COEUR D'ALENE RIVER BASIN

Water Year 2014 BEMP Sediment Sampling Data Summary

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Report

Water Year 2014 Basin Environmental Monitoring Plan Sediment Sampling Data Summary

Prepared for

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Contents

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 2014 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) Addendum (CH2M HILL, 2010) and BEMP Sample Plan Alteration Forms (SPAF) (CH2M HILL, 2011, 2012a, 2013a). 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, 2012, and 2013 including modification of sample collection methods, analyses, 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, 2010) and BEMP SPAF (CH2M HILL, 2011, 2012a, 2013a).

1.1 Purpose and Objectives

This report presents sediment data collected during water year (WY) 2014 (between October 1, 2013 and September 30, 2014). It supplements data reported previously in the *WY2013 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

WY2014 sediment sampling was conducted in accordance with 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) Addendum (CH2M HILL, 2010) and BEMP Sample Plan Alteration Form (SPAF) (CH2M HILL, 2011, 2012a, 2013a). 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 WY2014.

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, 2012a, 2013a) 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 WY2014 suspended sediment samples were collected at velocities outside the specified range for the sampler. Low river velocities (below 3.7 feet per second) were measured at some Rose Lake and Harrison sampling verticals. Sampler efficiency tests were conducted at the lower velocity verticals at Rose Lake. Test results indicate non-isokinetic sampling at an efficiency of 77 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 three discrete size fraction categories: clay and silt (<63 micrometers [μm]), very fine sand (63 to 125 μm), and fine sand (125 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.

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

[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.

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, ceramic tiles are placed on 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 largest flood events in the Coeur d'Alene River Basin during WY2014 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. WY2014 was characterized by a short duration peak runoff event early March, followed by a series of relatively smaller (10-13,000 cfs), short duration runoff events between early April and early-May. 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 WY2014 occurred March 11, with a peak flow of 18,900 cfs. The peak discharge at Cataldo for WY2014 occurred March 10, 2014 with a peak flow of 28,900 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 33.75 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 WY2014 recorded at the NWS Kellogg Station in the Upper Basin was 28.56 inches, approximately 5.2 inches less than the historical average. The snow water equivalent (SWE) for WY2014, as recorded by the Natural Resources Conservation Service (NRCS) at Lookout Ski Resort (located in the SFCDR headwaters), peaked on April 7, 2014, at 32.9 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 WY2014 on March 11, 2014. The locations and peak daily discharge rates for the gauging stations are shown in Table 2-1. The runoff event achieved flood stage at Cataldo and was slightly less than a 5-year recurrence interval flow. The hydrograph for WY2014 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 WY2014. Samples were collected close to the highest flows occurring during the season on March 11, 2014. Sampling objectives are to collect samples at all stations as close to peak flow as is logistically possible with available resources. However, the forecasted flow increased above the threshold for sampling less than one day before the peak flow occurred, and the peak was of short duration. As a result, only the two Lower Basin stations at Harrison and Rose Lake were sampled. Figure 2-1 shows the timing of sampling relative to the hydrograph.

Suspended sediment concentration results by station location are shown in Figures 3-1 (which includes data from WY2010 through WY2014) and 3-2 (which shows data only from WY2014). Table 3-1 presents SSC and metals concentrations by size fractions for all the samples collected during the WY2014 sampling events. Field measurements and observations are presented in Table 3-2.

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 addendum and SPAF (CH2M HILL 2004; 2010, 2011, 2012a, 2013a) 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 20 to 25 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 WY2014. 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 WY2014, and Figure 3-2 presents bulk SSC results for WY2014 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 WY2014, the highest SSC was measured at Harrison on March 11, 2014 (Q = 28,900 cfs at Cataldo and Q = 18,900 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 WY2014. 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 the two samples collected during the March 11, 2014 suspended sediment sampling event in WY2014. Results are presented in Table 3-1. Lead presents one of the greatest risks 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 through WY 2014. Figure 3-6 presents bulk lead results for WY2014 only. The highest concentration of lead measured in WY2014 suspended sediment sampling was at Harrison.

Suspended sediment samples were not collected in the Upper Basin during WY2014. Previously collected Upper Basin data are discussed in data summary reports for WYs 2010 to 2013, and are apparent in figures and tables providing cumulative and historical sampling data.

The lead concentration measured in WY2014 near Harrison was consistent with the average concentration, whereas, the lead concentration at Rose Lake was above average. The lead concentration measured at Harrison was 3,500 mg/kg (average of 3,513 mg/kg) and the lead concentration measured at Rose Lake was 3,410 mg/kg (average of 2,794 mg/kg). However, more data are available for the Harrison average value than the Rose Lake value. 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 in subsequent water years.

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 June 4 through 6, 2014, samples were collected in low-elevation Upper Basin stations (Elizabeth Park, Smelterville, and Pinehurst), the NFCDR station (Enaville), Lower Basin stations (Cataldo, Cataldo Dredge Site, Dudley East, CDR near Bull Run Bridge, Dudley, Rose Lake, Black Rock Trailhead, and Harrison), and some off-channel stations (Lane Marsh, Rainy Hill, and Anderson Lake). On July 10, 2014, samples were collected from the remaining Upper Basin stations (Shoshone Park, Ninemile Creek, and Canyon Creek) and the Spokane River station. Sampling was not conducted at some off –channel locations (Strobl Marsh, Killarney Lake, and Bare Marsh) due to the absence of depositional sediment on the tiles.

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 deposition was documented at Shoshone Park, Ninemile Creek, and Smelterville. In the Lower Basin, net deposition was documented at the stake locations Dudley East, Dudley, and Bull Run Bridge, and at the tile locations Lane Marsh, Rainy Hill, and Anderson Lake.

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. An additional modification in 2014 consisted of replacing the No. 140 (106 micron) sieve with a No. 120 (125 micron) sieve to provide the break between the very fine sand and fine sand. These modifications were 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 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 WY2014. 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 yielded the highest quantities of silt and clay content. (Table 4-3).

Table 4-4 presents the TOC results for samples collected at Lane Marsh. The TOC concentration in Lane Marsh sediment was measured at 4.1 percent.

4.3.2 Depositional Sediment Metals Concentrations

Bulk and size-specific metals concentrations were measured for all samples collected from depositional sediment sampling in WY2014 (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 Rainy Hill), were sampled in WY2014. 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 relatively similar.

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 show lower levels.

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 WY2014. Suspended and depositional sediment data are used to support project objectives, analyze status and trends, and support understanding of sediment transport dynamics. In addition, these data are used to support modeling of sediment transport processes in the Coeur d'Alene River Basin. Data are also be used for 5-year reviews of remedy effectiveness as required by CERCLA.

The WY2014 BEMP program conducted limited sampling during one short duration elevated flow event in March that was well above – albeit briefly - flood stage. Depositional sediment sampling was conducted following the spring runoff.

The following conclusions provide a general summary of the data collected for WY2014. :

- Consistent with previous sampling results, the lowest concentrations of lead in 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.
- Of the two suspended sediment samples collected during WY2014, the highest concentration of bulk lead was observed at Harrison (3,500 mg/kg) (Figure 5-1). The highest concentrations of bulk lead in depositional sediment in the WY2014 data set were at Anderson Lake (5,680 mg/kg) (Figure 5-1). These data are also provided in the context of previous data in Figure 5-2.
- The highest measured lead load was at Harrison (approximately 38 tons/day on March 11, 2014) (Figure 3-11). This value is largely attributable to higher SSC values, as bulk lead concentrations were similar at Rose Lake and Harrison.
- Compared with both upstream and downstream samples, lead concentrations were relatively low in the depositional 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 depositional sediment increased to levels above SFCDR levels—indicating that lead is being mobilized from within the CDR channel.
- Depositional 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

ASTM International (ASTM). 2007a. ASTM D3977 - 97(2007) Standard Test Methods for Determining Sediment Concentration in Water Samples. West Conshohocken, Pennsylvania.

ASTM International (ASTM). 2007b. ASTM D2974 - 07a Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils. West Conshohocken, Pennsylvania.

ASTM International (ASTM). 2007c. ASTM D422 - 63(2007) Standard Test Method for Particle-Size Analysis of Soils. West Conshohocken, Pennsylvania.

CH2M HILL. 2010. *Quality Assurance Project Plan Addendum, Coeur d'Alene Basin Environmental Monitoring Plan*. April.

CH2M HILL. 2011. *Sampling Plan Alteration Form for the QAPP Addendum, Coeur d'Alene Basin Environmental Monitoring Plan*.

CH2M HILL. 2012a. *Sampling Plan Alteration Form for the QAPP Addendum, Coeur d'Alene Basin Environmental Monitoring Plan*.

CH2M HILL. 2012b. *WY2011 BEMP Sediment Sampling Data Summary.*

CH2M HILL. 2013a. *Sampling Plan Alteration Form for the QAPP Addendum, Coeur d'Alene Basin Environmental Monitoring Plan*.

CH2MHILL. 2013b. *WY2012 BEMP Sediment Sampling Data Summary*.

CH2MHILL. 2013c. *WY2013 BEMP Sediment Sampling Data Summary*.

U.S. Environmental Protection Agency (EPA). 1982. Method 200.7, Methods for the Determination of Metals in Environmental Samples, Supplement 1 (EPA/600/R-94/111). Revision 4.4 (revised 1994).

U.S. Environmental Protection Agency (EPA). 2001. *Ecological Risk Assessment, Coeur d'Alene Basin Remedial Investigation/Feasibility Study*. May.

U.S. Environmental Protection Agency (EPA). 2002. *Record of Decision – Bunker Hill Mining and Metallurgical Complex Operable Unit 3*. September.

U.S. Environmental Protection Agency (EPA). 2004. *Basin Environmental Monitoring Plan – Bunker Hill Mining and Metallurgical Complex Operable Unit 3*. March.

U.S. Geological Survey (USGS). 2013. *Guidelines for FISP Bag Sampler Intake Efficiency Tests and Operational Velocities.*

U.S. Geological Survey (USGS). 1999a. *TWRI Book 9 Ch A4, Collection of Water Samples.*

U.S. Geological Survey (USGS). 1999b. *TWRI Book 3 Ch C2, Field Methods for Measurement of Fluvial Sediment.*

Western Regional Climate Center. 2012. NOWData – National Oceanic and Atmospheric Administration Online Weather Data. Accessed online at http://www.nws.noaa.gov/climate/xmacis.php?wfo=otx

Tables

TABLE 1-1
Sediment Monitoring Program
WY2014 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	--	--	--	--
Mouth of Canyon Creek at CDA Trail Bridge	CC-BSED-S-002	--	--	--	--
Mouth of Ninemile Creek at Culvert	NM-BSED-S-005	--	--	--	--
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	--	--	--	--
NFCDR near Enaville at Old River Road Bridge	LC-BSED-S-010	--	--	--	--
CDR near Cataldo at Riverview Road Bridge	LC-BSED-S-011	--	--	--	--
Latour Creek at East Dudley Road Bridge	LC-BSED-S-013	--	--	--	--
Rose Lake at Bull Run Road Bridge	LC-BSED-S-012	x	--	x	3/11/14
CDR near Harrison at Springston Bridge	LC-BSED-S-014	x	--	x	3/11/14
Depositional		**MET**	**PSD**	**TOC**	
SFCDR above Canyon Creek at Shoshone Park	SF-BSED-D-001	x	x	--	7/10/14
Mouth of Canyon Creek	CC-BSED-D-002	x	x	--	7/10/14
Mouth of Ninemile Creek	NM-BSED-D-005	x	x	--	7/10/14
SFCDR near Elizabeth Park	SF-BSED-D-006	x	x	--	6/4/14
SFCDR near Smelterville	SF-BSED-D-007	x	x	--	6/4/14
SFCDR near Pinehurst	SF-BSED-D-009	x	x	--	6/4/14
NFCDR near Enaville above Confluence	NF-BSED-D-010	x	x	--	6/4/14
CDR near Cataldo below Confluence	LC-BSED-D-011	x	x	--	6/4/14
Cataldo Dredge Site	LC-BSED-D-201	x	x	--	6/4/14
Dudley East	LC-BSED-D-202	x	x	--	6/4/14
CDR Near Bull Run Bridge	LC-BSED-D-203	x	x	--	6/4/14
Dudley	LC-BSED-D-101	x	x	--	6/4/14
Black Rock Trailhead	LC-BSED-D-102	x	x	--	6/5/14
Rose Lake	LC-BSED-D-012	x	x	--	6/4/14
Lane Marsh	LC-BSED-D-103	x	x	x	6/5/14
Strobl Marsh	LC-BSED-D-104	--	--	--	--
Killarney Lake	LC-BSED-D-105	--	--	--	--
Rainy Hill	LC-BSED-D-106	x	x	--	6/5/14
Bare Marsh	LC-BSED-D-107	--	--	--	--
Anderson Lake	LC-BSED-D-108	x	x	--	6/6/14
CDR near Harrison	LC-BSED-D-014	x	x	--	6/5/14
Spokane River near Stateline	LC-BSED-D-109	x	x	--	7/10/14

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
WY2014 BEMP Sediment Sampling Data Summary

Location	USGS Gage Station	WY 2014			Historical Average Peak Flow (cfs)	Period of Record
		Flow (cfs)	Date of Peak	Date of Suspended Sediment Sampling		
Shoshone Park[1]	--	NS	NS	NS	--	--
Canyon Creek	12413125	348	5/28/14	NS	460	1999 – 2013
Ninemile Creek[1]	12413130	NS	NS	NS	142	1999 – 2013
Wallace	12413131	1080	5/24/14	NS	--	--
SFCDR at Elizabeth Park	12413210	2,800	3/9/14	NS	2,452	1988 – 2013
SFCDR near Pinehurst	12413470	6,830	3/9/14	NS	4,282	1988 – 2013
NFCDR at Enaville	12413000	21,700	3/10/14	NS	18,318	1912 – 2013
CDR at Cataldo	12413500	28,900	3/10/14	NS	22,313	1911 – 2013
Latour Creek[1]	--	NS	NS	NS	--	--
CDR at Rose Lake[1]	--	--	--	3/11/14	--	--
CDR at Harrison	12413860	18,900	3/11/14	3/11/14	14,922	2004 – 2013

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] Real time USGS gaging station not present. Peak flow determined from discharge measurements at time of sampling.

TABLE 3-1
Suspended Sediment Sample Metals Concentrations by Size Fraction – March 11, 2014, Sampling Event
WY2014 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*
LC-BSED-S-012-3-11-14 -<63	CDR Rose Lake at Bull Run Road Bridge	03/11/14	25,583	70.16	Silt/clay	76.1	21.8	660	**4,070**	**3.1**	11.1	**4,190**
LC-BSED-S-012-3-11-14 -63-125		03/11/14			Very fine sand	81	57.5	224	**4,480**	**6.6**	17.5	**9,700**
LC-BSED-S-012-3-11-14 -125-250		03/11/14			Fine sand	45.8	36.1	112	**2,460**	**3.8**	12.8	**6,280**
LC-BSED-S-012-3-11-14 -BULK		03/11/14			Bulk	63.3	32.6	155	**3,410**	**3.9**	13.1	**5,400**
LC-BSED-S-014-3-11-14 -<63	CDR near Harrison at Springston Bridge	03/11/14	18,100	243.74	Silt/clay	143	26.9	145	**5,420**	**3.9**	17.3	**4,660**
LC-BSED-S-014-3-11-14 -63-125		03/11/14			Very fine sand	73.1	37.8	113	**3,350**	**4.8**	15.9	**6,160**
LC-BSED-S-014-3-11-14 -125-250		03/11/14			Fine sand	49.5	21.1	78.7	**2,140**	**2.8**	9.6	**3,300**
LC-BSED-S-014-3-11-14 -BULK		03/11/14			Bulk	86.9	38.9	122	**3,500**	**4.0**	16.3	**6,240**

NOTES:

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

Bold and shaded 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

LOAEL = lowest observed adverse effect level

mg/kg = milligrams per kilogram

mg/L = milligrams per liter

Silt/clay = <63 micrometers

TABLE 3-2
Suspended Sediment Sampling Field Observations
WY2014 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	NA	NA	NA	NA	Shoshone Park station not sampled this event.
CC-BSED-S-002	Mouth of Canyon Creek	Spring Peak Runoff	NA	NA	NA	NA	Canyon Creek station not sampled this event.
NM-BSED-S-005	Mouth of Ninemile Creek	Spring Peak Runoff	NA	NA	NA	NA	Ninemile Creek station not sampled this event.
SF-BSED-S-201	SFCDR at Wallace	Spring Peak Runoff	NA	NA	NA	NA	SFCDR at 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	SFCDR at Smelterville station not sampled this event.
SF-BSED-S-009	SFCDR near Pinehurst	Spring Peak Runoff	NA	NA	NA	NA	SFCDR near Pinehurst station not sampled this event.
LC-BSED-S-010	NFCDR at Enaville	Spring Peak Runoff	NA	NA	NA	NA	NFCDR at Enaville station not sampled this event.
LC-BSED-S-011	CDR at Cataldo	Spring Peak Runoff	NA	NA	NA	NA	CDR at Cataldo station not sampled this event.
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	3/11/2014	55.0	4.32	25,583[1]	
LC-BSED-S-014	CDR near Harrison	Spring Peak Runoff	3/11/2014	37.5	3.75	18,100[2]	

NOTES:
[1] Field discharge measurement conducted prior to sampling
[2] Real time discharge measurement taken from the USGS gaging station at the time of sampling.
CDR = Coeur d'Alene River
cfs = cubic feet per second
ft/sec = feet per second
NA = not applicable

TABLE 4-1
Depositional Sediment Sampling Field Observations
WY2014 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	2.8	7/10/2014	Deposition was measured at S1 and observed at the S2 location. The deposition was consistent at both stake locations consisting of a poorly graded sand overlying decaying vegetation. S3 was inundated and the surrounding area appears to have been washed out. Sample submitted for particle size and metals analysis.
		S2	Stake missing		
		S3	Stake inundated		
CC-BSED-D-002	Mouth of Canyon Creek	S1	-0.7	7/10/2014	Erosion measured across the site. One area of deposition observed adjacent to Canyon Creek S1 and S2 encompassing an areas of approximately 2 feet by 5 feet. The deposition consisted of small mounds and sheet deposition overlying existing vegetation. The maximum thicknesses measured at the small mounds and sheet deposition were 2.0 and 1.5 centimeters. The material consisted of a poorly graded sand with trace fine gravel. Sample submitted for particle size and metals analysis.
		S2	-6.2		
		S3	-0.2		
		S4	Stake missing		
NM-BSED-D-005	Mouth of Ninemile Creek	S1	Stake inundated	7/10/2014	Deposition measured in the area adjacent to S2. Ninemile Creek appeared to erode the deposition to the edge of the stake. The deposition consisted of about 2 centimeters of poorly graded sand with silt overlying over 5 centimeters of fine sand and silt laden with decomposing tree needles. Sample submitted for particle size and metals analysis.
		S2	6.9		
		S3	-2.3		
SF-BSED-D-006	Elizabeth Park	S1	-6.5	6/4/2014	Significant erosion across the site. Several feet of east/northeast bank eroded including the area near S1 and S2. Water flow paths across the site were evident and mounding/collection of sands was present downstream of vegetative structures. However, it is uncertain whether the sandy material was newly deposited material or reworked existing material. Sample was collected from the sands across the site using 30 subsamples of equal volume. Sample consisted of a well graded fine to coarse sand with trace fines. Sample submitted for particle size and metals analysis.
		S2	-7.7		
		S3	-12.0		
		S4	-2.2		
		S5	-1.0		
		S6	-2.9		
SF-BSED-D-007	Smelterville	S1	0.2	6/4/2014	The deposition measured at three stakes is not consistent with field observations. Erosion was observed across the site resulting in exposed grass clump roots. Mature moss growth was present on the ground around two stakes. Water flow paths at the site were evident and the collection of sands was present downstream of vegetative structures. However, it is uncertain whether the sandy material was deposited onsite or reworked existing material. Some areas of the site had a very thin layer of fines on the surface indicating pooling of water. Due to the uncertainty of deposition at the site, 30 equal subsamples were collected from the sands observed across the site. The sample consisted of a poorly graded fine sand with trace fines. Sample submitted for particle size and metals analysis.
		S2	2.7		
		S3	0.0		
		S4	0.7		
SF-BSED-D-009	Pinehurst	S1	Stake inundated	6/4/2014	Stakes inconclusive for determining deposition at this site. Two stakes impacted from human disturbance and one stake inundated. Erosion evident at the north end of the site in a water flow channel. Deposition present along the bank between S1 and S2 within the thick grasses overlying decaying vegetation. Sample collected opportunistically from material along the SFCDR bank. The grain size of newly deposited material was similar along the bank consisting of a poorly graded fine sand with trace fines. Sample submitted for particle size and metals analysis.
		S2	Stake pulled and laying on ground		
		S3	-0.3		
		S4	Stake missing		
LC-BSED-D-010	Enaville	S1	-0.4	6/4/2014	Stake measurements indicate erosion predominant across the site. The deposition at S6 is suspect because of mature moss growth around the stake. Deposition consisting of a thin layer of fines was observed closer to the edge of the NFCDR on top of moss and cobbles. Sample collected opportunistically from this area. Sample consisted of a silt with fine sand. Sample submitted for particle size and metals analysis.
		S2	-1.3		
		S3	-0.9		
		S4	-1.9		
		S5	-0.4		
		S6	1.0		
LC-BSED-D-011	Cataldo	S1	3.3	6/4/2014	Variable distribution of deposition and erosion across the site. Deposition consists of mounding downstream of vegetation or other natural features. Erosional rills present at the eastern end of the site. The characteristics of this site continues to change. Several large logs were deposited at the eastern end of the site resulting in modified flow paths during elevated flows. A significant amount of brush was also removed during utility work. Sample collected from recent deposition at S1 and S4. The sampled material consisted of a poorly graded fine sand with about 10% silt. Sample submitted for particle size and metals analysis.
		S2	Stake missing		
		S3	-3.6		
		S4	0.5		
LC-BSED-D-201	Cataldo Dredge Site	S1	1.2	6/4/2014	Deposition occurred along bank edge overlying existing vegetation. The thickness was variable and difficult to identify in some areas due to vegetation growth. Sample was collected opportunistically along the bank between S1 and S6 because of the limited quantity available at the stakes. The grain size of deposition was similar at the site consisting of a fine sand with trace silt. Sample submitted for particle size and metals analysis.
		S2	0.0		
		S3	0.6		
		S4	-1.5		
		S5	2.7		
		S6	-3.0		
LC-BSED-D-202	Dudley East	S1	0.9	6/4/2014	Deposition observed across this site and nearly 5 cm thick across the lower elevation flat area along the edge of the river. Material consisted of a silty sand with an oxidized surface overlying gray/reduced material. Deposition at the five stakes was overlying decaying vegetation. Sample collected from the vicinity of stakes S1 through S5, but predominantly from S4 and S5. Sample submitted for particle size and metals analysis.
		S2	3.5		
		S3	0.9		
		S4	4.9		
		S5	4.6		
		S6	0.0		
LC-BSED-D-101	Dudley	S1	Stake pulled and laying on ground	6/4/2014	Deposition occurred along the bank edge overlying existing vegetation. The thickness was variable and difficult to identify in some areas due to vegetation growth. Sample was collected opportunistically along the bank between S1 and S3 because of the limited quantity available at the stakes. The grain size of deposition was similar at the site consisting of a fine sand with trace silt. Sample submitted for particle size and metals analysis.
		S2	2.0		
		S3	2.4		

TABLE 4-1
Depositional Sediment Sampling Field Observations
WY2014 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	2.1	6/4/2014	Deposition occurred along the bank edge overlying and intermixed with decaying vegetation. The thickness was variable and difficult to identify in some areas, including around stakes, because of vegetation growth. To ensure sufficient sample quantity, sampling was conducted opportunistically along the bank between S1 and S5. Deposited material consisted of a fine sand with trace silt. Sample submitted for particle size and metals analysis.
		S2	1.8		
		S3	3.2		
		S4	1.9		
		S5	1.6		
		S6	-1.6		
LC-BSED-D-012	Rose Lake	S1	-2.9	6/4/2014	Variable deposition/erosion across the site based on stake measurements. Field observations indicate the presence of predominantly erosion across the site based on small rills, slumping of small dunes, and exposed grass clump roots. Equal sample collected from the vicinity of S2 and S4. Deposited material consisted of a fine sand with trace silt. Sample submitted for particle size and metals analysis.
		S2	2.1		
		S3	-4.1		
		S4	1.9		
LC-BSED-D-102	Black Rock Trailhead	S1	0.6	6/5/2014	Variable deposition/erosion across the site based on stake measurements and field observations. Recent deposition observed downstream of vegetation and existing mounds based on the covering of existing/decaying vegetation. Erosion present around grass clumps with exposed roots. Sample collected from the vicinity of S1 and S5 consisting of a fine sand with trace fines. A strip of bank approximately 10 feet wide and 60 feet long is beginning to separate toward the river as evident with a crack/depressed area running parallel with the river. Sample submitted of particle size and metals.
		S2	-0.9		
		S3	-1.0		
		S4	-2.9		
		S5	4.1		
LC-BSED-D-014	Harrison	S1	-8.2	6/5/2014	Two stakes show deposition; however, field observations indicate significant and continued erosion of the large shelf deposited in 2012. The eroding shelf had previously covered the iron oxide stained bank material, which is now exposed. The measured deposition at S2 appears to be bank slough and the mature moss growth is present at S4. Due to the observed erosion across this site, sample was collected from the lower shelf/beach frequented by recreational users. Sample was collected from the sands across the site using 30 subsamples of equal volume. Sample consisted of fine sand with trace fines. Sample submitted for particle size and metals analysis.
		S2	1.2		
		S3	-2.9		
		S4	1.1		
SR-BSED-D-109	Spokane River near Stateline	--	--	7/10/2014	A treed area downgradient of the public use area was targeted for sampling. Sample was collected opportunistically from several small mounds observed downgradient of large cobbles, trees, and other features. The depositional material was variable at the mounds and consisted of a poorly graded sand to a fine gravel with sand. The thickness of the depositional mounding was also variable, but the maximum thicknesses of the mounds measured was 0.5-1.5 cm. Sample submitted for particle size and metals analysis.
		--	--		
		--	--		
OFF-CHANNEL LOCATIONS					
LC-BSED-D-103	Lane Marsh	T1	0.5	6/5/2014	Deposition was observed on each of the tiles consisting of silt, but was intermixed with an orange/tan organic muck and decaying vegetation. The vegetation was removed from the tiles to the extent practicable, and all organic material/sediment from the five tiles was sampled. Sample submitted for particle size, metals, and total organic carbon analysis.
		T2	0.5		
		T3	0.3		
		T4	0.3		
		T5	0.2		
LC-BSED-D-104	Strobl Marsh	T1	0.0	--	Tiles appear to have been inundated during the peak runoff event. Tiles were partially covered with decaying vegetation, but no sediment was present. No sample collected.
		T2	0.0		
		T3	0.0		
		T4	0.0		
		T5	0.0		
LC-BSED-D-105	Killarney Lake	T1	0.0	--	Tiles appear to have been inundated during the peak runoff event. Tiles were partially covered with decaying vegetation, but no sediment was present. No sample collected.
		T2	0.0		
		T3	0.0		
		T4	0.0		
		T5	0.0		
LC-BSED-D-106	Rainy Hill	T1	1.2	6/5/2014	A depositional layer was present across the site and thicker closer the marsh connecting channel and decreasing with distance from the channel. Two tiles appear to have been moved from their original location next to the channel prior to the depositional event. Some decaying vegetation present on tiles and intermixed with the sediment. Depositional material consisted of a silt with very fine sand (~30%). Sample submitted for particle size and metals analysis.
		T2	1.2		
		T3	0.3		
		T4	0.3		
		T5	0.7		
LC-BSED-D-107	Bare Marsh	T1	0.0	--	Uncertainty whether tiles were inundated during the peak runoff event due to extensive vegetation growth. Tiles were partially covered with decaying vegetation, but no sediment was present. No sample collected.
		T2	0.0		
		T3	0.0		
		T4	0.0		
LC-BSED-D-108	Anderson Lake	T1	2.5	6/6/2014	Ten tiles placed in 2013 due to frequent anthropogenic disturbance. Four tiles were missing resulting in recovery of six tiles. Sediment was present on three tiles, an organic muck skim was present on one tile, and no sediment was present on two tiles. Tiles with the thickest deposition were located within the connecting channel outlet. Tiles with no deposition were located on the outer edge of the connecting channel outlet. Sampled material consists of very fine sand with silt. Sample submitted for particle size, metals, and total organic carbon analysis.
		T2	2.5		
		T3	1.1		
		T4	0.0		
		T5	0.0		
		T6	Organic muck skim		

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

TABLE 4-2
Depositional Sediment Particle Size Distribution – Post-Spring Runoff
WY2014 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 (125-250 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	07/10/14	5.18	3%	10.49	6%	60.10	33%	50.30	28%	35.58	20%	10.48	6%	4.18	2%	3.52	2%
CC-BSED-D-002	Mouth of Canyon Creek	07/10/14	1.62	1%	5.59	3%	9.36	4%	31.87	15%	75.66	35%	64.79	30%	17.13	8%	7.96	4%
NM-BSED-D-005	Mouth of Ninemile Creek	07/10/14	3.80	2%	10.23	5%	38.12	18%	48.18	23%	50.36	24%	26.02	12%	11.73	6%	17.59	8%
SF-BSED-D-006	Elizabeth Park	06/04/14	1.78	1%	5.03	2%	34.28	15%	54.81	24%	71.75	31%	46.35	20%	15.16	7%	3.74	2%
SF-BSED-D-007	Smelterville	06/04/14	2.58	1%	9.34	4%	60.30	29%	95.31	45%	40.01	19%	2.06	1%	0.06	0%	0.00	0%
SF-BSED-D-009	Pinehurst	06/04/14	2.53	1%	7.53	4%	85.64	41%	91.77	44%	17.86	9%	0.22	0%	0.04	0%	0.00	0%
LC-BSED-D-010	Enaville	06/04/14	8.84	11%	47.51	59%	10.61	13%	7.24	9%	2.55	3%	1.03	1%	0.00	0%	0.01	0%
LC-BSED-D-011	Cataldo	06/04/14	7.48	5%	25.56	17%	53.01	36%	42.15	29%	16.36	11%	0.48	0%	0.07	0%	0.33	0%
LC-BSED-D-201	Cataldo Dredge Site	06/04/14	1.60	1%	22.51	16%	98.78	71%	12.85	9%	0.77	1%	0.37	0%	0.02	0%	0.09	0%
LC-BSED-D-202	Dudley East	06/04/14	8.32	6%	26.66	20%	88.42	66%	6.44	5%	0.43	0%	0.18	0%	0.04	0%	0.00	0%
LC-BSED-D-203	CDR near Bull Run Bridge	06/04/14	6.61	4%	31.31	19%	118.80	72%	3.40	2%	0.87	1%	0.44	0%	0.06	0%	0.00	0%
LC-BSED-D-101	Dudley	06/04/14	0.58	0%	6.58	5%	126.82	94%	0.49	0%	0.09	0%	0.08	0%	0.00	0%	0.00	0%
LC-BSED-D-102	Rose Lake	06/05/14	4.14	2%	15.10	8%	156.05	85%	5.02	3%	0.52	0%	0.27	0%	0.00	0%	0.01	0%
LC-BSED-D-012	Black Rock Trailhead	06/04/14	6.45	3%	29.59	14%	164.39	78%	5.75	3%	0.92	0%	0.28	0%	0.00	0%	0.00	0%
LC-BSED-D-014	CDR near Harrison	06/05/14	2.36	1%	4.43	3%	149.88	94%	0.66	0%	0.06	0%	0.03	0%	0.04	0%	0.00	0%
SR-BSED-D-109	Spokane River near Stateline	07/10/14	2.76	1%	7.26	3%	19.40	7%	23.65	9%	47.65	18%	60.11	22%	74.55	27%	33.13	12%
OFF-CHANNEL																		
LC-BSED-D-103	Lane Marsh	06/05/14	22.23	22%	59.76	58%	10.43	10%	0.79	1%	1.03	1%	1.49	1%	0.25	0%	0.00	0%
LC-BSED-D-104	Strobl Marsh		*Location Not Sampled*															
LC-BSED-D-105	Killarney Lake		*Location Not Sampled*															
LC-BSED-D-106	Rainy Hill	06/05/14	7.40	5%	55.59	37%	79.42	53%	0.86	1%	0.47	0%	0.28	0%	0.03	0%	0.00	0%
LC-BSED-D-107	Bare Marsh		*Location Not Sampled*															
LC-BSED-D-108	Anderson Lake	06/06/14	15.02	12%	75.54	59%	32.74	25%	0.38	0%	0.42	0%	0.34	0%	0.02	0%	0.00	0%

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

TABLE 4-3

Depositional Sediment Average Particle Size Distribution by Reach

WY2014 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** (125-250 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%	4%	23%	30%	23%	12%	4%	3%
NFCDR	11%	59%	13%	9%	3%	1%	0%	0%
Lower Basin (in-channel)	3%	13%	74%	6%	2%	0%	0%	0%
Lower Basin (off-channel)	13%	51%	30%	1%	1%	1%	0%	0%
Spokane River	1%	3%	7%	9%	18%	22%	27%	12%

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

WY2014 BEMP Sediment Sampling Data Summary

Sample ID	Location Description	Sample Date	Total Organic Carbon (mg/kg)	Total Organic Carbon (%)
LC-BSED-D-103	Lane Marsh (Lower Basin)	06/05/14	41,000	4.1

NOTES:

mg/kg = milligrams per kilogram

TABLE 4-5

Depositional Sediment Metals Concentrations by Size Fraction

WY2014 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)	07/10/14	Silt/clay	15.67	9%	17	1.1	22.1	92	0.0972	0.99 U	148
			Very fine sand	60.10	33%	7.3	0.48 U	14.4	37.4	0.049 U	0.97 U	71.9
			Fine sand	50.30	28%	5.6	0.49 U	5.81	27.5	0.049 U	0.99 U	58.1
			Bulk	182.03	99%	8.8	0.5 U	10 J	32.7	0.047 UJ	1 U	73.7
CC-BSED-D-002	Mouth of Canyon Creek (Tributary to South Fork)	07/10/14	Silt/clay	7.21	3%	79.8	61.1	302	14,000	16.1	33.3	8,830
			Very fine sand	9.36	4%	46.4	43.9	163	7,780	7.56	17.2	7,080
			Fine sand	31.87	15%	26	34 J	141	6,210	4.82	15 J	5,950
			Bulk	216.43	99%	14	14.7	73 J	3,890	2.9 J	3.1	2,830
NM-BSED-D-005	Mouth of Ninemile Creek (Tributary to South Fork)	07/10/14	Silt/clay	14.03	7%	30.8	42.2	187	6,960	2.73	11.4	6,740
			Very fine sand	38.12	18%	26.2	27.8	120	5,060	1.76	8.84	5,160
			Fine sand	48.18	23%	18	27 J	115	4,110	1.33	7 J	5,650
			Bulk	208.30	99%	11	16.8	96 J	3,010	0.83 J	5.31	3,740
SF-BSED-D-006	Elizabeth Park (South Fork)	06/04/14	Silt/clay	6.81	3%	170	30.8	206	8,720	11.4	32.9	3,930
			Very fine sand	34.28	15%	157	21.8	151	4,820	4.14	17 J	3,390
			Fine sand	54.81	24%	77.3	22.1	135	4,590	2.37	10.8	3,490
			Bulk	232.92	100%	40.8	14	74.9	3,300	0.839	8.18	2,350
(Field Dup)			Silt/clay	6.81	3%	170	31.2	205	8,800	12.2	33.4	4,040
			Very fine sand	34.28	15%	139	21.9	159	4,840	5.79	19 J	3,330
			Fine sand	54.81	24%	93.2	20.9	124	4,330	2.38	9.35	3,320
			Bulk	232.92	100%	35.4	12.1	90.1	3,050	2.22	5.5	1,970
SF-BSED-D-007	Smelterville (South Fork)	06/04/14	Silt/clay	11.92	6%	87.7	24.4	116	3,310	2.4	10.7	2,490
			Very fine sand	60.30	29%	94.5	15.4	107	2,730	1.88	7.3 J	2,060
			Fine sand	95.31	45%	51.4	12.2	74.8	2,500	1.07	8.5	2,050
			Bulk	210.53	100%	37.1	11.6	60	2,070	0.652	4.3	1,640
SF-BSED-D-009	Pinehurst (South Fork)	06/04/14	Silt/clay	10.06	5%	113	18.5	115	3,900	2.98	11.8	2,210
			Very fine sand	85.64	41%	118	11.3	78.8	2,270	1.74	7.1 J	1,700
			Fine sand	91.77	44%	80.9	8.9	70.7	2,250	1.21	6.38	1,750
			Bulk	206.45	100%	96.6	8.46	64.7	2,140	0.863	3.9	1,440
LC-BSED-D-010	Enaville (South Fork)	06/04/14	Silt/clay	56.35	70%	14	0.83	22.7	106	0.101	1 U	168
			Very fine sand	10.61	13%	16	1.1	33.5	124	0.119	1 U	180
			Fine sand	7.24	9%	14	0.89	21.6	116	0.109	1 U	172
			Bulk	80.33	97%	14	0.74	20.2	103	0.095	1 U	163
LC-BSED-D-011	Cataldo (Mainstem)	06/04/14	Silt/clay	33.04	23%	62.5	13.4	76.5	2,450	2.31	7.7	1,590
			Very fine sand	53.01	36%	73.4	12.1	74.7	2,510	1.9	6.4 J	1,760
			Fine sand	42.15	29%	60.1	10	53.5	2,420	1.4	6.44	1,740
			Bulk	146.18	99%	51.2	8.37	43.9	2,050	1.05	5.29	1,310
LC-BSED-D-201	Cataldo Dredge Site (Mainstem)	06/04/14	Silt/clay	24.11	17%	118	18.2	100	3,510	2.55	8.89	2,420
			Very fine sand	98.78	71%	113	23.3	87.6	2,540	2.81	10 J	3,530
			Fine sand	12.85	9%	92.1	10.6	46.6	1,810	1.6	6.46	1,790
			Bulk	138.61	99%	92.7	14.7	62.6	2,240	1.89	7.49	2,280

TABLE 4-5

Depositional Sediment Metals Concentrations by Size Fraction

WY2014 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-202	Dudley East (Mainstem)	06/04/14	Silt/clay	34.98	26%	107	38.1	155	7,130	4.74	16.5	5,220
			Very fine sand	88.42	66%	67.9	64.3	135	4,640	6.59	14 J	9,810
			Fine sand	6.44	5%	42.2	26.8	69.6	2,680	3.22	7.69	4,440
			Bulk	133.83	98%	60.3	37.5	100	4,150	4.76	11.5	5,760
(Field Dup)			Silt/clay	34.98	26%	102	41.4	156	7,330	5.12	16.3	5,730
			Very fine sand	88.42	66%	68	62.3	115	4,310	7.08	14 J	9,590
			Fine sand	6.44	5%	42.6	26.7	66.9	2,550	2.45	7.75	4,500
			Bulk	133.83	98%	62.8	38.2	100	4,330	5.1	11.7	5,770
LC-BSED-D-203	CDR near Bull Run Bridge (Mainstem)	06/04/14	Silt/clay	37.92	23%	105	35.4	138	6,470	4.72	15.8	5,290
			Very fine sand	118.80	72%	73.7	48.1	114	3,920	5.43	14 J	7,500
			Fine sand	3.40	2%	49.8	34.4	80.8	3,580	3.93	9.1	5,550
			Bulk	165.88	97%	64.6	36.9	93.7	4,090	4.24	11.5	5,700
LC-BSED-D-101	Dudley (Mainstem)	06/04/14	Silt/clay	7.16	5%	114	39.5	151	7,090	5.22	17.5	5,970
			Very fine sand	126.82	94%	80.9	69.3	150	5,000	6.33	17 J	10,700
			Fine sand	0.49	0%	49.9	27.5	67	3,090	3.27	6.64	4,630
			Bulk	135.22	100%	59.8	39.2	105	4,280	4.2	11.7	6,230
LC-BSED-D-102	Black Rock Trailhead (Mainstem)	06/05/14	Silt/clay	19.24	11%	129	71	171	8,720	6.47	20.3	9,310
			Very fine sand	156.05	85%	85.7	79.2	150	4,450	7.01	17 J	11,900
			Fine sand	5.02	3%	45.5	39.9	85.1	2,630	4.85	10.3	6,210
			Bulk	183.18	99%	72.3	49.3	92.9	3,530	4.85	12.5	7,420
LC-BSED-D-012	Rose Lake (Mainstem)	06/04/14	Silt/clay	36.04	17%	117	51.1	173	8,220	5.84	20.1	7,220
			Very fine sand	164.39	78%	71.6	60.5	125	4,080	5.75	15 J	9,290
			Fine sand	5.75	3%	42.6	31.6	77.3	2,990	3.17	8.2	5,040
			Bulk	211.99	98%	56	42	97.4	4,170	4.24	10.8	6,390
LC-BSED-D-014	CDR near Harrison (Mainstem)	06/05/14	Silt/clay	6.79	4%	269	59.3	203	7,380	9.39	26.2	9,530
			Very fine sand	149.88	94%	107	63.2	122	2,940	7.79	18 J	10,300
			Fine sand	0.66	0%	45.6	11.9	39.2	1,450	1.71	5.15	2,280
			Bulk	159.05	99%	65.6	26.9	62.6	2,030	3.82	8.39	4,460
SR-BSED-D-109	Spokane River near Stateline (Spokane River)	07/10/14	Silt/clay	10.02	4%	18	12.3	41.7	777	0.279	0.98 U	1,860
			Very fine sand	19.40	7%	14	8.29	22.7	531	0.173	0.99 U	1,590
			Fine sand	23.65	9%	12	6.4 J	18.9	438	0.118	1 U	1,450
			Bulk	271.95	99%	11	4.4 J	13.1	376	0.062 J	1 U	1,230

TABLE 4-5

Depositional Sediment Metals Concentrations by Size Fraction

WY2014 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*
OFF-CHANNEL LOCATIONS												
LC-BSED-D-103	Lane Marsh (Lower Basin)	06/05/14	Silt/clay	81.99	80%	83	23.8	103	4,160	3.35	12.3	3,630
			Very fine sand	10.43	10%	56.1	23.5	87.7	3,720	3.2	8.6 J	3,320
			Fine sand	0.79	1%	85.5	32.1	111	6,240	3.5	12.3	3,630
			Bulk	103.13	93%	74.7	24.2	90.7	4,380	3	10.9	3,420
LC-BSED-D-104	Strobl Marsh	--										
LC-BSED-D-105	Killarney Lake	--										
LC-BSED-D-106	Rainy Hill (Lower Basin)	06/05/14	Silt/clay	62.99	42%	117	34.9	122	6,050	3.95	14.8	5,080
			Very fine sand	79.42	53%	69.5	39.1	87.1	3,470	3.91	11 J	5,990
			Fine sand	0.86	1%	57.9	27.8	71.4	4,280	2.75	8.75	3,770
			Bulk	148.48	97%	82.4	35.1	90	4,630	3.73	11.7	5,110
LC-BSED-D-107	Bare Marsh (Lower Basin)	--										
LC-BSED-D-108	Anderson Lake (Lower Basin)	06/06/14	Silt/clay	90.56	70%	117	27.7	115	5,170	3.71	13.6	4,180
			Very fine sand	32.74	25%	76.7	25.6	77	3,630	3.54	9 J	3,730
			Fine sand	0.38	0%	146	44.3	129	7,710	5.41	14.8	4,270
			Bulk	128.46	97%	132	28.3	97.6	5,680	3.54	12	3,900

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 mas

µm = micrometers

Bulk = ≤4,750 µm

Fine sand = 63-250 µm

J = Estimated value

LOAEL = lowest observed adverse effect leve

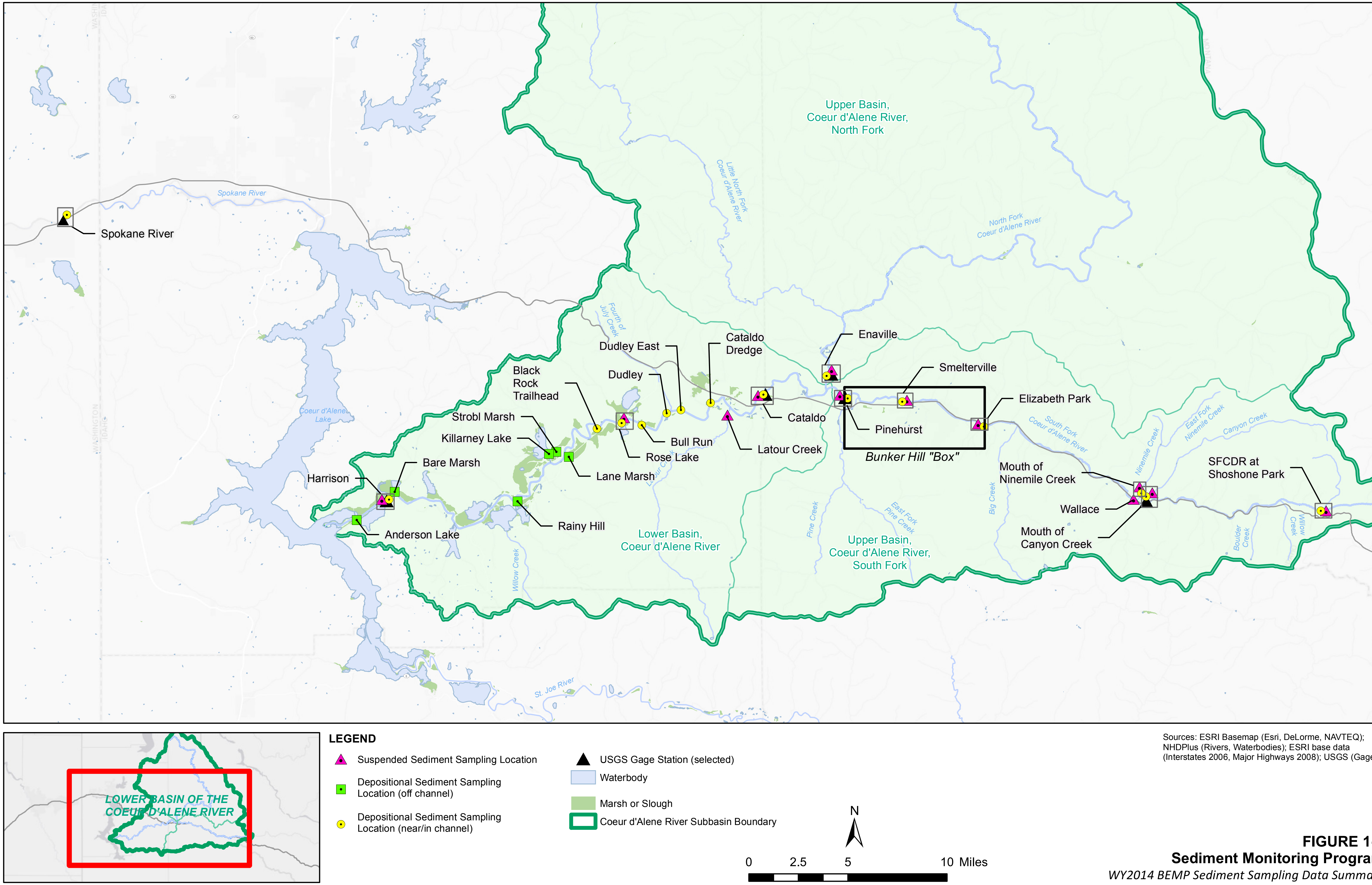
mg/kg = milligrams per kilogram

Silt/clay = <63 µm

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

Very fine sand = 63-125 µm

Figures



Sources: ESRI Basemap (Esri, DeLorme, NAVTEQ); NHDPlus (Rivers, Waterbodies); ESRI base data (Interstates 2006, Major Highways 2008); USGS (Gages).

FIGURE 1-1
Sediment Monitoring Program
WY2014 BEMP Sediment Sampling Data Summary

CH2MHILL

\\ROSA\PROJ\USEPA\382081BUNKERHILL\LOWERBASIN\GIS\MAPFILES\2014\BEMP_OPTIMIZATION\BEMPOVERVIEW.MXD GGEE 11/5/2014 2:42:27 PM

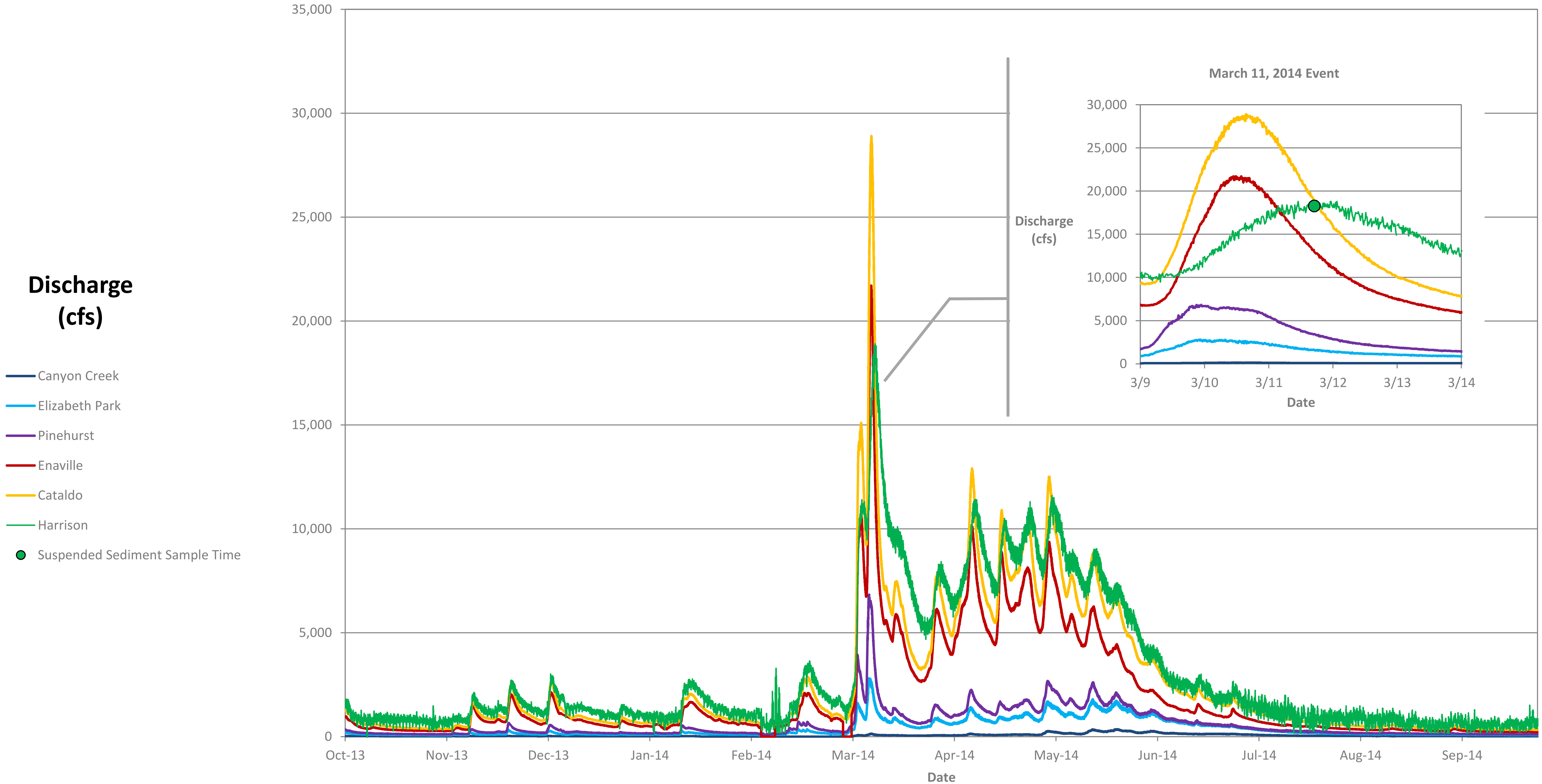
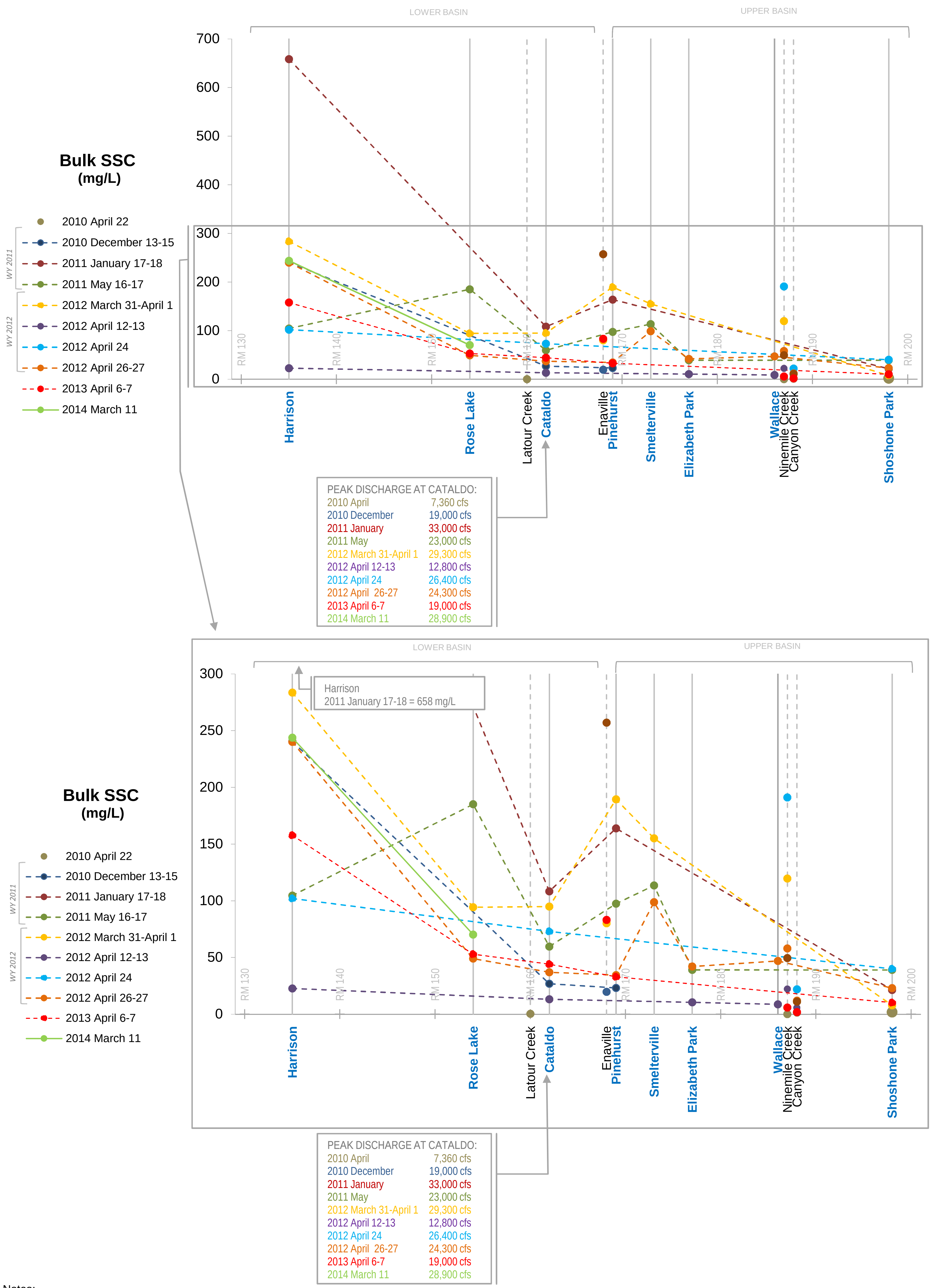
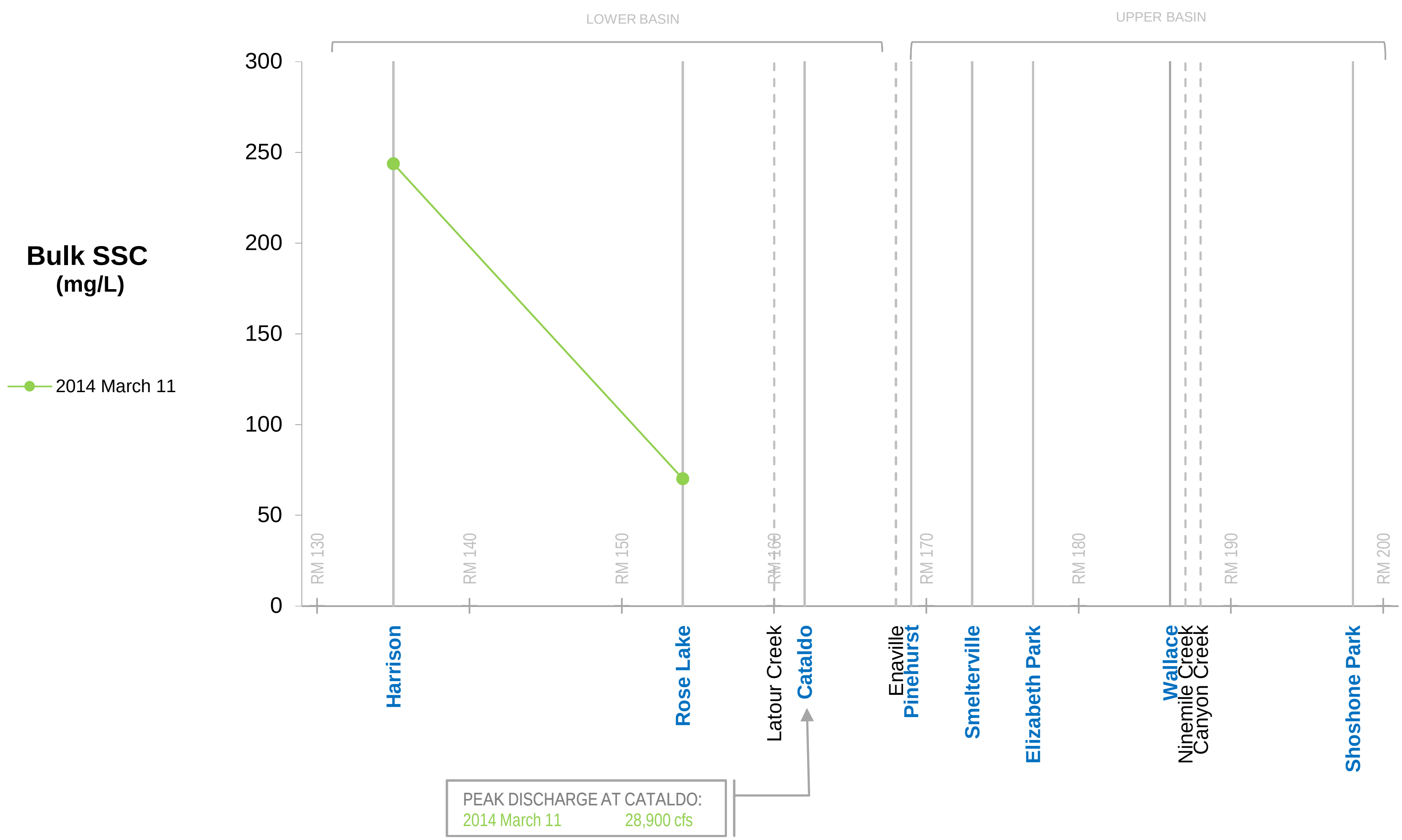


FIGURE 2-1
WY2014 Hydrograph
WY2014 BEMP Sediment Sampling Data Summary



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 - WY2014 Suspended Sediment Concentration
WY2014 BEMP Sediment Sampling Data Summary

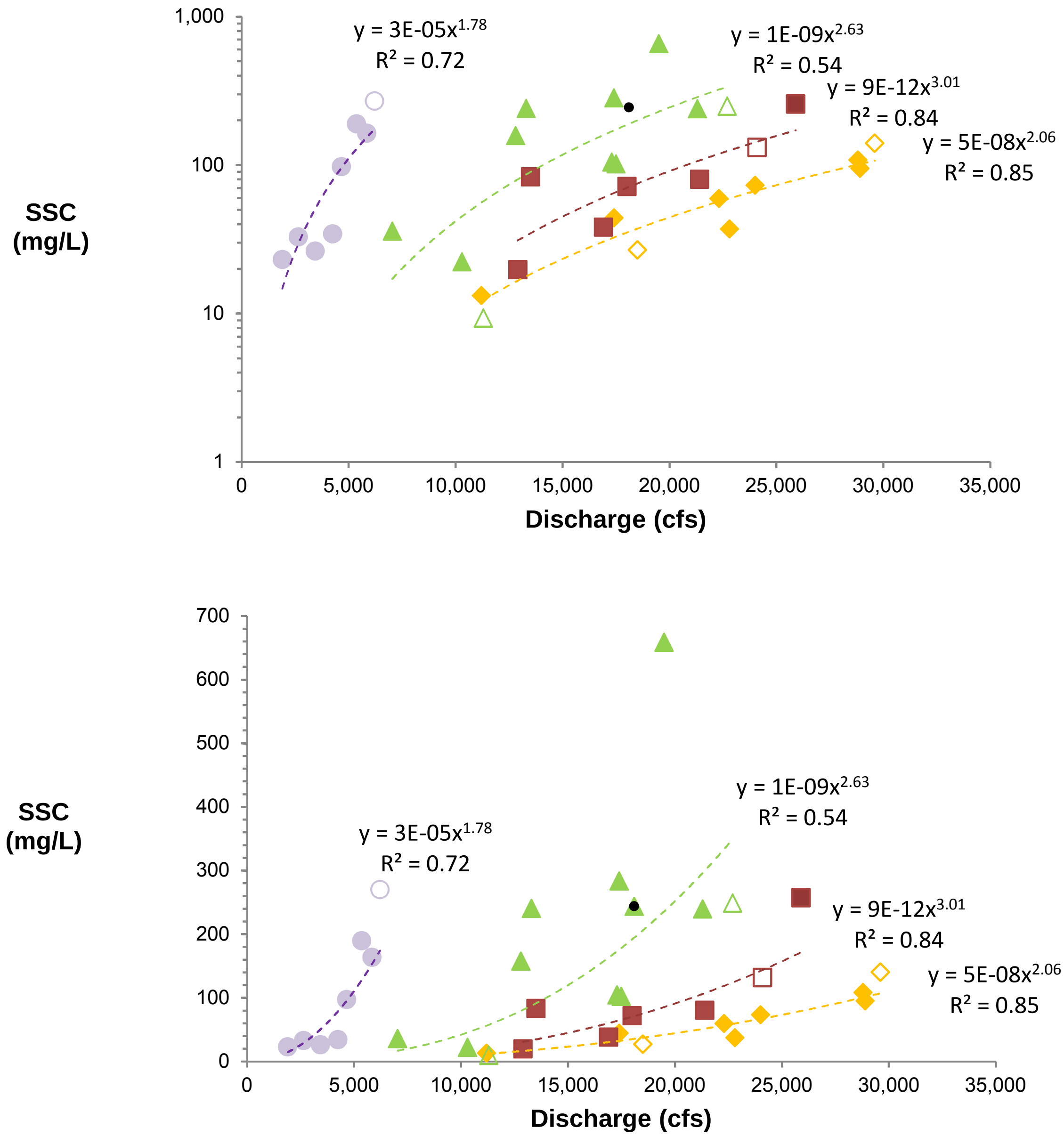


Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 3-2

WY2014 Suspended Sediment Concentration

WY2014 BEMP Sediment Sampling Data Summary



Legend:

- Cataldo
- Pinehurst
- Enaville
- Harrison
- WY2014 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
WY2014 BEMP Sediment Sampling Data Summary

Particle Size Distribution

March 11, 2014 Event

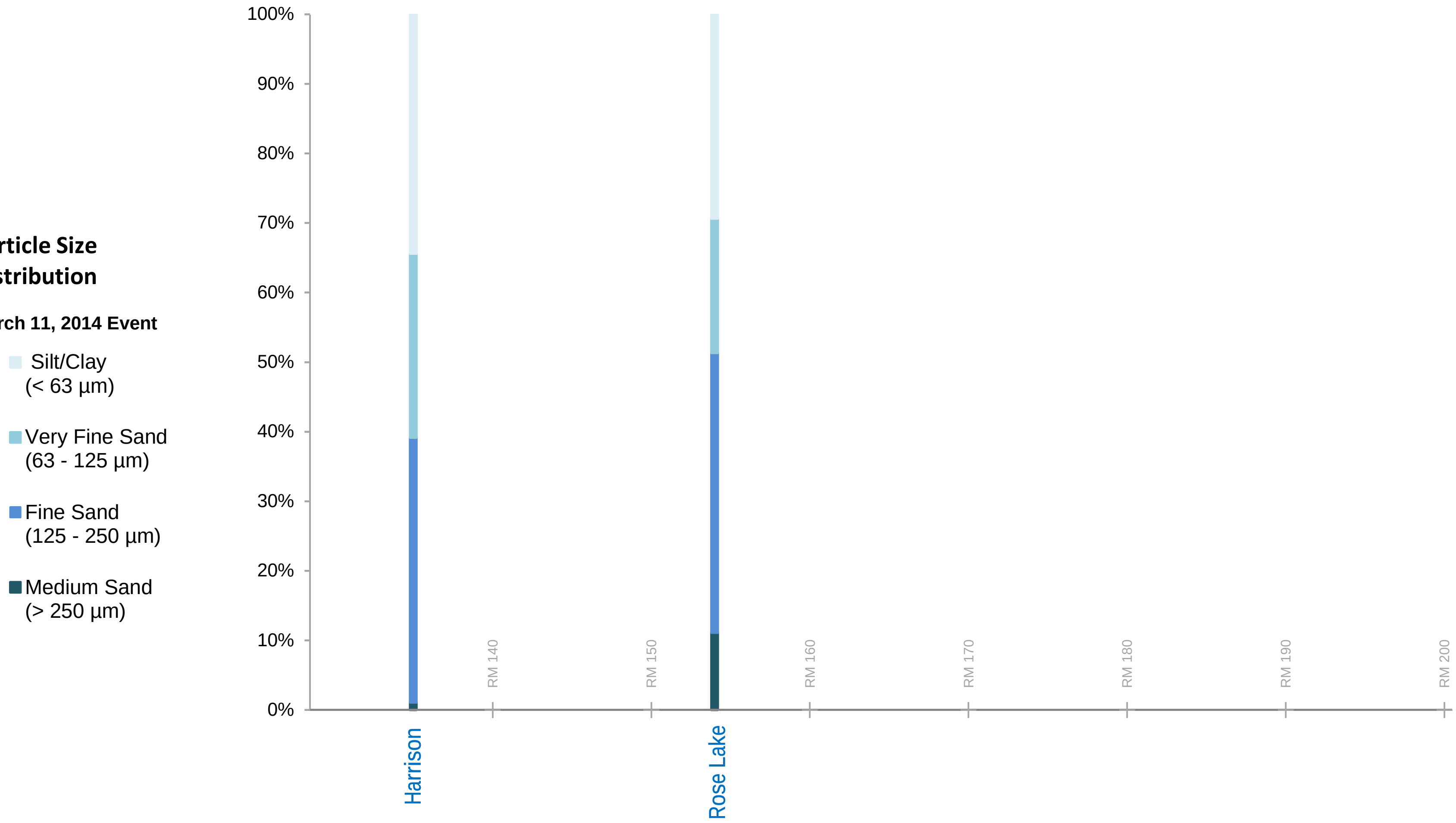
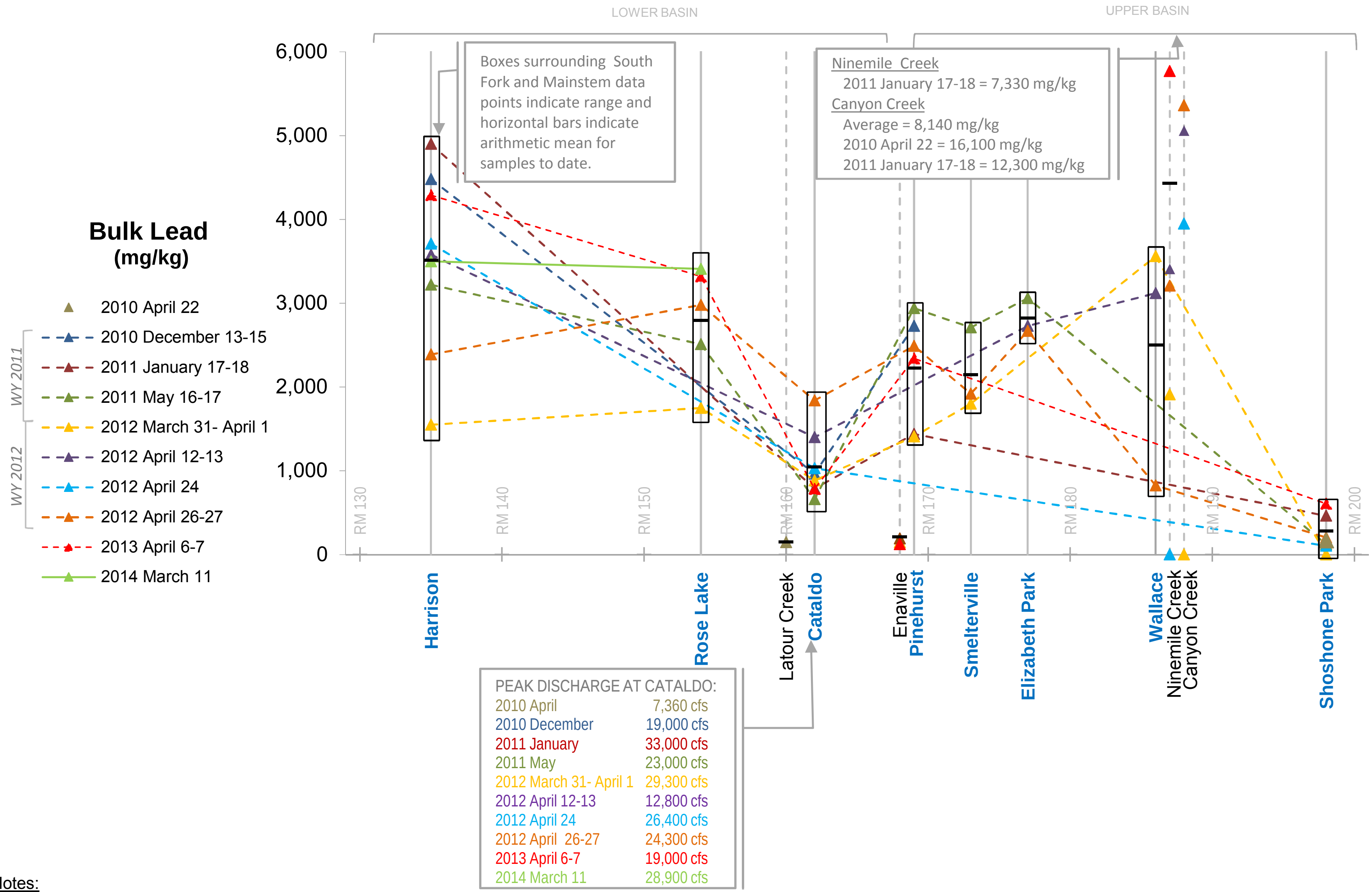


FIGURE 3-4

Suspended Sediment Particle Size Distribution

WY2014 BEMP Sediment Sampling Data Summary

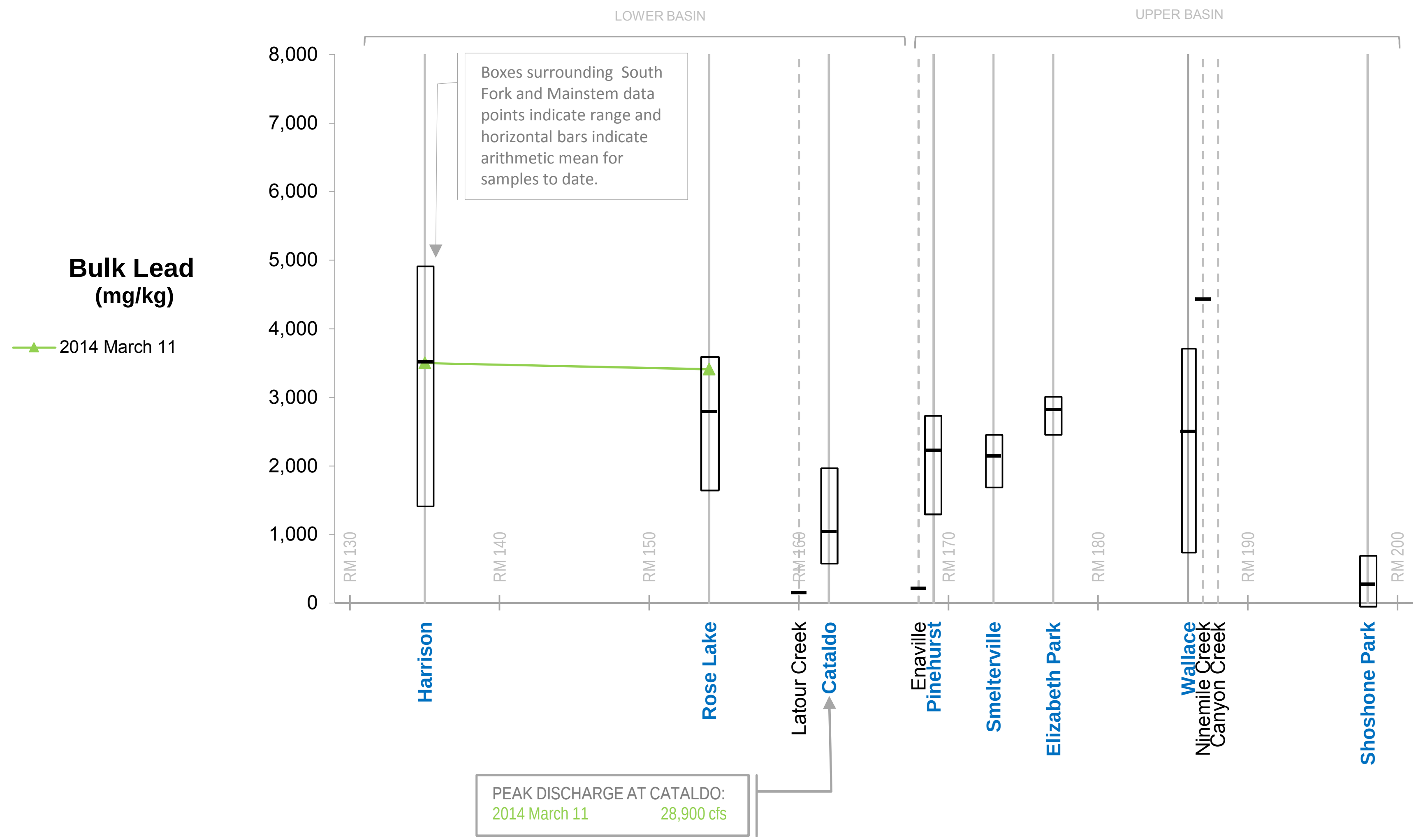


Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 3-5

WY2010 - WY2014 Suspended Sediment Bulk Lead Concentration

WY2014 BEMP Sediment Sampling Data Summary

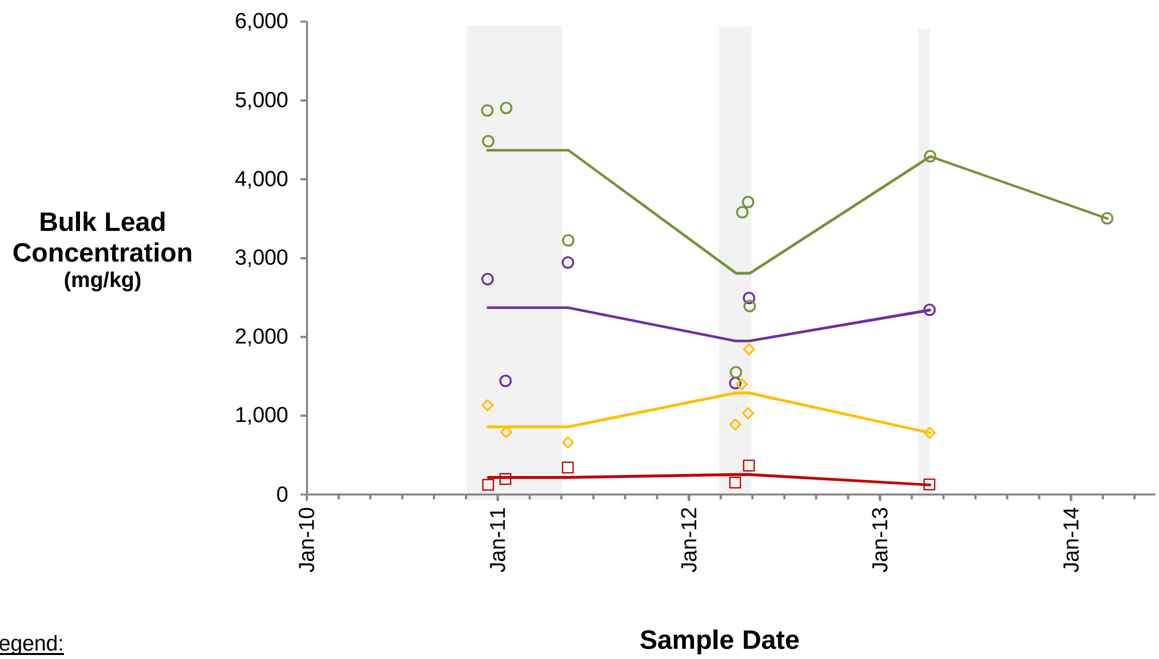


Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 3-6

WY2014 Suspended Sediment Bulk Lead Concentration

WY2014 BEMP Sediment Sampling Data Summary



Legend:

- Pinehurst
- Enaville
- Cataldo
- Harrison

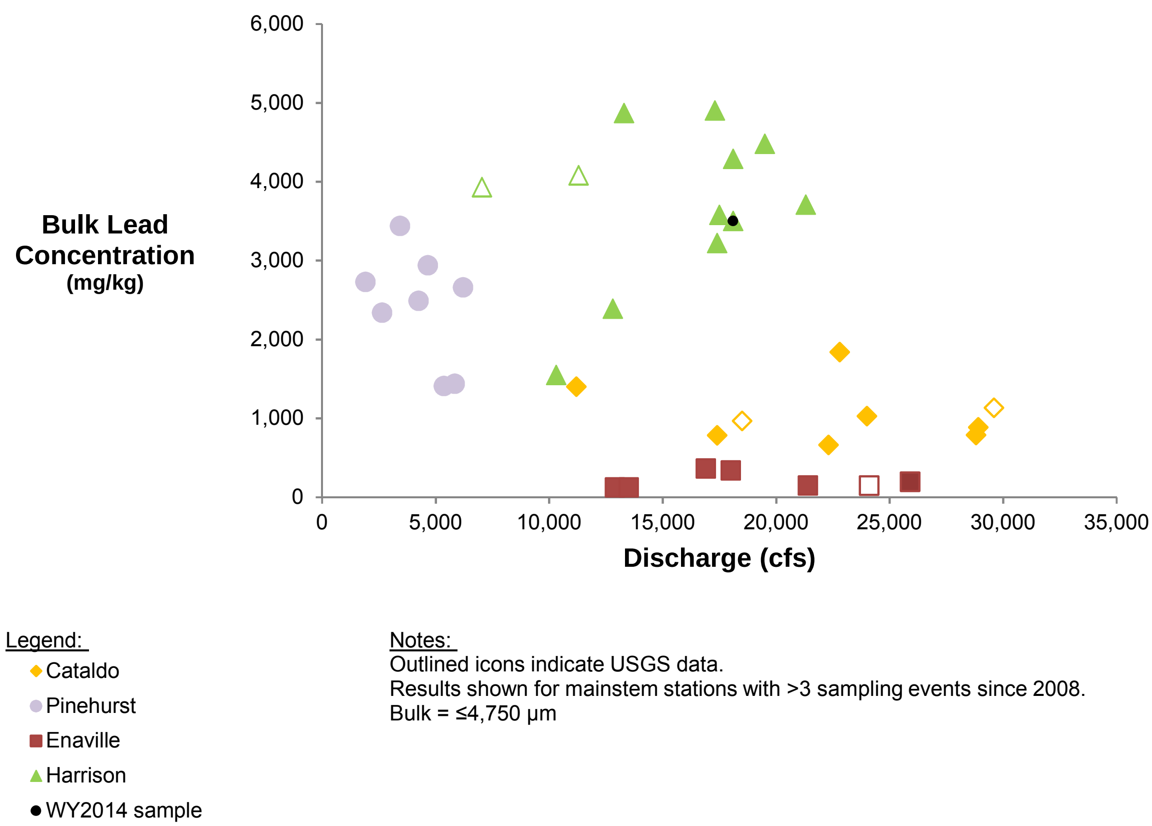
Notes:

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

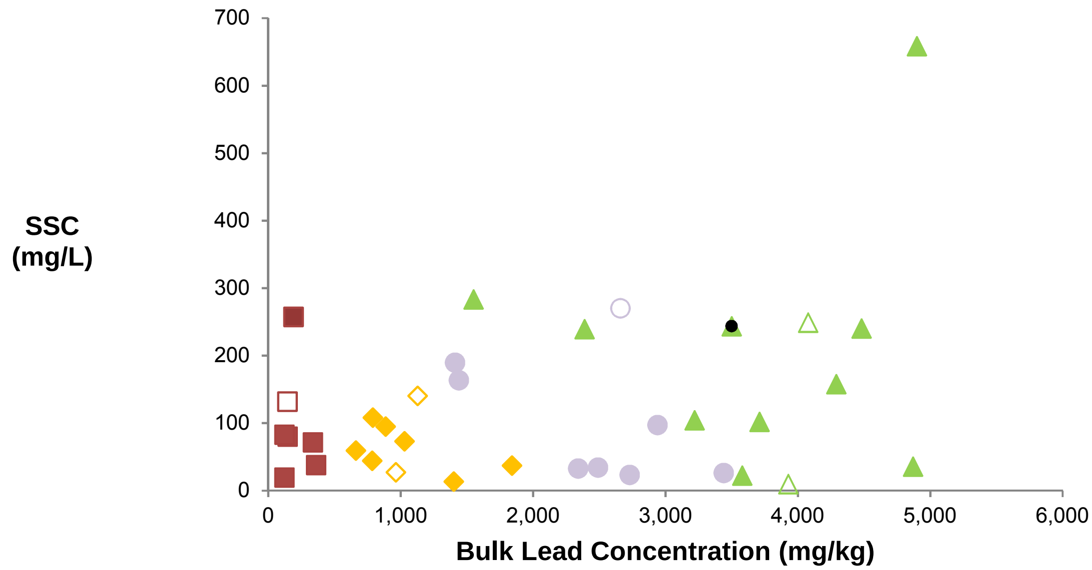
Suspended Sediment Bulk Lead Concentration Over Time

WY2014 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 3-8
Relationship Between Lead Concentration and Discharge
WY2014 BEMP Sediment Sampling Data Summary



Legend:

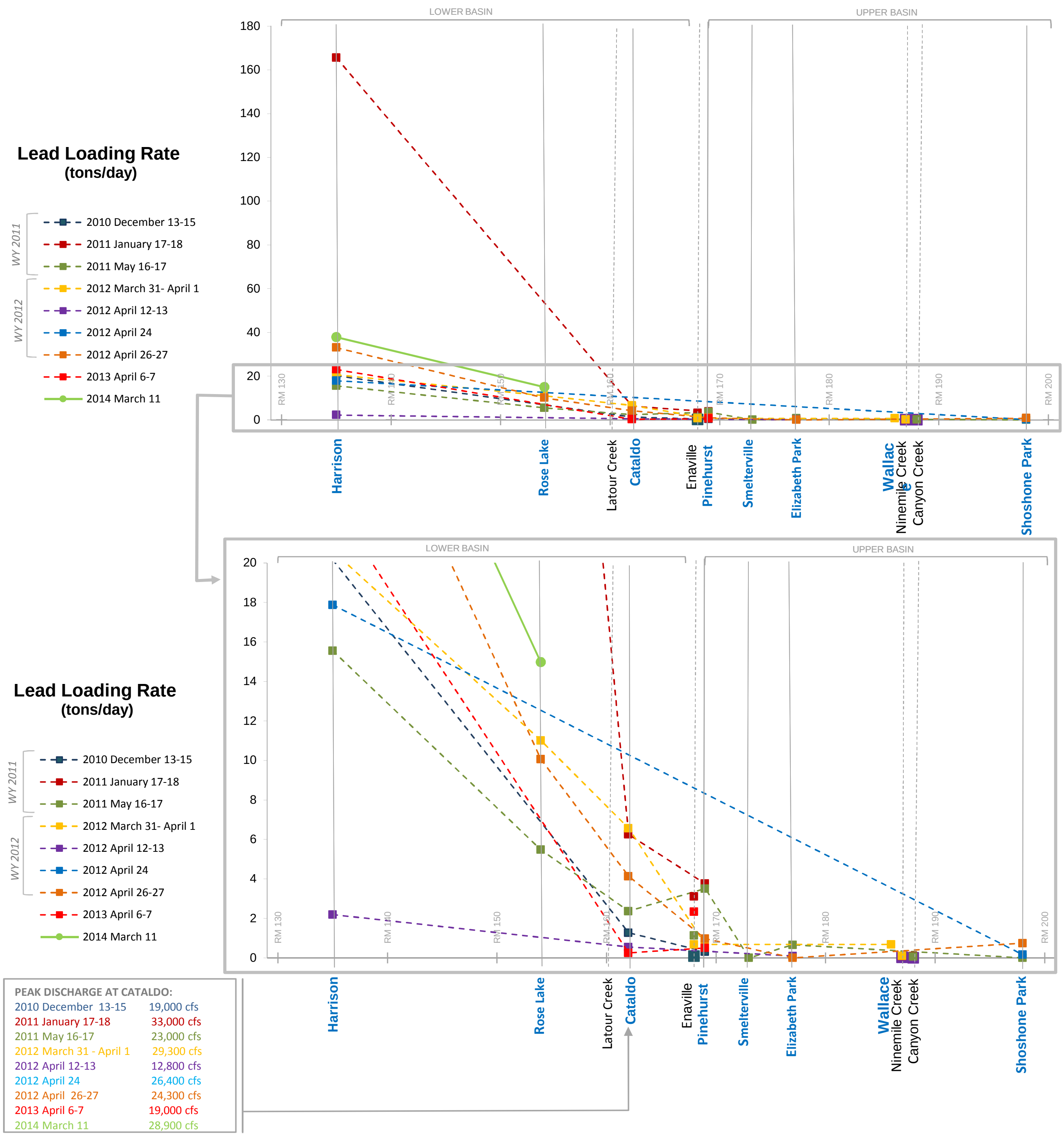
- Cataldo
- Pinehurst
- Enaville
- Harrison
- WY2014 sample

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

WY2014 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:

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

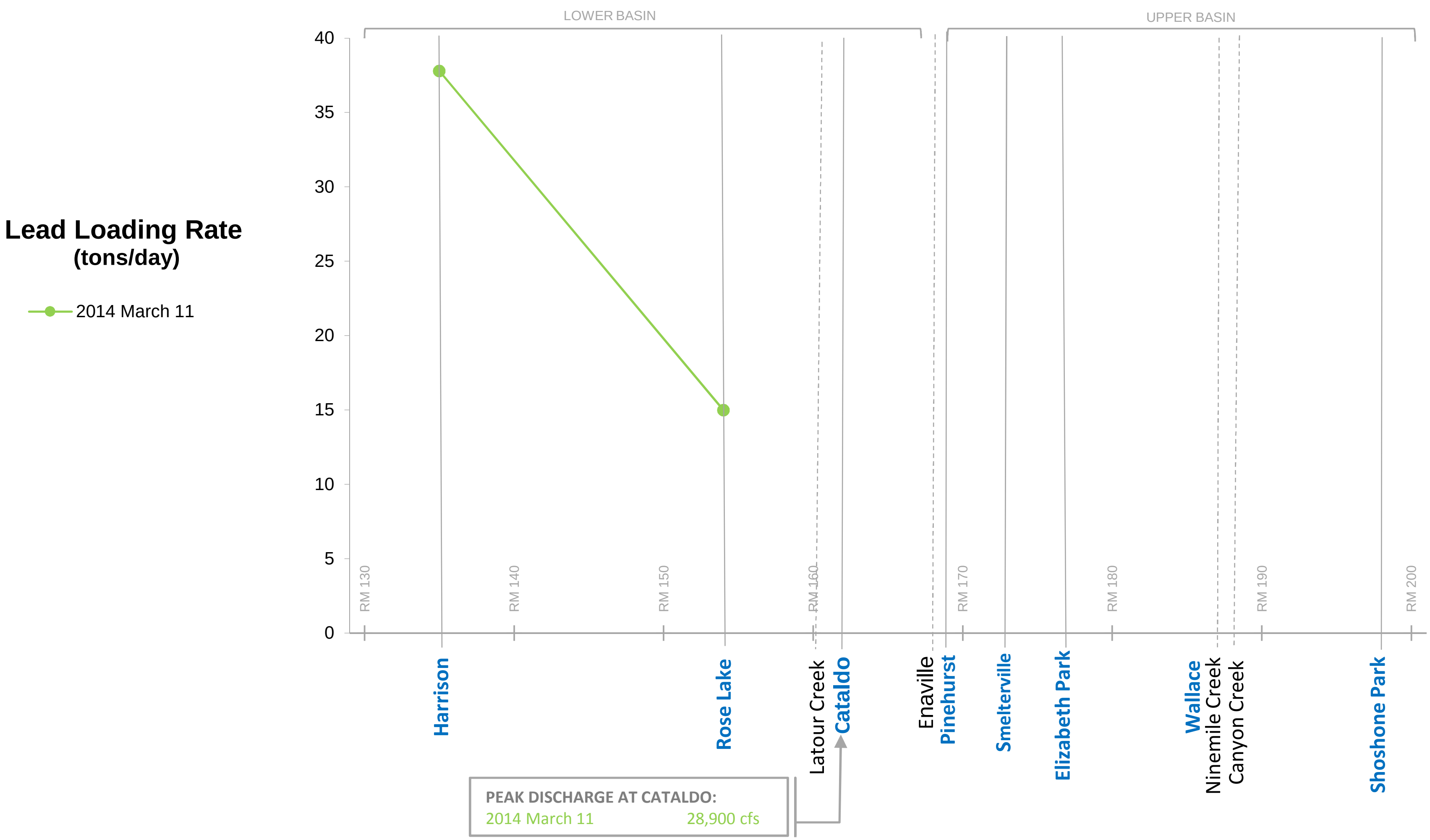
where

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 WY2014 Estimated Lead Loading Rate

WY2014 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

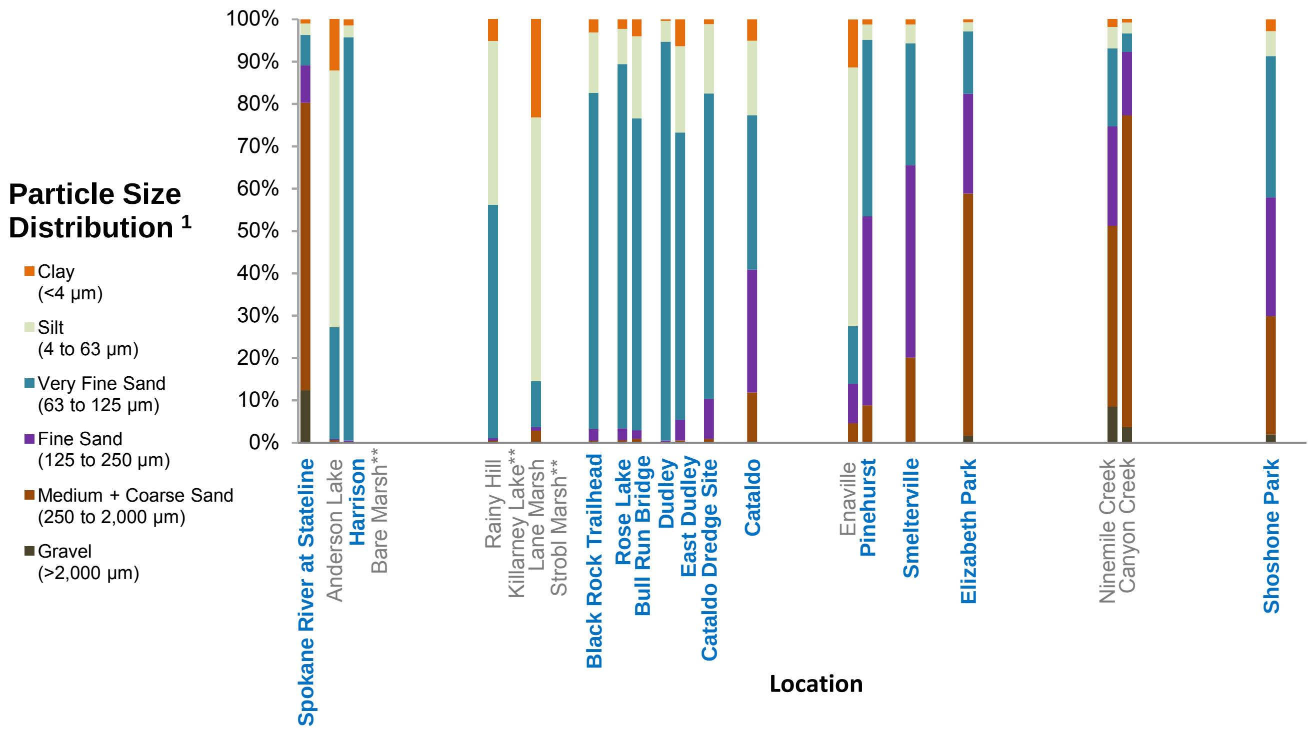
Q_{Pb} is the estimated lead load (metric tons/day), Q_w is discharge (cfs), C_s is suspended sediment concentration (mg/L), C_{Pb} is concentration of lead in sediment (mg/kg), K_1 is a coefficient to convert the sediment load from milligrams per second to kilograms per day (K_1= 2.45), and $K_2 \times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

FIGURE 3-11

WY2014 Estimated Lead Loading Rate

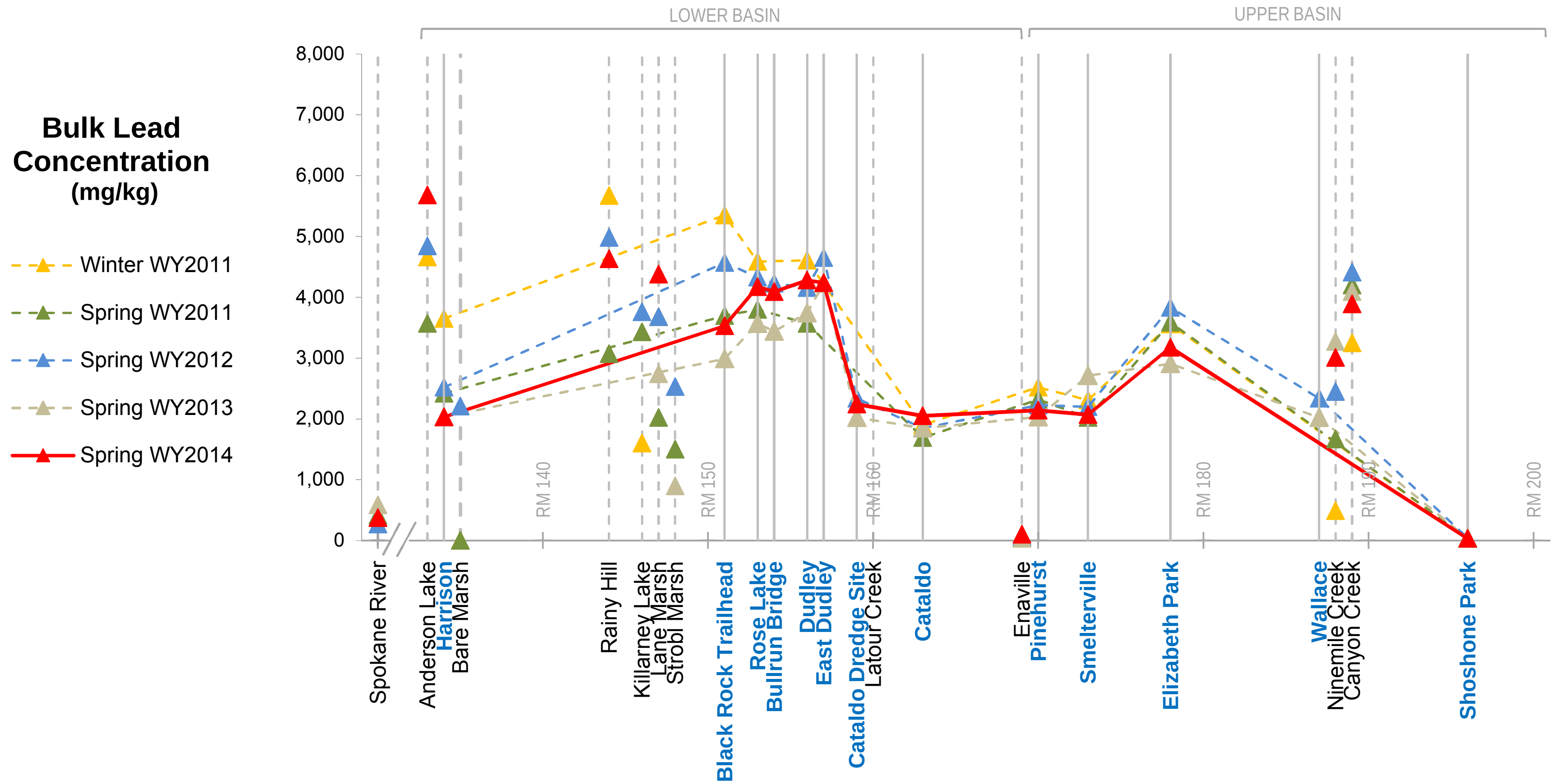
Notes:
"S" in sampling location code denotes stake.
"T" in sampling location code denotes tile.
* No measurement collected due to missing or inundated stake or tile.
** No measurement collected due to no inundation and/or no depositional sediment present.
Dashed lines show the sample location average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

FIGURE 4-1
Summary of Deposition and Erosion at Depositional Sediment Sampling Stations
WY2014 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
WY2014 BEMP Sediment Sampling Data Summary

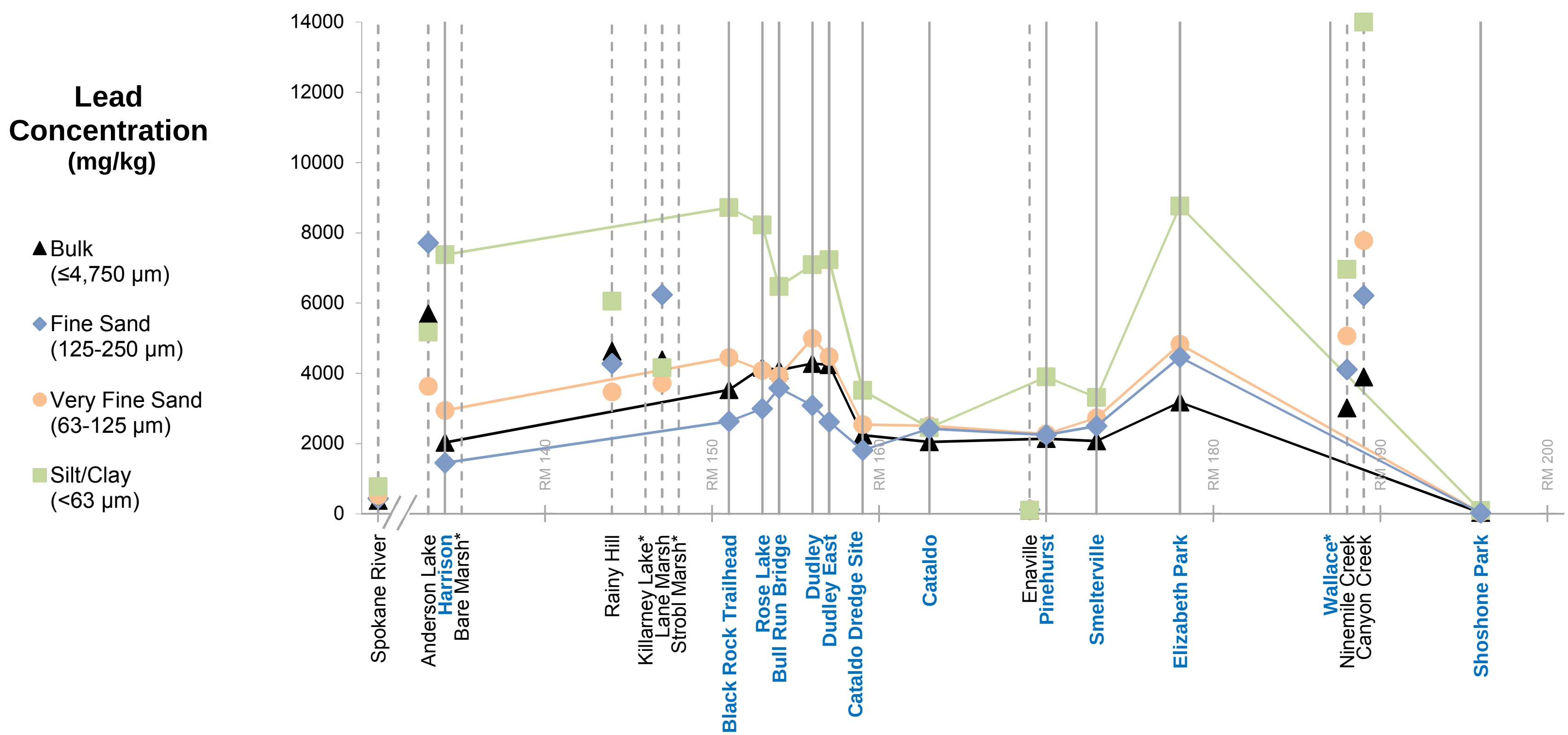


Notes:
Metal concentration for bulk samples based on analysis of particles ≤4.75 mm in size. Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries and off-channel floodplains are shown as unconnected points.
Bold = Mainstem and South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

FIGURE 4-3

WY2011 through WY2014 Lead Distribution in Depositional Sediment Samples

WY2014 BEMP Sediment Sampling Data Summary

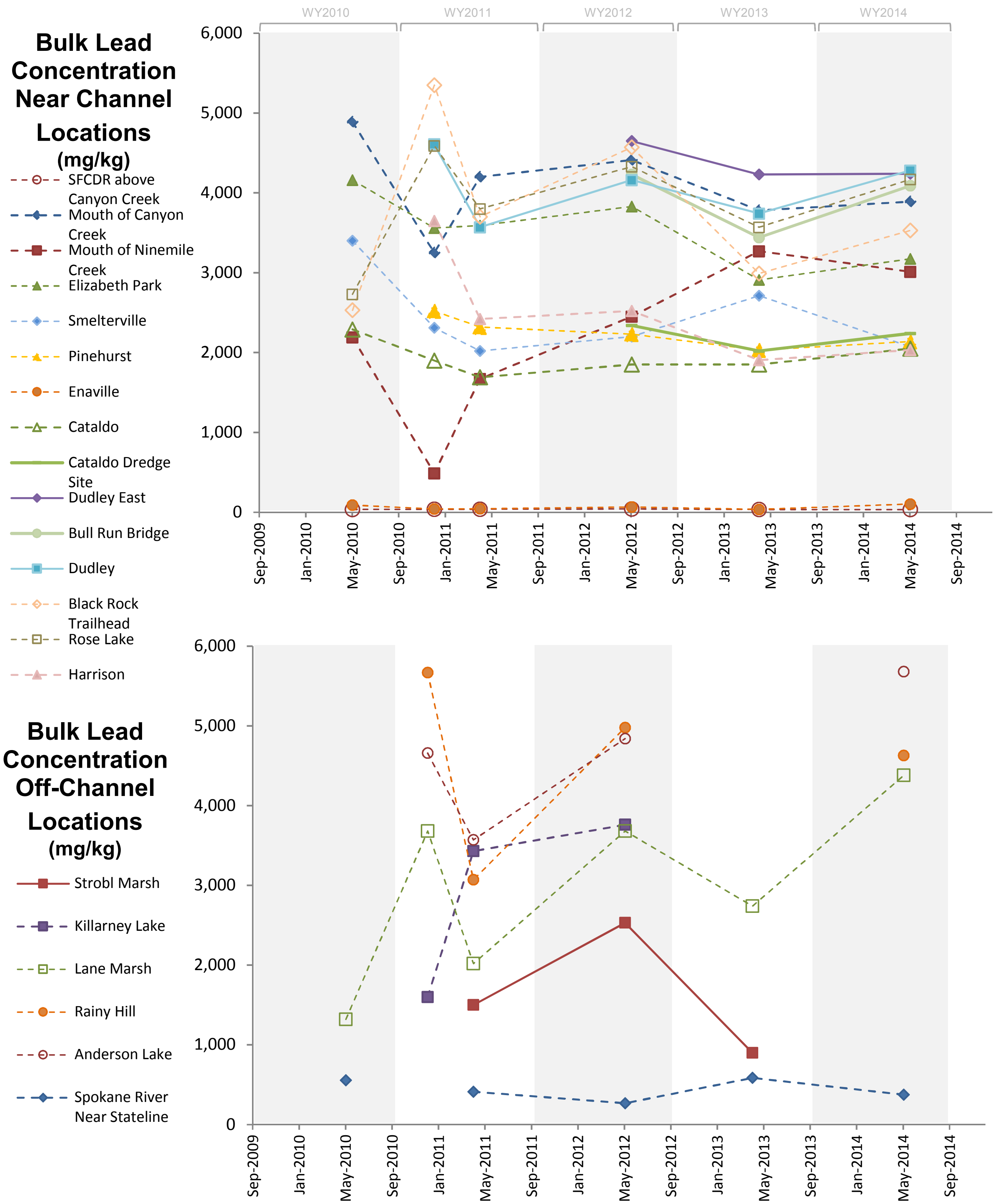


Notes:
Metal concentration for bulk samples based on analysis of particles ≤4.75mm in size. Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries and off-channel floodplains are shown as unconnected points.
Bold = Mainstem and South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

FIGURE 4-4

WY2014 Depositional Sediment Sample Lead Concentration by Size Fraction

WY2014 BEMP Sediment Sampling Data Summary

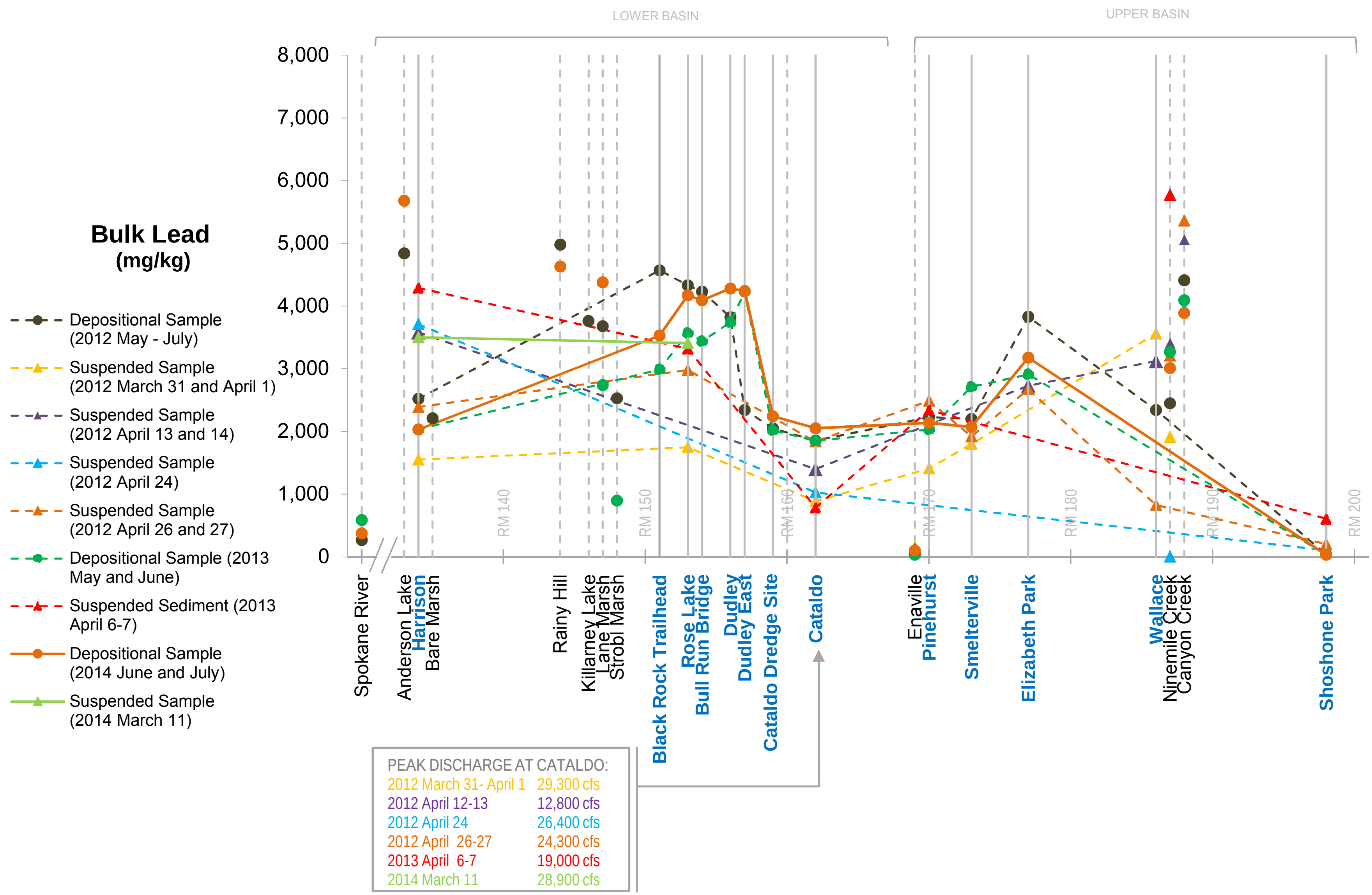


Notes:
Metal concentration for bulk samples based on analysis of particles ≤4.75 mm in size.
Data shown for depositional sampling stations sampled in WY2010 through WY2014.
Bold = Mainstem and South Fork locations

FIGURE 4-5

Bulk Lead Results in Depositional Samples Over Time

WY2014 BEMP Sediment Sampling Data Summary

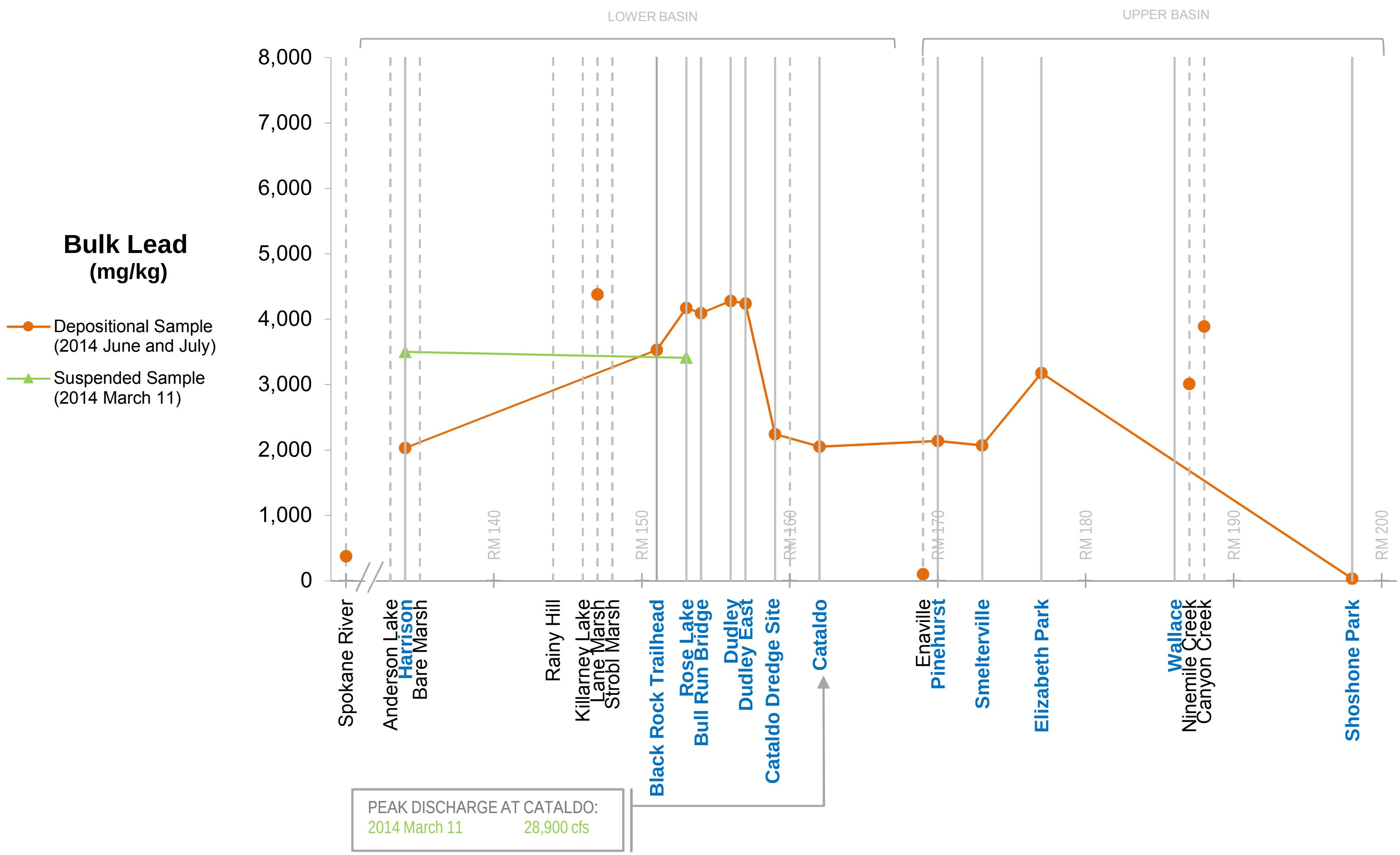


Notes:
Sampling stations along the South Fork and the Mainstem are shown as connected points, while sampling stations on tributaries are shown as unconnected points.
Bold = Mainstem and South Fork locations
Bulk = ≤4,750 µm

FIGURE 5-1

WY2012 - WY2014 Lead Results by Sample Type

WY2014 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
WY2014 Lead Results by Sample Type
WY2014 BEMP Sediment Sampling Data Summary

Appendix A
Photo Log

WY 2014 Depositional Sediment Sampling Photographs – Spring Runoff

July 2014, Shoshone Park (SF-BSED-D-001)

July 2014, Mouth of Canyon Creek (CC-BSED-D-002)

July 2014, Mouth of Ninemile Creek (NM-BSED-D-005)

June 2014, Elizabeth Park (SF-BSED-D-006)

June 2014, Smelterville (SF-BSED-D-007)

June 2014, Pinehurst (SF-BSED-D-009)

June 2014, Enaville (LC-BSED-D-010)

June 2014, Cataldo (LC-BSED-D-011)

June 2014, Dudley (LC-BSED-D-101)

June 2014, Rose Lake (LCBSED-D-012)

June 2014, Black Rock Trailhead (LC-BSED-D-102)

June 2014, Harrison (LC-BSED-D-014)

July 2014, Spokane River (SR-BSED-D-109)

June 2014, Lane Marsh (LC-BSED-D-103)

June 2014, Strobl Marsh (LC-BSED-D-104)

June 2014, Killarney Lake, (LC-BSED-D-105)

June 2014, Rainy Hill (LC-BSED-D-106)

June 2014, Bare Marsh (LC-BSED-D-107)

June 2014, Anderson Lake (LC-BSED-D-108)

June 2014, Cataldo Below Dredge Pool (LC-BSED-D-201)

June 2014, Dudley East (LC-BSED-D-202)

June 2014, 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:

March 11th 2014

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

- SF-BSED-S-01 was not sampled during this monitoring event.

CC-BSED-S-002 – Mouth of Canyon Creek

- CC-BSED-S-002 was not sampled during this monitoring event.

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

- NM-BSED-S-005 was not sampled during this monitoring event.

SF-BSED-S-006 – Elizabeth Park

- SF-BSED-S-006 was not sampled during this monitoring event.

SF-BSED-S-007 – Smelterville

- SF-BSED-S-007 was not sampled during this monitoring event.

SF-BSED-S-009 – Pinehurst

- SF-BSED-S-009 was not sampled during this monitoring event.

LC-BSED-S-010 – Enaville

- LC-BSED-S-010 was not sampled during this monitoring event.

LC-BSED-S-011 – Cataldo

- LC-BSED-S-011 was not sampled during this monitoring event.

LC-BSED-S-012 – Rose Lake

- Velocity measurements at two of 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, a portion of 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.

LC-BSED-S-014 – Harrison

- Velocity measurements at three of 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, a portion of the sample was likely collected using non-isokinetic methods.
- The EDI vertical at 43.6 feet was moved to 48 feet due to a bridge obstruction.

Special equipment, materials, or personnel required:

N/A

FISP Sampler Isokinetic Intake Efficiency Log Sheet

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

Location: SF-BSED-S-012 - RoseLake

Sampler Model and ID:

Name/Checked by:

Date	Time	Nozzle *P or TFE*	Nozzle Diameter Inches	Stream Velocity ft/sec	Sample Duration sec	Sample Volume cc	Depth ft	Water Temp ^{o}F	* Nozzle Factor K	Volume Rate cc/sec	Nozzle Velocity ft/sec	Transit Rate ft/sec	Intake Efficiency
			Measure 3 times where Intake Efficiency agrees within +/- 0.1										
EXAMPLE	10:17	P	5/16"	4	44	2600	18	68	0.0663	59	3.92	0.41	0.98
3/11/2014			1/4"	3.6	86	2300	54	38	0.1036	27	2.77	0.63	0.77
			1/4"	4.1	75	2300	35	38	0.1036	31	3.18	0.47	0.77
			Diameter										
			Diameter										
			Diameter										

*Note: Transit rate shaded red if exceeding 0.4*stream velocity; IE shaded if > +/- 15%*

INSTRUCTIONS FOR PERFORMING A FISP SAMPLER HYDRAULIC EFFICIENCY TEST

A sampler efficiency test requires 3 measurements:

Flow Velocity in the test sample vertical, Sample Volume, and Sample Time.

Flow velocity should be measured in the sampling vertical if possible,

particularly when conditions are near limits of sampler efficiency.

Sample Volume should be measured with a large calibrated cylinder (plastic for durability).

Sample Time is the precise, total submerged time for the sampler.

Accuracy of velocity, duration, and volume should be within 5% maximum

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

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

Select the nozzle size in cell C and Enter the measured data in columns A to H.

Repeat Measurment 3 times before each sampling data set. Repeat again if no agreement +/- 0.1.

The average Intake Efficiency (Column M). It should be between 0.85 and 1.15.

If outside those limits at low velocities and/or with no sand transport, then it may be acceptible, with qualification in notes, to use this sampler. Otherwise, select an alternative sampler and retest efficiency.

Appendix C
Analytical Data and Data Validation Reports

Provided on CD at the end of the text