Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site

PREPARED FOR: Bill Adams/U.S. Environmental Protection Agency (EPA) Region 10
Anne McCauley/EPA Region 10

PREPARED BY: Michelle Zaehring/CH2M HILL
Heather Perry/CH2M HILL

COPY TO: Alta Turner/CH2M HILL
Rebecca Maco/CH2M HILL
Joan Stoupa/CH2M HILL
Brian Tracy/CH2M HILL
Peter Lawson/CH2M HILL

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1.0 Introduction

The purpose of this Technical Memorandum (TM) is to document the estimated reductions in stream flow in Upper Basin surface water that will occur when groundwater remedial actions are implemented in Woodland Park, located on Canyon Creek, and in Osburn Flats, located along the mainstem of the South Fork Coeur d'Alene River (Mainstem SFCDR)[1]. These groundwater remedial actions will be components of the Selected Remedy for the Upper Basin of the Coeur d'Alene River that will be presented in the forthcoming Upper Basin Record of Decision (ROD) Amendment (EPA, in preparation). For this TM, measured stream flow data were compared to groundwater flow model-simulated stream flow reduction rates under various hydrologic conditions[2] to support the estimation of net stream flow reductions resulting from the groundwater remedial actions.

Stream flow reduction refers to the combination of:

- Reduction in groundwater discharge to streams included in the model (decrease in stream gain);
- Induced/increased groundwater recharge (increase in stream loss); and
- Reduction in groundwater discharge to land surface (decrease in stream gain).

Stream flow reductions attributable to groundwater remedial actions were evaluated under extreme low-flow and average annual hydrologic conditions in Canyon Creek and along the Mainstem SFCDR. In this evaluation, extreme low-flow conditions were based on the 7Q10 flow condition, which represents the lowest 7-day average flow that occurs on average only once every 10 years. Descriptions of how these hydrologic conditions were simulated in the groundwater flow model can be found in

[1] For the purposes of this analysis, the SFCDR is referred to as a "stream" throughout this TM.

[2] Smaller tributary streams were not included in the simulation because stream-specific hydrologic data were not available with which to calibrate the groundwater flow model. However, based on the topography of the area and the hydrologic data that were used to calibrate the model, the model results do include estimates of flow in these smaller tributary areas, based on simulated discharges of groundwater to land surface (in this case, small streams).

Appendix A of the Draft Final Focused Feasibility Study (FFS) Report for the Upper Basin (CH2M HILL, 2010).

The percentage net reduction in stream flow for a given hydraulic condition is defined as:

= (Net Stream Flow Reduction/Stream Flow) x (100 percent)

The development of net stream flow reduction estimates for the 7Q10 and average annual hydrologic conditions is presented in Sections 2.0 and 3.0, respectively.

Before conducting any water treatment project, EPA will perform additional study and remedial design to ensure that stream flows are not reduced to a point that will have negative effects on water rights holders or aquatic life. During and after remedy implementation, stream flows and collected flow rates will be monitored. Problems resulting from stream flow reduction are not expected; if any were to occur, collection rates could be modified to minimize or eliminate those problems.

2.0 Extreme Low-Flow (7Q10) Hydrologic Conditions

2.1 Net Stream Flow Reductions

The net stream flow reductions for Canyon Creek and the Mainstem SFCDR were estimated using the simulated data from the groundwater flow model. The basis for the calculation of net flow reduction following the implementation of remedial actions was a comparison of the water budgets for Woodland Park and Osburn Flats, respectively, between "no action" and "with action" groundwater flow model simulations. The 7Q10 simulated stream gains/losses (groundwater discharge/recharge rates) for Canyon Creek are included in Appendix A, Table A-13, of the Draft Final FFS Report and are presented in Table 2-1 below. The simulated stream gains/losses for the Mainstem SFCDR, based on the recently revised remedial action of installing a French drain only in Osburn Flats, are presented in the *Draft Final Technical Memorandum: Application of the SFCDR Watershed Groundwater Flow Model to the Revised Groundwater Components of the Upper Basin Selected Remedy for Mainstem SFCDR Watershed Segment 01* (CH2M HILL, 2012), which will be included as an attachment to the Addendum to the Final FFS Report (CH2M HILL, in preparation). The 7Q10 simulated stream gains/losses (groundwater discharge/recharge rates) for the Mainstem SFCDR (Segment 01) are found in Table 2 of that Draft Final TM and are also included in Table 2-1 below. Net stream flow reduction is calculated as:

Reduction in Stream Gain + Increase in Stream Loss

= (No Action Stream Gain – With Action Stream Gain) + (With Action Stream Loss – No Action Stream Loss)

The estimated net stream flow reduction for the Mainstem SFCDR is calculated by summing the net reduction resulting from the remedial action in Osburn Flats plus the net reduction resulting from the remedial action in Canyon Creek (Woodland Park).

TABLE 2-1
Net Stream Flow Reduction Estimates, Extreme Low-Flow (7Q10) Conditions

Stream	Action	Stream Gain (cfs)	Stream Loss (cfs)	Net Stream Flow Reduction (cfs)
Canyon Creek	No Action	1.7	1.1	
Canyon Creek	With Action	1.1	1.2	
Canyon Creek	Difference	0.6	0.1	0.6 + 0.1 = 0.7
Mainstem SFCDR	No Action	9.4	8.4	
Mainstem SFCDR	With Action	5.8	12.2	

TABLE 2-1
Net Stream Flow Reduction Estimates, Extreme Low-Flow (7Q10) Conditions

Stream	Action	Stream Gain (cfs)	Stream Loss (cfs)	Net Stream Flow Reduction (cfs)
Mainstem SFCDR	Difference	3.6	3.8	3.6 + 3.8 + 0.7 = 8.1

cfs = cubic feet per second
SFCDR = South Fork Coeur d'Alene River

2.2 Stream Flow Values

The 7Q10 stream flow values for Canyon Creek and the Mainstem SFCDR are presented in Table 2-2. The 7Q10 values are based on recorded stream flows at monitoring stations SF-268 (on the SFCDR near Elizabeth Park) and CC-288 (on Canyon Creek near the confluence with the SFCDR). EPA's software tool Dflow was used to estimate the 7Q10 flow in the Mainstem SFCDR based on flow data published by the U.S. Geological Survey (USGS). The period of record for these flow data is 1987 to 2009. The 7Q10 flow rate for Canyon Creek was obtained from a previously published study (EPA, 2000).

TABLE 2-2
Stream Flow Values, Extreme Low-Flow (7Q10) Conditions

Flow Conditions	Stream	Flow (cfs)	Source
Low-Flow (7Q10)	Canyon Creek	7.1	Table 6-3 in EPA, 2000, *Total Maximum Daily Load for Dissolved Cadmium, Dissolved Lead, and Dissolved Zinc in Surface Waters of the Coeur d'Alene Basin.*
Low-Flow (7Q10)	Mainstem SFCDR	51	Calculated by Dflow based on data collected from 1987 to 2009.

cfs = cubic feet per second
SFCDR = South Fork Coeur d'Alene River

2.3 Stream Flow Reduction Percentages

The maximum percent stream flow reductions that would occur during extreme low-flow (7Q10) conditions are estimated to be approximately 10 percent in Canyon Creek and 16 percent in the Mainstem SFCDR, as indicated in Table 2-3.

TABLE 2-3
Estimated Percent Stream Flow Reductions, Extreme Low-Flow (7Q10) Conditions

Flow Conditions	Stream	Net Flow Reduction (cfs)	Flow (cfs)	Stream Flow Reduction (%)
Low-Flow (7Q10)	Canyon Creek	0.7	7.1	10%
Low-Flow (7Q10)	Mainstem SFCDR	8.1	51	16%

cfs = cubic feet per second
SFCDR = South Fork Coeur d'Alene River

3.0 Average Annual Hydrologic Conditions

As discussed in Sections A.3.4 and A.6.4 in Appendix A of the Draft Final FFS Report (CH2M HILL, 2010), transient model simulations were performed to evaluate the effectiveness of remedial actions under an annual cycle. These simulations were performed for a 365-day period based on hydraulic data

collected from July 1, 2008 to June 30, 2009. The groundwater flow model simulations provided output that enabled the calculation of net stream flow reduction (as defined in Section 2.1 of this TM) on a daily basis. The net stream flow reductions were compared to corresponding measured stream flow at monitoring stations CC-288 and SF-268 for each day of the 365-day simulation period, to estimate the daily stream flow reduction percentages (as defined in Section 1.0). A statistical analysis of the daily estimated stream flow reduction percentages was performed as documented in Attachment 1 to this TM. The results of that analysis, summarized in Table 3-1, suggest that the mean annual stream flow reductions resulting from implementation of the anticipated remedial actions in Canyon Creek and the Mainstem SFCDR (the latter a cumulative reduction due to actions in both the Mainstem SFCDR and Canyon Creek) are on the order of 1 percent and 5 percent, respectively.

TABLE 3-1
Estimated Percent Stream Flow Reductions, Average Annual Flow Conditions

Stream	Mean Annual Stream Flow Reduction Percentage	95% Lower Confidence Interval	95% Upper Confidence Interval
Canyon Creek	1.3%	1.2%	1.3%
Mainstem SFCDR (Cumulative Mainstem SFCDR and Canyon Creek)	5.2%	4.9%	5.5%

SFCDR = South Fork Coeur d'Alene River

4.0 References

CH2M HILL, July 2010. *Draft Final Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site*. Prepared for U.S. Environmental Protection Agency Region 10.

CH2M HILL, April 5, 2012. *Draft Final Technical Memorandum: Application of the SFCDR Watershed Groundwater Flow Model to the Revised Groundwater Components of the Upper Basin Selected Remedy for Mainstem SFCDR Watershed Segment 01*. Prepared for U.S. Environmental Protection Agency Region 10.

U.S. Environmental Protection Agency (EPA), August 2000. *Total Maximum Daily Load for Dissolved Cadmium, Dissolved Lead, and Dissolved Zinc in Surface Waters of the Coeur d'Alene Basin*.

Attachment 1

Stream Flow Reduction Estimates for Canyon Creek and the Mainstem SFCDR under Average Annual Hydrologic Conditions Resulting from Groundwater Remedial Actions

This attachment documents calculations that were performed to estimate the relative percent reduction of discharge flow attributable to groundwater remedial actions anticipated for Woodland Park, located on Canyon Creek, and for Osburn Flats, located along the mainstem of the South Fork Coeur d'Alene River (Mainstem SCFDR). These groundwater remedial actions will be components of the Selected Remedy for the Upper Basin of the Coeur d'Alene River that will be presented in the forthcoming Upper Basin Record of Decision (ROD) Amendment (U.S. Environmental Protection Agency [EPA], in preparation). For Woodland Park, stream flow reductions attributable to the groundwater remedial actions are evaluated at the downstream monitoring station CC-288, which is located near the mouth of Canyon Creek. For Osburn Flats, stream flow reductions are evaluated at the nearest downstream monitoring station on the Mainstem SFCDR, SF-268, which is located near Elizabeth Park.

Groundwater modeling efforts performed to date to predict effects of remedial actions have drawn upon hydraulic data collected from July 1, 2008 through June 30, 2009. Corresponding U.S. Geological Survey (USGS) station discharge data were downloaded for this period to calculate the representative percent reductions attributable to the separate remedial actions at Elizabeth Park and Canyon Creek (upstream of Elizabeth Park), and the cumulative reductions at Elizabeth Park attributable to both sets of remedial actions over that time period. Three variables were developed to estimate the percentage of discharge flow, by day, that would be expected to be lost as the result of the implementation of remedial actions at the two separate locations as well as the cumulative reduction of flow at Elizabeth Park. Aggregate estimates of annual expected loss, averaged over the 365-day period of data used, provide a best estimate and confidence interval for flow reductions separately at each area of remedial action and cumulatively at downstream Elizabeth Park.

Section 1.0 documents the data sources and calculation of the daily percent flow reductions under average annual hydraulic conditions. Section 2.0 summarizes graphics and statistics supporting best estimates of the flow reductions attributable to the groundwater remedial actions.

1.0 Percent Stream Flow Reduction Estimates

The data sources and variables used for the percent stream flow reduction estimates are described in Table 1-1. The groundwater flow models used to estimate the net stream flow reductions resulting from the remedial actions are based upon hydraulic data collected from July 1, 2008 through June 30, 2009. Stream flow reductions have been normalized by the average daily discharge for the same period from the monitoring station where the average daily discharge is reported by USGS. The daily percent stream flow reduction calculations are documented in Table 1-2. Historical monthly average discharges for water years 1988 through 2001 at Elizabeth Park and 1998 through 2001 at Canyon Creek[1], using data available on the USGS websites, are shown in Table 1-3.

[1] 2004 and 2005 are not included in Table 1-3 because no data are available for those water years. The subsequent analysis in this attachment refers to a 10-year period of record at Canyon Creek.

2.0 Statistical Analysis of Percent Reduction Estimates

Graphics and statistical outputs provided in Figures 2-1a through 2-4b and Attachments A1 through A3 support the following observations:

- Daily average discharge over the period from July 1, 2008 through June 30, 2009 (the blue lines in Figures 2-1a and 2-1b) at both Elizabeth Park and Canyon Creek (at Wallace) exhibit high variability, particularly during winter-early spring flushing. The median daily discharge over the 23-year period of record (the tan lines in the same figures) demonstrates a similar sinusoidal pattern over the annual cycle but, as an aggregated measure, is a time series of reduced volatility. Flows between July and November during this data period are elevated in comparison to the period-of-record median values at both locations. This is also apparent in Figures 2-1a and 2-1b.

- The calculated percent stream flow reductions for the period from July 1, 2008 through June 30, 2009 (Figure 2-2) reflect a similar volatility, which is not unexpected given the variability in discharge. This plot includes percent stream flow reductions (a) at Elizabeth Park resulting from remedial action at Osburn Flats (the red line), (b) at Canyon Creek resulting from remedial action at Woodland Park (the green line), and (c) cumulatively at Elizabeth Park as the result of both sets of remedial actions (the blue line). Flow reductions from the Canyon Creek action are marginal and the net percentage reduction, accounting for the effects of both sets of remedial actions on SFCDR flow at Elizabeth Park, is dominated by the action at Osburn Flats.

- Figure 2-3 displays panels for the percent stream flow reductions at Elizabeth Park and Canyon Creek under separate remedial actions (panels A and B) and the cumulative reductions at Elizabeth Park resulting from both sets of remedial actions (panel C). Each panel includes probability plots of the three variables of interest (discharge flow, flow reduction, and percentage of flow affected) in the left column and scatterplot matrices of paired variables to the right. In all three cases, the sharply bimodal discharge (top) is the denominator of the percentage and the smoother distribution of the modeled remedy flow reduction (middle) smoothes the distribution of percent reductions (bottom). The scatterplot matrices of the three variables display relationships that differ between the two remedial actions. At Elizabeth Park, flow and volume reduced are positively correlated whereas at Canyon Creek, there is a distinctly bimodal but negative correlation between the flow and the flow reduction attributable to the remedial action. The cumulative reduction at Elizabeth Park is dominated by the remedial action at Osburn Flats; therefore, the reduction more closely tracks patterns observed at Osburn Flats.

- Figures 2-4a and 2-4b provide the context of the period from July 1, 2008 through June 30, 2009, plotting monthly average discharges for the 23 available water years at Elizabeth Park and the 10 available water years at Canyon Creek. In each figure, color-coding in red indicates the July 2008-June 2009 period. As shown in the figures, the flows from July 2008 through June 2009 are generally in line with the flows over the entire periods of record (i.e., there are no outliers); therefore, this time period is considered a representative year to model at both locations.

- Attachments A1 through A3 document goodness-of-fit testing of the 365 percentage reduction observations for the three reduction ratios. As is common with both discharge and discharge-related variables (e.g., loads), the percent reduction observations from the data set exhibit no theoretical distribution (normal, lognormal, or extreme values). Point-interval estimates for the three percentage reductions are shown in the following table.

Estimated Percent Stream Flow Reductions, Average Annual Flow Conditions

Stream	Mean Annual Stream Flow Reduction Percentage	95% Lower Confidence Interval	95% Upper Confidence Interval
Elizabeth Park (Mainstem SFCDR)	5.0%	4.7%	5.3%
Canyon Creek	1.3%	1.2%	1.3%
Cumulative (Elizabeth Park plus Canyon Creek)	5.2%	4.9%	5.5%

Tables

TABLE 1-1

Variables and Data Sources

Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site, Attachment 1

Variable	Stream	Data Source	
Net Flow Reduction (cfs)	Elizabeth Park (Mainstem SFCDR)	Groundwater Model	*Transient_Annual_WaterBudget_120611.xlsx (Worksheet: Summary_cfs, column P)*
	Canyon Creek		*CC_Summary_013012.xlsx*
	Cumulative (Elizabeth Park plus Canyon Creek)	Calculated	Sum of Net Flow Reduction at Elizabeth Park and Canyon Creek
Stream Flow (cfs)		USGS	Elizabeth Park Real-Time USGS site (http://waterdata.usgs.gov/nwis/dv/?site_no=12413210&referred_module=sw), Query selected for data: 1JUL2008-30JUN2009
	Elizabeth Park (Mainstem SFCDR)		
	Canyon Creek		Canyon Creek Real-Time USGS site (http://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=12413125), Query selected for data: 1JUL2008-30JUN2009
Stream Flow Reduction (%)	Elizabeth Park (Mainstem SFCDR)	Calculated	(Net Flow Reduction/Stream Flow) x 100%
	Canyon Creek		
	Cumulative (Elizabeth Park plus Canyon Creek)		

Notes:

cfs = cubic feet per second
SFCDR = South Fork Coeur d'Alene River
USGS = U.S. Geological Survey

TABLE 1-2

Daily Percent Stream Flow Reduction Calculations

Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site, Attachment 1

			Elizabeth Park (Mainstem South Fork Coeur d'Alene River)			Canyon Creek			Cumulative (Elizabeth Park plus Canyon Creek)	
Date	Sequential Days	Month	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow Reduction (%)
7/1/2008	1	JUL	9.2	844	1.09	0.02	175	0.01	9.20	1.09
7/2/2008	2	JUL	9.2	828	1.11	0.15	164	0.09	9.34	1.13
7/3/2008	3	JUL	13.8	732	1.88	0.19	145	0.13	13.98	1.91
7/4/2008	4	JUL	12.4	679	1.83	0.21	132	0.16	12.62	1.86
7/5/2008	5	JUL	11.6	609	1.9	0.23	115	0.2	11.81	1.94
7/6/2008	6	JUL	11.2	549	2.05	0.25	105	0.24	11.49	2.09
7/7/2008	7	JUL	10.9	499	2.18	0.26	95	0.27	11.11	2.23
7/8/2008	8	JUL	10.6	458	2.31	0.27	88	0.31	10.83	2.36
7/9/2008	9	JUL	10.3	426	2.43	0.28	79	0.35	10.61	2.49
7/10/2008	10	JUL	10.2	401	2.53	0.28	73	0.38	10.43	2.6
7/11/2008	11	JUL	10.0	370	2.71	0.28	67	0.43	10.30	2.78
7/12/2008	12	JUL	9.9	347	2.85	0.29	63	0.46	10.19	2.94
7/13/2008	13	JUL	9.7	325	2.99	0.29	58	0.51	10.00	3.08
7/14/2008	14	JUL	9.6	308	3.11	0.30	54	0.55	9.86	3.2
7/15/2008	15	JUL	9.4	294	3.21	0.30	51	0.59	9.73	3.31
7/16/2008	16	JUL	9.3	281	3.31	0.30	48	0.63	9.62	3.42
7/17/2008	17	JUL	9.2	267	3.45	0.31	46	0.68	9.52	3.56
7/18/2008	18	JUL	9.1	255	3.56	0.30	44	0.68	9.39	3.68
7/19/2008	19	JUL	9.0	243	3.69	0.31	42	0.73	9.26	3.81
7/20/2008	20	JUL	8.8	234	3.78	0.31	40	0.77	9.15	3.91
7/21/2008	21	JUL	8.7	225	3.87	0.31	39	0.79	9.02	4.01
7/22/2008	22	JUL	8.6	222	3.88	0.31	38	0.81	8.92	4.02
7/23/2008	23	JUL	8.5	219	3.89	0.31	38	0.82	8.82	4.03
7/24/2008	24	JUL	8.5	207	4.1	0.31	36	0.87	8.80	4.25
7/25/2008	25	JUL	8.4	196	4.3	0.31	34	0.93	8.75	4.46
7/26/2008	26	JUL	8.2	190	4.33	0.31	33	0.94	8.54	4.49
7/27/2008	27	JUL	8.1	184	4.39	0.31	32	0.98	8.38	4.56
7/28/2008	28	JUL	8.0	179	4.46	0.31	31	1.01	8.30	4.64
7/29/2008	29	JUL	7.9	174	4.54	0.31	30	1.05	8.22	4.72
7/30/2008	30	JUL	7.8	168	4.65	0.31	29	1.08	8.13	4.84
7/31/2008	31	JUL	7.7	164	4.71	0.32	29	1.09	8.04	4.9
8/1/2008	32	AUG	7.6	161	4.72	0.32	28	1.13	7.91	4.91
8/2/2008	33	AUG	7.5	158	4.75	0.32	28	1.13	7.82	4.95
8/3/2008	34	AUG	7.4	155	4.77	0.32	27	1.17	7.72	4.98
8/4/2008	35	AUG	7.3	153	4.77	0.32	27	1.17	7.61	4.98
8/5/2008	36	AUG	7.2	149	4.82	0.32	26	1.22	7.50	5.03
8/6/2008	37	AUG	7.1	145	4.9	0.32	26	1.22	7.43	5.12
8/7/2008	38	AUG	7.0	142	4.91	0.32	25	1.27	7.29	5.14
8/8/2008	39	AUG	6.8	141	4.86	0.32	25	1.27	7.16	5.08
8/9/2008	40	AUG	6.8	140	4.86	0.32	25	1.27	7.12	5.09
8/10/2008	41	AUG	6.8	138	4.9	0.32	25	1.26	7.08	5.13
8/11/2008	42	AUG	6.8	135	5.01	0.32	24	1.32	7.08	5.24
8/12/2008	43	AUG	6.7	132	5.05	0.32	24	1.32	6.98	5.29
8/13/2008	44	AUG	6.6	129	5.12	0.32	24	1.32	6.92	5.37
8/14/2008	45	AUG	6.5	126	5.16	0.32	23	1.38	6.82	5.41
8/15/2008	46	AUG	6.4	124	5.19	0.32	23	1.38	6.75	5.45
8/16/2008	47	AUG	6.4	123	5.17	0.32	22	1.45	6.68	5.43
8/17/2008	48	AUG	6.3	121	5.22	0.32	22	1.45	6.63	5.48
8/18/2008	49	AUG	6.3	119	5.31	0.32	22	1.44	6.64	5.58
8/19/2008	50	AUG	6.3	120	5.22	0.32	22	1.44	6.59	5.49
8/20/2008	51	AUG	6.2	140	4.45	0.32	24	1.31	6.54	4.67
8/21/2008	52	AUG	6.3	167	3.8	0.31	27	1.16	6.66	3.99
8/22/2008	53	AUG	7.0	148	4.74	0.32	24	1.33	7.34	4.96
8/23/2008	54	AUG	7.6	129	5.92	0.32	22	1.46	7.95	6.17
8/24/2008	55	AUG	6.8	123	5.55	0.32	22	1.46	7.15	5.81
8/25/2008	56	AUG	6.3	124	5.1	0.32	22	1.45	6.64	5.36
8/26/2008	57	AUG	6.3	133	4.74	0.32	22	1.45	6.62	4.98
8/27/2008	58	AUG	6.4	134	4.77	0.32	23	1.38	6.71	5.01
8/28/2008	59	AUG	6.8	126	5.39	0.32	21	1.53	7.11	5.64
8/29/2008	60	AUG	6.7	120	5.61	0.32	21	1.53	7.05	5.87
8/30/2008	61	AUG	6.5	117	5.55	0.32	20	1.61	6.82	5.83
8/31/2008	62	AUG	6.4	114	5.59	0.32	20	1.6	6.69	5.87
9/1/2008	63	SEP	6.3	113	5.62	0.32	19	1.69	6.67	5.9
9/2/2008	64	SEP	6.3	112	5.65	0.32	19	1.69	6.65	5.94
9/3/2008	65	SEP	6.4	110	5.78	0.32	19	1.69	6.68	6.08
9/4/2008	66	SEP	6.3	108	5.87	0.32	19	1.69	6.67	6.17
9/5/2008	67	SEP	6.3	107	5.89	0.32	19	1.69	6.62	6.19
9/6/2008	68	SEP	6.3	106	5.91	0.32	19	1.69	6.58	6.21
9/7/2008	69	SEP	6.3	104	6.02	0.32	18	1.78	6.58	6.33
9/8/2008	70	SEP	6.3	104	6.03	0.32	18	1.78	6.59	6.34
9/9/2008	71	SEP	6.2	102	6.12	0.32	18	1.78	6.56	6.43
9/10/2008	72	SEP	6.2	99	6.31	0.32	18	1.78	6.57	6.64
9/11/2008	73	SEP	6.2	100	6.23	0.32	18	1.78	6.55	6.55
9/12/2008	74	SEP	6.1	99	6.21	0.32	17	1.89	6.47	6.53
9/13/2008	75	SEP	6.2	96	6.49	0.32	17	1.89	6.56	6.83
9/14/2008	76	SEP	6.2	94	6.63	0.32	17	1.89	6.55	6.97
9/15/2008	77	SEP	6.1	93	6.61	0.32	17	1.89	6.47	6.95

TABLE 1-2

Daily Percent Stream Flow Reduction Calculations

Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site, Attachment 1

			Elizabeth Park (Mainstem South Fork Coeur d'Alene River)			Canyon Creek			Cumulative (Elizabeth Park plus Canyon Creek)	
Date	Sequential Days	Month	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow Reduction (%)
9/16/2008	78	SEP	6.2	92	6.69	0.32	16	2.01	6.48	7.04
9/17/2008	79	SEP	6.1	91	6.76	0.32	16	2	6.47	7.11
9/18/2008	80	SEP	6.2	88	6.99	0.32	16	2	6.48	7.36
9/19/2008	81	SEP	6.2	88	7	0.32	16	2	6.48	7.36
9/20/2008	82	SEP	6.1	88	6.91	0.32	16	2	6.40	7.27
9/21/2008	83	SEP	6.1	120	5.1	0.32	21	1.5	6.44	5.37
9/22/2008	84	SEP	6.2	123	5.02	0.32	21	1.52	6.49	5.28
9/23/2008	85	SEP	7.5	114	6.55	0.32	19	1.7	7.79	6.83
9/24/2008	86	SEP	7.2	102	7.08	0.32	18	1.79	7.54	7.39
9/25/2008	87	SEP	6.8	96	7.08	0.32	17	1.89	7.12	7.41
9/26/2008	88	SEP	6.4	94	6.78	0.32	16	2.01	6.69	7.12
9/27/2008	89	SEP	6.3	93	6.81	0.32	16	2.01	6.66	7.16
9/28/2008	90	SEP	6.4	91	7	0.32	16	2.01	6.70	7.36
9/29/2008	91	SEP	6.4	89	7.18	0.32	16	2.01	6.71	7.54
9/30/2008	92	SEP	6.4	88	7.24	0.32	15	2.14	6.69	7.6
10/1/2008	93	OCT	6.4	85	7.49	0.32	15	2.14	6.68	7.86
10/2/2008	94	OCT	6.4	86	7.4	0.32	15	2.14	6.68	7.77
10/3/2008	95	OCT	6.3	86	7.31	0.32	15	2.14	6.61	7.68
10/4/2008	96	OCT	6.3	92	6.9	0.32	16	2	6.66	7.24
10/5/2008	97	OCT	6.4	99	6.46	0.32	18	1.77	6.72	6.79
10/6/2008	98	OCT	6.6	95	6.97	0.32	17	1.89	6.95	7.31
10/7/2008	99	OCT	6.9	97	7.07	0.32	17	1.89	7.18	7.4
10/8/2008	100	OCT	6.6	91	7.3	0.32	16	2.01	6.96	7.65
10/9/2008	101	OCT	6.8	89	7.6	0.32	15	2.14	7.08	7.96
10/10/2008	102	OCT	6.5	87	7.46	0.32	15	2.14	6.81	7.83
10/11/2008	103	OCT	6.5	85	7.62	0.32	15	2.15	6.80	8
10/12/2008	104	OCT	6.5	84	7.69	0.32	15	2.15	6.78	8.08
10/13/2008	105	OCT	6.4	84	7.67	0.32	15	2.14	6.76	8.05
10/14/2008	106	OCT	6.5	87	7.44	0.32	15	2.14	6.80	7.81
10/15/2008	107	OCT	6.5	85	7.64	0.32	15	2.14	6.81	8.01
10/16/2008	108	OCT	6.7	84	7.94	0.32	15	2.14	6.99	8.32
10/17/2008	109	OCT	6.5	83	7.89	0.32	15	2.15	6.87	8.28
10/18/2008	110	OCT	6.6	83	7.9	0.32	15	2.14	6.88	8.28
10/19/2008	111	OCT	6.6	82	8	0.32	14	2.29	6.88	8.39
10/20/2008	112	OCT	6.6	82	8.05	0.32	14	2.28	6.92	8.44
10/21/2008	113	OCT	6.6	89	7.39	0.32	16	2	6.89	7.74
10/22/2008	114	OCT	6.6	87	7.59	0.32	15	2.14	6.92	7.96
10/23/2008	115	OCT	6.9	85	8.13	0.32	14	2.28	7.23	8.5
10/24/2008	116	OCT	6.8	82	8.28	0.32	14	2.29	7.11	8.67
10/25/2008	117	OCT	6.7	80	8.4	0.32	14	2.29	7.04	8.8
10/26/2008	118	OCT	6.6	79	8.39	0.32	14	2.29	6.95	8.8
10/27/2008	119	OCT	6.6	80	8.3	0.32	14	2.29	6.96	8.7
10/28/2008	120	OCT	6.6	78	8.51	0.32	14	2.29	6.96	8.92
10/29/2008	121	OCT	6.7	77	8.74	0.32	14	2.29	7.05	9.16
10/30/2008	122	OCT	6.6	76	8.74	0.32	13	2.46	6.96	9.16
10/31/2008	123	OCT	6.7	76	8.77	0.32	13	2.46	6.98	9.19
11/1/2008	124	NOV	6.7	79	8.42	0.32	14	2.28	6.97	8.83
11/2/2008	125	NOV	6.7	86	7.81	0.32	16	1.98	7.03	8.18
11/3/2008	126	NOV	6.9	97	7.11	0.32	16	1.99	7.22	7.44
11/4/2008	127	NOV	7.3	97	7.56	0.32	16	1.99	7.65	7.89
11/5/2008	128	NOV	7.2	96	7.52	0.32	15	2.12	7.53	7.85
11/6/2008	129	NOV	7.2	88	8.13	0.32	14	2.29	7.47	8.49
11/7/2008	130	NOV	7.2	121	5.91	0.31	21	1.5	7.47	6.17
11/8/2008	131	NOV	7.1	128	5.57	0.32	21	1.51	7.45	5.82
11/9/2008	132	NOV	7.7	112	6.83	0.32	19	1.68	7.97	7.12
11/10/2008	133	NOV	7.6	108	7.06	0.32	19	1.67	7.94	7.35
11/11/2008	134	NOV	7.4	107	6.89	0.32	19	1.68	7.69	7.19
11/12/2008	135	NOV	7.4	148	5.02	0.32	27	1.17	7.75	5.24
11/13/2008	136	NOV	7.6	277	2.75	0.27	48	0.56	7.88	2.84
11/14/2008	137	NOV	8.2	176	4.65	0.31	36	0.86	8.49	4.82
11/15/2008	138	NOV	9.1	150	6.09	0.32	30	1.07	9.46	6.31
11/16/2008	139	NOV	8.0	136	5.86	0.32	28	1.14	8.29	6.09
11/17/2008	140	NOV	7.9	127	6.18	0.32	26	1.24	8.17	6.44
11/18/2008	141	NOV	7.8	119	6.57	0.32	25	1.28	8.14	6.84
11/19/2008	142	NOV	7.8	114	6.82	0.32	24	1.34	8.09	7.1
11/20/2008	143	NOV	7.8	111	7	0.32	23	1.4	8.09	7.29
11/21/2008	144	NOV	7.8	117	6.63	0.32	24	1.33	8.07	6.9
11/22/2008	145	NOV	7.8	109	7.14	0.32	22	1.46	8.10	7.43
11/23/2008	146	NOV	7.9	105	7.53	0.32	21	1.53	8.23	7.84
11/24/2008	147	NOV	7.8	101	7.68	0.32	20	1.61	8.08	8
11/25/2008	148	NOV	7.8	99	7.85	0.32	20	1.61	8.10	8.18
11/26/2008	149	NOV	7.7	99	7.82	0.32	20	1.61	8.06	8.14
11/27/2008	150	NOV	7.8	96	8.09	0.32	19	1.69	8.09	8.43
11/28/2008	151	NOV	7.8	94	8.29	0.32	19	1.69	8.11	8.63
11/29/2008	152	NOV	7.8	97	8.03	0.32	19	1.68	8.11	8.36
11/30/2008	153	NOV	7.8	101	7.7	0.32	20	1.6	8.10	8.02
12/1/2008	154	DEC	7.8	100	7.84	0.32	19	1.69	8.16	8.16

TABLE 1-2

Daily Percent Stream Flow Reduction Calculations

Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site, Attachment 1

			Elizabeth Park (Mainstem South Fork Coeur d'Alene River)			Canyon Creek			Cumulative (Elizabeth Park plus Canyon Creek)	
Date	Sequential Days	Month	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow Reduction (%)
12/2/2008	155	DEC	7.9	161	4.92	0.31	25	1.25	8.24	5.12
12/3/2008	156	DEC	7.9	141	5.64	0.32	22	1.45	8.27	5.86
12/4/2008	157	DEC	8.5	122	6.95	0.32	21	1.53	8.80	7.22
12/5/2008	158	DEC	8.0	113	7.12	0.32	20	1.61	8.37	7.41
12/6/2008	159	DEC	7.9	110	7.21	0.32	20	1.61	8.25	7.5
12/7/2008	160	DEC	8.0	113	7.06	0.32	21	1.52	8.30	7.34
12/8/2008	161	DEC	8.0	111	7.18	0.32	20	1.6	8.29	7.47
12/9/2008	162	DEC	8.0	105	7.66	0.32	19	1.69	8.37	7.97
12/10/2008	163	DEC	8.0	103	7.73	0.32	19	1.68	8.29	8.04
12/11/2008	164	DEC	8.0	100	7.95	0.32	18	1.78	8.27	8.27
12/12/2008	165	DEC	8.0	99	8.03	0.32	18	1.78	8.27	8.36
12/13/2008	166	DEC	8.0	100	7.96	0.32	17	1.88	8.28	8.28
12/14/2008	167	DEC	8.0	60	13.37	0.29	9	3.19	8.31	13.85
12/15/2008	168	DEC	7.9	46	17.2	0.23	8	2.9	8.15	17.71
12/16/2008	169	DEC	7.4	54	13.79	0.18	10	1.77	7.62	14.12
12/17/2008	170	DEC	7.9	76	10.42	0.21	14	1.51	8.13	10.7
12/18/2008	171	DEC	10.1	95	10.63	0.30	17	1.79	10.40	10.95
12/19/2008	172	DEC	10.3	92	11.2	0.34	16	2.11	10.64	11.56
12/20/2008	173	DEC	10.3	83	12.42	0.34	15	2.25	10.65	12.83
12/21/2008	174	DEC	9.9	79	12.53	0.33	14	2.35	10.23	12.95
12/22/2008	175	DEC	9.4	85	11.08	0.33	15	2.18	9.75	11.47
12/23/2008	176	DEC	9.5	85	11.13	0.33	15	2.2	9.79	11.52
12/24/2008	177	DEC	9.4	86	10.91	0.33	15	2.22	9.72	11.3
12/25/2008	178	DEC	9.2	89	10.31	0.33	17	1.95	9.51	10.68
12/26/2008	179	DEC	8.7	85	10.29	0.33	15	2.22	9.08	10.68
12/27/2008	180	DEC	7.9	85	9.25	0.33	15	2.19	8.19	9.63
12/28/2008	181	DEC	7.9	105	7.51	0.33	18	1.82	8.22	7.83
12/29/2008	182	DEC	7.9	101	7.83	0.33	16	2.05	8.23	8.15
12/30/2008	183	DEC	8.2	94	8.72	0.33	15	2.18	8.53	9.07
12/31/2008	184	DEC	8.1	92	8.81	0.33	15	2.17	8.43	9.16
1/1/2009	185	JAN	8.0	92	8.72	0.33	15	2.17	8.35	9.07
1/2/2009	186	JAN	8.0	104	7.74	0.32	16	2.03	8.37	8.05
1/3/2009	187	JAN	8.2	78	10.45	0.32	11	2.91	8.47	10.86
1/4/2009	188	JAN	8.2	88	9.35	0.33	15	2.2	8.56	9.73
1/5/2009	189	JAN	8.2	89	9.18	0.33	15	2.18	8.49	9.54
1/6/2009	190	JAN	8.3	90	9.19	0.33	14	2.33	8.59	9.55
1/7/2009	191	JAN	8.1	362	2.24	0.31	32	0.96	8.42	2.33
1/8/2009	192	JAN	8.4	1310	0.64	0.25	71	0.36	8.68	0.66
1/9/2009	193	JAN	10.0	820	1.22	0.31	48	0.65	10.29	1.25
1/10/2009	194	JAN	11.9	473	2.51	0.32	37	0.88	12.21	2.58
1/11/2009	195	JAN	9.9	352	2.8	0.33	33	0.99	10.19	2.9
1/12/2009	196	JAN	9.1	292	3.12	0.33	30	1.09	9.44	3.23
1/13/2009	197	JAN	9.0	258	3.47	0.33	28	1.17	9.28	3.6
1/14/2009	198	JAN	8.8	236	3.75	0.33	27	1.21	9.17	3.88
1/15/2009	199	JAN	8.8	221	3.98	0.33	25	1.31	9.12	4.13
1/16/2009	200	JAN	8.7	208	4.2	0.33	24	1.37	9.06	4.36
1/17/2009	201	JAN	8.7	196	4.45	0.33	23	1.43	9.05	4.62
1/18/2009	202	JAN	8.7	185	4.69	0.33	23	1.42	9.01	4.87
1/19/2009	203	JAN	8.6	178	4.86	0.33	22	1.48	8.97	5.04
1/20/2009	204	JAN	8.6	172	5.01	0.33	21	1.55	8.94	5.2
1/21/2009	205	JAN	8.6	168	5.12	0.33	21	1.58	8.94	5.32
1/22/2009	206	JAN	8.6	166	5.2	0.33	22	1.51	8.97	5.4
1/23/2009	207	JAN	8.6	159	5.41	0.32	22	1.48	8.93	5.62
1/24/2009	208	JAN	8.6	153	5.59	0.32	22	1.47	8.88	5.8
1/25/2009	209	JAN	8.5	142	5.99	0.32	19	1.7	8.83	6.22
1/26/2009	210	JAN	8.5	102	8.33	0.25	16	1.57	8.74	8.57
1/27/2009	211	JAN	8.4	122	6.87	0.20	19	1.03	8.58	7.03
1/28/2009	212	JAN	8.1	157	5.15	0.24	25	0.97	8.33	5.3
1/29/2009	213	JAN	8.5	145	5.88	0.30	23	1.29	8.83	6.09
1/30/2009	214	JAN	8.6	132	6.5	0.35	21	1.67	8.93	6.77
1/31/2009	215	JAN	8.3	128	6.51	0.35	20	1.77	8.69	6.79
2/1/2009	216	FEB	8.2	122	6.75	0.34	18	1.89	8.57	7.03
2/2/2009	217	FEB	8.2	121	6.75	0.34	18	1.87	8.51	7.03
2/3/2009	218	FEB	8.3	117	7.07	0.33	17	1.97	8.61	7.36
2/4/2009	219	FEB	8.3	116	7.12	0.33	17	1.95	8.59	7.4
2/5/2009	220	FEB	8.3	117	7.06	0.33	17	1.94	8.59	7.34
2/6/2009	221	FEB	8.2	130	6.29	0.33	18	1.83	8.51	6.54
2/7/2009	222	FEB	8.2	129	6.34	0.33	17	1.94	8.51	6.6
2/8/2009	223	FEB	8.3	128	6.46	0.33	17	1.94	8.59	6.71
2/9/2009	224	FEB	8.2	131	6.25	0.33	17	1.93	8.51	6.5
2/10/2009	225	FEB	8.2	129	6.37	0.33	17	1.93	8.55	6.63
2/11/2009	226	FEB	8.2	126	6.54	0.33	17	1.94	8.57	6.8
2/12/2009	227	FEB	8.2	123	6.69	0.33	17	1.93	8.56	6.96
2/13/2009	228	FEB	8.2	120	6.84	0.33	17	1.93	8.54	7.11
2/14/2009	229	FEB	8.2	118	6.94	0.33	16	2.05	8.51	7.21
2/15/2009	230	FEB	8.2	116	7.06	0.33	16	2.05	8.52	7.34
2/16/2009	231	FEB	8.2	116	7.08	0.33	16	2.05	8.54	7.36

TABLE 1-2

Daily Percent Stream Flow Reduction Calculations

Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site, Attachment 1

			Elizabeth Park (Mainstem South Fork Coeur d'Alene River)			Canyon Creek			Cumulative (Elizabeth Park plus Canyon Creek)	
Date	Sequential Days	Month	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow Reduction (%)
2/17/2009	232	FEB	8.2	114	7.21	0.33	16	2.05	8.55	7.5
2/18/2009	233	FEB	8.2	111	7.39	0.33	16	2.04	8.53	7.68
2/19/2009	234	FEB	8.2	109	7.49	0.33	16	2.05	8.50	7.8
2/20/2009	235	FEB	8.2	108	7.58	0.33	15	2.18	8.52	7.89
2/21/2009	236	FEB	8.2	107	7.65	0.33	15	2.18	8.51	7.95
2/22/2009	237	FEB	8.2	110	7.43	0.33	15	2.18	8.50	7.73
2/23/2009	238	FEB	8.1	119	6.84	0.32	17	1.86	8.46	7.11
2/24/2009	239	FEB	8.1	190	4.29	0.31	23	1.35	8.46	4.45
2/25/2009	240	FEB	8.8	288	3.07	0.31	27	1.16	9.16	3.18
2/26/2009	241	FEB	12.4	378	3.28	0.32	28	1.13	12.72	3.36
2/27/2009	242	FEB	11.8	315	3.75	0.32	25	1.29	12.13	3.85
2/28/2009	243	FEB	11.8	270	4.38	0.32	23	1.41	12.15	4.5
3/1/2009	244	MAR	11.9	249	4.78	0.33	23	1.42	12.23	4.91
3/2/2009	245	MAR	11.6	268	4.32	0.32	25	1.3	11.92	4.45
3/3/2009	246	MAR	11.3	375	3.01	0.32	30	1.07	11.60	3.09
3/4/2009	247	MAR	11.4	425	2.68	0.32	31	1.04	11.70	2.75
3/5/2009	248	MAR	11.9	414	2.87	0.32	32	1.01	12.20	2.95
3/6/2009	249	MAR	12.0	356	3.38	0.33	30	1.09	12.35	3.47
3/7/2009	250	MAR	11.9	318	3.74	0.33	28	1.17	12.23	3.85
3/8/2009	251	MAR	12.3	295	4.15	0.33	27	1.22	12.58	4.27
3/9/2009	252	MAR	11.9	267	4.44	0.33	26	1.27	12.19	4.56
3/10/2009	253	MAR	11.8	249	4.75	0.33	25	1.33	12.15	4.88
3/11/2009	254	MAR	11.8	214	5.49	0.31	25	1.25	12.06	5.64
3/12/2009	255	MAR	12.1	210	5.75	0.33	25	1.31	12.40	5.9
3/13/2009	256	MAR	12.2	205	5.94	0.34	23	1.47	12.52	6.11
3/14/2009	257	MAR	12.2	204	5.98	0.34	22	1.52	12.54	6.15
3/15/2009	258	MAR	11.8	250	4.71	0.33	27	1.23	12.12	4.85
3/16/2009	259	MAR	11.2	284	3.95	0.33	26	1.28	11.56	4.07
3/17/2009	260	MAR	11.5	260	4.41	0.33	24	1.39	11.80	4.54
3/18/2009	261	MAR	12.0	246	4.88	0.33	23	1.45	12.35	5.02
3/19/2009	262	MAR	12.2	244	4.99	0.33	23	1.45	12.50	5.12
3/20/2009	263	MAR	12.2	263	4.63	0.33	25	1.33	12.51	4.76
3/21/2009	264	MAR	11.8	340	3.47	0.33	28	1.18	12.13	3.57
3/22/2009	265	MAR	11.8	519	2.28	0.33	38	0.86	12.16	2.34
3/23/2009	266	MAR	12.0	572	2.1	0.32	40	0.81	12.33	2.16
3/24/2009	267	MAR	12.7	507	2.51	0.33	38	0.87	13.07	2.58
3/25/2009	268	MAR	13.3	477	2.79	0.33	37	0.9	13.62	2.86
3/26/2009	269	MAR	12.6	414	3.05	0.34	34	0.99	12.98	3.14
3/27/2009	270	MAR	12.2	377	3.23	0.34	32	1.05	12.52	3.32
3/28/2009	271	MAR	12.6	358	3.51	0.34	31	1.09	12.89	3.6
3/29/2009	272	MAR	12.1	350	3.45	0.34	31	1.09	12.40	3.54
3/30/2009	273	MAR	11.6	316	3.66	0.34	29	1.16	11.90	3.77
3/31/2009	274	MAR	11.6	308	3.77	0.34	29	1.16	11.96	3.88
4/1/2009	275	APR	12.0	294	4.09	0.34	27	1.25	12.36	4.2
4/2/2009	276	APR	11.4	290	3.93	0.34	28	1.21	11.72	4.04
4/3/2009	277	APR	11.6	280	4.14	0.34	27	1.25	11.94	4.26
4/4/2009	278	APR	11.1	266	4.19	0.34	26	1.3	11.47	4.31
4/5/2009	279	APR	11.5	266	4.32	0.34	26	1.3	11.82	4.44
4/6/2009	280	APR	11.9	287	4.14	0.34	29	1.16	12.22	4.26
4/7/2009	281	APR	11.9	358	3.33	0.34	33	1.02	12.27	3.43
4/8/2009	282	APR	11.9	513	2.31	0.33	43	0.77	12.20	2.38
4/9/2009	283	APR	11.8	645	1.83	0.32	57	0.56	12.14	1.88
4/10/2009	284	APR	12.1	678	1.79	0.32	58	0.56	12.45	1.84
4/11/2009	285	APR	12.9	690	1.87	0.32	61	0.53	13.21	1.91
4/12/2009	286	APR	12.7	657	1.93	0.33	59	0.56	13.02	1.98
4/13/2009	287	APR	13.0	941	1.38	0.32	75	0.42	13.29	1.41
4/14/2009	288	APR	13.0	995	1.31	0.32	77	0.42	13.31	1.34
4/15/2009	289	APR	13.7	810	1.7	0.33	67	0.49	14.07	1.74
4/16/2009	290	APR	13.3	675	1.97	0.34	60	0.56	13.66	2.02
4/17/2009	291	APR	12.8	621	2.07	0.34	58	0.58	13.18	2.12
4/18/2009	292	APR	12.8	626	2.05	0.33	61	0.55	13.15	2.1
4/19/2009	293	APR	12.8	696	1.83	0.33	70	0.47	13.09	1.88
4/20/2009	294	APR	13.0	853	1.53	0.32	88	0.36	13.35	1.57
4/21/2009	295	APR	13.4	1330	1.01	0.28	141	0.2	13.65	1.03
4/22/2009	296	APR	14.0	1760	0.79	0.24	201	0.12	14.23	0.81
4/23/2009	297	APR	15.1	1710	0.88	0.26	209	0.12	15.32	0.9
4/24/2009	298	APR	15.2	1300	1.17	0.30	149	0.2	15.52	1.19
4/25/2009	299	APR	14.7	1010	1.46	0.32	111	0.29	15.05	1.49
4/26/2009	300	APR	13.6	835	1.63	0.33	99	0.33	13.97	1.67
4/27/2009	301	APR	12.9	725	1.78	0.33	90	0.37	13.27	1.83
4/28/2009	302	APR	12.8	649	1.97	0.34	84	0.4	13.12	2.02
4/29/2009	303	APR	12.4	579	2.13	0.34	77	0.44	12.69	2.19
4/30/2009	304	APR	12.2	530	2.3	0.34	72	0.48	12.52	2.36
5/1/2009	305	MAY	12.3	497	2.48	0.34	67	0.51	12.65	2.55
5/2/2009	306	MAY	12.1	503	2.41	0.34	70	0.49	12.46	2.48
5/3/2009	307	MAY	12.1	579	2.09	0.33	82	0.41	12.43	2.15
5/4/2009	308	MAY	11.8	625	1.89	0.33	87	0.38	12.17	1.95

TABLE 1-2

Daily Percent Stream Flow Reduction Calculations

Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site, Attachment 1

			Elizabeth Park (Mainstem South Fork Coeur d'Alene River)			Canyon Creek			Cumulative (Elizabeth Park plus Canyon Creek)	
Date	Sequential Days	Month	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow (cfs)	Stream Flow Reduction (%)	Net Flow Reduction (cfs)	Stream Flow Reduction (%)
5/5/2009	309	MAY	12.5	936	1.33	0.31	115	0.27	12.77	1.36
5/6/2009	310	MAY	12.4	1110	1.12	0.31	132	0.23	12.73	1.15
5/7/2009	311	MAY	13.4	1120	1.2	0.31	119	0.26	13.74	1.23
5/8/2009	312	MAY	13.7	1030	1.33	0.33	109	0.3	14.00	1.36
5/9/2009	313	MAY	13.7	905	1.51	0.33	98	0.34	14.04	1.55
5/10/2009	314	MAY	13.4	846	1.58	0.33	94	0.35	13.71	1.62
5/11/2009	315	MAY	12.8	954	1.35	0.32	104	0.31	13.16	1.38
5/12/2009	316	MAY	12.6	1090	1.16	0.31	117	0.27	12.96	1.19
5/13/2009	317	MAY	12.9	966	1.33	0.33	109	0.3	13.19	1.36
5/14/2009	318	MAY	13.1	1040	1.26	0.32	111	0.29	13.47	1.29
5/15/2009	319	MAY	12.9	1170	1.1	0.32	114	0.28	13.18	1.13
5/16/2009	320	MAY	12.9	1120	1.15	0.33	114	0.29	13.20	1.18
5/17/2009	321	MAY	13.6	1170	1.16	0.32	137	0.23	13.87	1.19
5/18/2009	322	MAY	13.3	1500	0.89	0.27	212	0.13	13.56	0.9
5/19/2009	323	MAY	13.6	1960	0.69	0.20	306	0.07	13.78	0.7
5/20/2009	324	MAY	14.2	1660	0.86	0.26	270	0.1	14.48	0.87
5/21/2009	325	MAY	15.0	1270	1.18	0.30	192	0.16	15.34	1.21
5/22/2009	326	MAY	14.2	1120	1.27	0.31	171	0.18	14.52	1.3
5/23/2009	327	MAY	13.2	1150	1.14	0.30	187	0.16	13.46	1.17
5/24/2009	328	MAY	12.9	1350	0.96	0.27	237	0.11	13.19	0.98
5/25/2009	329	MAY	13.2	1470	0.9	0.26	266	0.1	13.49	0.92
5/26/2009	330	MAY	13.9	1450	0.96	0.26	260	0.1	14.14	0.97
5/27/2009	331	MAY	14.1	1420	0.99	0.26	273	0.1	14.33	1.01
5/28/2009	332	MAY	13.9	1360	1.02	0.27	271	0.1	14.12	1.04
5/29/2009	333	MAY	13.9	1400	0.99	0.25	282	0.09	14.15	1.01
5/30/2009	334	MAY	13.7	1500	0.92	0.23	319	0.07	13.96	0.93
5/31/2009	335	MAY	13.9	1530	0.91	0.23	336	0.07	14.13	0.92
6/1/2009	336	JUN	14.0	1390	1.01	0.25	305	0.08	14.24	1.02
6/2/2009	337	JUN	13.8	1250	1.1	0.27	269	0.1	14.07	1.13
6/3/2009	338	JUN	13.4	1100	1.21	0.29	224	0.13	13.65	1.24
6/4/2009	339	JUN	13.0	1020	1.27	0.30	209	0.14	13.28	1.3
6/5/2009	340	JUN	12.4	996	1.25	0.30	212	0.14	12.72	1.28
6/6/2009	341	JUN	12.1	934	1.3	0.30	201	0.15	12.42	1.33
6/7/2009	342	JUN	11.7	806	1.46	0.32	172	0.18	12.06	1.5
6/8/2009	343	JUN	11.7	720	1.62	0.33	146	0.22	11.98	1.66
6/9/2009	344	JUN	11.3	633	1.78	0.33	128	0.26	11.61	1.83
6/10/2009	345	JUN	11.0	573	1.91	0.34	115	0.3	11.29	1.97
6/11/2009	346	JUN	10.6	538	1.97	0.34	108	0.32	10.96	2.04
6/12/2009	347	JUN	10.3	520	1.98	0.34	106	0.32	10.66	2.05
6/13/2009	348	JUN	10.2	515	1.98	0.34	109	0.31	10.52	2.04
6/14/2009	349	JUN	10.2	535	1.91	0.34	112	0.3	10.55	1.97
6/15/2009	350	JUN	10.1	593	1.7	0.33	119	0.28	10.44	1.76
6/16/2009	351	JUN	10.2	550	1.86	0.34	115	0.29	10.54	1.92
6/17/2009	352	JUN	10.3	518	1.98	0.34	110	0.31	10.61	2.05
6/18/2009	353	JUN	10.0	496	2.02	0.34	105	0.32	10.37	2.09
6/19/2009	354	JUN	9.8	471	2.09	0.34	102	0.33	10.17	2.16
6/20/2009	355	JUN	9.7	441	2.21	0.34	97	0.35	10.08	2.28
6/21/2009	356	JUN	9.5	418	2.26	0.34	92	0.37	9.80	2.35
6/22/2009	357	JUN	9.2	395	2.34	0.35	84	0.41	9.58	2.43
6/23/2009	358	JUN	9.2	367	2.5	0.35	76	0.46	9.53	2.6
6/24/2009	359	JUN	9.3	346	2.69	0.35	69	0.51	9.67	2.79
6/25/2009	360	JUN	9.1	332	2.73	0.35	65	0.54	9.43	2.84
6/26/2009	361	JUN	8.7	321	2.72	0.35	63	0.56	9.08	2.83
6/27/2009	362	JUN	8.9	305	2.92	0.35	58	0.61	9.25	3.03
6/28/2009	363	JUN	8.9	292	3.04	0.35	55	0.64	9.23	3.16
6/29/2009	364	JUN	8.9	282	3.16	0.35	52	0.68	9.26	3.29
6/30/2009	365	JUN	8.6	270	3.17	0.35	50	0.71	8.92	3.3

Note:

cfs = cubic feet per second

TABLE 1-3

Historical Monthly Average Discharge at Elizabeth Park and Canyon Creek

Estimated Stream Flow Reductions Resulting from Groundwater Remedial Actions, Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site, Attachment 1

Elizabeth Park Monthly Average Discharge: 1988-2011

Water Year	July	August	September	October	November	December	January	February	March	April	May	June
1988			59.3	53.2	54.6	80.5	67.9	94.1	257.6	766.9	581.5	273.9
1989	120	71.4	64.6	72	132.4	104.6	96.9	70.2	334.2	981	884.1	508.7
1990	151	105.6	77.9	74.5	287.1	363.5	454.7	265.9	464.5	1030	838.3	909
1991	245.9	119.2	82	101.9	365.6	268.1	234.7					852.2
1992	330.7	136.6	90.1	76.8	100.2	129.3	130.5	309.2	360.4	426.5	492	189.4
1993	105.2	75.1	76.1	65.9	90.1	65.8	74.2	85.4	323.6	587.2	1077	349.3
1994	220.9	131.1	85.9	80.4	67.4	88.3	120.5	79.4	261.9	559.1	459.1	205.4
1995	97.6	61.6	52.7	68.7	95.4	170.4	269.4	728.9	722.4	467.2	710.1	426.3
1996	166.5	96.1	77.3	153.4	579.6	865.1	428.4	1307	293.4	902.3	718.1	550.8
1997	198	101.4	82.5	83.4	105.9	194.9	513	353	689.8	1070	2026	1133
1998	347.2	131.9	103.9	119.2	152.7	116.9	151.6	218.6	380.9	548.8	895.5	389.2
1999	155.1	95.1	76.1	70.3	128.9	213.2	275.9	233.1	566.4	685.6	1085	1116
2000	393.2	147.3	88.7	91	188.7	260.8	153.5	294.1	423.8	1135	937.2	531.6
2001	167	90.3	81.3	76.7	67.1	57	55.8	58.4	130.9	261.8	621	266.1
2002	111.9	66.9	54.2	73.6	101.1	114.7	236.1	221.3	294.8	937.6	1347	1230
2003	308.3	126.6	84.8	72.5	79.2	100.3	174.1	316.3	468.7	623.8	612.5	369.3
2004	119.5	77.5	67.2	69.8	88.5	116	103.6	190.5	361.6	595.6	736	446.7
2005	152.3	111.7	114.7	113.2	181.8	346.2	347.9	257.6	265.4	567.9	545.1	265.4
2006	125.5	80	69.5	102.6	120.3	188.3	464.4	269.2	388.7	916.8	1089	661.5
2007	199.7	108.3	84.5	78.3	298.9	231.2	191.3	256.5	829.2	637.1	778.7	341.1
2008	128.3	81	68.4	84.9	107.6	178.8	112.9	129.9	250.4	424.9	1816	1310
2009	357.3	135	100.1	85	116.5	95.8	238	149.2	326.9	729	1155	597.6
2010	179.6	107.4	73.5	81.2	92.4	74.6	100.8	94.7	135.8	345.6	588.4	736.3
2011	217.4	108	87.6	80.5	115.7	219.4	541.6	281	388.5	739.8	1463	1416

Canyon Creek Monthly Average Discharge: 1998-2011

Water Year	July	August	September	October	November	December	January	February	March	April	May	June
1998										13.2	18.6	21.5
1999	23.7	20.1	50.7	81.6	160.7	193.1	85.9	29.7	17.1	16.1	26.3	28.1
2000	18.1	23.8	33.8	141.1	158.8	111.7	34.5	18.5	15.4	14.1	12.1	11
2001	10.1	10.3	17.2	41	138.1	67.4	26.5	15.8	12.1	14.4	17.1	17.1
2002	25	19.7	24.7	91	203	224.9	61.6	23.3	15.8	12.3	13	13.8
2003	17.9	35.1	43.8	88	131.1	83.5	23.9	16.1	13.3			
2006		29.4	32.6	85.7	221.5	129.5	32.6	19	15	12.7	53.8	28.2
2007	22.1	26.4	91	86.1	147.6	73.2	25.5	16.9	13.4	14.9	17.4	21
2008	14.9	14.5	20.2	36.4	248.2	217.2	66.2	23.7	17.6	14.9	22	16.7
2009	24.5	18.1	28.6	75.4	172.9	124.3	30.4	17.9	14.1	13.9	15.3	10.3
2010	12.4	12.1	17.8	52.4	105.3	147.9	38.3	18.6	14.4	13.4	18.4	26.4
2011	51.1	28.9	31.9	62.1	200.6	265	129.5	32.1	20.1			

Figures

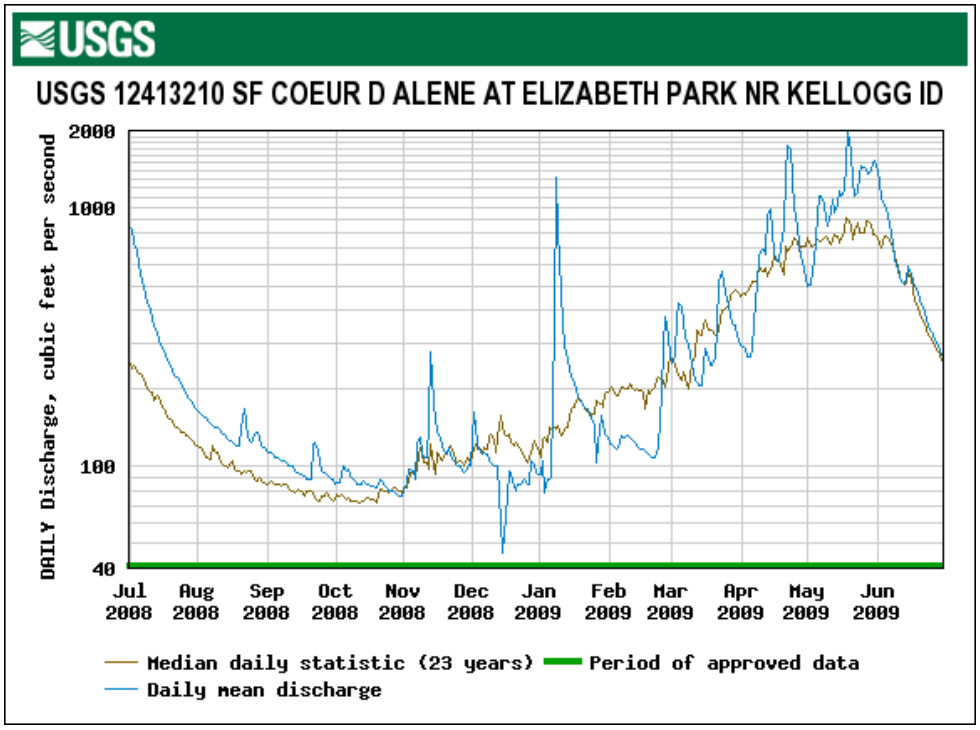


Figure 2-1a

Discharge (cfs), Mainstem South Fork Coeur d'Alene River at Elizabeth Park (23 Year Daily Mean)

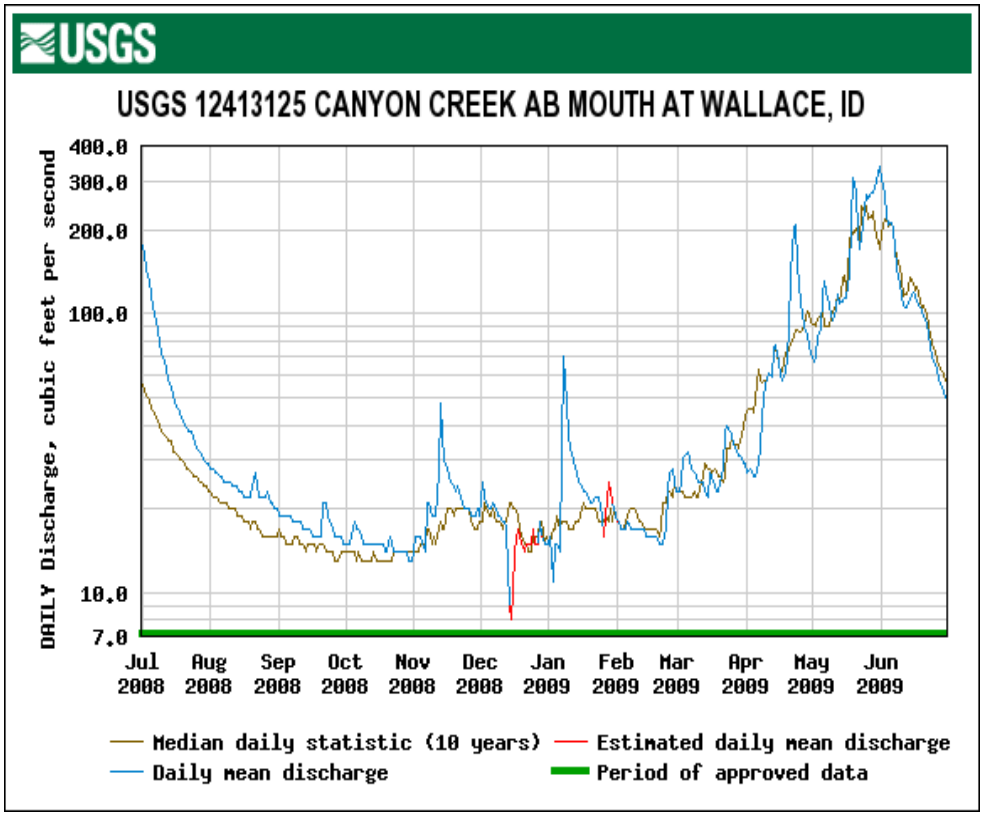


Figure 2-1b
Discharge (cfs), Canyon Creek at Wallace (10 Year Daily Mean)

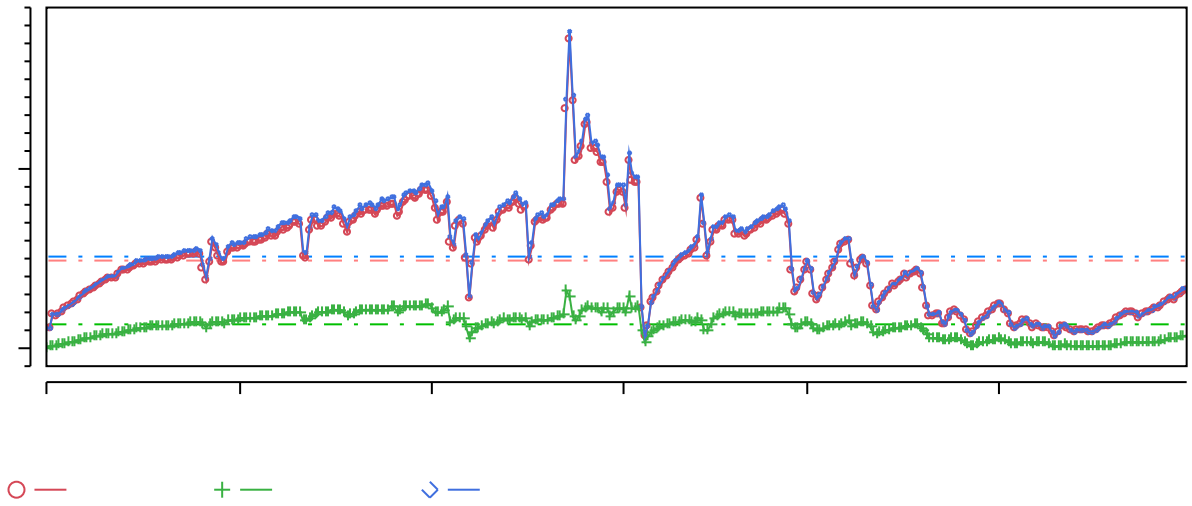
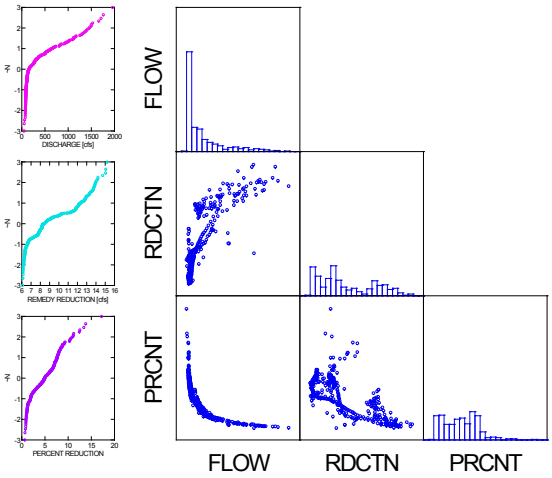


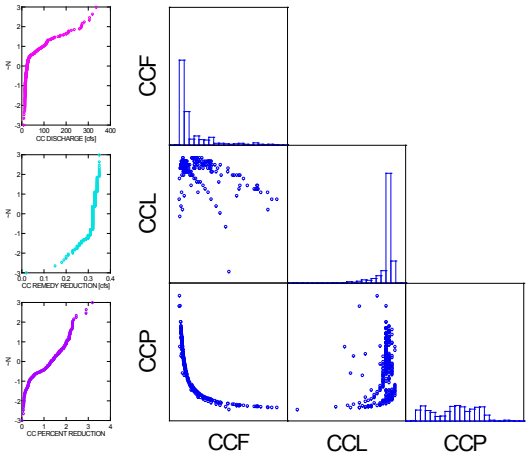
Figure 2-2

Daily Modeled Percent Stream Flow Reduction: July 1, 2008 through June 30, 2009

A **ELIZABETH PARK**



B **CANYON CREEK**



C **CUMULATIVE REMOVALS AT ELIZABETH PARK**

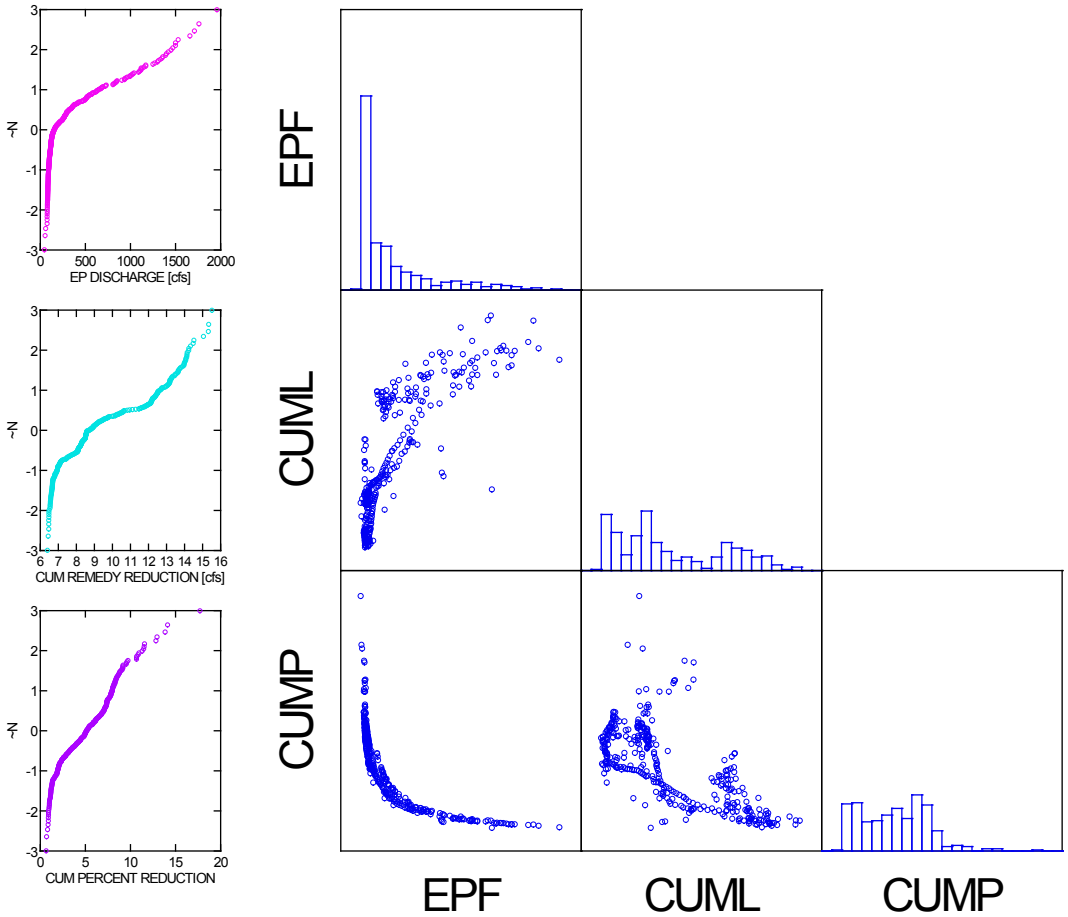


Figure 2-3

Variable Distributions: Discharge (cfs), Flow Reduction (cfs), Percent Flow Reduction

A **ELIZABETH PARK: 23 WATER YEARS**

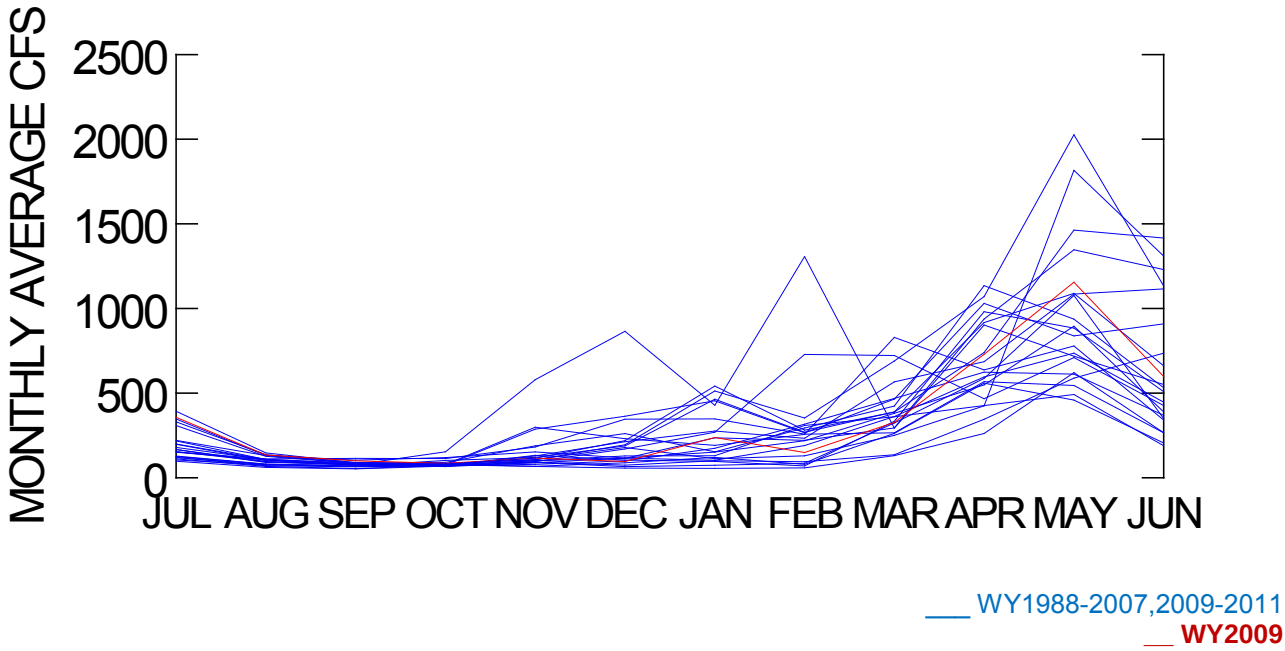


Figure 2-4a

Historic Monthly Average Discharge (cfs), Mainstem South Fork Coeur d'Alene River at Elizabeth Park (23 Year Daily Mean)

B **CANYON CREEK DISCHARGE: 10 WATER YEARS**

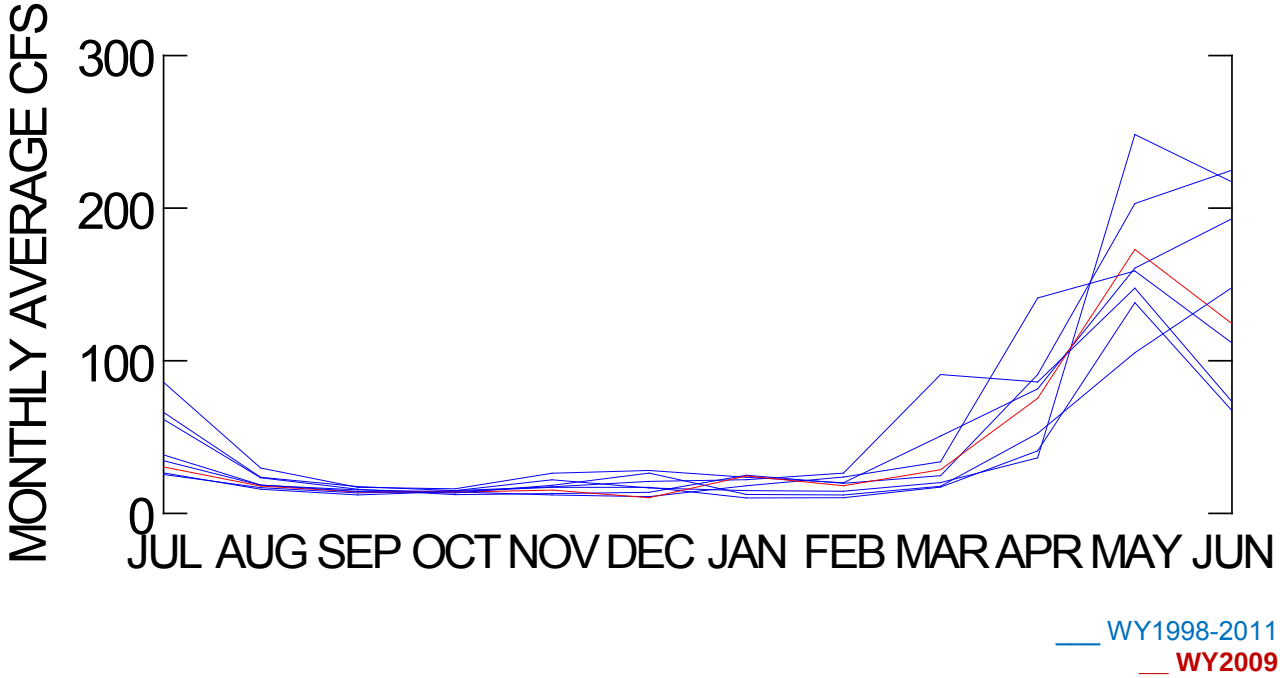


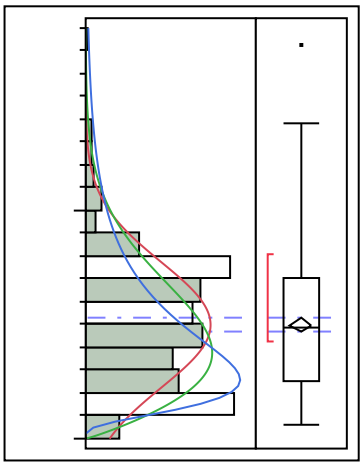
Figure 2-4b

Historic Monthly Average Discharge (cfs), Canyon Creek at Wallace (10 Year Daily Mean)

$ WWDFK P HQWV

Attachment A1: Elizabeth Park Remedy Reduction (July 1, 2008 – June 30, 2009), Statistical Estimate Output Documentation

RDCTNprcnt



Normal(4.98798,2.74596)
Extreme Value(1.72638,0.52988)
LogNormal(1.41266,0.68191)

Quantiles

100.0%	maximum	17.2034
99.5%		14.371
97.5%		10.8709
90.0%		8.03823
75.0%	quartile	7.0594
50.0%	median	4.91277
25.0%	quartile	2.50689
10.0%		1.31886
2.5%		0.92177
0.5%		0.6841
0.0%	minimum	0.64325

Moments

Mean	4.987985
Std Dev	2.7459639
Std Err Mean	0.1437303
Upper 95% Mean	5.270631
Lower 95% Mean	4.7053389
N	365

Fitted Normal
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	4.987985	4.7053389	5.270631
Dispersion	σ	2.7459639	2.5601634	2.9610665

-2log(Likelihood) = 1772.22161457615

Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.956170	<.0001*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Fitted Extreme Value

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Scale	λ	1.7263828	1.6685711	1.7832498
Shape	δ	0.5298805	0.4890076	0.5760535

-2log(Likelihood) = 1729.82216339402

Goodness-of-Fit Test

Cramer-von Mises W Test

W-Square		Prob>W^2
0.633525	<	0.0100*

Note: Ho = The data is from the Extreme Value distribution. Small p-values reject Ho.

Fitted LogNormal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Scale	μ	1.4126602	1.3425194	1.482801
Shape	σ	0.6819073	0.6352793	0.7345313

2log(Likelihood) = 1787.5781597823

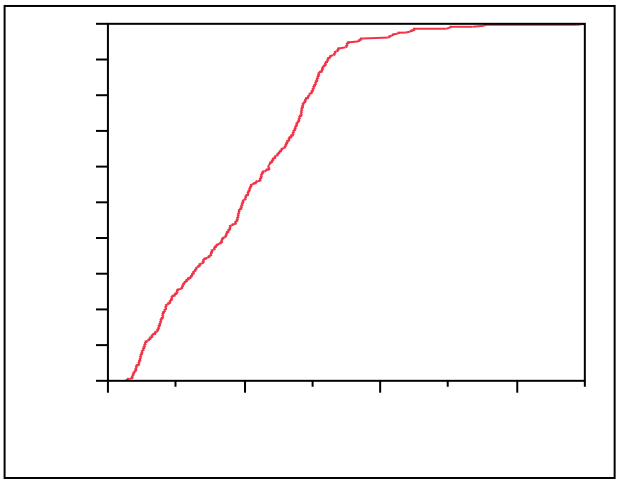
Goodness-of-Fit Test

Kolmogorov's D

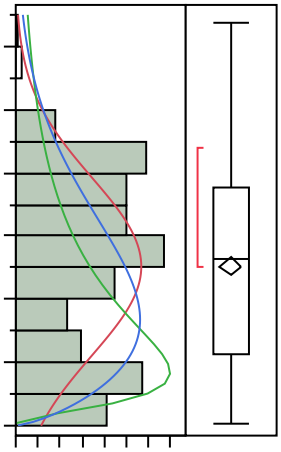
D		Prob>D
0.131421	<	0.0100*

Note: Ho = The data is from the LogNormal distribution. Small p-values reject Ho.

CDF Plot



Attachment A2: Canyon Creek Remedy Reduction (July 1, 2008 – June 30, 2009), Statistical Estimate Output Documentation



Normal(1.25894,0.70402)

Extreme Value(0.33506,0.58329)

Quantiles

100.0%	maximum	3.19286
99.5%		2.95493
97.5%		2.28976
90.0%		2.14391
75.0%	quartile	1.8844
50.0%	median	1.32386
25.0%	quartile	0.56098
10.0%		0.26625
2.5%		0.0972
0.5%		0.05662
0.0%	minimum	0.00944

Moments

Mean	1.2589415
Std Dev	0.7040151
Std Err Mean	0.0368498
Upper 95% Mean	1.3314068
Lower 95% Mean	1.1864762
N	365

Fitted Normal
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	1.2589415	1.1864762	1.3314068
Dispersion	σ	0.7040151	0.6563792	0.7591635

-2log(Likelihood) = 778.627604966264

Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.951531	<.0001*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Fitted LogNormal
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Scale	μ	-0.04778	-0.140646	0.0450868
Shape	σ	0.9028469	0.8411113	0.9725212

-2log(Likelihood) = 926.338196904071

Goodness-of-Fit Test

Kolmogorov's D

D		Prob>D
0.194151	<	0.0100*

Note: Ho = The data is from the LogNormal distribution. Small p-values reject Ho.

Fitted Extreme Value
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Scale	λ	0.3350637	0.2719398	0.3971751
Shape	δ	0.5832893	0.5349109	0.6379862

-2log(Likelihood) = 780.735656474936

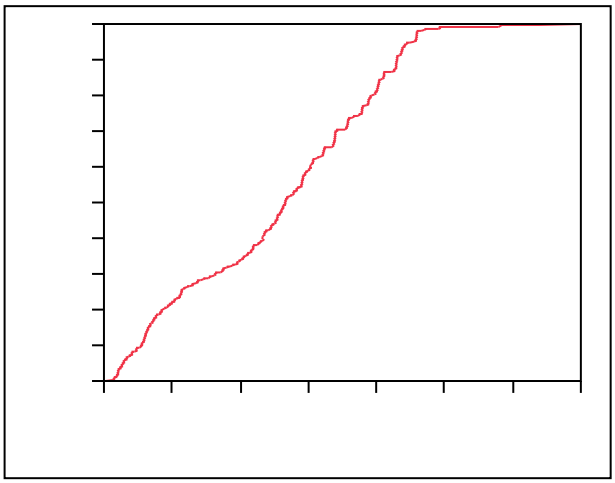
Goodness-of-Fit Test

Cramer-von Mises W Test

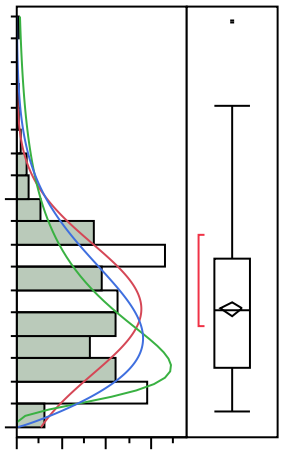
W-Square		Prob>W^2
1.803345	<	0.0100*

Note: Ho = The data is from the Extreme Value distribution. Small p-values reject Ho.

CDF Plot



Attachment A3: Cumulative (Elizabeth Park plus Canyon Creek) Remedy Reduction (July 1, 2008 – June 30, 2009), Statistical Estimate Output Documentation



Normal(5.18701,2.86562)

LogNormal(1.44848,0.68903)

Extreme Value(1.76517,0.5327)

Quantiles

100.0%	maximum	17.7071
99.5%		14.7294
97.5%		11.2475
90.0%		8.40738
75.0%	quartile	7.35871
50.0%	median	5.12445
25.0%	quartile	2.57975
10.0%		1.35073
2.5%		0.93756
0.5%		0.69596
0.0%	minimum	0.66249

Moments

Mean	5.1870141
Std Dev	2.8656173
Std Err Mean	0.1499933
Upper 95% Mean	5.4819762
Lower 95% Mean	4.892052
N	365

Fitted Normal
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	5.1870141	4.892052	5.4819762
Dispersion	σ	2.8656173	2.6717207	3.0900929

-2log(Likelihood) = 1803.35729916247

Goodness-of-Fit Test
Shapiro-Wilk W Test

W	Prob<W
0.956950	<.0001*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Fitted LogNormal
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Scale	μ	1.4484842	1.3776109	1.5193574
Shape	σ	0.6890282	0.6419132	0.7422017

-2log(Likelihood) = 1821.3131677546

Goodness-of-Fit Test
Kolmogorov's D

D		Prob>D
0.130763	<	0.0100*

Note: Ho = The data is from the LogNormal distribution. Small p-values reject Ho.

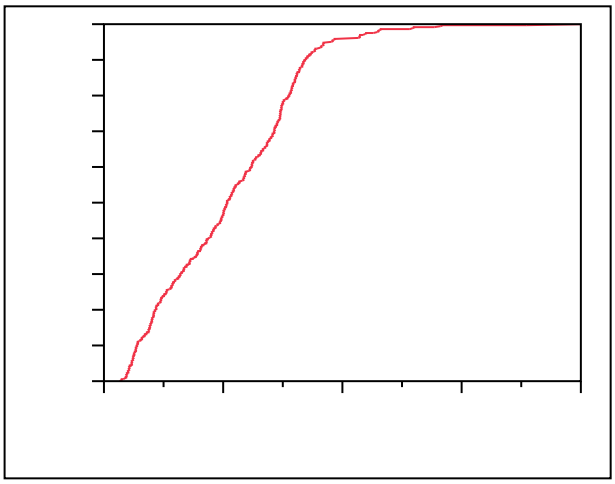
Fitted Extreme Value
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Scale	λ	1.7651742	1.7070615	1.8223303
Shape	δ	0.5326994	0.4914462	0.5792954

-2log(Likelihood) = 1761.62627375711

Goodness-of-Fit Test
Cramer-von Mises W Test

W-Square		Prob>W^2
0.664433	<	0.0100*

Note: Ho = The data is from the Extreme Value distribution. Small p-values reject Ho.

CDF Plot