4	--		
LC-BSED-D-108	Anderson Lake	T1	--	No Sample	Six ceramic tiles were placed below the summer pool elevation at the mouth of the Anderson Lake connecting channel. The tiles were moved to the west side of the mouth due to disturbance during prior years. Three tiles were missing and the other three were moved. No deposition was observed on the moved tiles or on the adjacent land. No sample was collected.
		T2	--		
		T3	--		
		T4	--		
		T5	--		
		T6	--		

NOTES:
-- = depositional/erosion could not be measured due to anthropogenic disturbance or access issues
ml = mililiter(s)
cm = centimeter(s)
NA = not applicable
mm = milimeter(s)

TABLE 4-2
Depositional Sediment Particle Size Distribution– Post-Spring Runoff
WY2013 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Date Collected	Clay (<4 µm)		Silt (4-63 µm)		Very Fine Sand (63-125 µm)		Fine Sand (123-250 µm)		Medium Sand (250-500 µm)		Coarse Sand (500-1,000 µm)		Very Coarse Sand (1,000-2,000 µm)		Gravel (>2,000 µm)	
			mass (g)	% of total mass	mass (g)	% of total mass	mass (g)	% of total mass	mass (g)	% of total mass	mass (g)	% of total mass	mass (g)	% of total mass	mass (g)	% of total mass	mass (g)	% of total mass
NEAR RIVER CHANNEL																		
SF-BSED-D-001	Shoshone Park	06/14/13	2.71	1%	32.89	17%	43.18	23%	41.36	22%	40.83	22%	15.15	8%	11.53	6%	0.77	0%
CC-BSED-D-002	Mouth of Canyon Creek	06/14/13	0.00	0%	43.11	17%	13.89	5%	47.77	19%	93.91	37%	24.11	9%	15.30	6%	16.94	7%
NM-BSED-D-005	Mouth of Ninemile Creek	06/14/13	2.96	1%	88.33	15%	99.92	17%	79.39	14%	77.11	13%	23.88	4%	73.97	13%	128.73	22%
SF-BSED-D-006	Elizabeth Park	05/15/13	4.23	1%	50.49	16%	68.20	21%	87.07	27%	89.55	28%	14.81	5%	5.24	2%	0.18	0%
SF-BSED-D-007	Smelterville	05/15/13	15.59	11%	75.73	52%	36.36	25%	8.53	6%	5.37	4%	1.64	1%	0.50	0%	0.21	0%
SF-BSED-D-009	Pinehurst	05/15/13	5.77	1%	32.25	8%	190.61	47%	159.67	40%	12.57	3%	0.15	0%	0.50	0%	0.07	0%
LC-BSED-D-010	Enaville	06/14/13	4.04	2%	20.63	9%	127.32	54%	61.51	26%	6.99	3%	0.26	0%	0.20	0%	13.04	6%
LC-BSED-D-011	Cataldo	06/14/13	3.98	2%	24.39	10%	93.37	39%	95.00	40%	18.64	8%	0.53	0%	0.92	0%	1.46	1%
LC-BSED-D-201	Cataldo Dredge Site	05/15/13	9.32	7%	33.84	24%	88.53	37%	5.32	2%	0.82	0%	0.30	0%	0.03	0%	0.02	0%
LC-BSED-D-202	Dudley East	05/15/13	12.40	11%	49.43	43%	46.94	20%	1.95	1%	0.71	0%	0.40	0%	0.01	0%	0.00	0%
LC-BSED-D-203	CDR near Bull Run Bridge	05/14/13	11.59	7%	49.83	30%	95.57	40%	2.04	1%	0.83	0%	0.24	0%	0.03	0%	0.02	0%
LC-BSED-D-101	Dudley	05/14/13	17.32	11%	62.68	40%	62.30	40%	2.79	2%	1.95	1%	0.60	0%	0.02	0%	0.01	0%
LC-BSED-D-102	Rose Lake	05/14/13	1.66	1%	12.76	7%	151.13	85%	12.29	7%	0.36	0%	0.08	0%	0.01	0%	0.01	0%
LC-BSED-D-012	Black Rock Trailhead	06/14/13	7.55	3%	33.86	12%	235.60	83%	6.21	2%	0.27	0%	0.03	0%	0.00	0%	0.00	0%
LC-BSED-D-014	CDR near Harrison	05/14/13	0.92	0%	6.32	3%	192.37	94%	1.25	1%	0.24	0%	0.16	0%	0.02	0%	0.00	0%
SR-BSED-D-109	Spokane River near Stateline		*Location Not Sampled for Particle Size Distribution*															
OFF-CHANNEL																		
LC-BSED-D-103	Lane Marsh		*Location Not Sampled for Particle Size Distribution*															
LC-BSED-D-104	Strobl Marsh		*Location Not Sampled*															
LC-BSED-D-105	Killarney Lake		*Location Not Sampled*															
LC-BSED-D-106	Rainy Hill		*Location Not Sampled*															
LC-BSED-D-107	Bare Marsh		*Location Not Sampled*															
LC-BSED-D-108	Anderson Lake		*Location Not Sampled*															

NOTES:
CDR = Coeur d'Alene River
g = gram(s)
µm = micrometer(s)

TABLE 4-3

Depositional Sediment Average Particle Size Distribution by Reach

WY2013 BEMP Sediment Sampling Data Summary

Location Description	Particle Size Distribution							
	Clay (<4 µm)	**Silt** (4-63 µm)	**Very Fine Sand** (63-125 µm)	**Fine Sand** (123-250 µm)	**Medium Sand** (250-500 µm)	**Coarse Sand** (500-1,000 µm)	**Very Coarse Sand** (1,000-2,000 µm)	**Gravel** (>2,000 µm)
SFCDR	1%	15%	28%	21%	16%	5%	6%	7%
NFCDR	9%	15%	45%	22%	1%	0%	0%	0%
Lower Basin (in-channel)	5%	19%	62%	8%	2%	0%	0%	0%
Lower Basin (off-channel)	10%	44%	38%	1%	0%	0%	0%	0%
Spokane River	3%	13%	80%	4%	0%	0%	0%	0%

NOTES:

µm = micrometers

NFCDR = North Fork Coeur d'Alene River

SFCDR = South Fork Coeur d'Alene River

TABLE 4-4

Depositional Sediment Total Organic Carbon Concentrations

WY2013 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Sample Date	Total Organic Carbon (mg/kg)	Total Organic Carbon (%)
LC-BSED-D-104	Strobl Marsh (Lower Basin)	05/14/13	71,400	7.14
LC-BSED-D-103	Lane Marsh (Lower Basin)	05/14/13	161,000	16.1
LC-BSED-D-109	Spokane River near Stateline	06/17/13	97,400	9.74

NOTES:

mg/kg = milligrams per kilogram

TABLE 4-5
Depositional Sediment Metals Concentrations by Size Fraction
WY2013 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Sample Date	Size Fraction	Total Mass (g)	Total Mass (%)	Metals (mg/kg)						
						Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
					*Wildlife Population/LOAEL-based:**	*222*	*173*	*2,157*	*530*	*2.5*	*NA*	*519*
NEAR-CHANNEL LOCATIONS												
SF-BSED-D-001	Shoshone Park (South Fork)	06/14/13	Silt/clay	35.60	18.90	13	0.94	16.3	72.4	0.0906	1 U	129
			Fine sand	152.04	80.70	6.1	0.5 U	6.1	28.3	0.049 U	0.99 U	59.5
			Bulk	188.42	100.00	8	0.5 U	5.73	33.6	0.049 U	1 U	72.1
CC-BSED-D-002	Mouth of Canyon Creek (Tributary to South Fork)	06/14/13	Silt/clay	43.11	16.90	80.2	52.5	274	13,900	11.8	36.8	7,790
			Fine sand	194.98	76.46	41.1	32.8	143	7,270	5.11	18.5	5,360
			Bulk	255.03	100.00	15	16	61.4	4,090	1.83	3.3	2,940
NM-BSED-D-005	Mouth of Ninemile Creek (Tributary to South Fork)	06/14/13	Silt/clay	91.29	15.90	34.9	42.5	183	7,500	2.84	15.3	6,740
			Fine sand	354.27	61.69	21	28	115	3,970	1.45	10.7	5,140
			Bulk	574.29	100.00	7.8	13.9	54.4	3,270	0.483	3.9	2,520
SF-BSED-D-006	Elizabeth Park (South Fork)	05/15/13	Silt/clay	54.72	16.89	155	28.5	189	6,670	9.37	26.6	3,660
			Fine sand	264.87	81.75	113	22 J	127	4,310	4.08	11.4	3,360
			Bulk	319.77	98.69	49.4	19.1	85.4	2,910	1.66	8.49	2,190
SF-BSED-D-007	Smelterville (South Fork)	05/15/13	Silt/clay	91.33	62.60	55.2	22.7	129	3,080	2.57	9	2,710
			Fine sand	52.40	35.92	50	23 J	125	2,940	3.17	8.46	2,450
			Bulk	143.94	98.69	49.7	20.3	106	2,710	2.07	7.66	2,290
SF-BSED-D-009	Pinehurst (South Fork)	05/15/13	Silt/clay	38.02	9.42	94.6	17.1	98.5	3,620	3.16	10.6	2,230
			Fine sand	363.49	90.08	83	9.6 J	73.8	2,190	1.41	8.34	1,740
			Bulk	401.58	100.00	74.9	7.31	56.8	2,030	1	6.19	1,310
LC-BSED-D-010	Enaville (South Fork)	06/14/13	Silt/clay	24.67	10.54	8.7	0.5 U	13.5	67.9	0.0639	1 U	109
			Fine sand	196.29	83.88	6.6	0.5 U	7.77	35.6	0.047 U	1 U	74.3
			Bulk	234.00	100.00	8.1	0.5 U	7.49	35.4	0.046 U	1 U	79.6
LC-BSED-D-011	Cataldo (Mainstem)	06/14/13	Silt/clay	28.38	11.91	69.8	13.8	72	2,910	2.86	9.86	1,700
			Fine sand	208.46	87.48	60	8.8	56.9	2,290	1.98	6.25	1,370
			Bulk	238.30	100.00	39.1	7.1	44.2	1,850	0.928	5.43	1,100
LC-BSED-D-201	Cataldo Dredge Site (Mainstem)	05/15/13	Silt/clay	43.16	30.72	89.2	18.1	78.8	2,570	2.47	6.71	2,050
			Fine sand	95.00	39.87	86.9	14 J	59	1,850	2.23	7.11	2,010
			Bulk	138.18	70.59	80.7	14.9	59	2,020	1.78	6.65	1,930
LC-BSED-D-202	Dudley East (Mainstem)	05/15/13	Silt/clay	61.83	53.43	75.2	31.3	114	4,930	4.09	12.4	4,430
			Fine sand	50.01	20.99	64.4	35 J	103	3,720	4.96	10.7	4,900
			Bulk	111.84	74.42	64.9	31.1	91.7	4,230	3.52	11	4,290
LC-BSED-D-203	CDR near Bull Run Bridge (Mainstem)	05/14/13	Silt/clay	61.43	37.01	91.1	30.2	117	4,650	4.6	12.7	4,390
			Fine sand	98.71	41.42	58.4	29 J	89.3	3,020	4.04	9.68	4,350
			Bulk	160.16	78.45	68.1	28.6	92.5	3,440	3.52	9.14	3,930
LC-BSED-D-101	Dudley (Mainstem)	05/14/13	Silt/clay	80.00	51.68	71.5	28.5	98.4	4,300	3.48	9.37	3,790
			Fine sand	67.66	43.71	62.7	31 J	93.5	2,900	5.51	9.27	4,580
			Bulk	147.67	95.39	68.8	28.3	91.3	3,740	3.98	11	4,200
LC-BSED-D-102	Black Rock Trailhead (Mainstem)	06/14/13	Silt/clay	14.42	8.09	139	64.5	176	6,790	9.24	23.1	9,920
			Fine sand	163.88	91.91	77.3	46.4	107	2,960	6.11	12	7,410
			Bulk	178.31	100.00	74.1	45.1	108	2,990	5.77	13	7,280

TABLE 4-5

Depositional Sediment Metals Concentrations by Size Fraction

WY2013 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Sample Date	Size Fraction	Total Mass (g)	Total Mass (%)	Metals (mg/kg)						
						Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
			*Wildlife Population/LOAEL-based:**			*222*	*173*	*2,157*	*530*	*2.5*	*NA*	*519*
LC-BSED-D-012	Rose Lake (Mainstem)	05/14/13	Silt/clay	41.41	14.53	129	41.8	162	6,600	6.22	18.1	6,630
			Fine sand	242.12	84.94	57.2	39 J	93	3,230	4.9	11.2	6,290
			Bulk	283.53	98.69	60.4	37.8	103	3,570	4.7	11.7	5,950
LC-BSED-D-014	CDR near Harrison (Mainstem)	05/14/13	Silt/clay	7.24	3.55	353	86.1	228	7,110	9.26	29.2	14,300
			Fine sand	194.04	95.10	69.9	25 J	67.5	1,750	2.99	9.46	4,170
			Bulk	201.28	98.69	78.2	24.6	63.5	2,030	3.09	8.66	4,160
SR-BSED-D-109	Spokane River near Stateline (Spokane River)	06/17/13	Silt/clay	--	--	17	21.3	38	743	0.315	1 U	2,230
			Fine sand	--	--	17	20.2	33.5	692	0.261	0.99 U	2,090
			Bulk	--	--	16	20.9	43.6	586	0.403	0.99 U	2,010
OFF-CHANNEL LOCATIONS												
LC-BSED-D-103	Lane Marsh (Lower Basin)	05/14/13	Silt/clay	--	--	78	12.4	74.2	2,190	1.96	7.8	1,540
			Fine sand	--	--	140	19 J	103	3,590	2.47	9.5	1,770
			Bulk	--	--	95.8	14.2	79.2	2,740	1.87	8.28	1,620
LC-BSED-D-104	Strobl Marsh (Lower Basin)	05/14/13	Silt/clay	--	--	230	16.5	57.6	938	0.636	5 U	2,130
			Fine sand	--	--	254	18 J	40.7	926	0.674	5 U	1,890
			Bulk	--	--	252	18 J	36.8	899	0.554	4.9 U	2,130
LC-BSED-D-105	Killarney Lake (Lower Basin)		Silt/clay	--	--	--	--	--	--	--	--	--
			Fine sand	--	--	--	--	--	--	--	--	--
			Bulk	--	--	--	--	--	--	--	--	--
LC-BSED-D-106	Rainy Hill (Lower Basin)		Silt/clay	--	--	--	--	--	--	--	--	--
			Fine sand	--	--	--	--	--	--	--	--	--
			Bulk	--	--	--	--	--	--	--	--	--
LC-BSED-D-107	Bare Marsh (Lower Basin)		Silt/clay	--	--	--	--	--	--	--	--	--
			Fine sand	--	--	--	--	--	--	--	--	--
			Bulk	--	--							
LC-BSED-D-108	Anderson Lake (Lower Basin)		Silt/clay	--	--	--	--	--	--	--	--	--
			Fine sand	--	--	--	--	--	--	--	--	--
			Bulk	--	--	--	--	--	--	--	--	--

NOTES:

* Preliminary Remediation Goal (PRG) Ecological Risk Assessment Population/LOAEL-Based Values for Sediment (mg/kg) Protective for Aquatic Birds and Mammals (EPA, 2001)

-- = analysis not conducted due to insufficient sample mass

Bulk = ≤4,750 µm

Fine sand = 63-250 µm

J = Estimated value

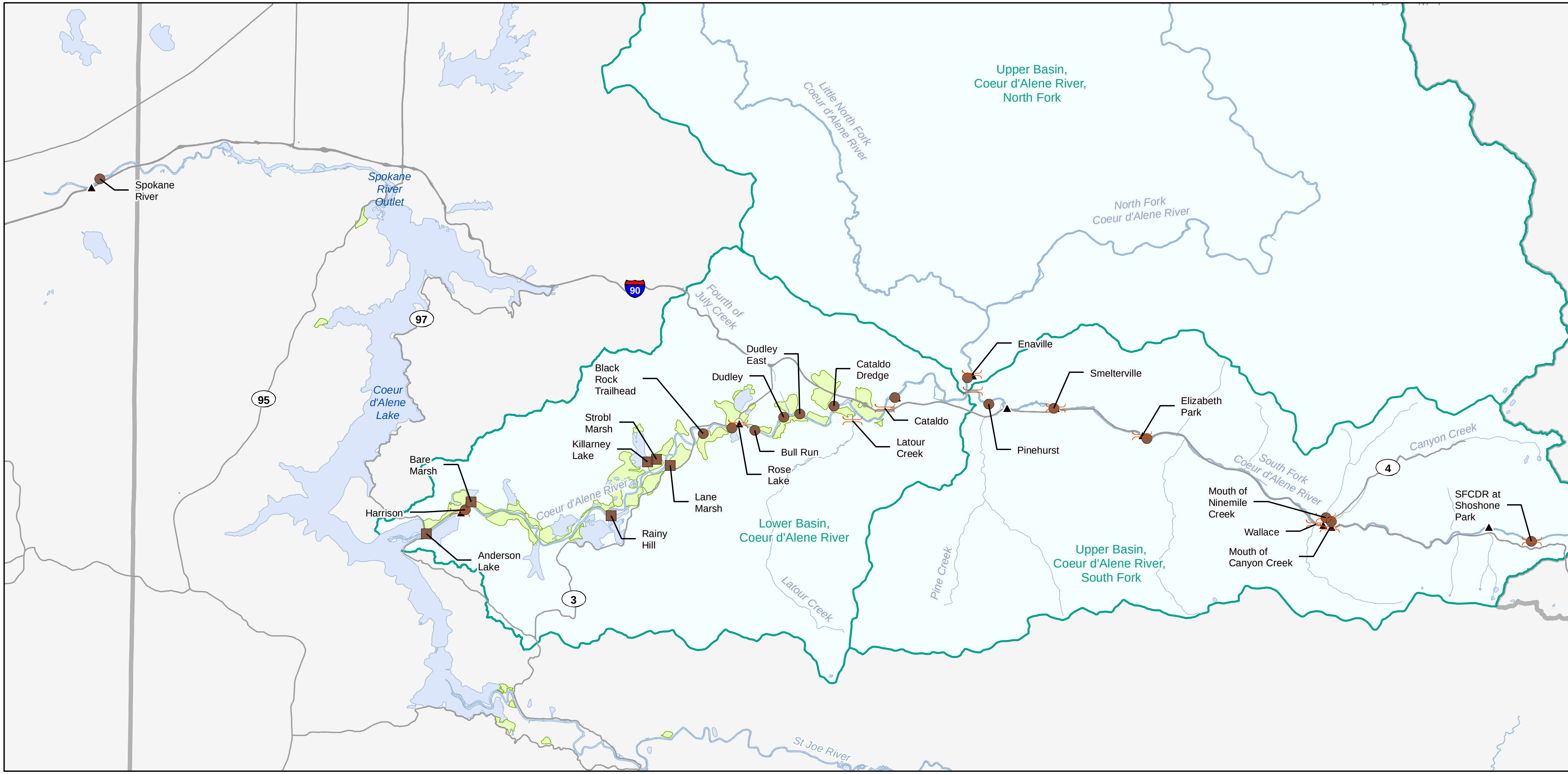
LOAEL = lowest observed adverse effect level

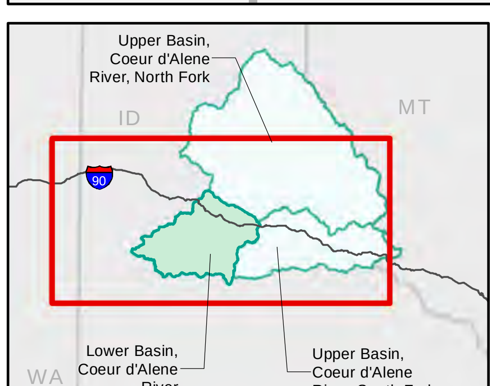
mg/kg = milligrams per kilogram

Silt/clay = <63 micrometers (µm)

U = The analyte was not detected at or above the reported value

Figures





Suspended Sediment Sampling Location
Depositional Sediment Sampling Location (off channel)
Depositional Sediment Sampling Location (near/in channel)
USGS Gage Station (selected)
Waterbody
Marsh or Slough
Coeur d'Alene River Subbasin Boundary

Source: NHDPlus (Rivers, Waterbodies); ESRI base data (Interstates 2006, Major Highways 2008); USGS (Gages).

0 2 4 8 Miles

N

FIGURE 1-1
Sediment Monitoring Program
WY2013 BEMP Sediment Sampling Data Summary

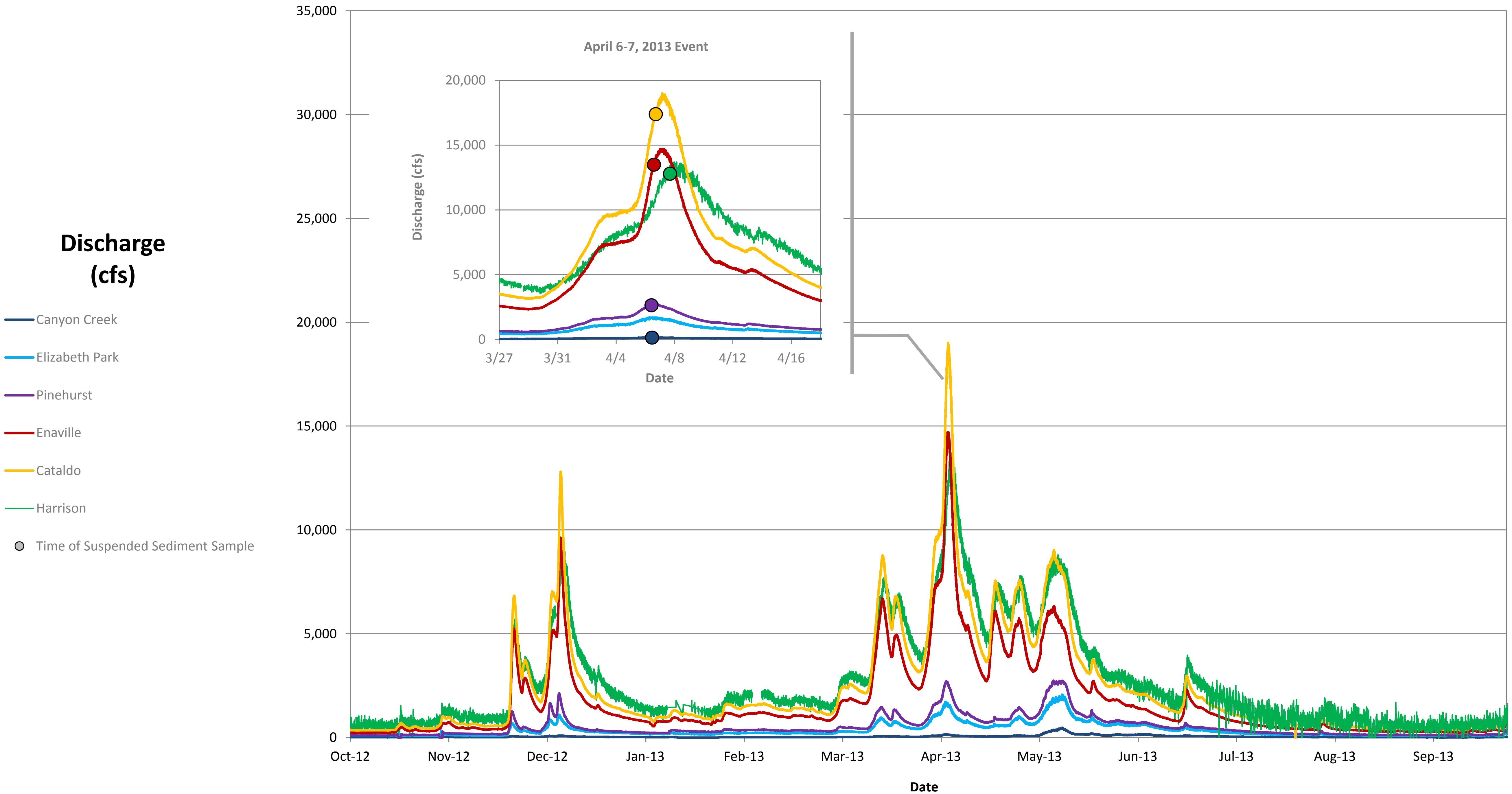
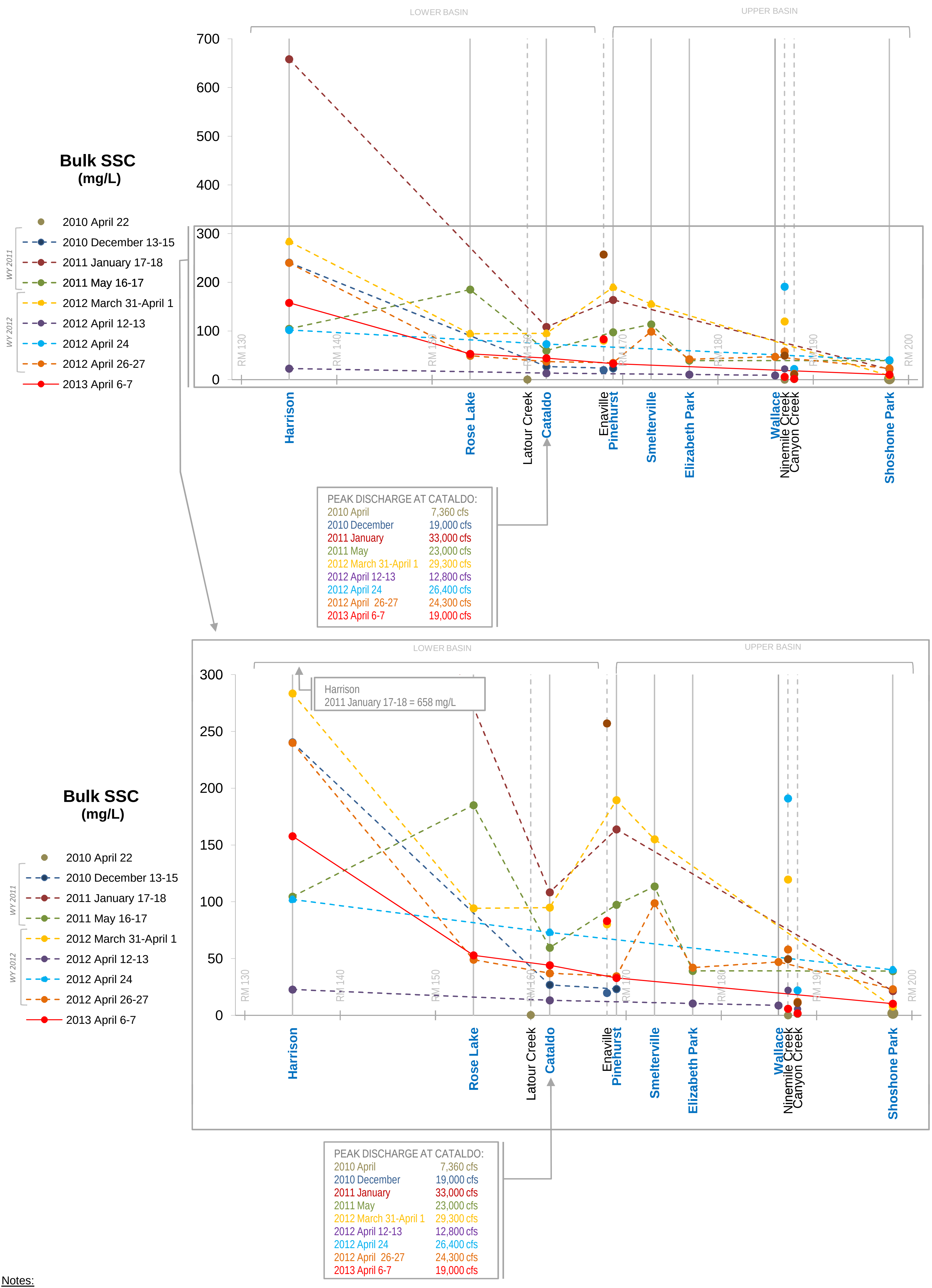


FIGURE 2-1
WY2013 Hydrograph
WY2013 BEMP Sediment Sampling Data Summary

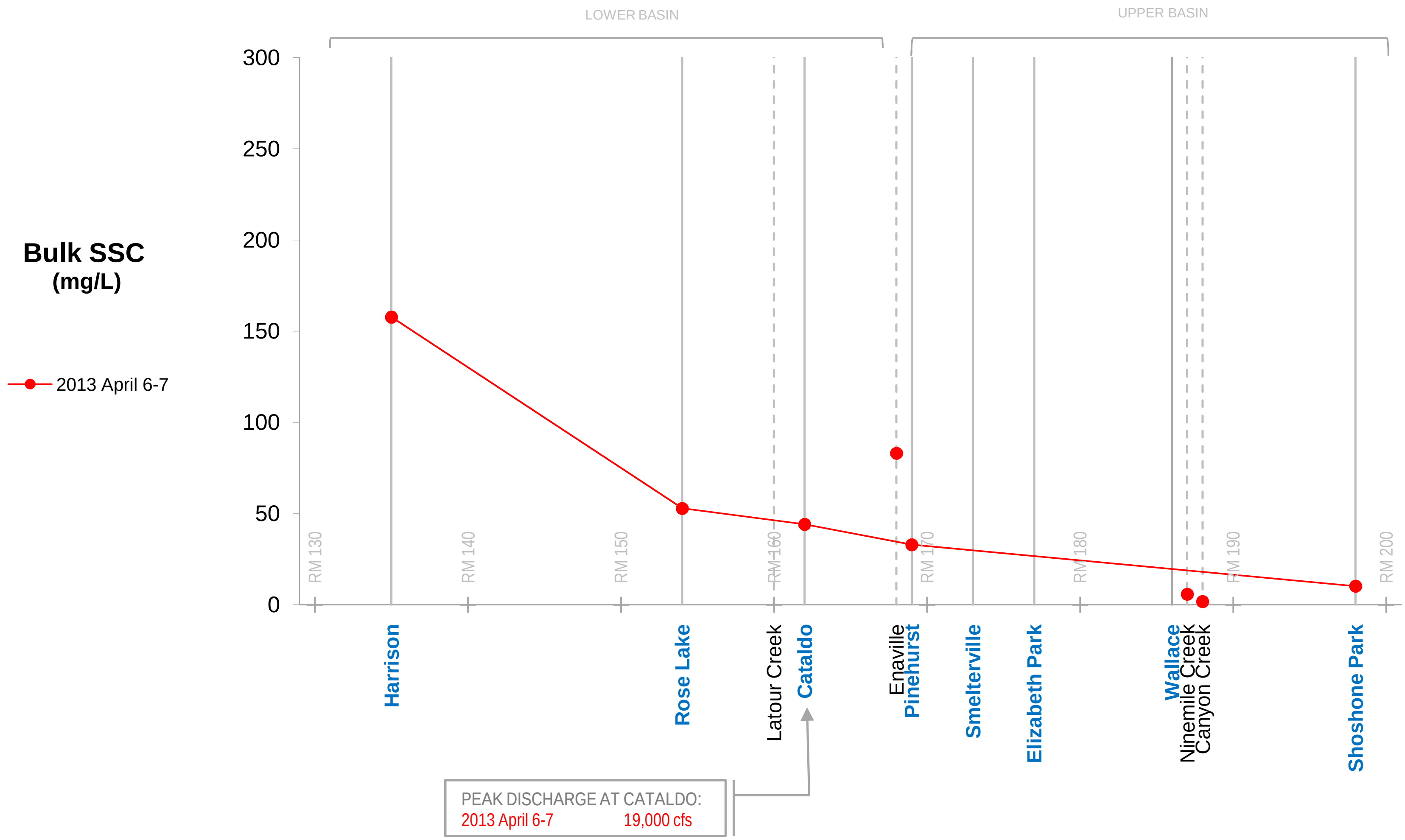


Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 3-1

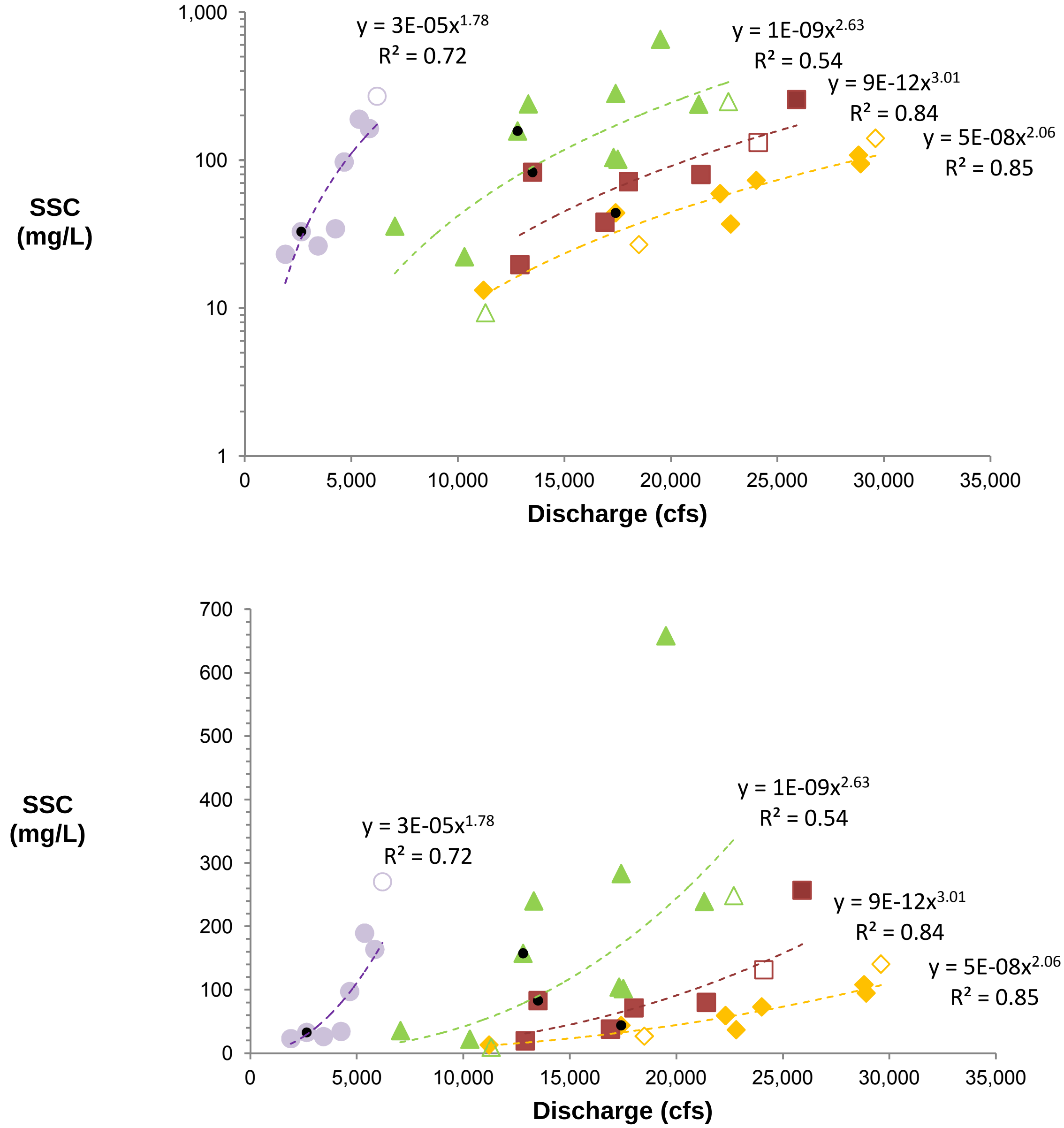
WY2010 - WY2013 Suspended Sediment Concentration

WY2013 BEMP Sediment Sampling Data Summary



Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 3-2
WY2013 Suspended Sediment Concentration
WY2013 BEMP Sediment Sampling Data Summary



Legend:
- Cataldo
- Pinehurst
- Enaville
- Harrison
- WY2013 sample

Notes:
Outlined icons indicate USGS data.
Results shown for mainstem stations with >3 sampling events since 2008.
Bulk = ≤4,750 µm

FIGURE 3-3
Relationship Between SSC and Discharge
WY2013 BEMP Sediment Sampling Data Summary

Particle Size Distribution

2103 April 6-7 Event

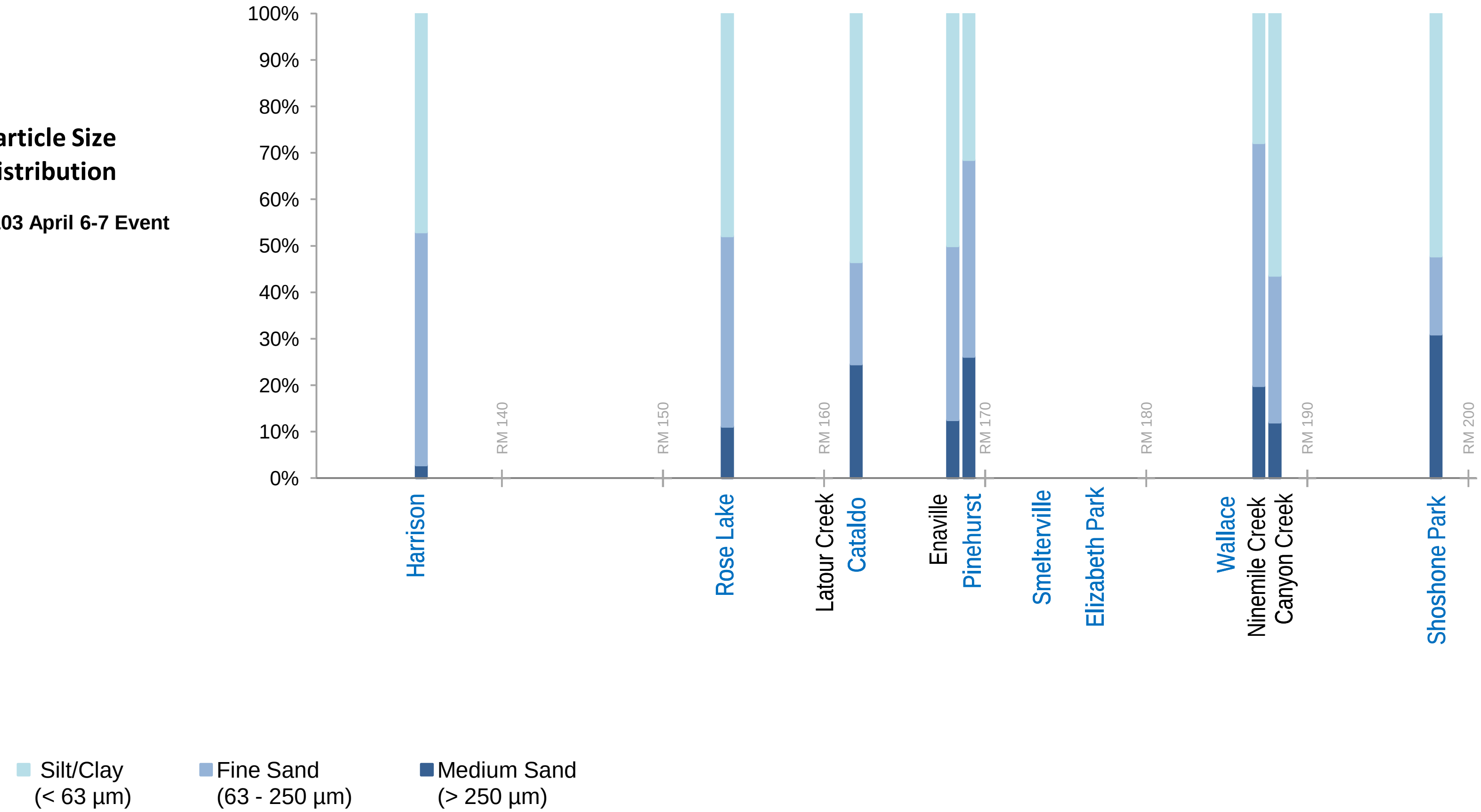
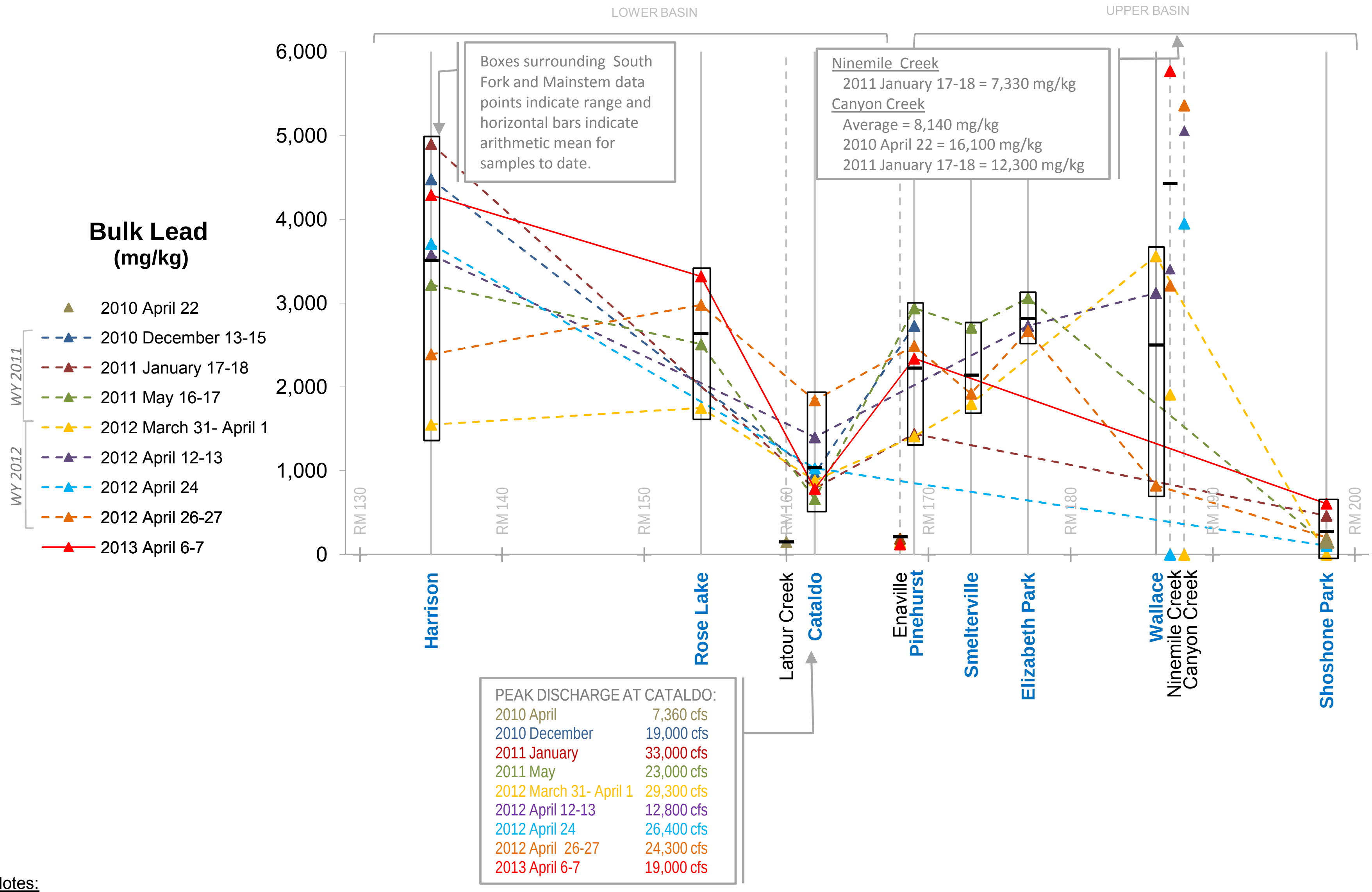


FIGURE 3-4

Suspended Sediment Particle Size Distribution

WY2013 BEMP Sediment Sampling Data Summary

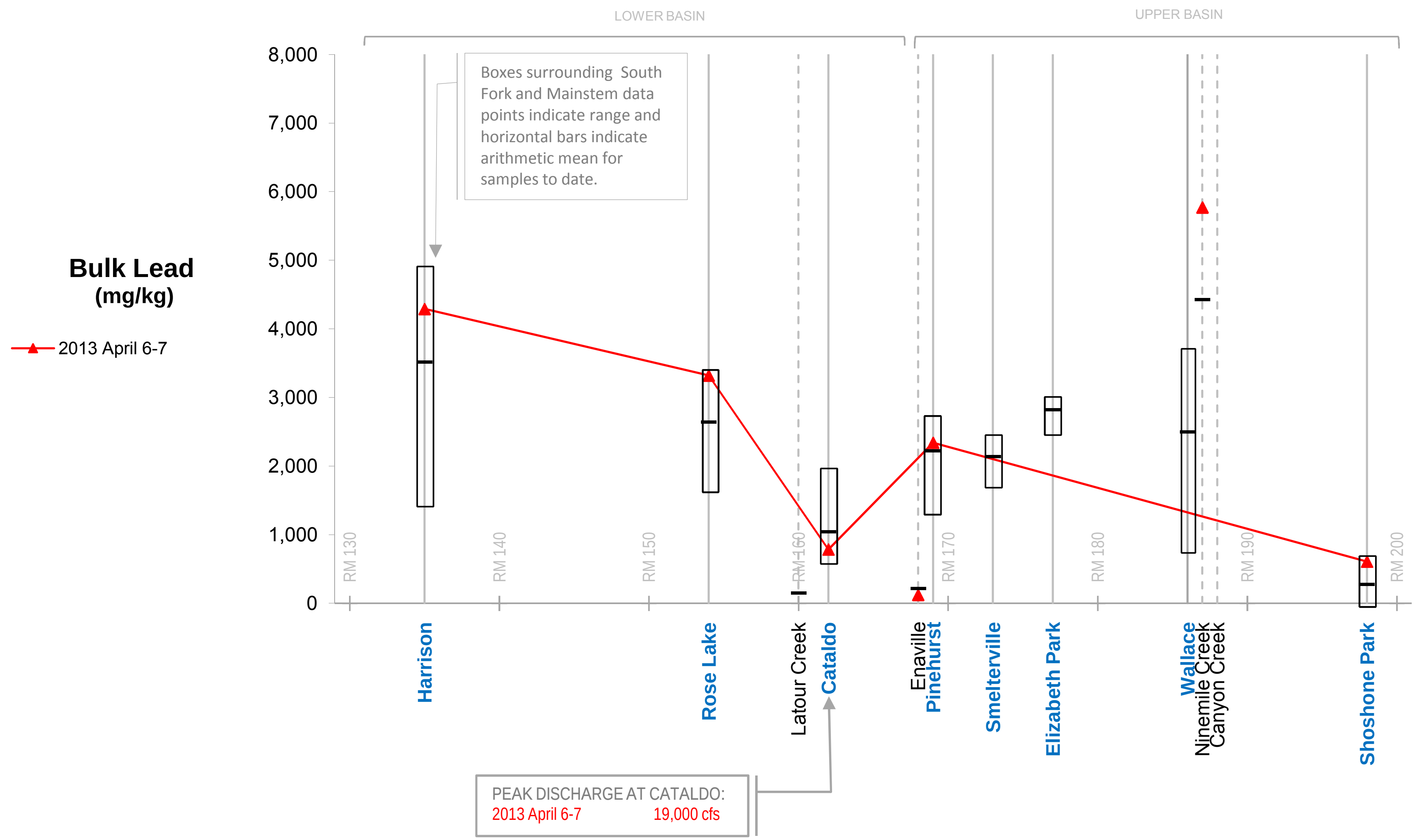


Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 3-5

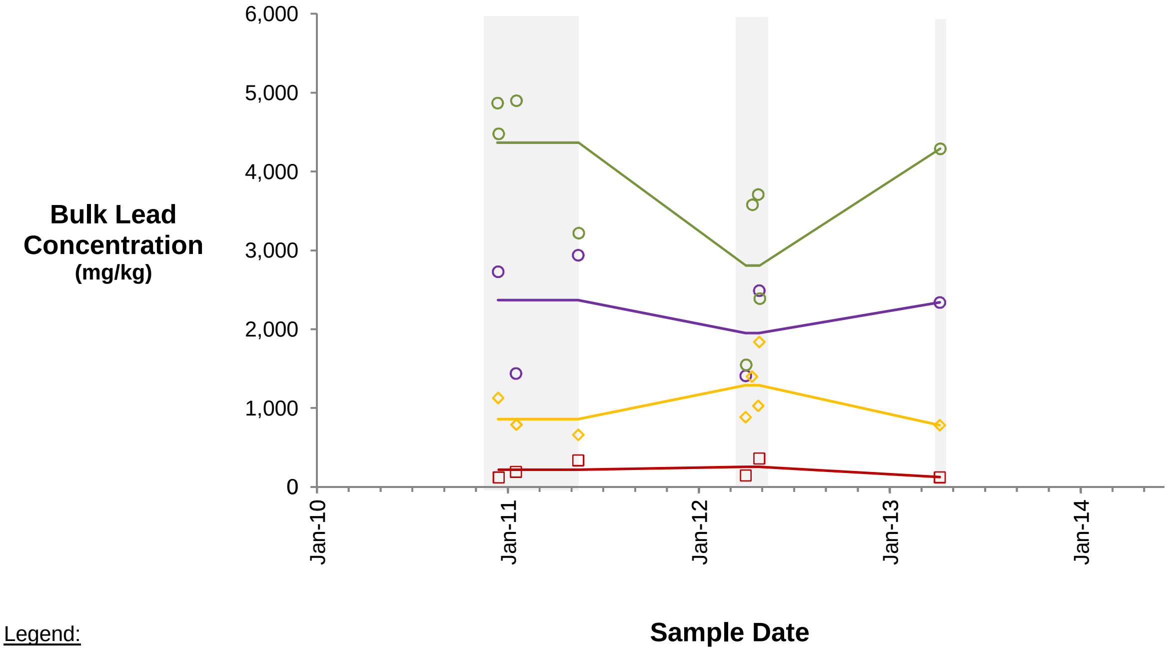
WY2010 - WY2013 Suspended Sediment Bulk Lead Concentration

WY2013 BEMP Sediment Sampling Data Summary



Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 μm

FIGURE 3-6
WY2013 Suspended Sediment Bulk Lead Concentration
WY2013 BEMP Sediment Sampling Data Summary



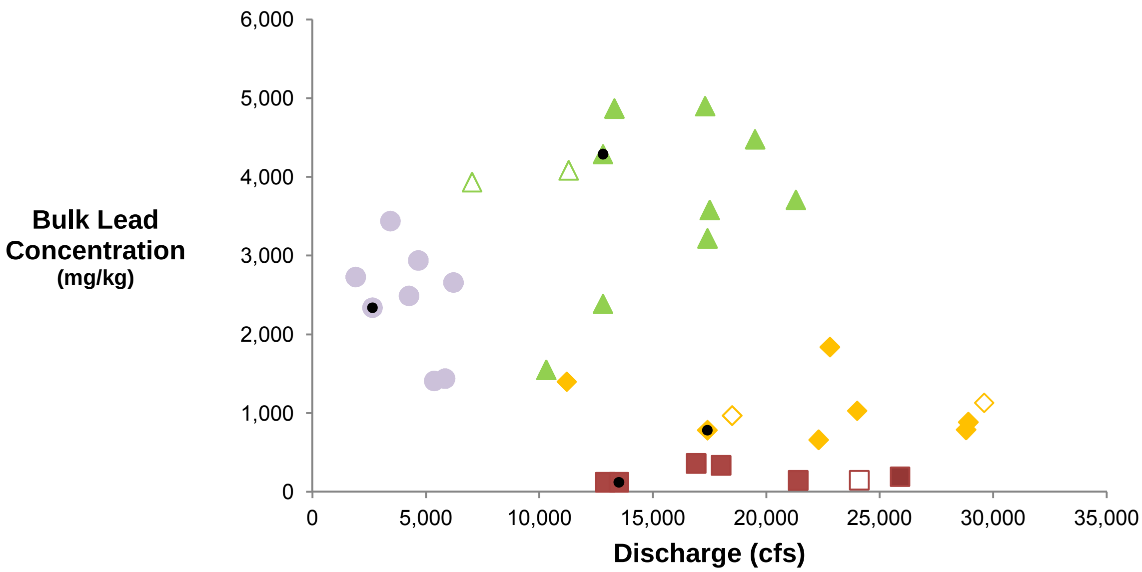
Legend:

- Pinehurst
- Enaville
- Cataldo
- Harrison

Notes:
Lines connect the average bulk lead concentration measured during the WY2011 and WY2012 peak flow sampling windows (shaded). Line colors correspond to colors presented in the legend.

FIGURE 3-7

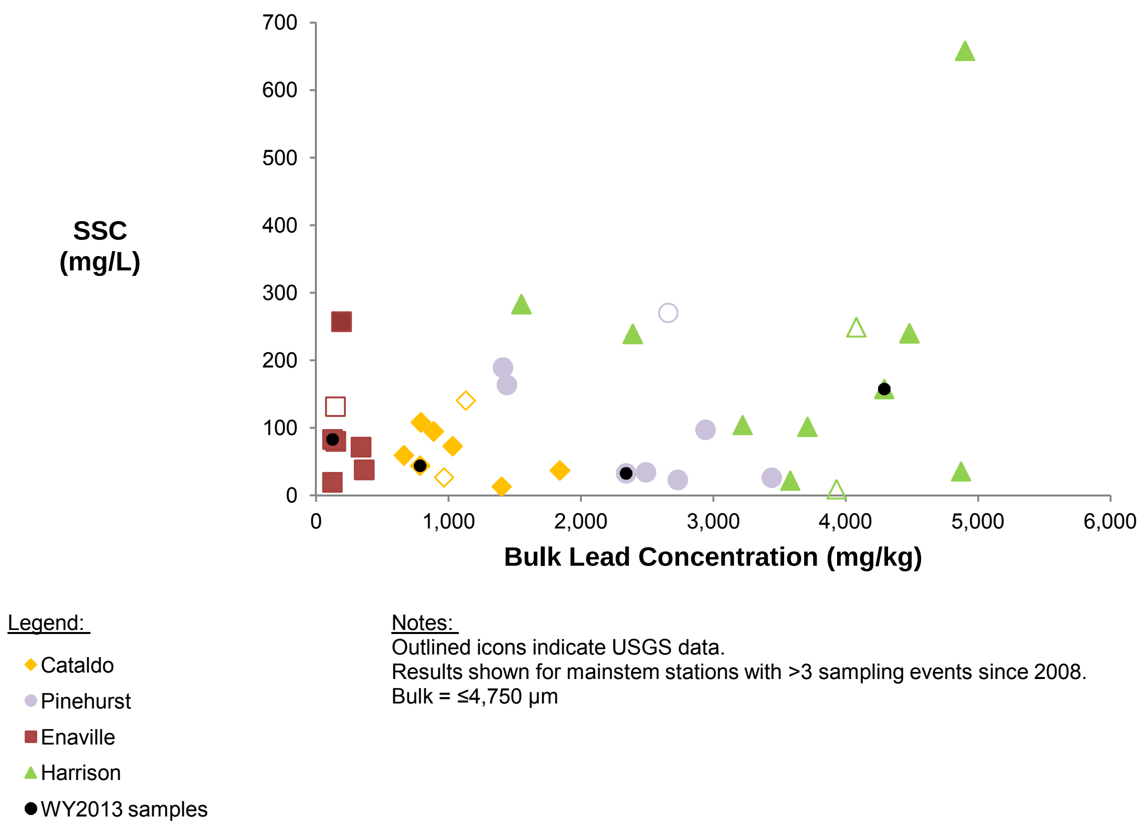
Suspended Sediment Bulk Lead Concentration Over Time



Legend:
- Cataldo
- Pinehurst
- Enaville
- Harrison
- WY2013 sample

Notes:
Outlined icons indicate USGS data.
Results shown for mainstem stations with >3 sampling events since 2008.
Bulk = ≤4,750 µm

FIGURE 3-8
Relationship Between Lead Concentration and Discharge
WY2013 BEMP Sediment Sampling Data Summary

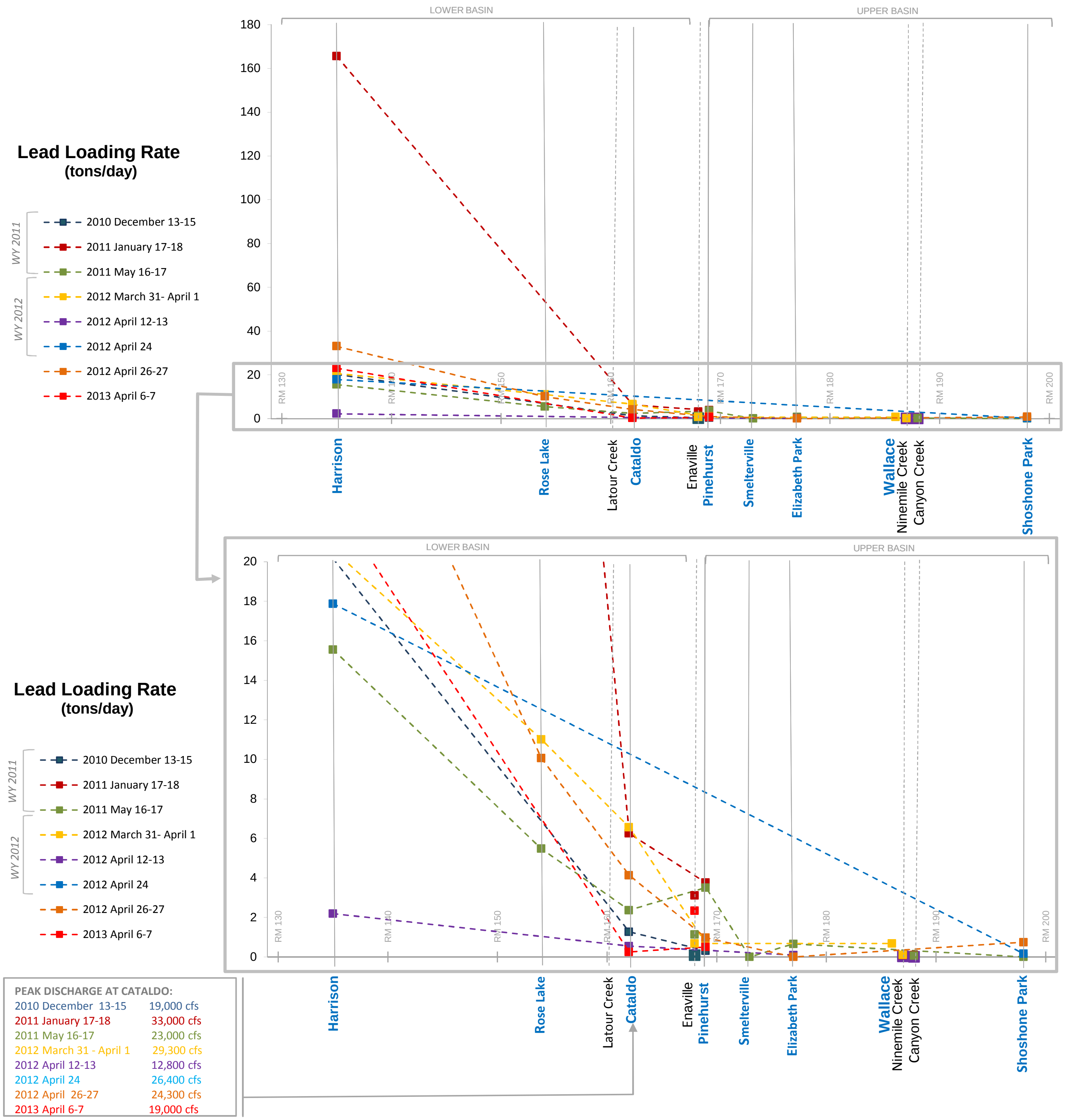


Notes:
Outlined icons indicate USGS data.
Results shown for mainstem stations with >3 sampling events since 2008.
Bulk = ≤4,750 µm

FIGURE 3-9

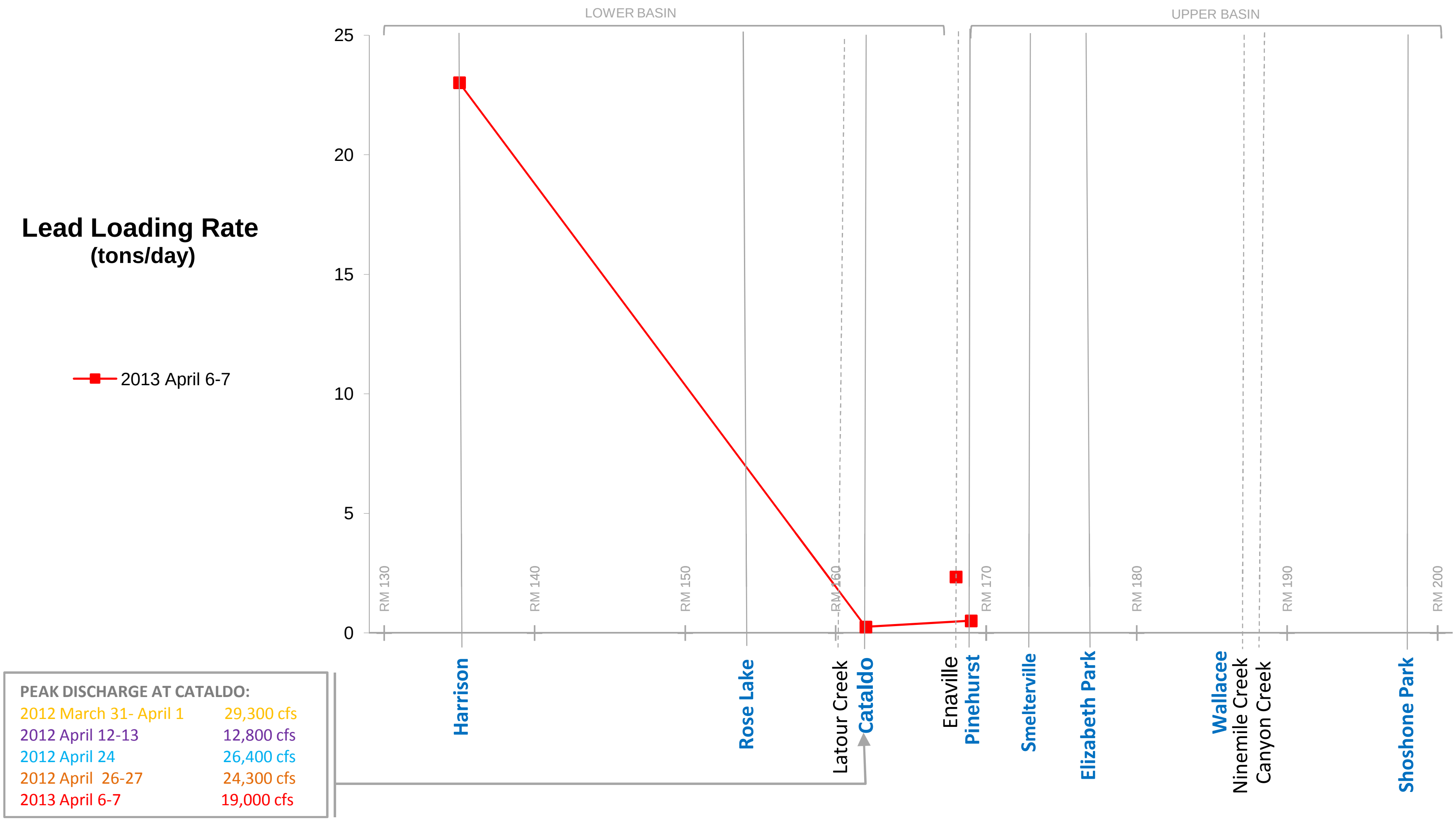
Relationship Between SSC and Lead Concentration

WY2013 BEMP Sediment Sampling Data Summary



Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Lead loading rate equation:
$Q_{Pb} = [Q_w \times C_s \times K_1] \times [C_{Pb} \times K_2 \times 10^{-9}]$
where
Q_{Pb} is the estimated lead load (metric tons/day), Q_w is discharge (cfs), C_s is suspended sediment concentration (mg/L), C_{Pb} is concentration of lead in sediment (mg/kg), K_1 is a coefficient to convert the sediment load from milligrams per second to kilograms per day (K_1= 2.45), and $K_2 \times 10^{-9}$ converts the lead mass from milligrams to English tons (short tons)

FIGURE 3-10
WY2011 through WY2013 Estimated Lead Loading Rate
WY2013 BEMP Sediment Sampling Data Summary



Notes:

Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.

Bold = Mainstem and South Fork locations

Lead loading rate equation:

$Q_{Pb} = [Q_w \times C_s \times K_1] \times [C_{Pb} \times K_2 \times 10^{-9}]$

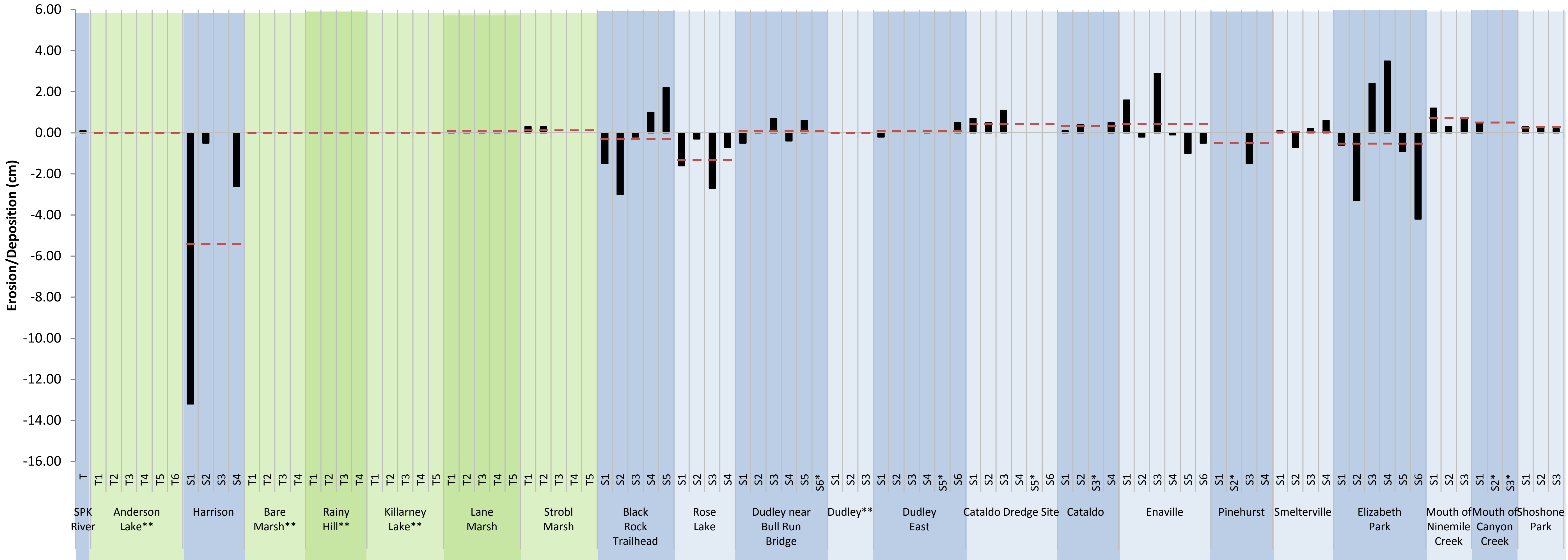
where

Q_{Pb} is the estimated lead load (metric tons/day), Q_w is discharge (cfs), C_s is suspended sediment concentration (mg/L), C_{Pb} is concentration of lead in sediment (mg/kg), K_1 is a coefficient to convert the sediment load from milligrams per second to kilograms per day (K_1= 2.45), and $K_2 \times 10^{-9}$ converts the lead mass from milligrams to English tons (short tons) (K_2= 1.1023)

FIGURE 3-11

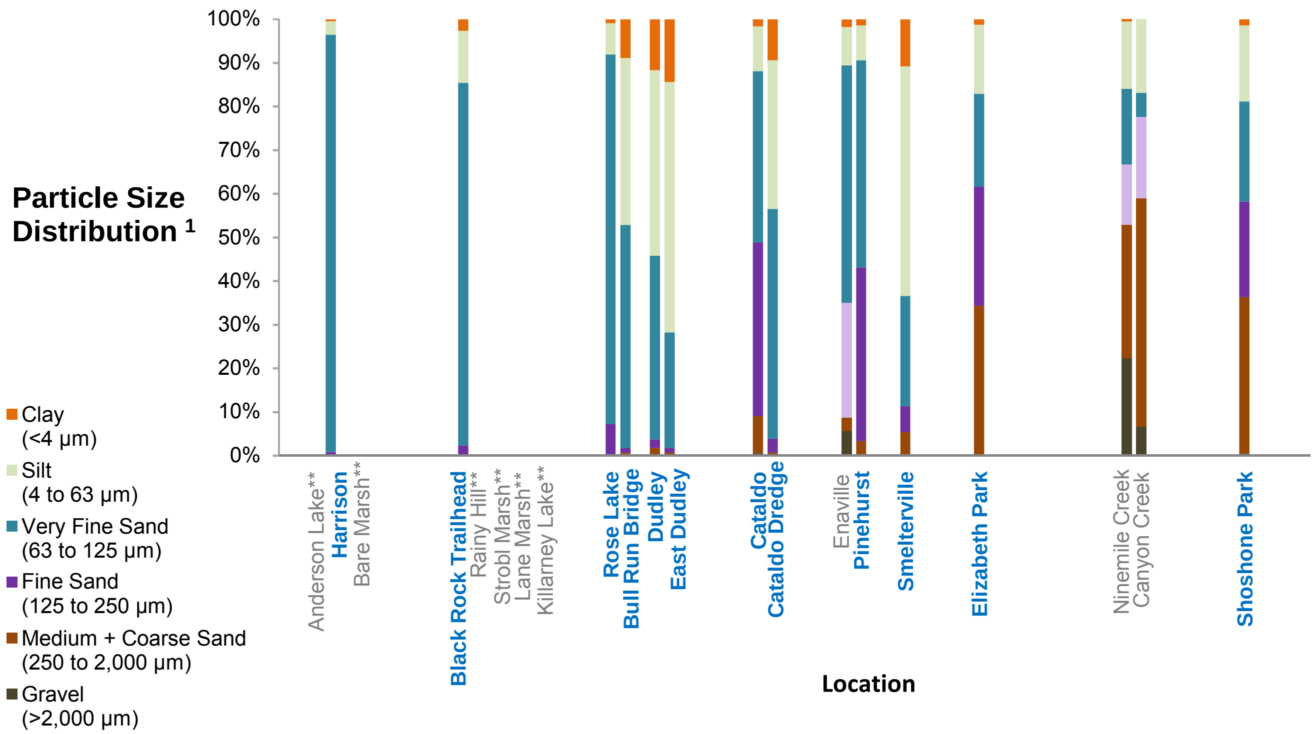
WY2013 Estimated Lead Loading Rate

WY2013 BEMP Sediment Sampling Data Summary



Notes:
"S" in sampling location code denotes stake.
"T" in sampling location code denotes tile.
* No measurement collected due to missing or inundated stake or tile.
** No measurement collected due to no inundation and/or no depositional sediment present.
Dashed lines show the sample location average (arithmetic mean) deposition/erosion.

FIGURE 4-1
Summary of Deposition and Erosion at Depositional Sediment Sampling Stations
WY2013 BEMP Sediment Sampling Data Summary

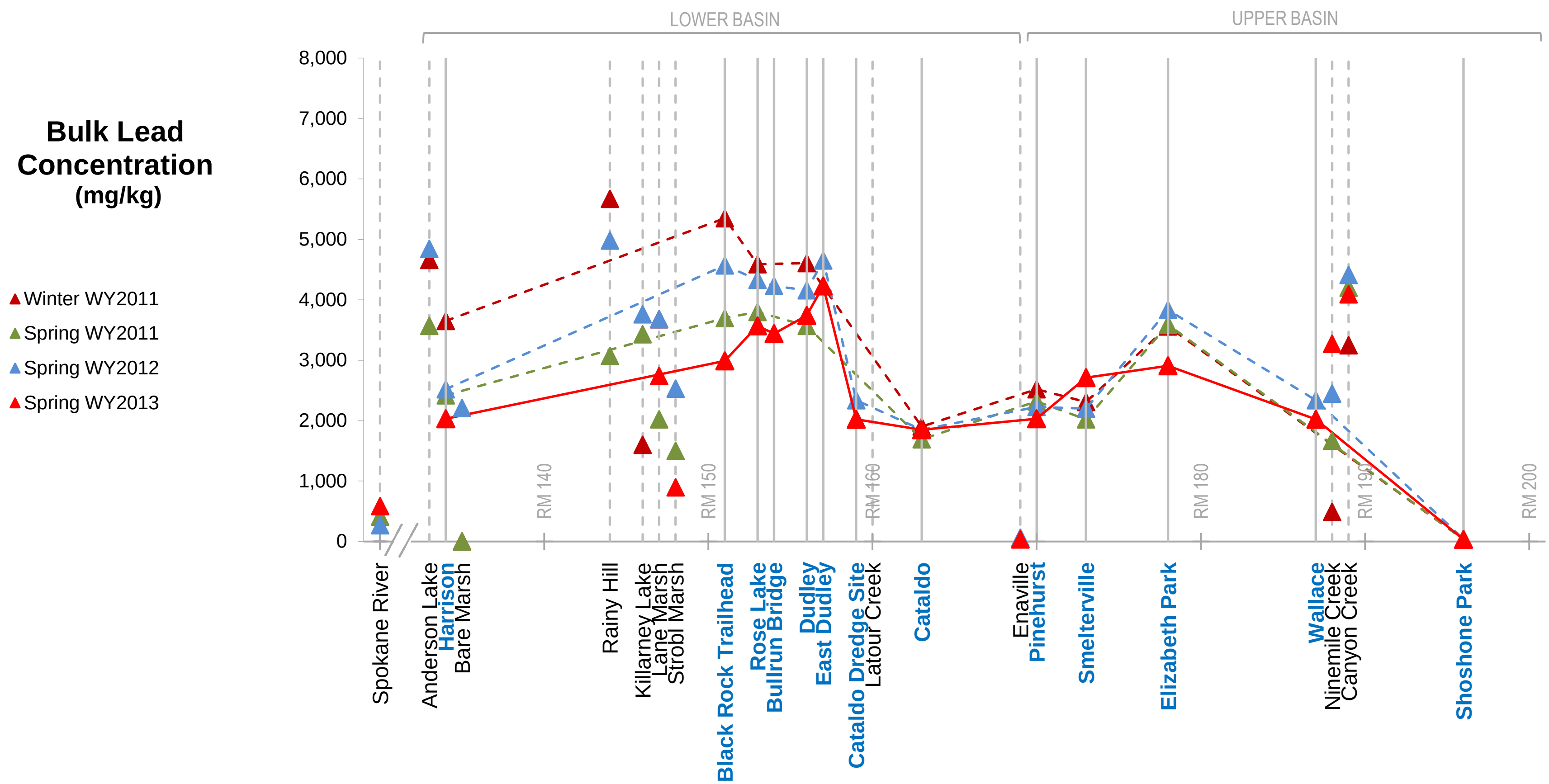


Notes:
[1] Particle size distribution calculated by dividing mass of size fraction by total mass of sample.
** No particle size data available due to inadequate sample mass or absence of freshly deposited material for sample collection.
Bold = Mainstem and South Fork locations

FIGURE 4-2

Depositional Sediment Sample Particle Size Distribution

WY2013 BEMP Sediment Sampling Data Summary

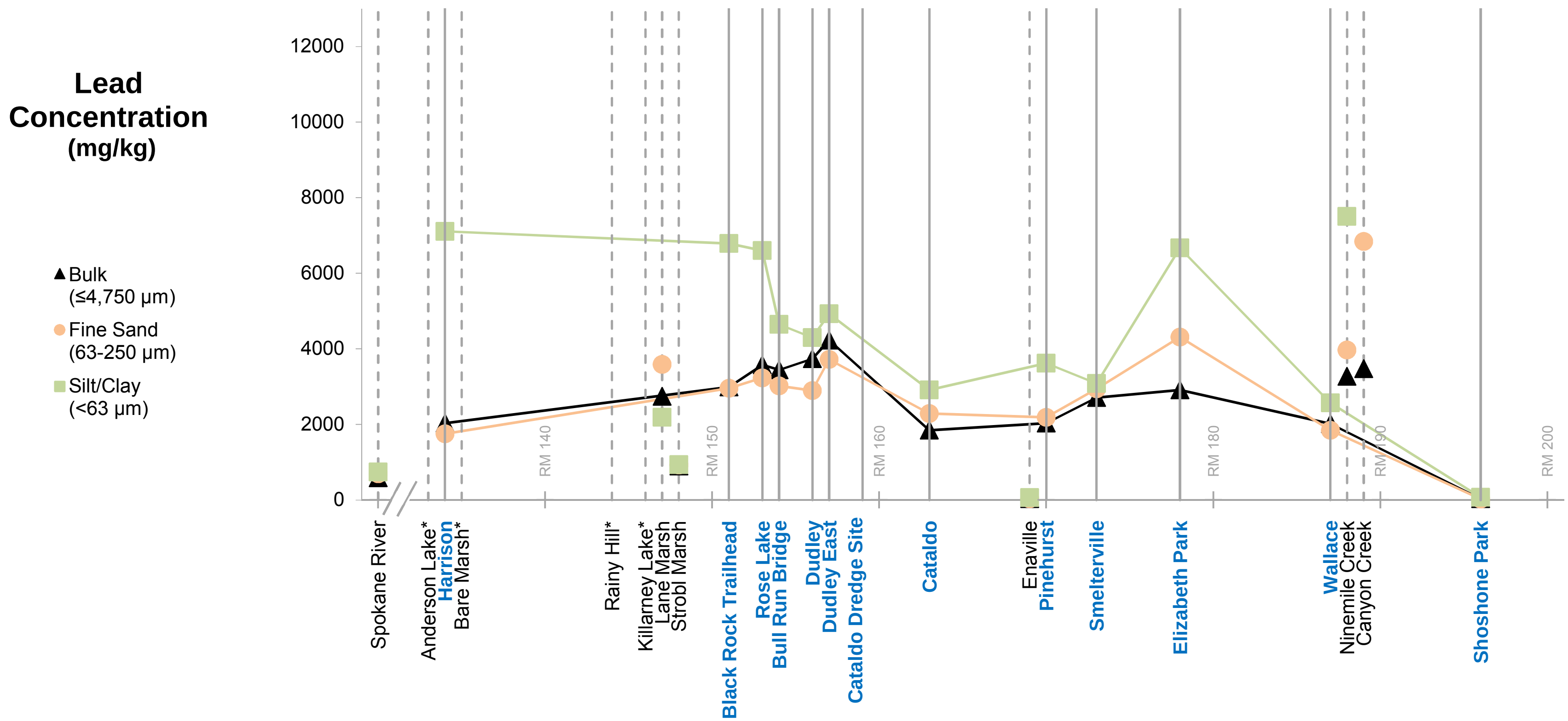


Notes:
Metal concentration for bulk samples based on analysis of particles ≤4.75 mm in size. Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries and off-channel floodplains are shown as unconnected points.
Bold = Mainstem and South Fork locations

FIGURE 4-3

WY2011 through WY2013 Lead Distribution in Depositional Sediment Samples

WY2013 BEMP Sediment Sampling Data Summary

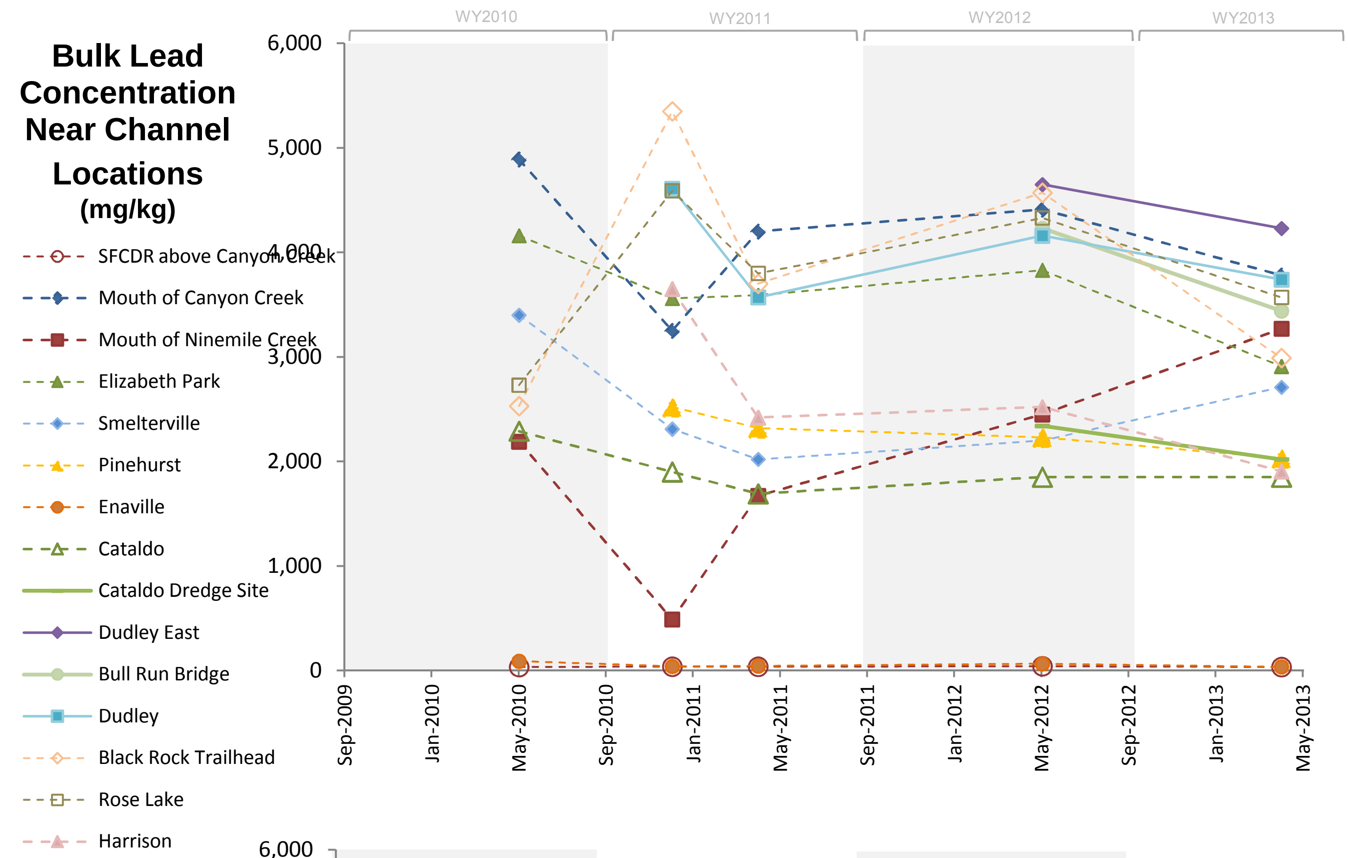


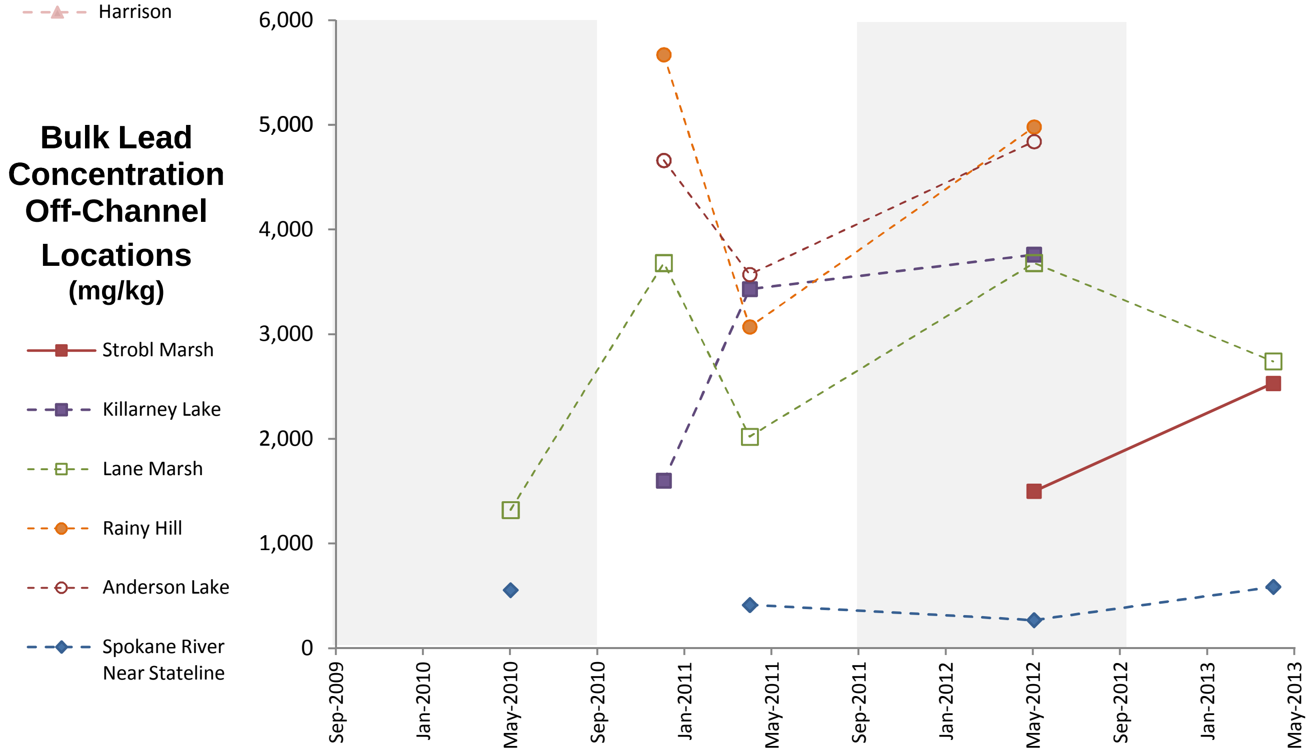
Notes:
Metal concentration for bulk samples based on analysis of particles ≤4.75mm in size. Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries and off-channel floodplains are shown as unconnected points.
Bold = Mainstem and South Fork locations
* Depositional sample not collected due to inadequate sample mass.

FIGURE 4-4

WY2013 Depositional Sediment Sample Lead Concentration by Size Fraction

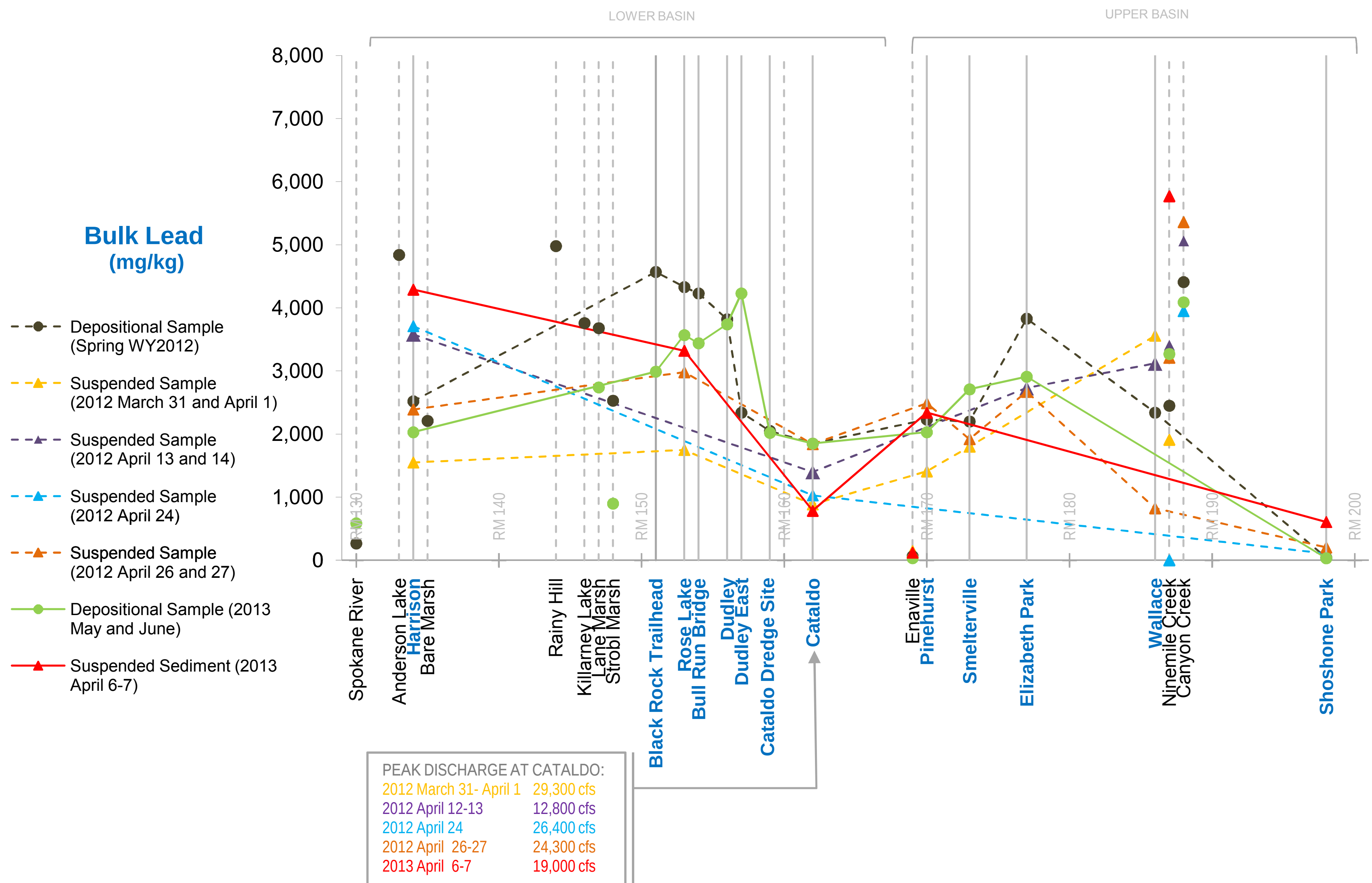
WY2013 BEMP Sediment Sampling Data Summary





Notes:
Metal concentration for bulk samples based on analysis of particles ≤4.75 mm in size.
Data shown for depositional sampling stations sampled in WY2010 through WY2013.
Bold = Mainstem and South Fork locations

FIGURE 4-5
Bulk Lead Results in Depositional Samples Over Time
WY2013 BEMP Sediment Sampling Data Summary

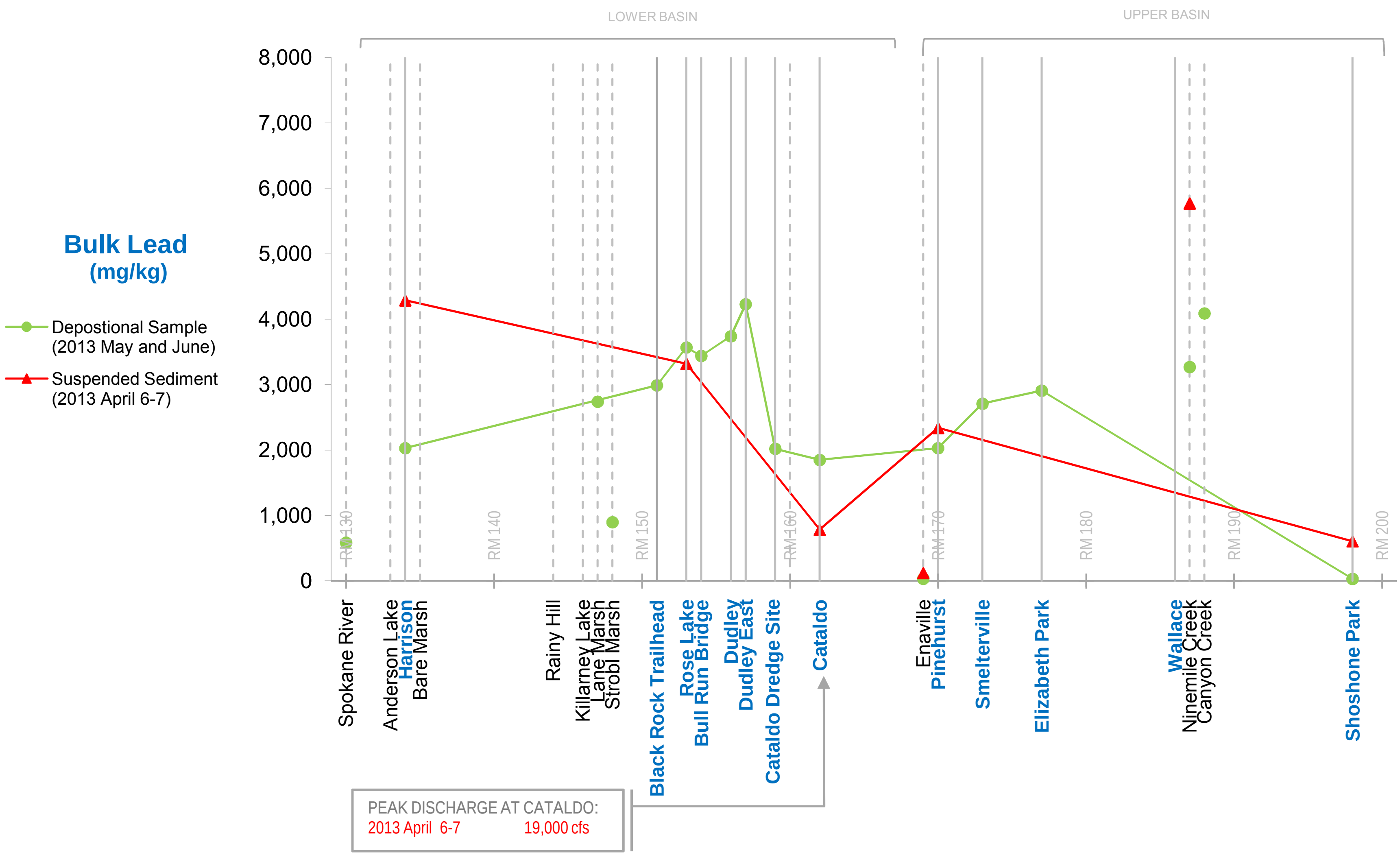


Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 5-1

WY2012 - WY2013 Lead Results by Sample Type

WY2013 BEMP Sediment Sampling Data Summary



Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 5-2

WY2013 Lead Results by Sample Type

WY2013 BEMP Sediment Sampling Data Summary

Appendix A
Photo Log

WY 2013 Depositional Sediment Sampling Photographs – Spring Runoff

June 2013, Shoshone Park (SF-BSED-D-001)

June 2013, Mouth of Canyon Creek (CC-BSED-D-002)

No Picture Taken

June 2013, Mouth of Ninemile Creek (NM-BSED-D-005)

May 2013, Elizabeth Park (SF-BSED-D-006)

May 2013, Smelterville (SF-BSED-D-007)

May 2013, Pinehurst (SF-BSED-D-009)

June 2013, Enaville (LC-BSED-D-010)

July 2013, Cataldo (LC-BSED-D-011)

May 2013, Dudley (LC-BSED-D-101)

May 2013, Rose Lake (LCBSED-D-012)

June 2013, Black Rock Trailhead (LC-BSED-D-102)

May 2013, Harrison (LC-BSED-D-014)

June 2013, Spokane River (SR-BSED-D-109)

May 2013, Lane Marsh (LC-BSED-D-103)

May 2013, Strobl Marsh (LC-BSED-D-104)

May 2013, Killarney Lake, (LC-BSED-D-105)

June 2013, Rainy Hill (LC-BSED-D-106)

May 2013, Bare Marsh (LC-BSED-D-107)

May 2013, Anderson Lake (LC-BSED-D-108)

May 2013 Cataldo Below Dredge Pool (LC-BSED-D-201)

May 2013, Dudley East (LC-BSED-D-202)

May 2013, Bull Run (LC-BSED-D-203)

Appendix B
Deviation Forms

BEMP Deviation Form

Project name and number:

BEMP Suspended Sediment Sampling

Project #: 382081

Material sampled:

Suspended Sediment

Sampling Dates/Event:

April 6th through 7th 2013

Standard procedure for field collection and laboratory analysis (cite reference):

BEMP QAPP Addendum (4/16/2010)

List change, including reason, in field procedure or analysis variation:

SF-BSED-S-001 – SFCDR at Shoshone Park

- The designated sampling location at this station is a foot bridge crossing the SFCDR in Shoshone Park. The snow (icy and compact) height was to the top of the bridge railing resulting in no fall protection. The characteristics of this location inhibited the use of engineering controls for fall protection. Therefore, the discharge measurement and sampling was conducted from a culvert located approximately 0.5 miles downstream.
- The maximum velocity observed in the SFCDR appeared to exceed the limits of the D81 sampler, which is designed for isokinetic sampling up to 6.2 feet per second. Therefore, this sample was likely collected using non-isokinetic methods.
- Due to high stream velocity, entry into the creek was not deemed safe. Field staff attempted to collect stream readings from above the river on a culvert but were unable to read staff measurements. Unsafe traction conditions on the bank of the culvert precluded depth or velocity measurements; therefore, no discharge measurement was made. Sample was collected by attempting to collect volume evenly from across the width of the stream.
- Only 15 gallons were collected due to time constraints.

CC-BSED-S-002 – Mouth of Canyon Creek

- The maximum velocity observed at Canyon Creek appeared to exceed the limits of the D81 sampler, which is designed for isokinetic sampling up to 6.2 feet per second. Therefore, this sample was likely collected using non-isokinetic methods.

NM-BSED-S-005 – Mouth of Ninemile Creek

- Due to high stream velocity, entry into the creek was not deemed safe. Field staff attempted to collect stream readings from above the creek on a culvert but were unable to read staff measurements. Unsafe traction conditions on the bank precluded depth or velocity measurements; therefore, no discharge measurement was made. Sample was collected by attempting to collect volume evenly from across the width of the stream.
- The Ninemile Creek velocity appeared to exceed the limits of the D81 sampler, which is designed for isokinetic sampling up to 6.2 feet per second. Therefore, this sample was likely collected using non-isokinetic methods.

SF-BSED-S-006 – Elizabeth Park

- SF-BSED-S-006 was not sampled during this monitoring event because sampling resources were utilized to implement the Lower Basin Coeur d'Alene River Focused Suspended Sediment Investigation conducted concurrently with the BEMP suspended sediment sampling.

SF-BSED-S-007 – Smelterville

- SF-BSED-S-007 was not sampled during this monitoring event because sampling resources were utilized to implement the Lower Basin Coeur d'Alene River Focused Suspended Sediment Investigation conducted concurrently with the BEMP suspended sediment sampling.

SF-BSED-S-009 – Pinehurst

- Several SFCDR velocity measurements were above and below the limits of the D96A1 sampler, which is designed to for isokinetic sampling between 3.7 and 6 feet per second when the water temperature is less than 10 degrees Celsius. Therefore, a portion of the sample was likely collected using non-isokinetic methods. Results of a sampler efficiency test conducted at a low velocity vertical indicate a sampler efficiency of 72 percent, below the recommended range of 75-125 percent.

LC-BSED-S-010 – Enaville

- The EWI sampling method implemented instead of the EDI method at the NFCDR at Enaville station. The EDI field form generated from the USGS sampling location does not apply to the BEMP suspended sediment sampling location.
- Only 7 of the 10 EWI verticals were sampled. The first vertical (1) near the left edge was not sampled due to the high potential for equipment damage on the left edge, which consists of a vertical bedrock wall.
- The NFCDR velocity exceeded the limits of the D96A1 sampler, which is designed for isokinetic sampling up to 6 feet per second. Therefore, the NFCDR sample was likely collected using non-isokinetic methods.
- An accurate river depth could not be measured at three EWI verticals due to high velocity and subsequent angle of the sampler/cable.
- Significant lateral movement of the D96 sampler at the EWI verticals.

LC-BSED-S-011 – Cataldo

- EDI Station at 59.3 velocity was recorded at 0.0 feet per second, thus no sample was collected at this station.
- Several CDR velocity measurements were below the limits of the D96A1 sampler, which is designed to for isokinetic sampling between 3.7 and 6 feet per second when the water temperature is less than 10 degrees Celsius. Therefore, a portion of the sample was likely collected using non-isokinetic methods. Results of three sampler efficiency tests conducted at velocities of about 3.7 feet per second indicate a sampler efficiency of 63-71 percent, below the recommended range of 75-125 percent.

LC-BSED-S-012 – Rose Lake

- Velocity measurements at the five verticals were below the limits of the D96A1 sampler, which is designed for isokinetic sampling between 3.7 and 6 feet per second when the water temperature is less than 10 degrees Celsius. Therefore, the sample was likely collected using non-isokinetic methods.

LC-BSED-S-013 – Latour Creek

- SF-BSED-S-013 was not sampled during this monitoring event because sampling resources were utilized to implement the Lower Basin Coeur d'Alene River Focused Suspended Sediment Investigation conducted concurrently with the BEMP suspended sediment sampling.

LC-BSED-S-014 – Harrison

- Velocity measurements at the five verticals were below the limits of the D96A1 sampler, which is designed for isokinetic sampling between 3.7 and 6 feet per second when the water temperature is less than 10 degrees Celsius. Therefore, the sample was likely collected using non-isokinetic methods.

Special equipment, materials, or personnel required:

N/A

FISP Sampler Isokinetic Intake Efficiency Log Sheet

Location: ____________________

Name/Checked by: ____________________

Nozzle Diameter	Nozzle Factor (K)
3/16"	0.1841
1/4"	0.1036
5/16"	0.0663

Sampler Information		
Sampler ID #	Model Type	pcode 84164
	select sampler	

		Nozzle Characteristics				Stream Velocity						computed values				
Date	**Time**	**Diameter Inches**	***PCODE 72220***	**[1]Mater-ial**	***PCODE 72219***	**ft/sec 72196**	**Me-thod Code**	**Sample Duration sec 72217**	**Sample Volume cc 72218**	**Sampled Depth ft 00003**	**Water Temp °C 00010**	**[2] Nozzle Factor K**	**[3] Nozzle Velocity ft/sec**	**[4] (Vertical Transit) ÷ (Stream Velocity)**	**[5] Intake Efficiency**	**Comments**
EXAMPLE	10:17	1/4"	4	P	2	3.92	VADCP	88	2820	11.3	57.	0.1036	3.32	0.07	**0.85**	Velocity measured with stationary ADCP in streamline
EXAMPLE	10:22	1/4"	4	P	2	3.92	VADCP	92	2910	11.3	57.	0.1036	3.28	0.06	**0.84**	Velocity measured with stationary ADCP in streamline
EXAMPLE	10:26	1/4"	4	P	2	3.92	VADCP	100	2950	11.3	57.	0.1036	3.06	0.06	**0.78**	Velocity measured with stationary ADCP in streamline
--Average--	10:22	1/4"	4	P	2	3.92	VADCP	93	2893	11.3	57.	0.1036	3.21	0.06	**0.82**	<-- Average Values: Enter Measurments into NWIS QWDATA
Cataldo	14:15	5/16"	5	P	2	3.60	VIPAA	55	2050	19.0	NM	0.0663	2.47	0.19	**0.69**	
Cataldo	10:00	5/16"	5	P	2	3.76	VIPAA	50	1800	19.3	NM	0.0663	2.39	0.21	**0.63**	
Cataldo	10:05	5/16"	5	P	2	3.76	VIPAA	50	2000	19.3	NM	0.0663	2.65	0.21	**0.71**	
Pinehurst	11:00	5/16"	5	P	2	2.85	VIPAA	71	2200	6.5	NM	0.0663	2.05	0.06	**0.72**	
		Diameter														
		Diameter														
		Diameter														
		Diameter														
		Diameter														
		Diameter														
		Diameter														
		Diameter														
		Diameter														
		Diameter														
		Diameter														
		Diameter														

[1] Nozzle Material: P = plastic; TFE = teflon; Brass

[2] Nozzle Factor K depends on size of nozzle opening

[3] Nozzle Velocity = K*(Sample Volume)/(Sample Duration)

[4] Ratio of Vertical Transit Rate (Depth/Duration) and Stream Velocity. Highlighted if <0.4.

[5] Intake Efficiency = (Nozzle Velocity) / (Stream Veocity). Text in red if (0.7<**IE**<1.3); but actual

[5] theshold of concern depends on concentration of sand-size particles and desired accuracy

INSTRUCTIONS FOR PERFORMING A FISP SAMPLER HYDRAULIC EFFICIENCY TEST

A sampler efficiency test requires 3 measurements:

(a) Sample Duration; (b) Sample Volume; and (c) Stream Velocity in the test sample vertical

Sample Volume should be measured with a large calibrated cylinder or pitcher (measure to nearest mL)

Sample Time is the total submerged time for the sampler to nearest second. For a P- type sampler it is time valve is open.

Record the Water **Temperature** and the **Depth** to which the sample is lowered in the vertical.

Flow velocity should be measured in or near the IE-test vertical, and at or near the IE sample time.

Velocity could be from a meter (cup-meter or ADCP) deployed from the sampling vessel or suspended in the sampling streamline. The velocity at the IE-test vertical also could be taken from an ADCP moving–boat transect (particularly for steady flow conditions) using manufacturer software or the USGS EDI program. Please note the method of velocity measurement in the method code and comments.

The sampler type, serial number, and nozzle diameter also are critical data for this test and computation.

For US-D-99, please note if a 3L or 6L bag is used.

Make additional copies of this worksheet or file as needed.

Method Codes for existing Parameter Code 72196 Velocity to compute isokinetic transit rate, feet per second

PCODE	Method	Method Name
72196	SADVM	Stream velocity measured using a sideways looking acoustic doppler velocity meter.
72196	UADVM	Stream velocity measured using an upward looking acoustic doppler velocity meter.
72196	V-EST	Stream velocity, estimated
72196	VADCP	Stream velocity, acoustic doppler current profiler
72196	VADV	Stream velocity, acoustic doppler velocimeter
72196	VELC	Stream velocity measured using an Electromagnetic Velocity Meter
72196	VICE	Stream velocity measured with Ice Vane Meter
72196	VIPAA	Stream Velocity measured with a Price AA meter with polymer cups
72196	VIPYG	Stream Velocity measured with a Price Pygmy meter with polymer cups
72196	VOTT	Stream velocity, horizontal shaft (Ott) meter
72196	VPAA	Stream velocity, Price AA meter
72196	VPYG	Stream velocity, Price pygmy meter
72196	VRAD	Stream velocity, radar
72196	VTIME	Stream velocity measured by any time of travel method
72196	VTRNS	The method used to measure the velocity is not known.
72196	VULT	Stream velocity, ultrasonic meter

Appendix C
Analytical Data and Data Validation Reports

Provided on CD at the end of the text