Appendix A
Amphibian Survey Report

Rimini Wetland Restoration and Amphibian Habitat Enhancement
Tenmile Creek Near Rimini, Montana

Draft Report
September 2006

US Army Corps of Engineers®
Omaha District

Amphibian Survey
Rimini Wetland Restoration and Amphibian Habitat Enhancement Project
Tenmile Creek, Rimini, Montana

Prepared by Kristine Nemec

U.S. Army Corps of Engineers
106 S. 15th St.
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July 2006

Introduction

This amphibian survey was conducted within approximately one acre of wetlands north of Rimini, Montana, located within Township 9 North, Range 5 West, NE ¼ of the NE ¼ of Section 32, in Lewis and Clark County. The survey area is located within the Helena National Forest, which is managed by the U.S. Forest Service (USFS). A wetland restoration and amphibian habitat enhancement project is proposed along a 300-yard stretch of Tenmile Creek north of Rimini. The project would consist of lowering an existing rock berm along Tenmile Creek, connecting wetlands on the western and eastern sides of Rimini Road by installing culverts, installing an amphibian friendly tunnel, and adding stream diversity and fish structures.

The objective of the survey was to determine if the Western toad, *Bufo boreas*, is in the project area and to assess the possible impacts of the project on the toad. The subspecies of Western toad that occurs in Montana is the boreal toad, *Bufo boreas boreas* (Werner et al. 2004). The Western toad is found in a variety of habitats including wetlands, forests, woodlands, sagebrush, meadows, and floodplains in mountains and mountain valleys (Maxell 2000, Werner et al. 2004).

Within the last 30 years populations of Western toads have crashed in Colorado, Utah, southeast Wyoming, and New Mexico (Maxell 2000). Although the Western toad population in Montana was thought to be stable, surveys in the late 1990s revealed that toads were absent from a large number of their historic locations and occupied an extremely small proportion of suitable habitat (Maxell 2000). Factors contributing to the toad's decline may include spread of the chytrid fungus, mortality along highways, predation by ravens, trampling of metamorphs by livestock, toxic effects of antimycin, rotenone, insecticides, and heavy metals on toad tadpoles and larvae, and weakened immune systems from increasing ambient levels of UV-B light (Maxell 2000).

As a result of these declines, in 1999 the USFS classified the Western toad as a sensitive species in all Region 1 Forests, which includes 12 national forests in northeastern Washington, northern Idaho, and Montana (USFS 1999). A sensitive species is a plant, bird, mammal, reptile, amphibian, fish, or invertebrate designated by the Regional Forester whose: population viability is a concern on National Forests within a Region; current population and/or habitats have been reduced/restricted; populations and/or habitats are considered vulnerable to certain management activities; or monitoring requires a special emphasis (USFS 2006).

There are few records of Western toad in the project area. Several years ago a biologist who lives in Rimini observed a Western toad in a meander channel about ¼ mile to the north of the project area, along the road between Tenmile Creek and a wetland meander that was cut off by the roadway (Eakin 2006). However, the Columbia spotted frog, *Rana luteiventris*, is the only amphibian species that the biologist and his children, who participate in the FrogWatch program, have observed in the project area wetlands (Eakin 2006).

The nearest Montana Natural Heritage program records for Western toads include 2002-2004 observations from inactive beaver ponds 3.5 miles to the southeast of Rimini and 2000 and 2002 observations in the Sure Thing Swamps approximately 4.5 miles to the southwest of Rimini (MNHP 2006).

Methods

Sites for the amphibian survey were identified through conversations with a senior biologist from the URS Corporation who resides in Rimini, the coordinator of the Upper Tenmile Watershed Group, and study of 2004 aerial photos.

The amphibian survey was conducted on the morning of June 13, 2006. Wetland margins were searched for adults and juveniles while walking slowly along the edge, in accordance with the amphibian survey procedures described in Sampling Amphibians in Lentic Habitats (Thoms et al. 1997). Because Western toads breed between May and July, entwining strings of eggs around vegetation or scattering eggs loose on the bottom of the body of water (Werner et al. 2004), a visual search was also conducted for egg masses attached to vegetation or egg strings in open water. Western toads breed in standing water in shallow areas of large and small lakes, beaver ponds, temporary ponds, slow-moving streams, backwater channels of rivers, roadside ditches, or gravel pits (Maxell 2000, Werner et al. 2004).

Information on the time of day, weather conditions, site features, and species observed were recorded on a standardized U.S. Fish and Wildlife Service data sheet (Appendix A).

Results and Discussion

No Western toads or evidence of their egg masses were detected within the survey area. Although no toads were detected, it is generally impossible to confirm a species' absence from an area (MacKenzie 2005). The nondetection of the toad may be the result of the survey failing to detect toads that are actually present in the project area (MacKenzie 2005). It is possible that individual toads could have been obscured by vegetation and not detected or occasionally use the wetlands but were present in another part of the landscape at the time of the survey. However, given that local residents have not observed the toad in the wetlands odds are the toad is not normally present within the survey area.

Four adult Columbia spotted frogs were observed in the wetlands on the western side of the road (Appendix A). Numerous spotted frog tadpoles were observed in the wetlands on the western and eastern sides of the road. No spotted frog egg masses were observed in the water, possibly because the survey was conducted at the end of the spotted frog breeding season, which runs from mid-March to mid-June (Maxell 2000).

Columbia spotted frogs are the most common frog in the mountains and mountain valleys of western Montana and are found in the majority of water bodies that have emergent vegetation and do not have fish or bullfrogs (Maxell 2000). Although spotted frogs are highly aquatic and are normally not found far from the marshy edges of ponds or lakes, they commonly bask and forage outside several feet from the water's edge and may move up to 1.5 kilometers (0.9 miles) to a seasonal breeding, foraging, or overwintering site (Maxell 2000). Therefore, it is highly probable that spotted frogs cross Rimini Road to bask, forage, or breed. The construction of one or more amphibian friendly tunnels or culverts could help reduce the number of adults killed on the road. Because Columbia spotted frogs are found most often in water bodies that do not contain fish, the merits of introducing fish spawning habitat in the wetlands must be weighed against decreasing the local spotted frog population.

Literature Cited

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Appendix A
Survey site data form
and site pictures

Site Data Form for Lentic Breeding Amphibian and Aquatic Reptile Surveys

Date 6/13/06	Observer(s) Kristine Nemec	GPS Receiver N/A	GPS File N/A	GPS Datum N/A	GPS EPE N/A
Strata Number N/A	HUC Number N/A	Site Number N/A	State MT	County Lewis and Clark	Map Name Three Brothers
Locality Approximately 120 meters north of northernmost house in town of Rimini. Begins on west side of Rimini Road, extends about 230 meters north.		T 9N	R 5W	S 32	Section Description NE1/4 of NE1/4 of Sec 32
Owner USFS	Map Elevation 4,800 FT	UTM Zone: 12	UTM East 403719E		UTM North 5150024

Habitat Information

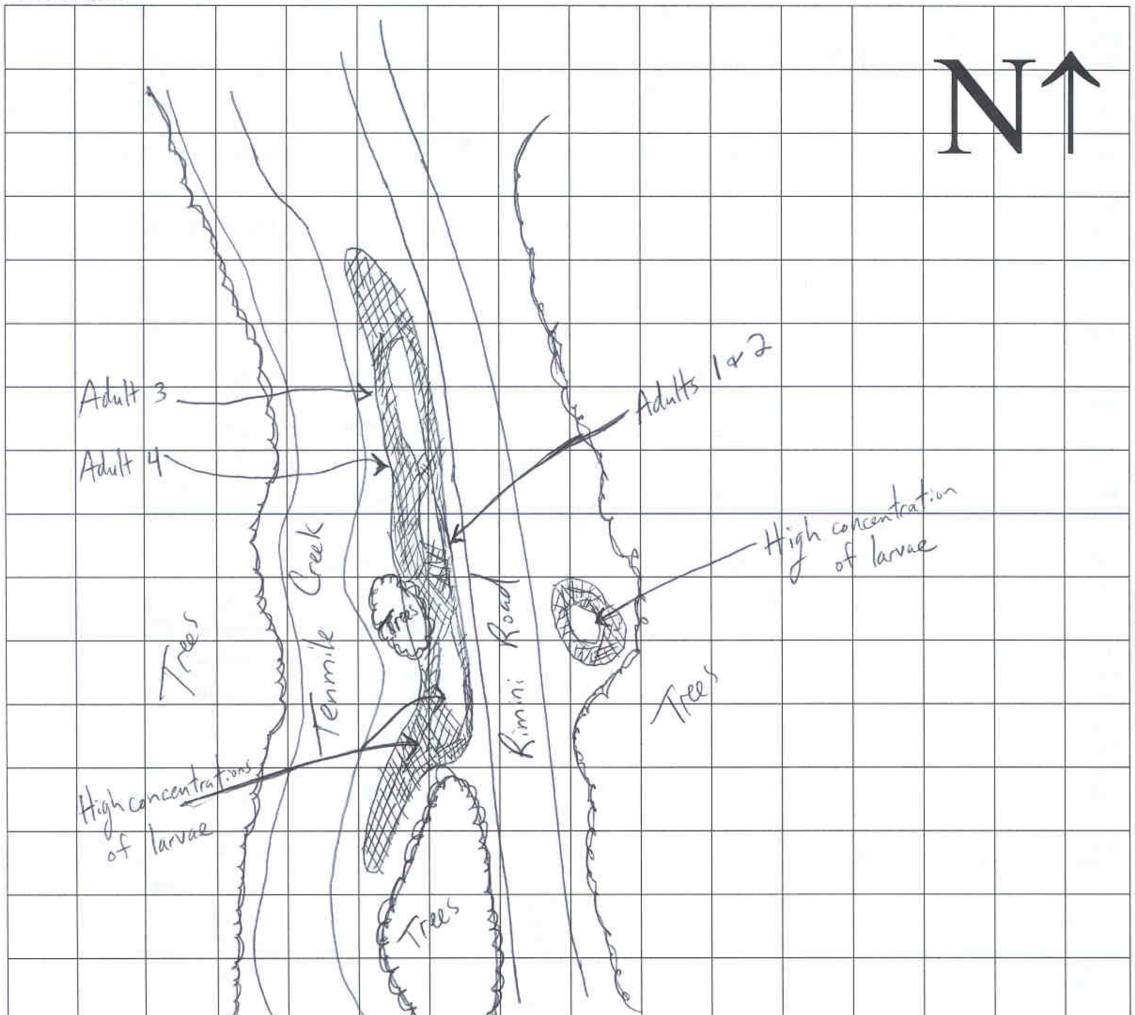
Begin Time 0745	End Time 0915	Total Person Minutes of Search 90	Site Detection: **Aerial Photo** Topo Map NWI Map Incidental		
Camera Number N/A	Photo Frame Number(s)/ Description(s) N/A				
Weather: Clear **Partly Cloudy** Overcast Rain Snow			Wind: **Calm** Light Strong		
Air Temp ~55 °C	Water Temp N/A °C	Water pH N/A	Color: **Clear** Stained	Turbidity: **Clear** Cloudy	
Habitat Type: Lake/Pond **Wetland/Marsh** Bog/Fen Backwater/Oxbow Spring/Seep Active Beaver Pond Inactive Beaver Pond Site Dry Site Multipooled Ditch/Puddle Reservoir/Stockpond Well/Tank					
Water Connectedness: Permanent Temporary **Isolated**	Water Permanence: Permanent **Temporary**		Max Depth: **<1 M** 1-2 M >2 M	Percent of Site > 2 M **0** 1-25 26-50 51-75 76-100	
Site Length: ~200 yards	Site Width: 5-30 feet	~Site Area: 1 acre	Percentage of Site Searched: 1-25 26-50 51-75 **76-100**	Percent of Site at ≤ 50 cm Depth: 0 1-25 **26-50** 51-75 76-100	~ Emergent Veg Area (M²) 2,800
Percentage of Site with Emergent Veg: 0 1-25 26-50 **51-75** 76-100			Percentage of Site with Larval Activity: 0 **1-25** 26-50 51-75 76-100		
Rank Emergent Veg Species in Order of Abundance: 3 Sedges 1 Grasses ___ Cattails 2 Rushes ___ Water Lily 4 Shrubs ___ Other ___					
Primary Substrate Of Shallows: **Silt/Mud** Sand Gravel Cobble Boulder/Bedrock			North Shoreline Characteristics: **Shallows Present** Shallows Absent **Emergent Veg Present** Emergent Veg Absent		
Site Origin: Glacial Beaver Flooding Manmade Other Groundwater/Precip.			Human Impacts Or Modifications: Separated from creek by manmade rock dike		
Distance (M) to Forest Edge: 5-30	Fish Detected?: Y **N**	Time at First Detection:	Fish Species If Identified:		Support Reproduction? Y N
Fish Spawning Habitat Present? Y **N** U	Inlet Width: N/A	Inlet Depth: N/A	Inlet Substrate N/A	Outlet Width N/A	Outlet Depth N/A / Outlet Substrate N/A

Species Information

Amphibian Species	Columbia spotted frog	Time at first detection	E L M J A	No. Egg Masses		5-20mm larvae	≤10 ≤100 **≤1000** ≤10K >10K
20-50mm larvae	≤10 ≤100 **≤1000** ≤10K >10K	>50mm larvae	≤10 **≤100** ≤1000 ≤10K >10K	Number Juveniles		Number Adults	4
Tissue Number		Voucher Number		Breeding with Fish?	Y N	If breeding with fish is cover present?	Y N
Amphibian Species		Time at first detection	E L M J A	No. Egg Masses		5-20mm larvae	≤10 ≤100 ≤1000 ≤10K >10K
20-50mm larvae	≤10 ≤100 ≤1000 ≤10K >10K	>50mm larvae	≤10 ≤100 ≤1000 ≤10K >10K	Number Juveniles		Number Adults	
Tissue Number		Voucher Number		Breeding with Fish?	Y N	If breeding with fish is cover present?	Y N
Amphibian Species		Time at first detection	E L M J A	No. Egg Masses		5-20mm larvae	≤10 ≤100 ≤1000 ≤10K >10K
20-50mm larvae	≤10 ≤100 ≤1000 ≤10K >10K	>50mm larvae	≤10 ≤100 ≤1000 ≤10K >10K	Number Juveniles		Number Adults	
Tissue Number		Voucher Number		Breeding with Fish?	Y N	If breeding with fish is cover present?	Y N
Amphibian Species		Time at first detection	E L M J A	No. Egg Masses		5-20mm larvae	≤10 ≤100 ≤1000 ≤10K >10K
20-50mm larvae	≤10 ≤100 ≤1000 ≤10K >10K	>50mm larvae	≤10 ≤100 ≤1000 ≤10K >10K	Number Juveniles		Number Adults	
Tissue Number		Voucher Number		Breeding with Fish?	Y N	If breeding with fish is cover present?	Y N
Reptile Species		Time at first detection	E J A	Number Individuals	SVL in CM	Tissue Number	Voucher Number
Reptile Species		Time at first detection	E J A	Number Individuals	SVL in CM	Tissue Number	Voucher Number
Reptile Species		Time at first detection	E J A	Number Individuals	SVL in CM	Tissue Number	Voucher Number

Site Map For Lentic Breeding Amphibian and Aquatic Reptile Surveys

Grid Scale:



* Indicate the following locations on the map: **T** = temperature, **G** = GPS reading, **C** = clinometer reading, and **P→** = photo locations and directions of photos. Indicate area with emergent vegetation with cross-hatching and indicate a 2-meter depth contour with a dashed line.

Other Notes: See Attached aerial photo for figure locations

Compass Bearing	70°	90°	110°	130°	150°	170°	190°	210°
Inclination (degrees)								


N
Figures 9 and 10
Figures 5 and 6
Figure 7
Figures 3 and 4
Figure 8
Figures 1 and 2
100 0 100 200 Feet


Figure 1. Looking south at southern end of wetland area.


Figure 2. Looking east at southern end of wetland area.


Figure 3. Looking south towards open area of wetland in southern end of wetland area.


Figure 4. Looking north from open area of wetland in southern end of wetland area.


Figure 5. Looking south from central portion of wetland area.


Figure 6. Looking north from central portion of wetland area.

Figure 7. Looking west at wetland on eastern side of the road.

Figure 8. Looking northeast at potential wetland restoration area on eastern side of road.


Figure 9. Looking south at northern end of project area.


Figure 10. Looking north at northern end of project area.

Appendix B
Analytical Data Report

Rimini Wetland Restoration and Amphibian Habitat Enhancement
Tenmile Creek Near Rimini, Montana

Draft Report

September 2006

US Army Corps
of Engineers ®
Omaha District

ANALYTICAL DATA REPORT
Tenmile Creek Near Rimini, Mt

1. BACKGROUND INFORMATION

A 300 linear yard rock and gravel dike, was built in 1981 to canalize a section of Upper Tenmile Creek near the Town of Rimini following an extreme flood event which over-ran and washed out the Rimini Road. The dike separates the stream course from its floodplain, as well as adjacent springs and associated wetlands.

The existing situation causes the stream flow to accelerate through the canalized reach and incise the streambed immediately below the canalized section, to erode the downstream meadow soils and undercut the stream banks, to increase downstream meanders, to exacerbate the potential for flooding downstream of the subject reach, and to severely attenuate the spawning beds of the local trout fishery.

The object of this Sampling and analysis is the obtaining of samples from the rock and gravel to be removed to determine characterization and possible disposal options. If possible water/sediment samples will also be obtained from the wetlands.

2. SAMPLE COLLECTION

Two rock samples were obtained from the dike, and two surface water and two sediment samples were obtained from the adjoining wetlands. The dike only consisted of rocks so the two rock samples were obtained from two areas of the dike. This was a deviation from the Sampling and Analysis Plan, where six samples of loose fill soils between the rocks was called for. The two rock samples are, however, representative of the dike contents. Along with the wet lands surface water samples, sediment samples were also obtained.

The samples obtained were:

Surface water samples:
UTCRM-W-1-6/13/06
UTCRM-W-2-6/13/06

Sediment samples:
UTCRM-SD-1-6/13/06
UTCRM-SD-2-6/13/06

Rock samples:
UTCRM-R-1-6/13/06
UTCRM-R-2-6/13/06

3. SAMPLE ANALYSIS

3.1. SAMPLE DISPASISTION

All samples were sent to USACE ECB Lab in Omaha, Nebraska. The rock samples were then sent to Energy Labs in Billings, Montana where the rock was ground to a fine grain material. Part of the ground material was used for Acid Base Accounting (ABA) analysis at Energy labs and some was sent back to Omaha for metals analysis. The surface water and sediment samples were analyzed for metals at ECB.

3.2. ANALYTICAL METHODS

The following methods used by the USACE/ECB Laboratory are:

Parameters	Analytical Methods	Extraction
TAL Metals Water	EPA Method 6010B,	3005A
TAL Metals soil	EPA Method 6010B,	3050A
Hg water	EPA method 7470A	
Hg soil	EPA method 7471A	

Acid Base Accounting at Energy lab, Montana
ABA *

* Analysis shall be denoted as Acid Base Accounting (ABA), Sulfur forms, Exchangeable Acidity and SMP buffer

3.2.1. Analytical Sensitivity

Required analytical sensitivity (MDL and RL) are the ECB and Energy laboratory set criteria for the analytical methods.

4. DATA QUALITY INDICATORS AND MEASUREMENT QUALITY OBJECTIVES

Measurement quality objectives (MQOs) to be followed are prescribed within the EPA methodology. Laboratory quality control samples and data quality indicators will be utilized in accordance with the ECB’s Laboratory Quality Assurance Manual. Routine internal quality control checks are placed in the measurement system to assess the quality of the data generated. These checks typically include: with each preparative batch, a Method Blank, a Matrix Spike and Matrix Spike Duplicate, a Laboratory Duplicate, and a Laboratory Control Sample. Inclusion of the Matrix Spike, Matrix Spike Duplicate and Laboratory Duplicate are contingent on sufficient sample material being provided. In addition to the checks within the preparative batch there are analysis batch checks that are also completed (retained on file by the laboratory, but typically not reported in a standard data package) including Calibration Blanks and Continuing Calibration Verifications. Additional samples are analyzed periodically (results retained on file) and may include reagent blanks, second source check standards and other performance checks. External quality control checks are provided in the form of Performance and System Audits and Surveillance. For a more complete description of these checks, including their frequency of measurement, acceptance criteria and corrective action protocol, refer to the USACE/ECB Laboratory Quality Management Manual (USACE, 2001).

5. DATA QUALITY REVIEW

Data quality review is the process for assuring that data verification and validation will be implemented in an objective and consistent manner. Data verification and validation is the conformation by examination and objective evidence that specific requirements of the SAP and intended use of the data have been fulfilled. Data verification is the process of evaluating the completeness, correctness, and conformance of a specific data set against the method, procedural, or contractual requirements. Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., verification) to determine the analytical quality of a specific data set. Data verification and validation will be performed by the project chemist and documented within a Quality Control Summary Report (QCSR). The QCSR is found in Appendix A.

6. ANALYTICAL DATA TABLES

The qualified data is given in Appendix B. The data given in the analytical results tables has been reviewed by the analytical laboratory (USACE/ECB laboratory). Data quality review will be based on meeting the project's data quality objectives. If data verification and validation indicate that any data quality objectives can't be achieved, that information will be provided to Project Manager. The Chain-of-Custody is Appendix C. The Laboratory Analytical Data is in Appendix D.

7. DATA INTERPRETATION

The two rock samples that were obtained from the material to be removed from within the canalized section of Upper Tenmile Creek were analyzed for total RCRA heavy metals. The total metals analytical results will be used to determine possible placement of the material and the 20 time will be used to give an indication of the leachability of the material.

The RCRA metals results of the rock obtained from the dike is given in Table 3 of Appendix B. The total metals results, by using the 20 times rule in TCLP analysis, show that even if the metals in the rock were 100 % leachable the material would pass TCLP analysis. An example: The lead content of disposable material would have to be 100 mg/kg and 100 % leachable to obtain the TCLP regulatory level of 5 mg/l for lead. All metals in the two samples (UTCRM-R-1-6/13/06 and UTCRM-R-2-6/13/06) obtained from the dike would pass TCLP analysis.

Since the materials are from areas of mine tailings acid base accounting will be determined. Acid Base Accounting is the determination of the balance between the acid production and acid consumption properties of waste material. These two parameters are represented in the data table by Neutralization Potential and Acid Potential. The differences and ratios are represented NNP and NPR respectively.

Neutralization Potential	NP
Acid Potential	AP
Net Neutralization Potential	NNP = NP – AP
Neutralization Potential Ratio	NPR = NP/AP.

The units are expressed in parts per thousand (ppt). The units on the ABA data (Table 4, Appendix B) is expressed in t/kt (tons/kilatons). This is parts per thousand.

The predominate acid neutralization compound is calcium carbonate and the predominate acid producing compound is reduced forms of sulfur. NNP is given in the data table as Acid/Base Potential.

The criteria used for interpretation are as follows:

NNP > 20	non acid producing
NNP <-20	acid producing
NNP -20 to 20	variable
NPR < 1	acid producing
NPR > 3	non acid producing

From the analytical parameters NP and AP the acid base accounting can be determined, and an estimate of the acid production or acid neutralization of the material can be determined.

From the ABA data in Table 4 of Appendix B the NNP values are within the range of -20 to 20. This indicates that the overall acid production/neutralization properties or Acid/Base potential of the dike contents is variable.

The Neutralization Potential Ratio NPR = NP/AP can not be calculated since division by a zero value is undefined, however if it is assumed that the Acid Potential AP is very small then the NPR value would be very large, and non acid producing.

Wetlands water samples were also analyzed for RCRA metals. The sediment metals contents is significant, especially AS, and lead. The surface water samples from the pools in the wetlands appears to only have significant values of As. This is consistent with the solubility properties of As. The reduced form of As (As III) is the most soluble form and in stagnant pools with much organic growth the water would be low in oxygen and thus in a reduced state where the solubility As is increased.

APPENDIX A

Quality Control Summary Report

QUALITY CONTROL SUMMARY REPORT

For

Upper Tenmile Creek,
Rock and Gravel Dike
Rimini, Montana

July 2006

Upper Tenmile Creek,

A review of the batch quality control samples for the following analytical batches has been performed and appropriate qualifiers applied to the data.

WG17613/WG17632 Water RCRA Metals:

Samples: UTCRM-W-1-6/13/06
UTCRM-W-2-6/13/06

COC, Shipping and Handling were as required. Samples were as obtained from contractor.

Method Blank was non detect for metals.

Lab Matrix duplicate RPD was within criteria. No qualification applied.

Matrix Spike/Matrix Spike Duplicate: RPD and % Rec were within criteria. No qualification required.

LCS was within criteria. No qualification applied.

QUALIFICATIONS No qualifications applied and data is usable.

WG17678/WG17617 Sediment TAL Metals:

Samples: UTCRM-SD-1-6/13/06
UTCRM-SD-2-6/13/06

COC, Shipping and Handling were as required. Samples were as obtained from contractor.

Method Blank was non detect for metals.

Lab Matrix duplicate RPD was within criteria. No qualification applied.

Matrix Spike/Matrix Spike Duplicate: RPD and % Rec were within criteria. No qualification required.

LCS was within criteria. No qualification applied.

QUALIFICATIONS No qualifications applied and data is usable.

WG17679/WG17684 Rock, TAL Metals:

Samples: UTCRM-R-1-6/13/06
UTCRM-R-2-6/13/06

COC, Shipping and Handling were as required. Samples were as obtained from contractor.

Method Blank was non detect for metals.

Lab Matrix duplicate RPD was within criteria.   No qualification applied.

Matrix Spike/Matrix Spike Duplicate: RPD and % Rec were within criteria. No qualification required.

LCS was within criteria. No qualification applied.

QUALIFICATIONS   No qualifications applied and data is usable.

APPENDIX B

Analytical Data Results Tables

Table 1. Surface Water RCRA Metals (Methods 6010B/7470A)

Analyte	Method Detection Limit (ug/L)	Laboratory Reporting Limit (ug/L)	UTCRM-W-1-6/13/06 (ug/L)	UTCRM-W-2-6/13/06 (ug/L)
As	3	15	39	71
Ba	0.5	2.5	26.2	14
Cd	0.5	2.5	1 J	u
Cr	2	10	u	u
Pb	2	10	u	u
Hg	0.02	0.1	u	u
Se	4	20	u	u
Ag	1	5	u	u

Table 2. Sediment, RCRA Metals (Methods 6010B/7471A)

Analyte	Method Detection Limit (mg/kg)	Laboratory Reporting Limit (mg/kg)	UTCRM-SD-1-6/13/06 (mg/kg)	UTCRM-SD-2-6/13/06 (mg/kg)
As	0.6	3.0	3010	1100
Ba	0.1	0.5	166	271
Cd	0.1	0.5	93.2	11.2
Cr	0.4	2.0	13	12
Pb	0.4	2.0	7310	572
Hg	0.001	0.005	0.197	0.088
Se	0.8	4.0	u	1 J
Ag	0.2	1.0	24.4	2.9

Table 3. Rock, RCRA Metals (Methods 6010B/7471A)

Analyte	Method Detection Limit (mg/kg)	Laboratory Reporting Limit (mg/kg)	UTCRM-R-1-6/13/06 (mg/kg)	UTCRM-R-2-6/13/06 (mg/kg)
As	0.6	3.0	4.4	3.5
Ba	0.1	0.5	96.9	99.1
Cd	0.1	0.5	u	u
Cr	0.4	2.0	3.0	2.9
Pb	0.4	2.0	13	13
Hg	0.001	0.1	0.0061	0.0079
Se	0.8	4.0	u	u
Ag	0.2	1.0	u	u

Table 4. Acid Base Accounting, Sobek Modified

Analyses	Units	RL	UTCRM-1-1-6/13/06	UTCRM-2-1-6/13/06
Neutralization Potential	t/kt	1.0	17	9.0
Acid Potential	t/kt	1.0	0	0
Acid/Base Potential	t/kt		17	9.0
Sulfur, Total	%	0.01	ND	ND
Sulfur, Hot Water Extractible	%	0.01	ND	ND
Sulfur, HCl Extractible	%	0.01	ND	ND
Sulfur, HNO3 Extractible	%	0.01	ND	ND
Sulfur, Residual	%	0.01	ND	ND

APPENDIX C

Chain-of-Custody

U.S. ARMY CORPS OF ENGINEERS

CHAIN OF CUSTODY RECORD

PROJ. NO.: LIMS # 7329

PROJECT NAME: Upper Tenmile Creek FY06 Design

SAMPLERS: (Signature) Gordon S. Lewis, Kimberlee K. Mulhern

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	ABA*	RCRA Metals (H_2O)	RCRA Metals (Soil)				REMARKS
R-1	6/13/06	0740	X		UTCRM-1-1-6/13/06	1	X						
R-2		0750	X		UTCRM-2-1-6/13/06	1	X						
SW/SD-1		0805		X	UTCRM-W-1-6/13/06	1		X					
SW/SD-1		0805		X	UTCRM-SD-1-6/13/06	1			X				
SW/SD-2		0815		X	UTCRM-W-2-6/13/06	1		X					
SW/SD-2		0815		X	UTCRM-SD-2-6/13/06	1			X				

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Gordon S. Lewis Kimberlee K. Mulhern	6-13-06 0945 6-13-06 2000				
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	
		[signature]	6/20/06 1000		

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

12235

COOLER RECEIPT FORM
Environmental Chemistry Branch Laboratory

LIMS # 7329 ECB Cooler # — Number of Coolers 1 Contractor Cooler —

Project: Upper Ten Mile Creek Date received: 6/20/06

USE OTHER SIDE OF THIS FORM TO NOTE DETAILS CONCERNING CHECK-IN PROBLEMS.

A. **PRELIMINARY EXAMINATION PHASE:** Date cooler opened: 6/20/06 C-of-C Number: 12235

by (print) Laura Percifield (sign) Laura Percifield

1. Did cooler come with a shipping slip (air bill, etc.)? .... YES NO

   If YES, enter carrier name & air bill number here:

2. Were custody seals on outside of cooler? .... (YES) NO

   How many & where: 1 each side seal date: 6/19/06 seal name: illegible

3. Were custody seals unbroken and intact at the date and time of arrival? .... (YES) NO
4. Did you screen samples for radioactivity using the Geiger Counter? .... (YES) NO
5. Were custody papers sealed in a plastic bag & taped inside to the lid? .... (YES) NO
6. Were custody papers filled out in the appropriate place? .... (YES) NO
7. Did you sign custody papers in the appropriate place? .... (YES) NO
8. Was project identifiable from custody papers? .... (YES) NO
9. Type of ice: regular Temperature: 4.0°C Date temperature measured: 6/20/06
10. Describe type of packing in cooler: bubble wrap
11. Were all bottles sealed in separate plastic bags? .... (YES) NO

B. **LOG-IN-PHASE:** Date samples were logged-in: 6/20/06

by (print) Laura Percifield (sign) Laura Percifield

12. Did all bottles arrive unbroken & were labels in good condition? .... (YES) NO
13. Were all bottle labels complete (ID, date, time, signature, preservative, etc.)? .... (YES) NO
14. Did all bottle labels agree with custody papers? .... (YES) NO
15. Were correct containers used for the tests indicated? .... (YES) NO
16. Were correct preservatives added to samples? .... (YES) NO
17. Was a sufficient amount of sample sent for tests indicated? .... (YES) NO
18. Was headspace absent in volatile samples? If NO, list by QA#: ~~YES~~ ~~NO~~
19. Were the custody papers checked against the sample receipt form? By whom? LP Date: 6/20/06

APPENDIX D

Laboratory Analytical Data

ENERGY LABORATORIES, INC. • P.O. Box 30916 • 1120 South 27th Street • Billings, MT 59107-0916
800-735-4489 • 406-252-6325 • 406-252-6069 fax • eli@energylab.com

LABORATORY ANALYTICAL REPORT

Client: US Army Corps of Engineers
Project: Upper Tenmile Creek, Proj #7329
Lab ID: B06061801-001
Client Sample ID: R-1, UTCRM-1-1-6/13/06

Report Date: 06/28/06
Collection Date: 06/13/06 07:40
Date Received: 06/21/06
Matrix: Solid

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
ACID-BASE ACCOUNTING							
Neutralization Potential	17	t/kt		1.0		Sobek Modifie	06/26/06 11:44 / srm
Acid Potential	0	t/kt		1.0		Sobek Modifie	06/26/06 11:44 / srm
Acid/Base Potential	17	t/kt				Sobek Modifie	06/26/06 11:44 / srm
Sulfur, Total	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm
Sulfur, Hot Water Extractable	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm
Sulfur, HCl Extractable	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm
Sulfur, HNO3 Extractable	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm
Sulfur, Residual	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm

- The acid base potential was calculated from non-sulfate sulfur.

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: US Army Corps of Engineers
Project: Upper Tenmile Creek, Proj #7329
Lab ID: B06061801-002
Client Sample ID: R-2, UTCRM-2-1-6/13/06

Report Date: 06/28/06
Collection Date: 06/13/06 07:50
Date Received: 06/21/06
Matrix: Solid

Analyses	Result	Units	Qual	RL	MCL/ QCL	Method	Analysis Date / By
ACID-BASE ACCOUNTING							
Neutralization Potential	9.0	t/kt		1.0		Sobek Modifie	06/26/06 11:44 / srm
Acid Potential	0	t/kt		1.0		Sobek Modifie	06/26/06 11:44 / srm
Acid/Base Potential	9	t/kt				Sobek Modifie	06/26/06 11:44 / srm
Sulfur, Total	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm
Sulfur, Hot Water Extractable	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm
Sulfur, HCl Extractable	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm
Sulfur, HNO3 Extractable	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm
Sulfur, Residual	ND	%		0.01		Sobek Modifie	06/26/06 11:44 / srm

- The acid base potential was calculated from non-sulfate sulfur.

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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Omaha Laboratory

Total Metals

Project Name: Upper Ten Mile Creek
Project Number: 7329
Client Sample ID: UTCRM-W-1-6/13/06
Sample ID: M060291-001

Date Sampled: 06/13/06
Date Received: 06/20/06
Date Reported: 07/07/06

Matrix: Water
Units: ug/L

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1	39.	15.	3.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-39-3	Barium	1	26.2	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-43-9	Cadmium	1	1 J	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-47-3	Chromium	1	u	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7439-92-1	Lead	1	u	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7782-49-2	Selenium	1	u	20.	4.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-22-4	Silver	1	u	5.0	1.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit

J: Estimated concentration below laboratory reporting limit.

Quality Assurance / Quality Control

ICP Method Blank ID: WG17613-1
GFAA Method Blank ID: NA
CVAA Method Blank ID: NA

ICP LCS ID: WG17613-2
GFAA LCS ID: NA
CVAA LCS ID: NA

ICP LD ID: WG17613-3
GFAA LD ID: NA
CVAA LD ID: NA

ICP MS ID: WG17613-4
GFAA MS ID: NA
CVAA MS ID: NA

ICP MSD ID: WG17613-5
GFAA MSD ID: NA
CVAA MSD ID: NA

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PHONE: (402) 444-4300

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Total Metals

Project Name:	Upper Ten Mile Creek		Matrix: Water
Project Number:	7329	Date Sampled: 06/13/06	Units: ug/L
Client Sample ID:	UTCRM-W-2-6/13/06	Date Received: 06/20/06	
Sample ID:	M060291-002	Date Reported: 07/07/06	

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1	71.	15.	3.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-39-3	Barium	1	14.	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-43-9	Cadmium	1	u	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-47-3	Chromium	1	u	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7439-92-1	Lead	1	u	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7782-49-2	Selenium	1	u	20.	4.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-22-4	Silver	1	u	5.0	1.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit

Quality Assurance / Quality Control

	ICP LCS ID: WG17613-2	ICP MS ID: WG17613-4
	GFAA LCS ID: NA	GFAA MS ID: NA
ICP Method Blank ID: WG17613-1	CVAA LCS ID: NA	CVAA MS ID: NA
GFAA Method Blank ID: NA		
CVAA Method Blank ID: NA	ICP LD ID: WG17613-3	ICP MSD ID: WG17613-5
	GFAA LD ID: NA	GFAA MSD ID: NA
	CVAA LD ID: NA	CVAA MSD ID: NA

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Method Blank

Method Blank ICP Sample ID: WG17613-1
Method Blank GFAA Sample ID:
Method Blank CVAA Sample ID:

Matrix: Water
Units: ug/L

CAS Number	Analyte	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	u	15.	3.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-39-3	Barium	u	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-43-9	Cadmium	u	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-47-3	Chromium	u	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7439-92-1	Lead	u	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7782-49-2	Selenium	u	20.	4.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-22-4	Silver	u	5.0	1.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit

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Laboratory Matrix Duplicate

Matrix Duplicate ICP Sample ID: WG17613-3
Matrix Duplicate GFAA Sample ID:
Matrix Duplicate CVAA Sample ID:

Matrix: Water
Units: ug/L

CAS Number	Analyte	Sample Result	Dup Result	RPD	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	u	u	NC	15.	3.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-39-3	Barium	27.6	28.7	4	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-43-9	Cadmium	u	u	NC	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-47-3	Chromium	4. J	4. J	7	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7439-92-1	Lead	3. J	4. J	24	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7782-49-2	Selenium	u	u	NC	20.	4.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-22-4	Silver	u	u	NC	5.0	1.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit
NC: Not Calculable
J: Estimated concentration below laboratory reporting limit

ICP Sample: M060292-001

CVAA Sample: M060292-001

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Matrix Spike, Matrix Spike Duplicate

MS ICP Sample ID:	WG17613-4	MSD ICP Sample ID:	WG17613-5	Matrix: Water
MS GFAA Sample ID:		MSD GFAA Sample ID:		Units: ug/L
MS CVAA Sample ID:		MSD CVAA Sample ID:		

CAS Number	Analyte	Sample Result	MS Conc	Spike Added	%Rec MS	MSD Conc	%Rec MSD	RPD	Method	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	u	1050	1000	105	1060	106	1	EPA 6010B	06-22-06	07-05-06	Shannon
7440-39-3	Barium	27.6	1080	1000	105	1080	106	0	EPA 6010B	06-22-06	07-05-06	Shannon
7440-43-9	Cadmium	u	491.	500.	98	493.	99	0	EPA 6010B	06-22-06	07-05-06	Shannon
7440-47-3	Chromium	4. J	967.	1000	96	969.	96	0	EPA 6010B	06-22-06	07-05-06	Shannon
7439-92-1	Lead	3. J	969.	1000	97	972.	97	0	EPA 6010B	06-22-06	07-05-06	Shannon
7782-49-2	Selenium	u	1020	1000	102	1040	104	1	EPA 6010B	06-22-06	07-05-06	Shannon
7440-22-4	Silver	u	213.	200.	106	214.	107	0	EPA 6010B	06-22-06	07-05-06	Shannon

%Rec: Percent of the spike recovered from the matrix

NC: Not Calculable

*: Indicates the value is outside control limits (80-120) for %Rec.

NC(1): Not calculated; original analyte concentration too large to accurately determine recovery.

J: Estimated concentration below laboratory reporting limit
ICP Sample: M060292-001

CVAA Sample:

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Laboratory Control Sample

LCS ICP Sample ID: WG17613-2
LCS GFAA Sample ID:
LCS CVAA Sample ID:

Matrix: Water
Units: ug/L

CAS Number	Analyte	LCS Result	True Value	%Rec	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1040	1000	104	15.	3.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-39-3	Barium	1040	1000	104	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-43-9	Cadmium	522.	500.	104	2.5	0.5	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-47-3	Chromium	1000	1000	100	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7439-92-1	Lead	1020	1000	102	10.	2.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7782-49-2	Selenium	1030	1000	103	20.	4.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon
7440-22-4	Silver	209.	200.	105	5.0	1.	EPA 6010B	WG17613	06-22-06	07-05-06	Shannon

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Total Metals

Project Name: Upper Ten Mile Creek		Matrix: Soil	
Project Number: 7329	Date Sampled: 06/13/06	Units: mg/kg	
Client Sample ID: UTCRM-SD-1-6/13/06	Date Received: 06/14/06	% Solids: 20.7	
Sample ID: M060291-003	Date Reported: 07/15/06		

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1	3010	3.0	0.6	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-39-3	Barium	1	166.	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	1	93.2	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	1	13.	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7439-92-1	Lead	2	7310	4.0	0.8	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	1	u	4.0	0.8	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-22-4	Silver	1	24.4	1.0	0.2	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit

Quality Assurance / Quality Control

	ICP LCS ID: WG17678-2	ICP MS ID: WG17678-4
	GFAA LCS ID: NA	GFAA MS ID: NA
ICP Method Blank ID: WG17678-1	CVAA LCS ID: NA	CVAA MS ID: NA
GFAA Method Blank ID: NA		
CVAA Method Blank ID: NA	ICP LD ID: WG17678-3	ICP MSD ID: WG17678-5
	GFAA LD ID: NA	GFAA MSD ID: NA
	CVAA LD ID: NA	CVAA MSD ID: NA

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Total Metals

Project Name: Upper Ten Mile Creek		Matrix: Soil	
Project Number: 7329	Date Sampled: 06/13/06	Units: mg/kg	
Client Sample ID: UTCRM-SD-2-6/13/06	Date Received: 06/14/06	% Solids: 42.5	
Sample ID: M060291-004	Date Reported: 07/15/06		

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1	1100	3.0	0.6	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-39-3	Barium	1	271.	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	1	11.2	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	1	12.	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7439-92-1	Lead	1	572.	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	1	1 J	4.0	0.8	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-22-4	Silver	1	2.9	1.0	0.2	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon

J: Estimated concentration below laboratory reporting limit.

Quality Assurance / Quality Control

ICP Method Blank ID: WG17678-1
GFAA Method Blank ID: NA
CVAA Method Blank ID: NA

ICP LCS ID: WG17678-2
GFAA LCS ID: NA
CVAA LCS ID: NA

ICP LD ID: WG17678-3
GFAA LD ID: NA
CVAA LD ID: NA

ICP MS ID: WG17678-4
GFAA MS ID: NA
CVAA MS ID: NA

ICP MSD ID: WG17678-5
GFAA MSD ID: NA
CVAA MSD ID: NA

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Method Blank

Method Blank ICP Sample ID: WG17678-1
Method Blank GFAA Sample ID:
Method Blank CVAA Sample ID:

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	u	3.0	0.6	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-39-3	Barium	u	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	u	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	u	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7439-92-1	Lead	u	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	u	4.0	0.8	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-22-4	Silver	u	1.0	0.2	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit

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Laboratory Matrix Duplicate

Matrix Duplicate ICP Sample ID: WG17678-3
Matrix Duplicate GFAA Sample ID:
Matrix Duplicate CVAA Sample ID:

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Sample Result	Dup Result	RPD	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1. J	u	NC	3.0	0.6	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-39-3	Barium	76.8	61.6	22	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	u	u	NC	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	4.9	4.9	1	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7439-92-1	Lead	4.3	4.2	4	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	u	u	NC	4.0	0.8	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-22-4	Silver	u	u	NC	1.0	0.2	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit
NC: Not Calculable
J: Estimated concentration below the laboratory reporting limit
** Indicates the value is outside control limits (25) for RPD.

ICP Sample: M060312-001

CVAA Sample: M060312-001

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Matrix Spike, Matrix Spike Duplicate

MS ICP Sample ID: WG17678-4
MS GFAA Sample ID:
MS CVAA Sample ID:

MSD ICP Sample ID: WG17678-5
MSD GFAA Sample ID:
MSD CVAA Sample ID:

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Sample Result	MS Conc	Spike Added	%Rec MS	MSD Conc	%Rec MSD	RPD	Method	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1. J	98.6	100.	98	98.0	97	1	EPA 6010B	07-07-06	07-12-06	Shannon
7440-39-3	Barium	76.8	177.	100.	100	167.	90	6	EPA 6010B	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	u	49.3	50.0	99	49.7	99	1	EPA 6010B	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	4.9	107.	100.	102	106.	101	1	EPA 6010B	07-07-06	07-12-06	Shannon
7439-92-1	Lead	4.3	102.	100.	97	101.	97	1	EPA 6010B	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	u	89.8	100.	90	90.2	90	0	EPA 6010B	07-07-06	07-12-06	Shannon
7440-22-4	Silver	u	19.8	20.0	99	19.8	99	0	EPA 6010B	07-07-06	07-12-06	Shannon

%Rec: Percent of the spike recovered from the matrix

NC: Not Calculable

*: Indicates the value is outside control limits (80-120) for %Rec.

NC(1): Not calculated; original analyte concentration too large to accurately determine recovery.

J: Estimated concentration below laboratory reporting limit
ICP Sample: M060312-001

CVAA Sample:

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Laboratory Control Sample

LCS ICP Sample ID: WG17678-2
LCS GFAA Sample ID:
LCS CVAA Sample ID:

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	LCS Result	True Value	%Rec	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	100.	100.	100	3.0	0.6	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-39-3	Barium	104.	100.	104	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	51.1	50.0	102	0.50	0.1	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	101.	100.	101	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7439-92-1	Lead	100.	100.	100	2.0	0.4	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	93.7	100.	94	4.0	0.8	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon
7440-22-4	Silver	20.2	20.0	101	1.0	0.2	EPA 6010B	WG17678	07-07-06	07-12-06	Shannon

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Total Metals

Project Name: Upper Ten Mile Creek
Project Number: 7329
Client Sample ID: UTCRM-1-1-6/13/06
Sample ID: M060329-001

Date Sampled: 06/13/06
Date Received: 06/28/06
Date Reported: 07/15/06

Matrix: Soil
Units: mg/kg
% Solids: 99.9

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1	4.4	3.0	0.6	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-39-3	Barium	1	96.9	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	1	u	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	1	3.0	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7439-92-1	Lead	1	13.	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	1	u	4.0	0.8	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-22-4	Silver	1	u	1.0	0.2	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit

Quality Assurance / Quality Control

ICP Method Blank ID: WG17679-1
GFAA Method Blank ID: NA
CVAA Method Blank ID: NA

ICP LCS ID: WG17679-2
GFAA LCS ID: NA
CVAA LCS ID: NA

ICP LD ID: WG17679-3
GFAA LD ID: NA
CVAA LD ID: NA

ICP MS ID: WG17679-4
GFAA MS ID: NA
CVAA MS ID: NA

ICP MSD ID: WG17679-5
GFAA MSD ID: NA
CVAA MSD ID: NA

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Total Metals

Project Name: Upper Ten Mile Creek		Matrix: Soil	
Project Number: 7329	Date Sampled: 06/13/06	Units: mg/kg	
Client Sample ID: UTCRM-2-1-6/13/06	Date Received: 06/28/06	% Solids: 99.9	
Sample ID: M060329-002	Date Reported: 07/15/06		

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	1	3.5	3.0	0.6	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-39-3	Barium	1	99.1	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	1	u	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	1	2.9	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7439-92-1	Lead	1	13.	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	1	u	4.0	0.8	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-22-4	Silver	1	u	1.0	0.2	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit

Quality Assurance / Quality Control

	ICP LCS ID: WG17679-2	ICP MS ID: WG17679-4
	GFAA LCS ID: NA	GFAA MS ID: NA
ICP Method Blank ID: WG17679-1	CVAA LCS ID: NA	CVAA MS ID: NA
GFAA Method Blank ID: NA		
CVAA Method Blank ID: NA	ICP LD ID: WG17679-3	ICP MSD ID: WG17679-5
	GFAA LD ID: NA	GFAA MSD ID: NA
	CVAA LD ID: NA	CVAA MSD ID: NA

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Method Blank

Method Blank ICP Sample ID: WG17679-1
Method Blank GFAA Sample ID:
Method Blank CVAA Sample ID:

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	u	3.0	0.6	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-39-3	Barium	u	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	u	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	u	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7439-92-1	Lead	u	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	u	4.0	0.8	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-22-4	Silver	u	1.0	0.2	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit

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Laboratory Matrix Duplicate

Matrix Duplicate ICP Sample ID: WG17679-3
Matrix Duplicate GFAA Sample ID:
Matrix Duplicate CVAA Sample ID:

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Sample Result	Dup Result	RPD	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	3.9	3.8	4	3.0	0.6	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-39-3	Barium	104.	108.	4	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	0.1 J	u	NC	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	8.6	9.1	6	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7439-92-1	Lead	7.3	9.3	24	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	u	u	NC	4.0	0.8	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-22-4	Silver	u	u	NC	1.0	0.2	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon

u: Analyte was analyzed for but not detected at or above the sample reporting limit
NC: Not Calculable
J: Estimated concentration below laboratory reporting limit

ICP Sample: M060330-002

CVAA Sample: M060330-002

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Matrix Spike, Matrix Spike Duplicate

MS ICP Sample ID: WG17679-4
MS GFAA Sample ID:
MS CVAA Sample ID:

MSD ICP Sample ID: WG17679-5
MSD GFAA Sample ID:
MSD CVAA Sample ID:

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Sample Result	MS Conc	Spike Added	%Rec MS	MSD Conc	%Rec MSD	RPD	Method	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	3.9	99.4	100.	96	99.5	96	0	EPA 6010B	07-07-06	07-12-06	Shannon
7440-39-3	Barium	104.	221.	100.	117	221.	117	0	EPA 6010B	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	0.1 J	45.9	50.0	92	46.1	92	1	EPA 6010B	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	8.6	107.	100.	98	107.	99	1	EPA 6010B	07-07-06	07-12-06	Shannon
7439-92-1	Lead	7.3	101.	100.	94	102.	95	0	EPA 6010B	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	u	88.0	100.	88	88.1	88	0	EPA 6010B	07-07-06	07-12-06	Shannon
7440-22-4	Silver	u	19.6	20.0	98	19.5	98	0	EPA 6010B	07-07-06	07-12-06	Shannon

%Rec: Percent of the spike recovered from the matrix

NC: Not Calculable

*: Indicates the value is outside control limits (80-120) for %Rec.

NC(1): Not calculated; original analyte concentration too large to accurately determine recovery.

J: Estimated concentration below laboratory reporting limit
ICP Sample: M060330-002

CVAA Sample:

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Laboratory Control Sample

LCS ICP Sample ID: WG17679-2
LCS GFAA Sample ID:
LCS CVAA Sample ID:

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	LCS Result	True Value	%Rec	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7440-38-2	Arsenic	99.8	100.	100	3.0	0.6	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-39-3	Barium	103.	100.	103	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-43-9	Cadmium	50.5	50.0	101	0.50	0.1	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-47-3	Chromium	101.	100.	101	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7439-92-1	Lead	100.	100.	100	2.0	0.4	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7782-49-2	Selenium	92.5	100.	93	4.0	0.8	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon
7440-22-4	Silver	20.2	20.0	101	1.0	0.2	EPA 6010B	WG17679	07-07-06	07-12-06	Shannon

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Total Metals

Project Name: Upper Ten Mile Creek		Matrix: Water	
Project Number: 7329	Date Sampled: 06/13/06	Units: ug/L	
Client Sample ID: UTCRM-W-1-6/13/06	Date Received: 06/20/06		
Sample ID: M060291-001	Date Reported: 06/29/06		

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	1	u	0.10	0.02	EPA 7470	WG17632	06-27-06	06-28-06	Bond

u: Analyte was analyzed for but not detected at or above the sample reporting limit

Quality Assurance / Quality Control

ICP Method Blank ID: NA
GFAA Method Blank ID: NA
CVAA Method Blank ID: WG17632-1

ICP LCS ID: NA
GFAA LCS ID: NA
CVAA LCS ID: WG17632-2

ICP LD ID: NA
GFAA LD ID: NA
CVAA LD ID: WG17632-3

ICP MS ID: NA
GFAA MS ID: NA
CVAA MS ID: WG17632-4

ICP MSD ID: NA
GFAA MSD ID: NA
CVAA MSD ID: WG17632-5

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Total Metals

Project Name: Upper Ten Mile Creek		Matrix: Water	
Project Number: 7329	Date Sampled: 06/13/06	Units: ug/L	
Client Sample ID: UTCRM-W-2-6/13/06	Date Received: 06/20/06		
Sample ID: M060291-002	Date Reported: 06/29/06		

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	1	u	0.10	0.02	EPA 7470	WG17632	06-27-06	06-28-06	Bond

u: Analyte was analyzed for but not detected at or above the sample reporting limit

Quality Assurance / Quality Control

ICP Method Blank ID: NA
GFAA Method Blank ID: NA
CVAA Method Blank ID: WG17632-1

ICP LCS ID: NA
GFAA LCS ID: NA
CVAA LCS ID: WG17632-2

ICP LD ID: NA
GFAA LD ID: NA
CVAA LD ID: WG17632-3

ICP MS ID: NA
GFAA MS ID: NA
CVAA MS ID: WG17632-4

ICP MSD ID: NA
GFAA MSD ID: NA
CVAA MSD ID: WG17632-5

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Method Blank

Method Blank ICP Sample ID:
Method Blank GFAA Sample ID:
Method Blank CVAA Sample ID: WG17632-1

Matrix: Water
Units: ug/L

CAS Number	Analyte	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	u	0.10	0.02	EPA 7470	WG17632	06-27-06	06-28-06	Bond

u: Analyte was analyzed for but not detected at or above the sample reporting limit

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Laboratory Matrix Duplicate

Matrix Duplicate ICP Sample ID:
Matrix Duplicate GFAA Sample ID:
Matrix Duplicate CVAA Sample ID: WG17632-3

Matrix: Water
Units: ug/L

CAS Number	Analyte	Sample Result	Dup Result	RPD	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	u	u	NC	0.10	0.02	EPA 7470	WG17632	06-27-06	06-28-06	Bond

u: Analyte was analyzed for but not detected at or above the sample reporting limit
NC: Not Calculable

ICP Sample:

CVAA Sample: M060278-001

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Matrix Spike, Matrix Spike Duplicate

MS ICP Sample ID:	MSD ICP Sample ID:	Matrix: Water
MS GFAA Sample ID:	MSD GFAA Sample ID:	Units: ug/L
MS CVAA Sample ID: WG17632-4	MSD CVAA Sample ID: WG17632-5	

CAS Number	Analyte	Sample Result	MS Conc	Spike Added	%Rec MS	MSD Conc	%Rec MSD	RPD	Method	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	u	1.86	2.00	93	1.93	97	4	EPA 7470	06-27-06	06-28-06	Bond

%Rec: Percent of the spike recovered from the matrix

ICP Sample:

CVAA Sample: M060278-001

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Laboratory Control Sample

LCS ICP Sample ID:
LCS GFAA Sample ID:
LCS CVAA Sample ID: WG17632-2

Matrix: Water
Units: ug/L

CAS Number	Analyte	LCS Result	True Value	%Rec	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	2.09	2.00	105	0.10	0.02	EPA 7470	WG17632	06-27-06	06-28-06	Bond

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Total Metals

Project Name: Upper Ten Mile Creek
Project Number: 7329
Client Sample ID: UTCRM-SD-1-6/13/06
Sample ID: M060291-003

Date Sampled: 06/13/06
Date Received: 06/14/06
Date Reported: 06/23/06

Matrix: Soil
Units: mg/kg
% Solids: 20.7

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	1	0.197	0.0050	0.001	EPA 7471	WG17617	06-22-06	06-23-06	Bond

Quality Assurance / Quality Control

ICP Method Blank ID: NA
GFAA Method Blank ID: NA
CVAA Method Blank ID: WG17617-1

ICP LCS ID: NA
GFAA LCS ID: NA
CVAA LCS ID: WG17617-2

ICP LD ID: NA
GFAA LD ID: NA
CVAA LD ID: WG17617-3

ICP MS ID: NA
GFAA MS ID: NA
CVAA MS ID: WG17617-4

ICP MSD ID: NA
GFAA MSD ID: NA
CVAA MSD ID: WG17617-5

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Total Metals

Project Name: Upper Ten Mile Creek
Project Number: 7329
Client Sample ID: UTCRM-SD-2-6/13/06
Sample ID: M060291-004

Date Sampled: 06/13/06
Date Received: 06/14/06
Date Reported: 06/23/06

Matrix: Soil
Units: mg/kg
% Solids: 42.5

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	1	0.0875	0.0050	0.001	EPA 7471	WG17617	06-22-06	06-23-06	Bond

Quality Assurance / Quality Control

ICP Method Blank ID: NA
GFAA Method Blank ID: NA
CVAA Method Blank ID: WG17617-1

ICP LCS ID: NA
GFAA LCS ID: NA
CVAA LCS ID: WG17617-2

ICP LD ID: NA
GFAA LD ID: NA
CVAA LD ID: WG17617-3

ICP MS ID: NA
GFAA MS ID: NA
CVAA MS ID: WG17617-4

ICP MSD ID: NA
GFAA MSD ID: NA
CVAA MSD ID: WG17617-5

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Method Blank

Method Blank ICP Sample ID:
Method Blank GFAA Sample ID:
Method Blank CVAA Sample ID: WG17617-1

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	u	0.0050	0.001	EPA 7471	WG17617	06-22-06	06-23-06	Bond

u: Analyte was analyzed for but not detected at or above the sample reporting limit

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Laboratory Matrix Duplicate

Matrix Duplicate ICP Sample ID:
Matrix Duplicate GFAA Sample ID:
Matrix Duplicate CVAA Sample ID: WG17617-3

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Sample Result	Dup Result	RPD	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	0.025	0.025	`1	0.0050	0.001	EPA 7471	WG17617	06-22-06	06-23-06	Bond

ICP Sample:

CVAA Sample: M060256-008

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Matrix Spike, Matrix Spike Duplicate

MS ICP Sample ID:		MSD ICP Sample ID:	Matrix: Soil
MS GFAA Sample ID:		MSD GFAA Sample ID:	Units: mg/kg
MS CVAA Sample ID:	WG17617-4	MSD CVAA Sample ID: WG17617-5	

CAS Number	Analyte	Sample Result	MS Conc	Spike Added	%Rec MS	MSD Conc	%Rec MSD	RPD	Method	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	0.025	0.212	0.200	94	0.193	84	9	EPA 7471	06-22-06	06-23-06	Bond

%Rec: Percent of the spike recovered from the matrix

ICP Sample:

CVAA Sample: M060256-008

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Laboratory Control Sample

LCS ICP Sample ID:
LCS GFAA Sample ID:
LCS CVAA Sample ID: WG17617-2

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	LCS Result	True Value	%Rec	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	0.199	0.200	100	0.0050	0.001	EPA 7471	WG17617	06-22-06	06-23-06	Bond

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Total Metals

Project Name: Upper Ten Mile Creek		Matrix: Soil	
Project Number: 7329	Date Sampled: 06/13/06	Units: mg/kg	
Client Sample ID: UTCRM-1-1-6/13/06	Date Received: 06/28/06	% Solids: 99.9	
Sample ID: M060329-001	Date Reported: 07/12/06		

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	1	0.0061	0.0050	0.001	EPA 7471	WG17684	07-11-06	07-12-06	Bond

Quality Assurance / Quality Control

ICP Method Blank ID: NA
GFAA Method Blank ID: NA
CVAA Method Blank ID: WG17684-1

ICP LCS ID: NA
GFAA LCS ID: NA
CVAA LCS ID: WG17684-2

ICP LD ID: NA
GFAA LD ID: NA
CVAA LD ID: WG17684-3

ICP MS ID: NA
GFAA MS ID: NA
CVAA MS ID: WG17684-4

ICP MSD ID: NA
GFAA MSD ID: NA
CVAA MSD ID: WG17684-5

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DEPARTMENT OF THE ARMY
Corps of Engineers
Environmental Chemistry Branch
Omaha Laboratory

Total Metals

Project Name: Upper Ten Mile Creek		Matrix: Soil
Project Number: 7329	Date Sampled: 06/13/06	Units: mg/kg
Client Sample ID: UTCRM-2-1-6/13/06	Date Received: 06/28/06	% Solids: 99.9
Sample ID: M060329-002	Date Reported: 07/12/06	

CAS Number	Analyte	Dilution	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	1	0.0079	0.0050	0.001	EPA 7471	WG17684	07-11-06	07-12-06	Bond

Quality Assurance / Quality Control

ICP Method Blank ID: NA	ICP LCS ID: NA	ICP MS ID: NA
GFAA Method Blank ID: NA	GFAA LCS ID: NA	GFAA MS ID: NA
CVAA Method Blank ID: WG17684-1	CVAA LCS ID: WG17684-2	CVAA MS ID: WG17684-4
	ICP LD ID: NA	ICP MSD ID: NA
	GFAA LD ID: NA	GFAA MSD ID: NA
	CVAA LD ID: WG17684-3	CVAA MSD ID: WG17684-5

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Method Blank

Method Blank ICP Sample ID:
Method Blank GFAA Sample ID:
Method Blank CVAA Sample ID: WG17684-1

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Result	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	u	0.0050	0.001	EPA 7471	WG17684	07-11-06	07-12-06	Bond

u: Analyte was analyzed for but not detected at or above the sample reporting limit

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Laboratory Matrix Duplicate

Matrix Duplicate ICP Sample ID:
Matrix Duplicate GFAA Sample ID:
Matrix Duplicate CVAA Sample ID: WG17684-3

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Sample Result	Dup Result	RPD	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	0.004 J	0.004 J	0	0.0050	0.001	EPA 7471	WG17684	07-11-06	07-12-06	Bond

J: Estimated concentration below laboratory reporting limit

ICP Sample:

CVAA Sample: M060338-003

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Matrix Spike, Matrix Spike Duplicate

MS ICP Sample ID:
MS GFAA Sample ID:
MS CVAA Sample ID: WG17684-4

MSD ICP Sample ID:
MSD GFAA Sample ID:
MSD CVAA Sample ID: WG17684-5

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	Sample Result	MS Conc	Spike Added	%Rec MS	MSD Conc	%Rec MSD	RPD	Method	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	0.004 J	0.198	0.200	97	0.202	99	2	EPA 7471	07-11-06	07-12-06	Bond

%Rec: Percent of the spike recovered from the matrix

J: Estimated concentration below laboratory reporting limit
ICP Sample:

CVAA Sample: M060338-003

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Laboratory Control Sample

LCS ICP Sample ID:
LCS GFAA Sample ID:
LCS CVAA Sample ID: WG17684-2

Matrix: Soil
Units: mg/kg

CAS Number	Analyte	LCS Result	True Value	%Rec	Sample Quant Limit	Sample Det Limit	Method	Batch ID	Date Digested	Date Analyzed	Analyst
7439-97-6	Mercury	0.216	0.200	108	0.0050	0.001	EPA 7471	WG17684	07-11-06	07-12-06	Bond

Appendix C
Hydrologic Analysis

Rimini Wetland Restoration and Amphibian Habitat Enhancement
Tenmile Creek Near Rimini, Montana

Draft Report
September 2006

US Army Corps
of Engineers ®
Omaha District

Table of Contents

Appendices

Hydrologic Analysis
Tenmile Creek, Montana

1. Introduction

A hydrologic analysis was conducted to design project features. The project goal is to restore wetland habitat adjacent to Upper Tenmile Creek immediately downstream of the town of Rimini, MT. Existing conditions and observations from the site visit on 12 June 2006 are as follows:

1.1 Stream Channel.

The channel material consists of medium to large cobbles with many intermittent boulders. Many log debris jams were observed through the site and downstream. Channel conditions through the site appear stable with no observed bank failure sections. The channel width through the site may be constricted in some locations. A rock berm within the site was constructed following a major flood event in 1981 to protect the road from flooding and stream erosion. The existing rock berm prevents significant overbank flow on the right side although the left bank is available with some observed lower flow sections that connect to the downstream two culverts. Midway through the site, an existing high gradient rapid flow section occurs with visible large boulders. It is apparent that the stream has experienced high flows. The normal stream section bottom width varies in the range of 20 – 30 feet with bank side slopes that average 2H on 1V. Due to the high gradient and high energy nature of the stream, stability is a concern of all stream related project features. At the time of the site visit, stream channel flow appeared to be near bankfull conditions. Flow depths were shallow with high flow velocity. Site photos are available in the trip report in App C-A.

1.2 Sediment Observations.

Numerous exposed sediment deposition plumes consisting of cobbles and gravels are present throughout the overbank area. Discussion indicated that these are probably related to the major flood that occurred in 1981. Additional sediment deposition is the result of glacial outwash deposits and the break in slope at the southern end of the project area appears to be a terminal moraine. Plans were furnished by the County that illustrated flood repair work following the 1981 flood. Based on the plans and photos of the site, it appears that the channel was temporarily flowing down the road and in the right overbank (east of Rimini Road) location. Repair work was conducted to remove sediment blockage, reconstruct the channel, and add the confining dike.

2. Hydrology

Site hydrology was determined using existing reports and gage data information. The USGS maintains a gage #06062500 Tenmile Creek near Rimini, MT, that is located downstream of the project site. Hydrologic analysis was conducted using the gage record. The drainage basin is illustrated in figure 1.

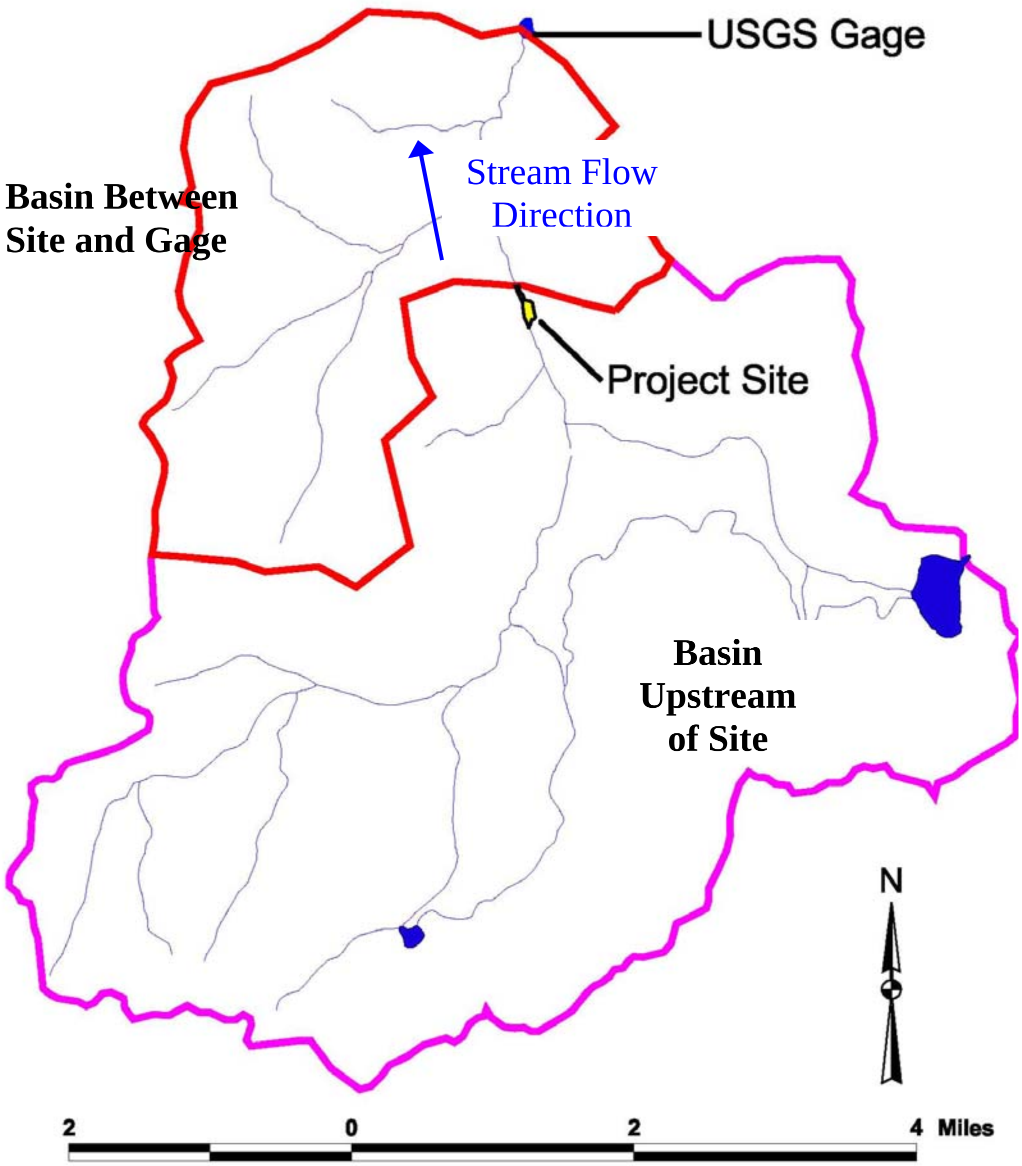


Figure 1. Drainage Basin Outline

2.1 Flow Frequency.

The USGS gage #06062500, Tenmile Creek near Rimini, MT, is located downstream of the project. The gage record is from July 1914 to September 1994 and May 1997 to current. The flows are affected by Chessman and Scott reservoirs and city of Helena diversion. Flow frequency analysis for the gage was completed using available reports and the gage record to verify tabulated values.

Peak flow frequency at the gage was determined using the gage annual peak record and standard Bulletin 17B analysis methods using the computer program HEC-SSP version 1, June 2006. In order to improve the frequency estimate, a low outlier value of 50 cfs was employed. In addition, the record includes an apparent high outlier value of 3,290 cfs from the 22 May 1981 event.

However, the curve fit appeared a better match to the remainder of the observed values if this event was not excluded. Results are presented in Attachment A. Peak frequency values are summarized in table 1.

Table 1
Tenmile Creek USGS Gage # 06062500
Annual Peak Frequency (cfs)

Percent Chance Exceedance	Recurrence Interval (Years)	Expected Probability	Computed Curve	Confidence Limits 0.05	0.95
0.2	500	2,990	3,450	4,460	2,190
0.5	200	2,010	2,230	2,840	1,540
1	100	1,480	1,590	2,000	1,170
2	50	1,080	1,140	1,400	879
5	20	703	724	863	596
10	10	500	508	589	435
20	5	347	350	395	309
50	2	199	199	221	178
80	1.25	135	134	152	118
90	1.11	116	116	132	100
95	1.05	106	105	121	90
99	1.01	94	93	108	79

Using the computed flow frequency, the 1981 event peak flow rate of 3,290 cfs exceeded a 500-year event.

2.2 Site Flow Frequency.

USGS quadrangle maps were used to determine the drainage area at the gage location and at the site. Drainage area at the gage is reported as 30.9 square miles. The major tributary between the gage and the project area is Minnehaha Creek. The measured drainage area from the quad map between the gage and the project site was approximately 8.6 sq miles. This compares to the approximately 8.1 square miles indicated by the report (USGS, 2000, Table 2) that also tabulated 22.8 square miles for Tenmile Creek at Rimini with 0.6 sq miles additional area for Moore's Spring Creek. The drainage area upstream of the site includes both Scott and Chessman reservoirs and flows are also impacted by city of Helena diversions. The difference between the two estimated drainage areas is minor. For the purposes of this analysis, the drainage area at the site was estimated as 23.4 square miles with an incremental increase of 7.5 square miles to reach the 30.9 square miles at the gage station.

Flow frequency values computed with the gage data were transposed to the site using the relationship presented in the report *Methods for Estimating Flood Frequency in Montana Based on Data Through Water Year 1998, Water Resources Investigative Report 03-4308* (USGS, 2003). The presented relationship is:

$$Q_{T,U} = Q_{T,G}\left(\frac{DA_U}{DA_G}\right)^{\exp_T}, \quad (19)$$

where

$Q_{T,G}$ is the T-year flood at the gaged site, in cubic feet per second,

DA_U is the drainage area at the ungaged site, in square miles,

DA_G is the drainage area at the gaged site, in square miles, and

$\exp_T$ is the regression coefficient for a simple OLS regression relating the log of T-year flood to log of drainage area within each region (table 13).

(Eq. 19, pg 34, USGS, 2003).

Using the above relationship and the T year regional exponents (Table 13, pg 34, USGS, 2003), the site flow frequency values were computed and are shown in Table 2:

Table 2
Site Flow Frequency

Event	T Exponent(1)	Q Gage (Table 1)	Q Site
$Q_{1.25}$	0.894	134	105
Q_2	0.894	199	155
Q_5	0.776	350	280
Q_{10}	0.72	508	420
Q_{25}	0.661	810	670
Q_{50}	0.622	1140	960
Q_{100}	0.585	1590	1350
Q_{200}	0.55	2230	1910
Q_{500}	0.51	3450	2990
Site Visit 12 June 2006(2)	0.894	90	70

1 Table 13, pg 34, USGS, 2003
2 Observed flow from the USGS gage record for Tenmile Creek near Rimini, MT gage station at the time of the site visit.

2.3 Site Flow Duration.

Hydrologic analysis for the gage location is available from the report *Statistical Summaries of Streamflow in Montana and Adjacent Areas, Water Years 1900-2002, Scientific Investigations Report 2004-5266* (USGS, 2004). Data presented in this report is based on daily values and not annual peaks. The report presents daily flow duration results at the Tenmile Creek near Rimini gage site. Results presented in this report for the gage site are shown in Att. B. Tabulated data illustrates that the average monthly flow at the gage is 12 cfs for July and less than 3 cfs for August. Wetland connections for the spring months were evaluated with average flows of 83 and 73 cfs in May and June at the gage location (Att. B) which converts to between 65 and 55 cfs at the site. From the average monthly flow data, it is clear that the creek channel is nearly dry in July and August and that direct streamflow wetland connections are not feasible.

3. Hydraulic Analysis

Hydraulic analysis was performed using site survey data and the flow frequency values for the creek to compute flow depths and velocities. Sediment size information was also collected.

3.1 Site Surveys.

Site surveys were conducted on 12 -14 June 2006. At the time of the survey, stream flow was approximately 70 cfs (Table 2). Due to the high flow velocity within the channel, stream section surveys were not possible. Water surface elevation data was recorded through the site. Forest Service personnel returned to the site and collected stream section surveys on 26 July 2006 and also set bankfull indicators at sections 1-5. These sections were combined with the site survey to form the input for the hydraulic model. Six sections were collected by the Forest Service. Water surface elevations were extended downstream to verify the continuing slope and check for any indicators of slope variation and channel instability. A plot of the observed water surface elevation data and bankfull indicators for the site is shown in Att. C.

3.2 Stream Material.

Numerous exposed sediment deposition plumes consisting of cobbles and gravels are present throughout the overbank area. During the site visit, a pebble count was conducted of one of the exposed sediment plumes. Collection of channel sediment data was not possible due to the high flow rate. Forest Service representatives collected pebble count data at section 3. Both areas have a material D_{50} of about 50 mm. Gradations are for both areas are similar with the exception that the sediment plume does not contain the larger material greater than about D_{80}. This is expected since the larger material would not be transported in the floodplain. Data from the two collection areas are shown in figure 2.

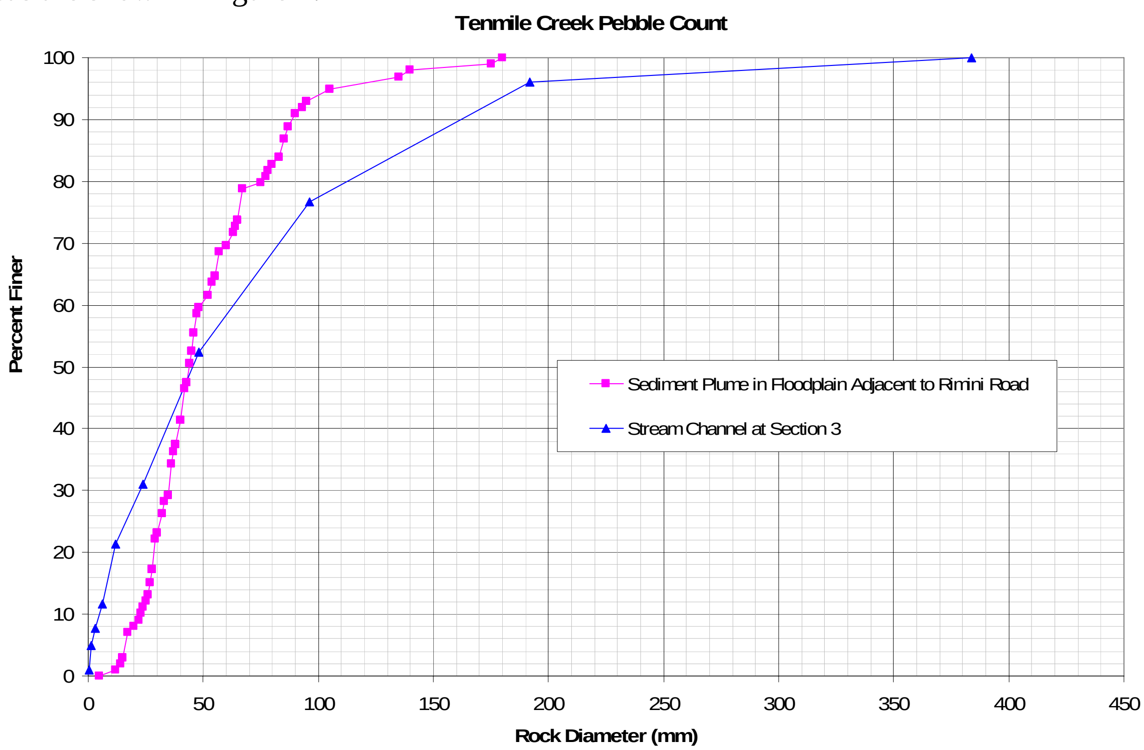


Figure 2 Material Gradation

3.3 Stream Characteristics and Classification .

The site surveys, field observations, and sediment information provides information summarized as:

Channel Slope: Usually 2 to 2.5% and increases to 4 to 5% through the rapids section.
Bankfull Channel Width: Varies from 20 to 25 feet
Bankfull Depth: Range of 1.2 to 1.5 feet
Bank Height: Varies from 3 to 4 feet
Channel Material: D_{50} of 50 mm, D_{90} of 160 mm
Channel Sinuosity: Varies from 1.2 to 1.4

Based on the site survey water surface elevation, the gage flow at the time of the survey, and the bankfull elevations determined by the Forest Service when surveying the cross sections, the bankfull discharge is estimated as between 70 and 100 cfs. Based on the site flow frequency this is slightly greater than an average annual peak flow rate and considerably less than the 2-year annual peak flow rate of 155 cfs. However, it should be noted that due to the steep creek slope, the flow elevation change from 100 to 155 cfs is minor.

Stream characteristics based on gage data analysis was performed using measured flows from the USGS gage Tenmile Creek Near Rimini, MT. The results from this analysis are shown in graphic format in Att. D.

Of the various classification systems, the applied method is that developed by Rosgen (Rosgen, 1996). Within the project reach, the channel slope varies from 2% to 3%. Channel sinuosity is low and varies from 1.2 to 1.4. The entrenchment ratio is about 1.5 to 2. The width/depth ratio is generally low. Using a pebble count procedure, the D_{50} of the existing bed material was determined as 50 mm. According to the Rosgen method (Rosgen, 1996), the stream channel within the project site is classified as B3.

3.4 HEC-RAS Analysis .

The site surveys were employed to construct an HEC-RAS model of the site. The model was calibrated to the surveyed water surface elevations throughout the site using the estimated flow of 70 cfs based on the gage flow rate (Table 2). A plan view of the site, surveyed section locations, and additional sections employed within the model are illustrated in Att. E. HEC-RAS computation results are summarized in Table 3.

Table 3.
HEC-RAS Model Summary

Event	Reach Value	Channel Velocity (ft/sec)	Flow Area (sq. ft)	Top Width (ft)	Max. Flow Depth (ft)	Channel Shear (lb/sq ft)
2-Year	Average	6.4	25	26	1.7	1.8
	Maximum	*8.1*	*41*	*34*	*2.6*	*4.0*
25-Year	Average	10.0	86	63	3.3	3.4
	Maximum	*13.0*	*131*	*171*	*4.4*	*9.7*

3.5 HEC-RAS Calibration .

The calibrated roughness value for the site was 0.036. This roughness value is consistent with the bed material size and shallow flow depth. The calibrated HEC-RAS profile is shown in Att. F. Tabulated results are included in Att. G. In order to match the observed water surface elevations, additional loss was required through the steep slope rapid section that includes numerous boulders. Cross section data was not available for this area and was generated within the RAS model from adjacent areas. Without any additional information, the boulder reach was simulated by adding geometry to represent boulders within the stream channel section until the observed elevations were matched.

The site flow rate at the time of the survey on 12 – 13 June 2006 was estimated from the downstream USGS gage that had an average daily flow value of 96 and 82 cfs. Inflow between the site and the gage was unknown, so the estimated flow range at the site is between 70 and 100 cfs. Observed data was also compared to the computed water surface and the energy grade elevation. The appropriate value for calibration is probably between these two values. The HEC-RAS model adequately reproduces the observed values at all locations. The calibrated profile is shown in Att. F. A comparison of model and surveyed water surface elevations is shown in Table 4.

Table 4. Calibration Results

Survey XSEC	Station	Invert Elev	Survey WSEL(1)	HEC-RAS 70 cfs	HEC-RAS 100 cfs	2-Year RAS	HEC-RAS 25-Year (670 cfs)	Survey Bankfull(2)	Top of Road(3)
NA	1933	5155.21	5156.45	5156.38	5156.56	5156.8	5158.37	NA	NA
6	1651	5148.53	5149.92	5149.68	5149.88	5150.23	5152.10	NA	5154.2
5	1394	5142.00	5143.35	5143.27	5143.49	5143.86	5145.65	5143.35	5146.7
4	1273	5137.82	5139.81	5139.60	5140.02	5140.39	5141.87	5138.21	5143.9
3	1149	5135.56	5136.53	5136.59	5136.81	5137.19	5138.46	5136.5	5140.6
2	972	5131.47	5133.10	5133.10	5133.30	5133.62	5135.06	5133.16	5136.1
1	828	5128.37	5129.61	5129.50	5129.70	5130.04	5132.36	5129.72	5134.8

(1) Survey WSEL is the edge of water surface elevation surveyed in the field on 12-13 June 06.
(2) Survey bankfull refers to the bankfull indictors set in the field by the Forest Service.
(3) Top of road is the approx. elevation along the section line extended from the stream channel.

4. Site Feature Design

Design of site features was performed following the hydrologic and hydraulic analysis. The restoration features were developed to maximize site potential without altering stream stability and threatening surrounding infrastructure. Site design is performed using the best available data and a reasonable design methodology. However, construction of all features must be supervised by a qualified Construction Field Engineer and may require modification from the original design to meet project performance objectives.

No major modification is proposed to the existing stream channel through the site. The existing stream channel is a high energy stream confined by the constructed dike. It is preferred that the project maintains the existing stream alignment, bank stability, and should not compromise infrastructure including Rimini Road, the septic field, and underground utilities. In this context, the opportunity for stream channel enhancement within some areas of the project site is limited.

4.1 Streambank Rock Dike Removal.

About 1,000 feet of rock dike adjacent to the right (defined looking downstream) stream bank will be removed down to an elevation approximately equivalent to a 2-year flow event profile. After rock lowering, backfill of the rock voids with gravel mulch is required to establish vegetation and improve aesthetics. Removed rock will be used to build the downstream dike berm and provide rock protection at the Rimini Road toe. In many locations, the 2-year flow line is lower than the adjacent natural floodplain grade. Excavation should not continue into the floodplain.

Within the bend upstream of the rapids, lowering should also include the insertion of large (2-4 ft) boulders around the bend to provide outside bank stability. The location of the additional boulders will be adjusted by the Construction Field Engineer during the construction period but is generally from station 15+00 to 17+50. The boulders are concealed within the remaining rock dike.

The typical dike removal section includes a stability key section. This section is provided since the dike bottom elevation and rock composition is unknown. Inclusion of the stability key will be at the direction of the Construction Field Engineer. The stability key must be included at locations where the remaining dike rock following removal is deemed incapable of maintaining stream stability. Due to the close proximity of Rimini road, other existing infrastructure, and the construction of wetlands and the interpretive area, eroding banks and stream channel migration is not allowable.

Location of the landside dike toe is subjective and will be performed at the direction of the Construction Field Engineer. In many locations, selection of the landside dike toe will be based on visible evidence of the rock toe and existing floodplain vegetation. The streamside dike toe will be excavated down to the 2-year flow level. In most locations, the existing dike rock slopes down to the bank toe. Impacting dike material below 2-year flow level is not desirable and will be avoided to the extent possible to limit bank stability impacts and stream turbidity. The existing dike side slope varies from 2H on 1V to over 10H on 1V. Dike height varies from 2 to over 8 ft. Dike crown width is generally low or peaked.

Dike removal is proposed from approximately station 9+90 to station 19+00. Final limits of dike removal shall be determined by the Construction Field Engineer. The dike removal elevations, corresponding to the 2-year creek flow elevation, were computed with the HEC-RAS model. A profile plot is included in Att. F and is also included in the project drawings. Based on the site visit and Forest Service noted bankfull indicators, the proposed dike lowering elevation is generally about 0.5 to 1 foot above the bankfull elevation. Project drawings also illustrate the typical dike removal section and the proposed profile. Project dike removal elevations at selected locations are also illustrated in table 5.

NOTE: Stream channel slope is very high with minimal flow depth change between normal and extreme events. For long term stability and protection of existing infrastructure, it is imperative that a sufficient portion of the rock dike remains to prevent bank erosion or flood event channel avulsion. The Construction Field Engineer may adjust dike removal levels upward if warranted by site conditions.

Table 5. Project Dike Removal Elevations	
Channel Station (ft)	Dike Removal Base Elev. (ft NAD 88)
1933	5156.8
1828	5154.9
1764	5153.7
1695	5151.3
1651	5150.2
1583	5148.6
1522	5146.8
1453	5144.8
1394	5143.9
1318	5141.7
1273	5140.4
1240	5139.2
1233	5138.8
1149	5137.2
1106	5136.1
1041	5135.0
972	5133.6

4.2 Stream Channel Widening.

Stream enhancement is proposed in the reach upstream of the boulder rapids that is also upstream of the current location of the EPA contractor trailer. In this reach, topography is amenable to perform channel widening on the left bank (opposite of Rimini Road). The concept is to widen the stream and install rock vanes with large boulders to create some pools for depth diversity. Rock vanes are proposed to deflect near-bank erosional forces away from the streambank and to improve/create aquatic habitat through the formation of scour pools and depth diversity. The existing stream contains numerous occurrences of woody debris and log jams. During the course of construction, any suitable trees removed could be incorporated with the proposed structures at the discretion of the Construction Field Engineer. However, incorporation of woody components to provide structure stability is not proposed due to the high energy nature of this stream. In the vicinity of this location, the plan also includes installation of a few rock control structures to enhance flood flows to enter the left overbank through the bend. The stream widening and floodplain connection enhancement will terminate at the upstream end of the existing rapids.

Stream channel widening is proposed for a bank length of about 150 ft from station 13+40 to 14+90. The channel widening includes the construction of 5 dike vanes. The vanes are angled upstream and slope from the bank down to the channel bottom. Vane spacing was based on the site survey and typical guidance for spacing of 1.5 to 2 times the bankfull width or around 2 to 2.5 times the protected bank length. The floodplain connection(s) will be installed between station 13+40 and the upstream end of the boulder rapids at existing natural overflow locations.

4.3 Upstream Wetland Connection.

A wetland connection to the stream is proposed at the upstream end of the dike lowering section. The wetland connection is proposed at a level of 0.3 ft lower than the dike removal level. At this location, the HEC-RAS model computed an elevation difference of 0.4 feet between the 2-year flow (155 cfs) and the 70 cfs profile. The wetland connection centerline station is approximately station 19+20. Flow through the connection is estimated with the weir equation as about 6 cfs for the 2-year event. This flow rate should maintain velocities of less than 1.5 ft/sec based on the limited flow area within the wetlands at some locations. For greater events, the entire wetland area will be inundated as flows are no longer confined to the stream channel and the wetland connection will not have a large impact on floodplain flow. Connection data is summarized as follows:

Centerline Station – 19+20
Dike Removal Elev. at Centerline (2-year flow) – 5156.2
Wetland Connection Invert at Centerline – 5155.9
Connection Width – 4 feet

If necessary, the location of the wetland connection may be adjusted during construction to a preferred location. If the connection location is moved, the invert elevation should also be adjusted using a slope of 1.8%.

4.4 Road and Amphibian Connections.

Culvert connections are included beneath Rimini Road on the upstream and downstream end to provide flow connection to the east wetland. At low flows, the culverts will also function as amphibian crossings. An additional centrally located amphibian crossing is proposed for high stream flow periods. In order to facilitate use by amphibians, a natural substrate lining is preferred. The culverts are also oversized to increase light and air circulation. All top of culvert elevations should be adjusted to maintain minimum cover required for highway loading. Exit swale construction is also required on the culvert exit on the east side of Rimini road through the sediment deposition. All culvert entrance and exits include a flared end section and a preformed scour hole to dissipate energy. Culvert details are summarized as follows in Table 6:

Table 6.
Culvert Data Summary

Culvert	Culvert Invert Elev. (ft NAD 88)		Approx. Length	Exist. Top of Road
	Creek Side	East of Road		
Upper	5150	5149.8	50	5154
Middle	5145	5144.8	50	5149
Lower	5135	5135.2	55	5138

All culverts are 22.5” rise x 36” span concrete arch. Culvert invert is filled with 6 inches of natural rock. All listed invert elevations are top of fill. Maintain minimum of 2 ft of cover from road. Construct an exit swale through deposited sediments on the east side of Rimini Road to maintain drainage.

Culvert computations are summarized in Att. H from the Federal Highways computer program Hydrain Version 6.1. These computations determined a maximum flow of about 15 cfs for full pipe flow. At an elevation of 1 foot above the culvert invert, the maximum flow rate is less than 6 cfs with a flow velocity of about 5 ft/sec assuming critical depth at the outlet. At a headwater depth of 4 feet, culvert flow increases to over 40 cfs with a flow velocity of over 9 ft/sec. Computations account for an estimated partial flow reduction due to substrate lining. Given the flow velocities, the substrate lining is expected to erode even at minor events.

Preformed scour holes were employed as energy dissipators at the exit of all the culverts. The plunge pool design followed general design guidance (USACE, 1988). Typical plunge pool width was approximately 2 times the channel width, the plunge pool length was approximately 3 times the channel width, and the plunge pool depth was 1 to 1.5 feet.

NOTE: Utilities are known to exist in the Rimini Road corridor. Work construction must locate all utilities prior to culvert installation.

4.5 Flow Control Weir.

A flow control weir is required below the upstream culvert to regulate flow split between the wetlands on the east and west side of Rimini Road. The weir will act to force low flows through the upper culvert to the wetlands on the east side of Rimini Road. The weir elevation is 5151, or 1 ft above the culvert invert. At the 1 foot depth, the maximum culvert capacity assuming critical depth at the outlet is estimated as 5 or 6 cfs which is about equal to the wetland connection capacity. Therefore, flows will be directed to the wetland area east of Rimini Road first. A small V notch is included in the flow control weir (1 foot top width) to maintain a trickle flow to the lower wetlands west of Rimini road.

4.6 Additional Stability Features.

Features will be included in the project design to maintain stability of existing site features. A dike berm is proposed at the downstream end of the project to provide rock protection to the septic field and assure that all flows between the channel and Rimini Road are captured and directed back to the channel. Wetland and culvert flows will return to the stream upstream of the dike berm. An intermittent rock toe is proposed for Rimini Road at critical locations to protect the road against future stream impingement. The rock toe will be buried and constructed with rock removed from the existing stream channel berm.

4.7 Rock Size.

The design includes the specification of three rock sizes for construction of project features. All rock requires a specific weight of 165 lb/cu ft or greater. Rock properties should conform with standard Montana DOT riprap as specified in section 701.06. Rock sizes are summarized as follows:

<u>Vane Boulders</u>
Minimum boulder size was evaluated with bankfull shear stress (Rosgen, 2001) as shown in Att. I. Another source for estimating stream boulder material is the Stability Thresholds for Stream Restoration Materials, also shown in Att. I. Using the HEC-RAS computed average bankfull shear stress of 3.4 lb/sq ft at the 25-year event and Att. I, the minimum rock size required for

stability is in the range of 3 – 4 foot diameter. This size is consistent with the large boulders visible in the stream. While using the average shear stress may be non-conservative, stream shear stress values should be reduced following dike removal in that flood flows will be allowed to expand into the floodplain. Boulder gradation is selected as follows:

Vane Boulder Gradation
3 – 4 foot diameter
2500 – 5000 pound

Natural Stream Type A
Stability of the natural stream type A rock was evaluated by simplifying the channel to a uniform section and employing the steep slope riprap criteria. The riprap design guidance (USACE, 1994, eq. 3-5) is stated as:

$$D_{30} = \frac{1.95 S^{.555} q^{2/3}}{g^{1/3}} \qquad (3)$$

where d_{30} is the riprap size of which 30 percent is finer by weight (feet), S is the bed slope (ft/ft), q is the unit discharge (cfs/ft), and g is the gravitational constant (ft/sec^2). The design methodology states many recommendations including multiplying the unit discharge by a flow concentration factor of 1.25.

Approximating the channel width as 26 feet for the 2-year event peak flow of 155 cfs, the unit discharge is about 7.5 cfs/ft. For a maximum slope of 5%, the computed D_{30} is 0.44 ft. For the 25-year event peak flow of 670 cfs and using a channel width of 63 feet, the unit discharge is about 13.3 cfs/ft. For a maximum slope of 5%, the computed D_{30} is 0.65 ft. COE design guidance recommends increasing the rock size by a factor of 1.25 if rounded stone is used. Using this factor would increase the minimum D_{30} to 0.81 ft. Using the standard COE gradation, this corresponds to a rock size of midway between 18 and 21 inches. The selected gradation for the Natural Stream Type A rock is as follows in Table 7:

Table 7.
Natural Stream Type A Rock Gradation

	W_{100} (lbs)		W_{50} (lbs)		Min.
D_{100} (ft)	Max	Min	Max	Min	D_{30} (ft)
1.5	292	117	86	58	0.73

Note: This rock may be substituted with a gradation equal to Montana DOT section 701.06, Class II rock gradation, if the layer thickness is increased to 36 inches. The Class II rock is a larger stone than the specified gradation for the natural stream type A rock.

Number 57 Stone
Gravel to cobble size material, 1 – 3 inches

Note: This is a small cobble material suitable to fill void space in the large rock. The material is roughly equivalent to the drain aggregate specified in Montana DOT section 701.10.

Representative samples of rock to be imported to the project site shall be tested for Acid-Base Accounting (ABA) to determine sulfur forms, exchangeable acidity and SMP buffer. Rock shall have an NNP value greater than zero. Test results shall be submitted to the Construction Field Engineer not less than 7 days prior to delivery of the rock to the site.

Random Fill
Random fill consists of a combination of soil, sand and gravel up to 3 inches in size.

Note: This material is suitable for vegetative media and filling voids in larger rocks. This material will be reclaimed from removal of the alluvial portion of the creek dike and excavation for the east wetland areas.

5. References

Rosgen, *D.L. 1996. Applied River Morpholog*y, Wildland Hydrology, Colorado, 3-1 – 5-189.

Rosgen, D.L. 2001. *The Cross-Vane, W-Weir and J-Hook Structures, Their Description, Design and Application for Stream Stabilization and River Restoration*, Proceedings of the 2001 Wetlands Engineering & River Restoration Conference, Reno, NV, Aug 2001.

USACE, 1994. *Hydraulic Design of Flood Control Channels*, EM 1110-2-1601, Change 1, U.S. Army Corps of Engineers, Washington, D.C.

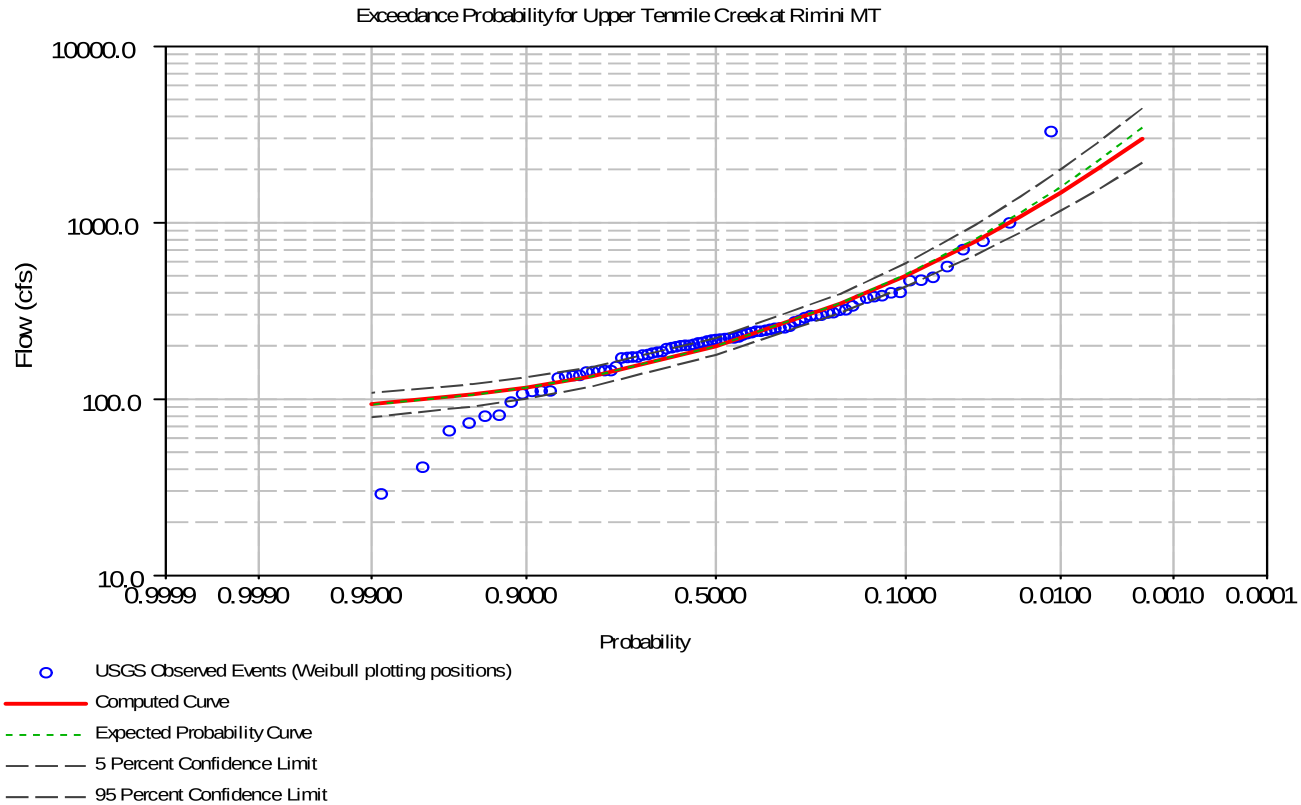
USACE, 1988. *Hydraulic Design Criteria, Sheet 722-4 to 722-7, Storm Drain Outlets*, Riprap Energy Dissipators, Waterways Experiment Station, Vicksburg, MS.

USGS, 2004. *Statistical Summaries of Streamflow in Montana and Adjacent Areas, Water Years 1900-2002, Scientific Investigations Report 2004-5266* (USGS, 2004).

USGS, 2003. *Methods for Estimating Flood Frequency in Montana Based on Data Through Water Year 1998, Water Resources Investigative Report 03-4308* (USGS, 2004).

USGS, 2000. *Streamflow and Water-Quality Characteristics in the Upper Tenmile Creek Watershed, Lewis and Clark County, West-Central Montana, Water Resources Investigative Report 00-4129* , USGS, 2000.

Results from annual peak frequency analysis, computer program HEC-SSP, version 1, June 2006.

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Bulletin 17B Frequency Analysis
    07 Aug 2006   02:41 PM
-------------------------------

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DSS Pathname: /UPPER TENMILE CREEK/06062500/FLOW-ANNUAL PEAK/01jan1900/IR-CENTURY/USGS/

Report File Name: C:\proj\rams\tenmile\ssp\Tenmile
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XML File Name: C:\proj\rams\tenmile\ssp\Tenmile
Creek\Bulletin17bResults\Upper_Tenmile_Creek_at_Rimini_MT\Upper_Tenmile_Creek_at_Rimini_MT.xml

Skew Option: Use Station Skew

Regional Skew: -0.2
Regional Skew MSE: 0.302
Round adopted skew to nearest tenth

Plotting Position Type: Weibull
```

Upper Confidence Level: 0.05
Lower Confidence Level: 0.95

Use High Outlier Threshold
High Outlier Threshold: 4000.0
Use Low Outlier Threshold
Low Outlier Threshold: 50.0
Use Historic Data
Historic Period Start Year: ---
Historic Period End Year: ---

Use non-standard frequencies
Frequency: 0.2
Frequency: 0.5
Frequency: 1.0
Frequency: 2.0
Frequency: 4.0
Frequency: 10.0
Frequency: 20.0
Frequency: 50.0
Frequency: 80.0
Frequency: 90.0
Frequency: 95.0
Frequency: 99.0

Round ordinate values to 3 significant digits
Display ordinate values using 0 digits in fraction part of value

--- End of Input Data ---

--- Final Results ---

<< Plotting Positions >>

UPPER TENMILE CREEK-06062500-FLOW-ANNUAL PEAK

Events Analyzed				Ordered Events			
			FLOW		Water	FLOW	Weibull
Day	Mon	Year	cfs	Rank	Year	cfs	Plot Pos
16	Jun	1915	471	1	1981	3,290	1.19
28	Jun	1916	296	2	1975	995	2.38
27	May	1917	781	3	1917	781	3.57
07	Jun	1918	172	4	1927	703	4.76
20	May	1919	80	5	1964	563	5.95
07	Jun	1920	299	6	1938	490	7.14
17	May	1921	373	7	1915	471	8.33
25	May	1922	385	8	1953	469	9.52
24	May	1923	173	9	1948	403	10.71
16	May	1924	367	10	1929	400	11.90
18	May	1925	173	11	1922	385	13.10
19	Apr	1926	200	12	1976	379	14.29
11	Jun	1927	703	13	1921	373	15.48
09	May	1928	249	14	1924	367	16.67
23	May	1929	400	15	1947	338	17.86
24	Apr	1930	179	16	1967	320	19.05
13	May	1931	41	17	1950	319	20.24
13	May	1932	195	18	1969	308	21.43
31	May	1933	258	19	1997	306	22.62
07	Jun	1934	143	20	1920	299	23.81
23	May	1935	81	21	1943	297	25.00
08	Jun	1936	66	22	1916	296	26.19
20	May	1937	134	23	1951	289	27.38
26	May	1938	490	24	1968	278	28.57
29	Apr	1939	136	25	1960	274	29.76
10	May	1940	96	26	1933	258	30.95
05	Jun	1941	209	27	1983	253	32.14
25	May	1942	242	28	1944	253	33.33
27	May	1943	297	29	1982	252	34.52
27	Jun	1944	253	30	1928	249	35.71
10	Jun	1945	231	31	1965	246	36.90

28 May 1946	73	32	1952	242	38.10
08 May 1947	338	33	1942	242	39.29
21 May 1948	403	34	1978	237	40.48
13 May 1949	107	35	1979	234	41.67
18 Jun 1950	319	36	1945	231	42.86
11 Jun 1951	289	37	1984	224	44.05
27 Apr 1952	242	38	1998	222	45.24
02 Jun 1953	469	39	1962	222	46.43
10 Jun 1954	111	40	1974	220	47.62
21 May 1955	145	41	1956	219	48.81
20 May 1956	219	42	1970	218	50.00
26 May 1957	145	43	1958	216	51.19
11 May 1958	216	44	1999	214	52.38
06 Jun 1959	202	45	1941	209	53.57
12 May 1960	274	46	1980	208	54.76
25 May 1961	186	47	1972	204	55.95
26 May 1962	222	48	1986	202	57.14
25 May 1963	152	49	1959	202	58.33
09 Jun 1964	563	50	1926	200	59.52
17 Jun 1965	246	51	1993	198	60.71
06 May 1966	142	52	1932	195	61.90
23 May 1967	320	53	1994	193	63.10
09 Jun 1968	278	54	1961	186	64.29
07 Jul 1969	308	55	1989	184	65.48
26 May 1970	218	56	1992	182	66.67
31 May 1971	177	57	1930	179	67.86
01 Jun 1972	204	58	1971	177	69.05
17 May 1973	110	59	1925	173	70.24
27 May 1974	220	60	1923	173	71.43
19 Jun 1975	995	61	1918	172	72.62
14 May 1976	379	62	1991	171	73.81
26 Apr 1977	29	63	1963	152	75.00
22 May 1978	237	64	1987	145	76.19
26 May 1979	234	65	1957	145	77.38
31 May 1980	208	66	1955	145	78.57
22 May 1981	3,290	67	1934	143	79.76
13 Jun 1982	252	68	1966	142	80.95
26 May 1983	253	69	1939	136	82.14
15 May 1984	224	70	1990	135	83.33
03 May 1985	111	71	1937	134	84.52
28 May 1986	202	72	1988	132	85.71
27 May 1987	145	73	1985	111	86.90
16 May 1988	132	74	1954	111	88.10
10 May 1989	184	75	1973	110	89.29
30 May 1990	135	76	1949	107	90.48
21 May 1991	171	77	1940	96	91.67
16 Jun 1992	182	78	1935	81	92.86
16 Jun 1993	198	79	1919	80	94.05
22 Apr 1994	193	80	1946	73	95.24
11 Jun 1997	306	81	1936	66	96.43
20 Jun 1998	222	82	1931	41*	97.62
03 Jun 1999	214	83	1977	29*	98.81

Note: Plotting positions based on historic period (H) = 85
Number of historic events plus high outliers (Z) = 0
Weighting factor for systematic events (W) = 1

* Outlier

<< Outlier Tests >>

<< High Outlier Test >>

Based on 83 events, 10 percent outlier test value K(N) = 2.953
0 high outlier(s) identified above test value of 1,502
or input threshold of 4,000

<< Low Outlier Test >>

Based on 85 events, 10 percent outlier test value K(N) = 2.961

Computed low outlier test value = 31
2 low outlier(s) identified below test value of 50

Statistics and frequency curve adjusted for 2 low outliers.

<< Skew Weighting >>

Based on 85 events, mean-square error of station skew = 0.173
Default or input mean-square error of regional skew = 0.302

<< Frequency Curve >>
UPPER TENMILE CREEK-06062500-FLOW-ANNUAL PEAK

Computed Curve FLOW-ANNUAL PEAK, cfs	Expected Probability FLOW-ANNUAL PEAK, cfs	Percent Chance Exceedance	Confidence Limits 0.05 FLOW-ANNUAL PEAK, cfs	Confidence Limits 0.95 FLOW-ANNUAL PEAK, cfs
2,990	3,450	0.2	4,460	2,190
2,010	2,230	0.5	2,840	1,540
1,480	1,590	1.0	2,000	1,170
1,080	1,140	2.0	1,400	879
782	810	4.0	973	656
500	508	10.0	589	435
347	350	20.0	395	309
199	199	50.0	221	178
135	134	80.0	152	118
116	116	90.0	132	100
106	105	95.0	121	90
94	93	99.0	108	79

<< Synthetic Statistics >>
UPPER TENMILE CREEK-06062500-FLOW-ANNUAL PEAK

Log Transform: FLOW-ANNUAL PEAK, cfs		Number of Events	
Mean	2.3492	Historic Events	0
Standard Dev	0.2607	High Outliers	0
Station Skew	1.1641	Low Outliers	2
Regional Skew	-0.2000	Zero Events	0
Weighted Skew	0.6681	Missing Events	0
Adopted Skew	1.2000	Systematic Events	83
		Historic Period	85

06062500 Tenmile Creek near Rimini, Mont.
Site Number 45

LOCATION.--Lat 46°31'27", long 112°15'22" (NAD 27), in NE¼SW¼NE¼ sec.20, T.9 N., R.5 W., Lewis and Clark County, Hydrologic Unit 10030101, Helena National Forest, on left bank at U.S. Forest Service Moose Creek campground, 500 ft upstream from Moose Creek, 2.5 mi north of Rimini, and at river mile 20.4.

DRAINAGE AREA.--30.9 mi^2.

PERIOD OF RECORD.--July 1914 to September 1994, May 1997 to current year (2002). Monthly discharge only for some periods, published in WSP 1309.

REVISED RECORDS.--WSP 1309: 1917, 1921, 1924-25. WSP 1509: 1915, 1916-17(M), 1920(M), 1927(M), 1928-30, 1947(M), 1948, 1950(M). WSP 1559: Drainage area. WSP 1709: 1959. WDR-MT-97-1: Drainage area.

GAGE.--Water-stage recorder and concrete control. Altitude of gage is 4,850 ft (NGVD 29). Prior to Dec. 17, 1934, water-stage recorder at site 40 ft downstream at different datum and different control.

REMARKS.--Flow partly regulated by Chessman and Scott Reservoirs on tributaries upstream from station, combined capacity, 2,340 acre-feet. Some small diversions upstream from station. U.S. Geological Survey satellite telemeter at station.

Magnitude and probability of annual low flow based on 84 years of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent					
	2	5	10	20	50	100
	50%	20%	10%	5%	2%	1%
1	0.33	0.13	0.04	0.00	0.00	0.00
3	.36	.14	.07	.00	.00	.00
7	.43	.15	.07	.04	.00	.00
14	.47	.20	.13	.09	.06	.04
30	.58	.27	.18	.13	.09	.07
60	.76	.37	.26	.19	.14	.11
90	.91	.44	.30	.22	.15	.12
120	1.0	.50	.34	.25	.18	.14
183	1.3	.60	.42	.32	.23	.19

Magnitude and probability of seasonal low flow from March-June based on 86 seasons of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent					
	2	5	10	20	50	100
	50%	20%	10%	5%	2%	1%
1	0.96	0.41	0.26	0.18	0.12	0.09
3	1.0	.43	.28	.19	.12	.09
7	1.1	.49	.31	.21	.14	.10
14	1.3	.58	.37	.26	.17	.12
30	1.8	.81	.51	.35	.22	.16

Magnitude and probability of seasonal low flow from November-February based on 85 seasons of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent					
	2	5	10	20	50	100
	50%	20%	10%	5%	2%	1%
1	0.49	0.22	0.14	0.10	0.07	0.05
3	.53	.23	.15	.11	.07	.06
7	.62	.28	.19	.13	.09	.07
14	.72	.34	.22	.16	.10	.08
30	.86	.40	.26	.18	.12	.09

Duration of daily mean flows based on 85 years of record

Discharge, in ft^3/s, which was equaled or exceeded for indicated percent of time							
99%	98%	95%	90%	80%	70%	60%	50%
0.03	0.07	0.17	0.33	0.66	0.99	1.4	2.1
40%	30%	20%	15%	10%	5%	2%	1%
3.5	6.2	17	30	54	101	168	215

Magnitude and probability of annual high flow based on 85 years of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent					
	2	5	10	25	50	100
	50%	20%	10%	4%	2%	1%
1	172	299	397	532	641	756
3	165	271	342	428	489	548
7	148	237	291	352	391	427
15	125	200	244	294	327	356
30	103	164	201	243	270	295
60	75	118	144	171	189	204
90	56	88	106	127	140	151

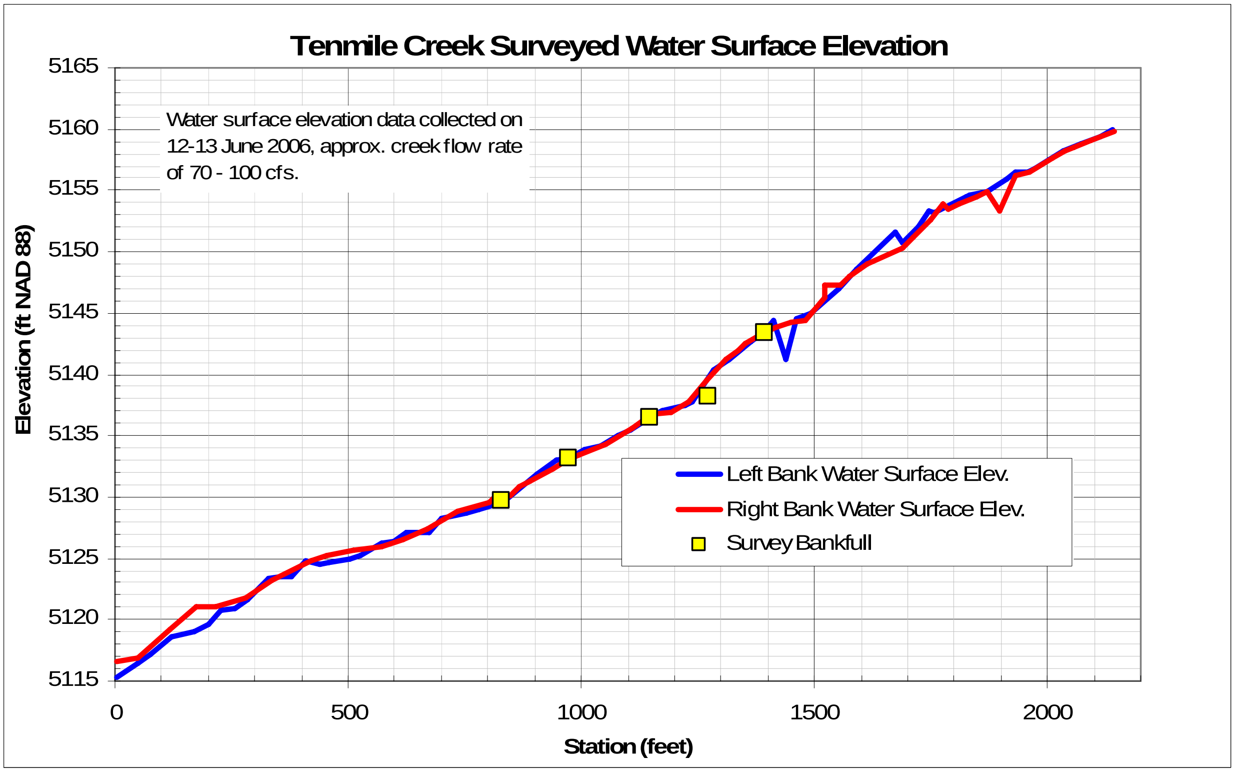
Magnitude and probability of seasonal low flow from July-October based on 85 seasons of record

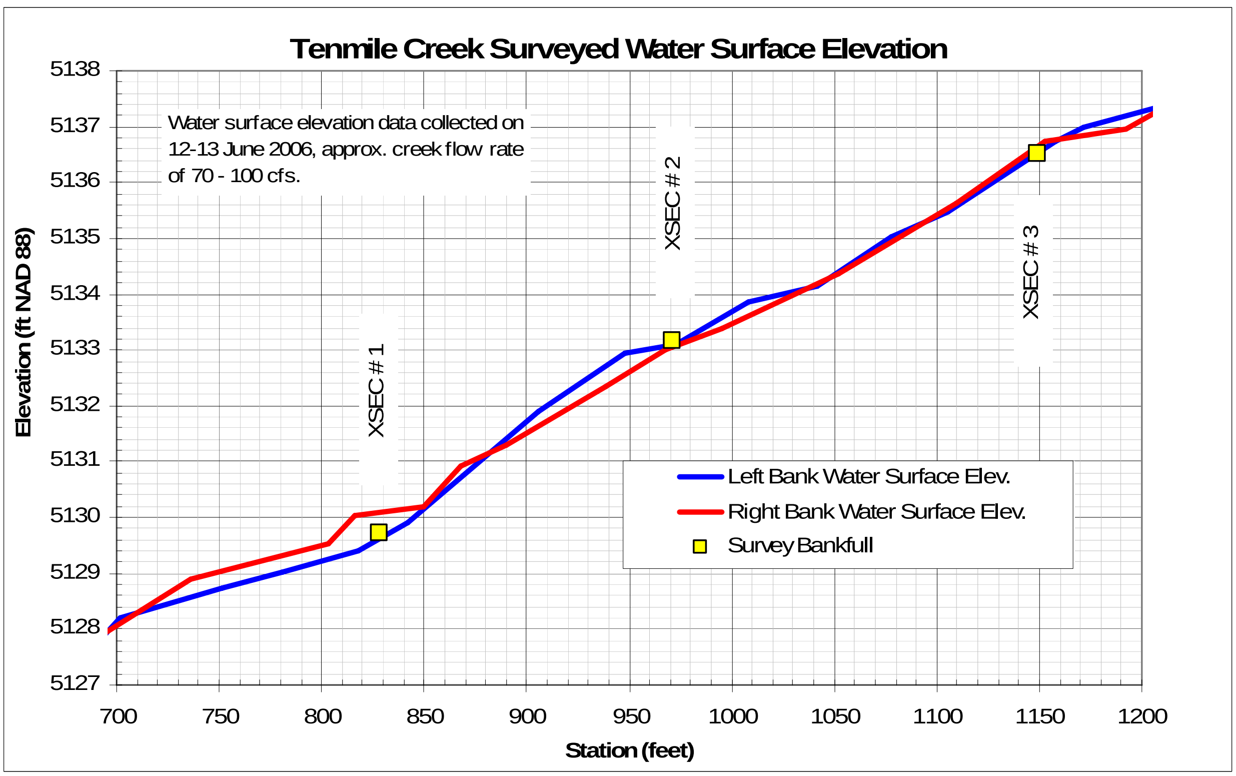
Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent					
	2	5	10	20	50	100
	50%	20%	10%	5%	2%	1%
1	0.42	0.17	0.07	0.00	0.00	0.00
3	.45	.17	.09	.00	.00	.00
7	.52	.18	.09	.04	.00	.00
14	.56	.23	.15	.10	.06	.05
30	.70	.31	.21	.16	.11	.09

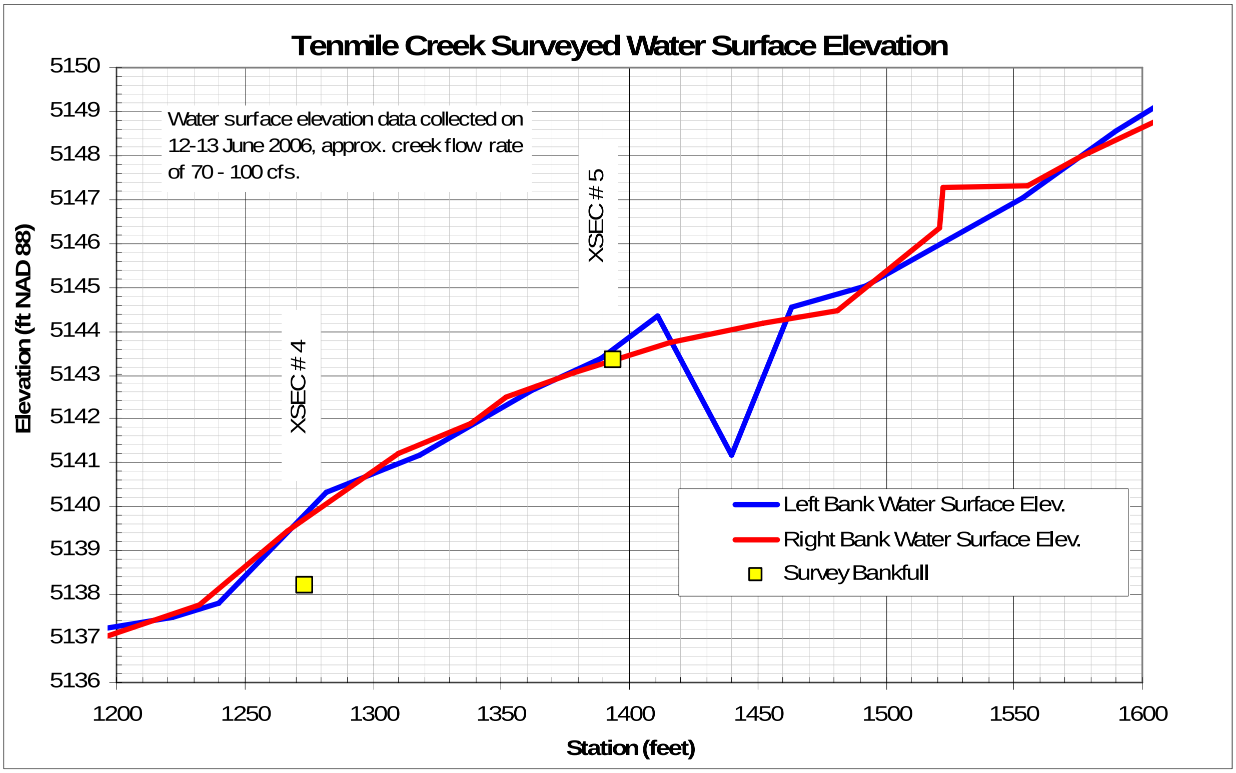
Monthly and annual mean discharges

Month	Maximum (ft^3/s)	Minimum (ft^3/s)	Mean (ft^3/s)	Standard deviation (ft^3/s)	Years of record
October	23	0.19	3.1	4.2	86
November	14	.22	2.3	2.5	86
December	9.6	.17	1.8	1.7	86
January	7.0	.14	1.5	1.2	86
February	5.1	.06	1.3	1.0	86
March	18	.07	2.5	2.7	86
April	67	1.5	18	14	86
May	300	6.1	83	46	87
June	346	3.0	73	63	87
July	66	.34	12	14	86
August	22	.13	2.5	3.1	86
September	22	.23	2.4	3.5	86
Annual	53	1.7	17	9.2	85

Reference: *Statistical Summaries of Streamflow in Montana and Adjacent Areas, Water Years 1900-2002, Scientific Investigations Report 2004-5266* (pg 62, USGS, 2004).


Tenmile Creek Surveyed Water Surface Elevation
Water surface elevation data collected on 12-13 June 2006, approx. creek flow rate of 70 - 100 cfs.
Elevation (ft NAD 88)
5165
5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
0
500
1000
1500
2000
Station (feet)
Left Bank Water Surface Elev.
Right Bank Water Surface Elev.
Survey Bankfull


Tenmile Creek Surveyed Water Surface Elevation
Water surface elevation data collected on 12-13 June 2006, approx. creek flow rate of 70 - 100 cfs.
XSEC # 1
XSEC # 2
XSEC # 3
Elevation (ft NAD 88)
5138
5137
5136
5135
5134
5133
5132
5131
5130
5129
5128
5127
700
750
800
850
900
950
1000
1050
1100
1150
1200
Station (feet)
Left Bank Water Surface Elev.
Right Bank Water Surface Elev.
Survey Bankfull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Water surface elevation data collected on 12-13 June 2006, approx. creek flow rate of 70 - 100 cfs.
XSEC # 4
XSEC # 5
Elevation (ft NAD 88)
Station (feet)
Left Bank Water Surface Elev.
Right Bank Water Surface Elev.
Survey Bankfull
5150
5149
5148
5147
5146
5145
5144
5143
5142
5141
5140
5139
5138
5137
5136
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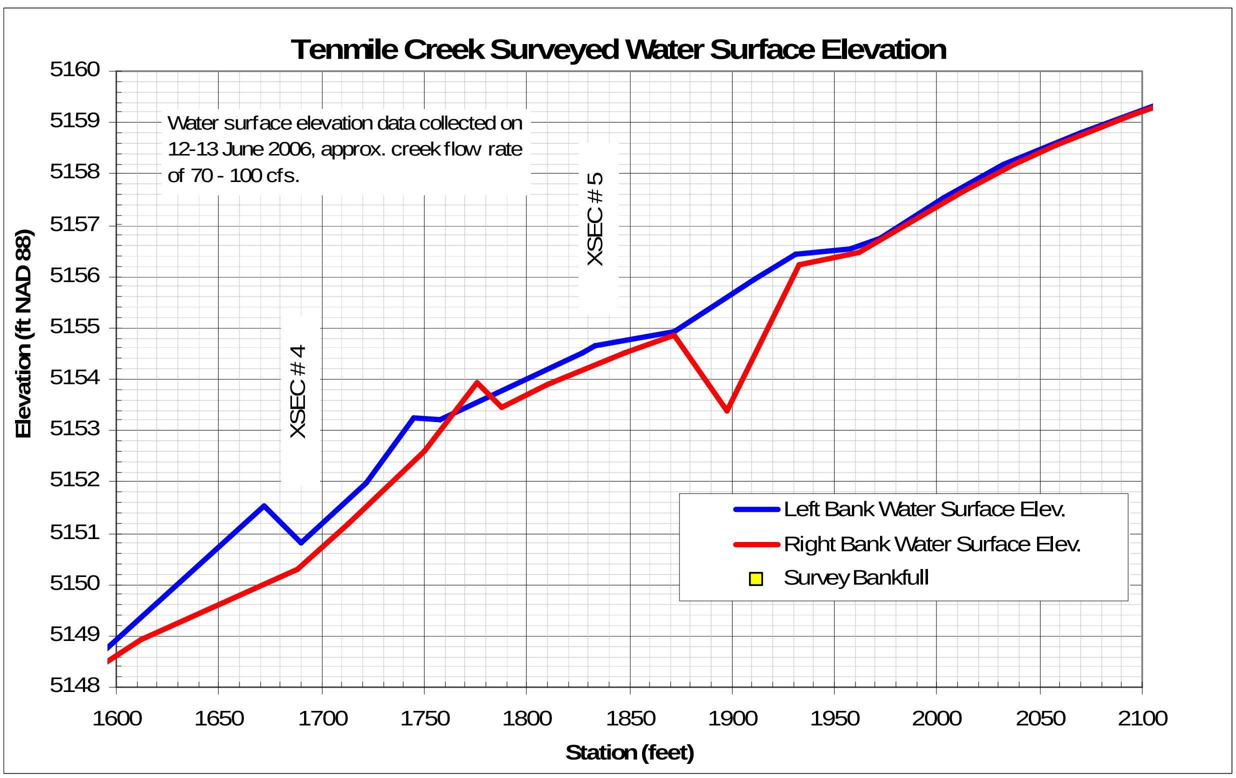
1550
1600


Tenmile Creek Surveyed Water Surface Elevation
Water surface elevation data collected on 12-13 June 2006, approx. creek flow rate of 70 - 100 cfs.
XSEC # 4
XSEC # 5
Elevation (ft NAD 88)
Station (feet)
Left Bank Water Surface Elev.
Right Bank Water Surface Elev.
Survey Bankfull
5160
5159
5158
5157
5156
5155
5154
5153
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5148
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1650
1700
1750
1800
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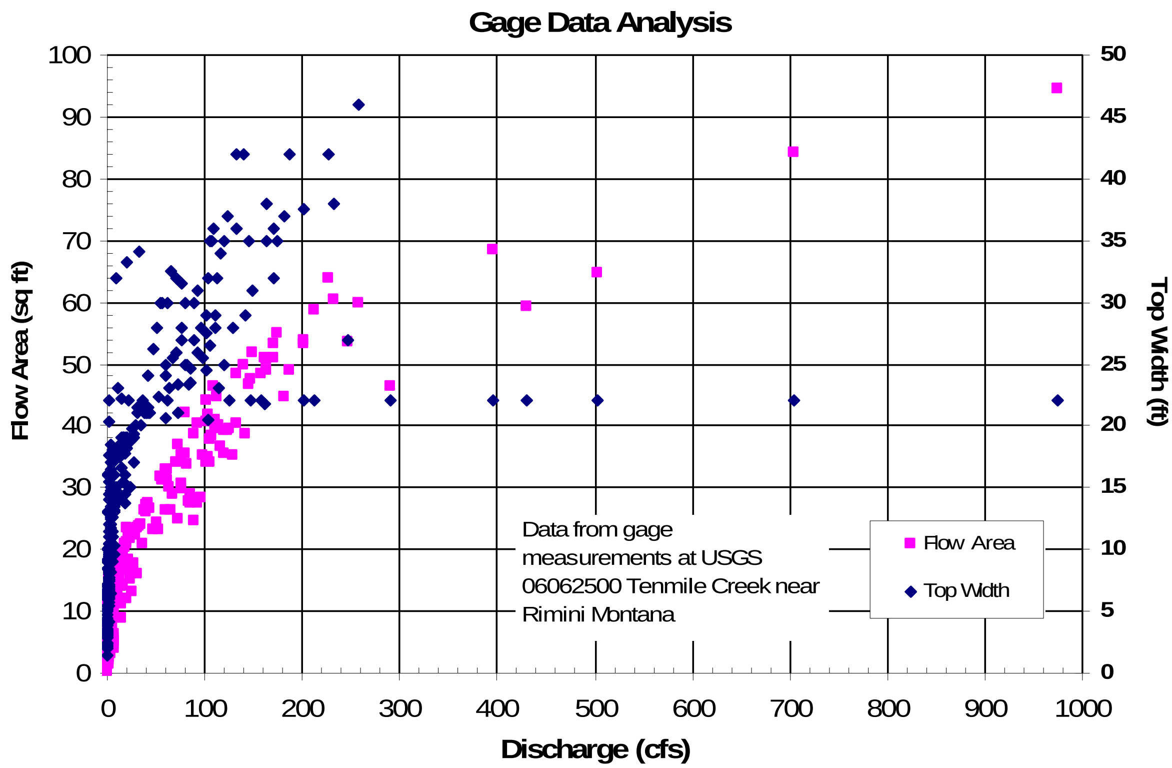
1950
2000
2050
2100


Gage Data Analysis
Flow Area (sq ft)
Top Width (ft)
Discharge (cfs)
Data from gage measurements at USGS 06062500 Tenmile Creek near Rimini Montana
Flow Area
Top Width
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100
0
5
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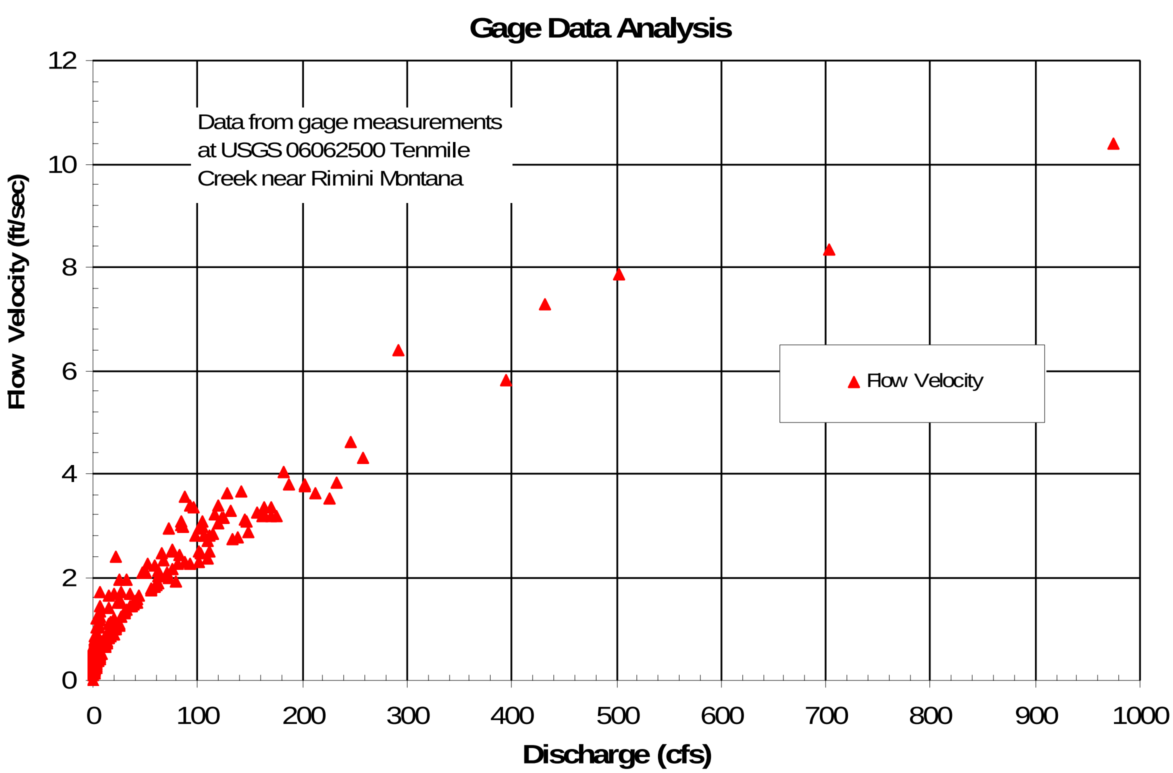
30
35
40
45
50


Gage Data Analysis
Flow Velocity (ft/sec)
Discharge (cfs)
Data from gage measurements at USGS 06062500 Tenmile Creek near Rimini Montana
Flow Velocity
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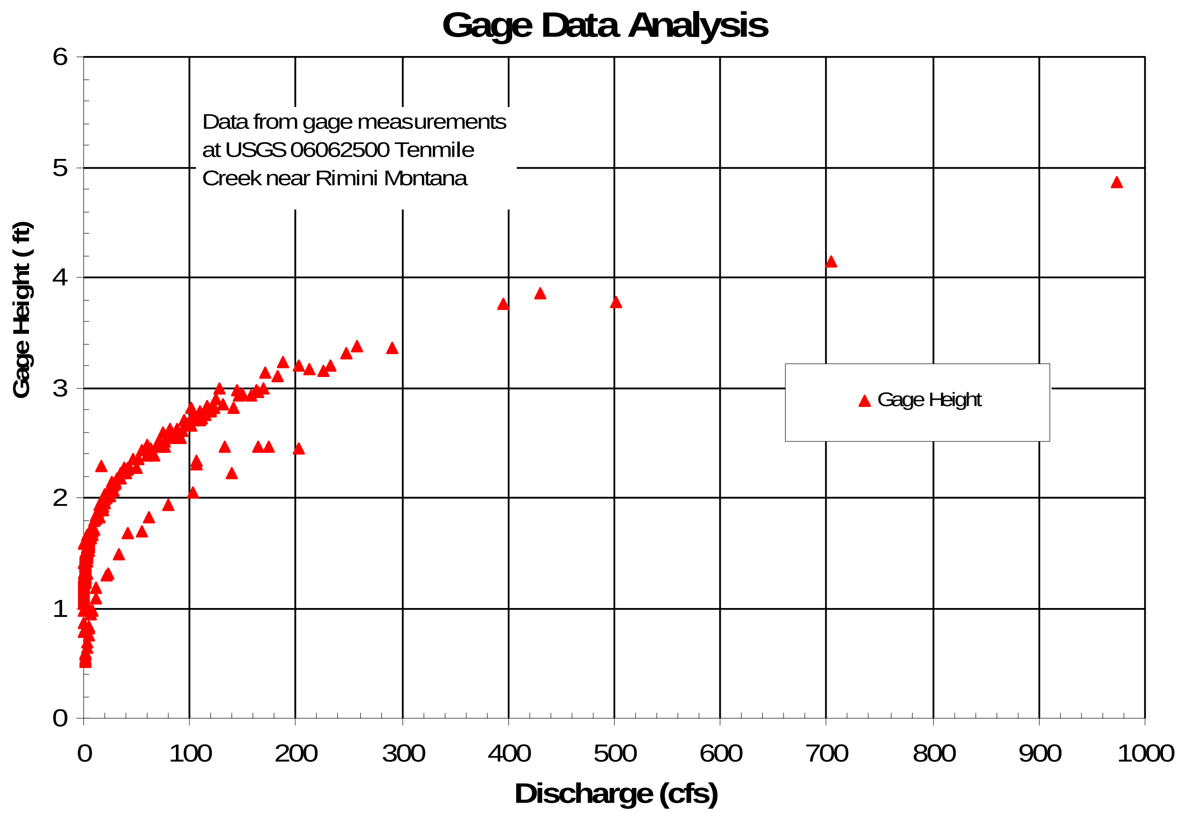
300
400
500
600
700
800
900
1000
0
2
4
6
8
10
12


Gage Data Analysis
Data from gage measurements at USGS 06062500 Tenmile Creek near Rimini Montana
Gage Height
Gage Height (ft)
Discharge (cfs)
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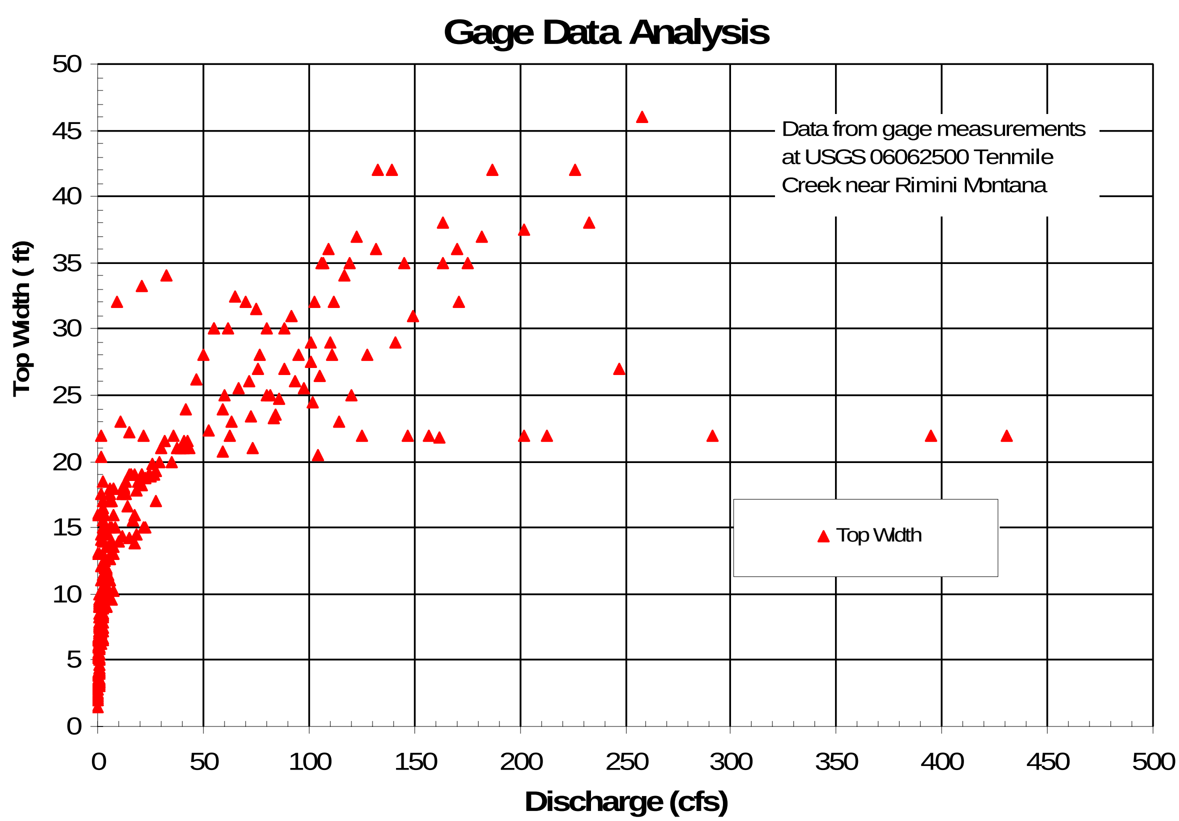
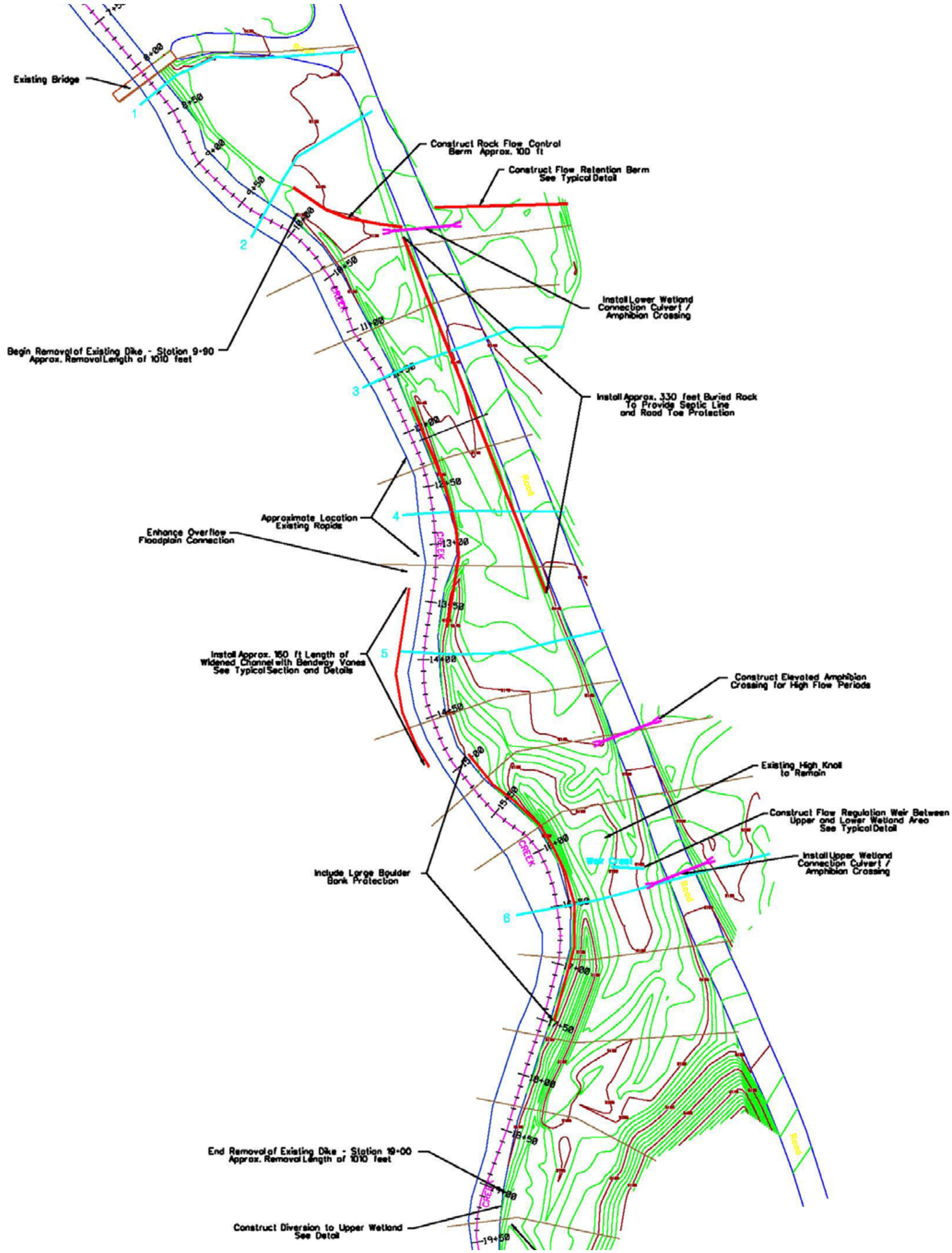
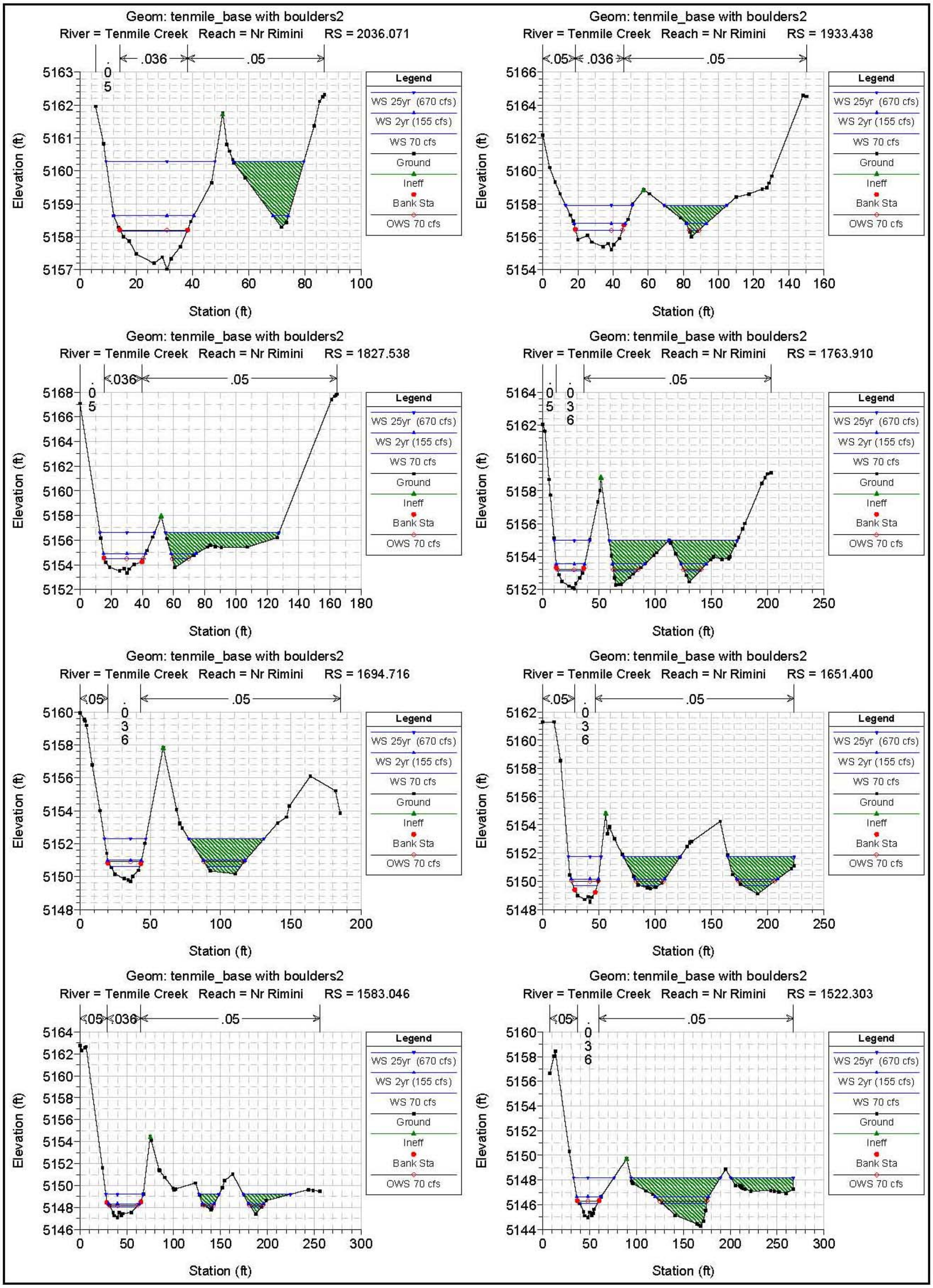
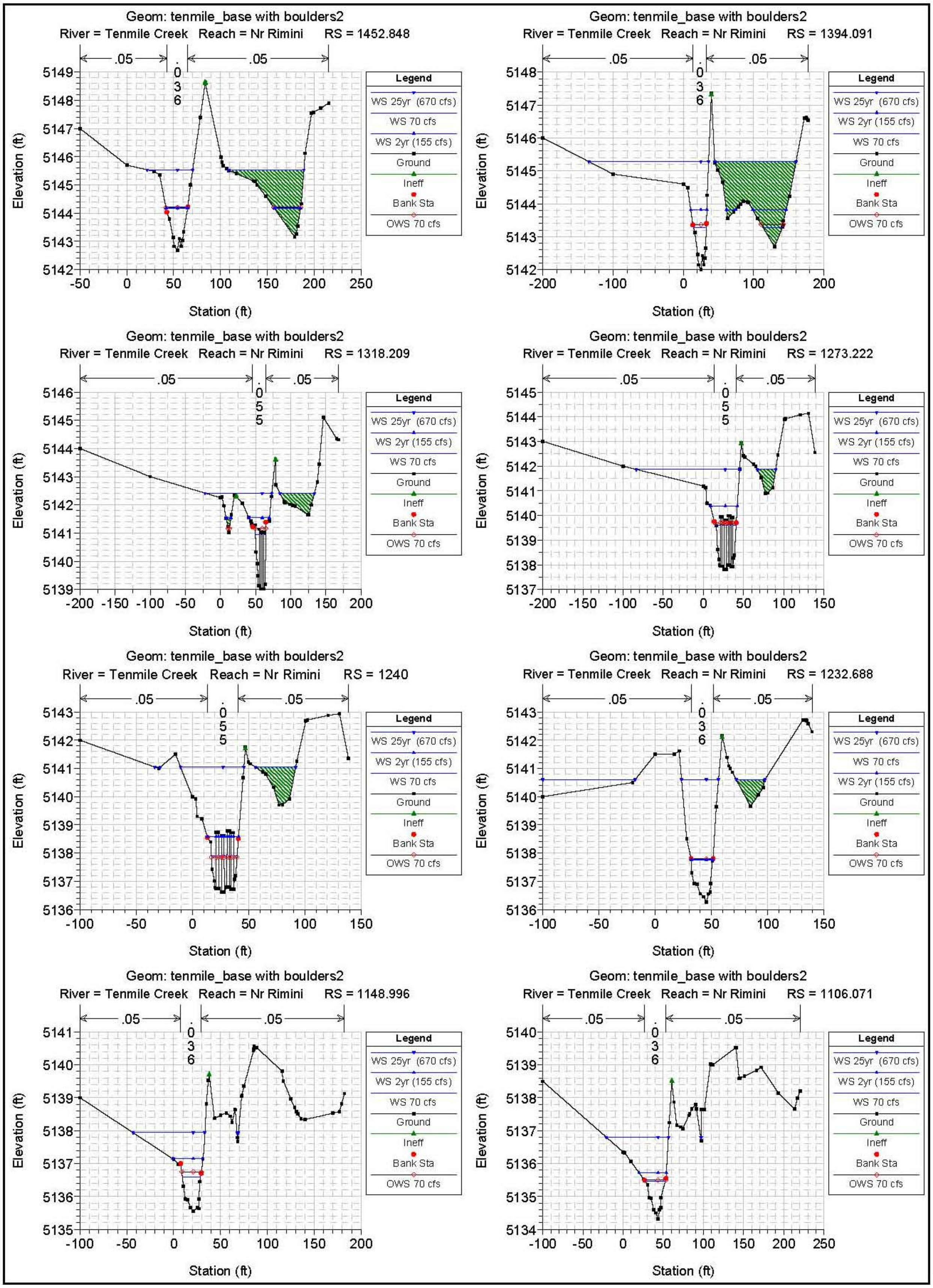
1
2
3
4
5
6
0
100
200
300
400
500
600
700
800
900
1000


Gage Data Analysis
Data from gage measurements at USGS 06062500 Tenmile Creek near Rimini Montana
Top Width
Top Width (ft)
Discharge (cfs)
0
5
10
15
20
25
30
35
40
45
50
0
50
100
150
200
250
300
350
400
450
500


Existing Bridge
Construct Rock Flow Control Berm Approx. 100 ft
Construct Flow Retention Berm See Typical Detail
Install Lower Wetland Connection Culvert / Amphibian Crossing
Begin Removal of Existing Dike - Station 9+90 Approx. Removal Length of 1010 feet
Install Approx. 330 feet Buried Rock To Provide Septic Line and Road Toe Protection
Approximate Location Existing Rapids
Enhance Overflow Floodplain Connection
Install Approx. 160 ft Length of Widened Channel with Bendway Vanes See Typical Section and Details
Construct Elevated Amphibian Crossing for High Flow Periods
Existing High Knoll to Remain
Construct Flow Regulation Weir Between Upper and Lower Wetland Area See Typical Detail
Install Upper Wetland Connection Culvert / Amphibian Crossing
Include Large Boulder Bank Protection
End Removal of Existing Dike - Station 19+00 Approx. Removal Length of 1010 feet
Construct Diversion to Upper Wetland See Detail
Road
CREEK


Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 2036.071
.05 .036 .05
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1933.438
.05 .036 .05
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1827.538
.05 .036 .05
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1763.910
.05 .036 .05
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1694.716
.05 .036 .05
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1651.400
.05 .036 .05
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1583.046
.05 .036 .05
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1522.303
.05 .036 .05
Legend
WS 25yr (670 cfs)
WS 2yr (155 cfs)
WS 70 cfs
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)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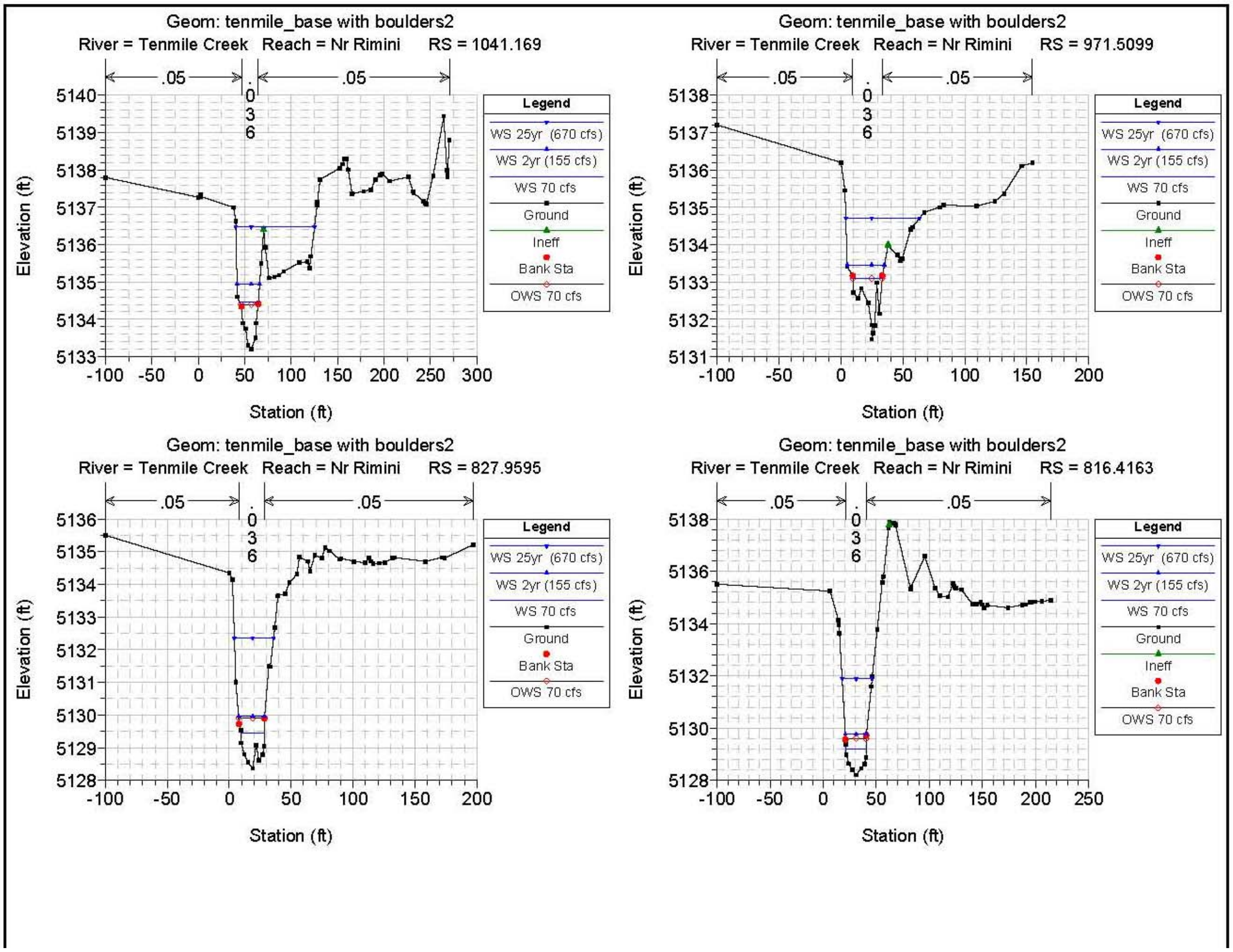
River = Tenmile Creek Reach = Nr Rimini RS = 1452.848
Legend
WS 25yr (670 cfs)
WS 70 cfs
WS 2yr (155 cfs)
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1394.091
Legend
WS 25yr (670 cfs)
WS 2yr (155 cfs)
WS 70 cfs
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1318.209
Legend
WS 25yr (670 cfs)
WS 2yr (155 cfs)
WS 70 cfs
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1273.222
Legend
WS 25yr (670 cfs)
WS 2yr (155 cfs)
WS 70 cfs
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1240
Legend
WS 25yr (670 cfs)
WS 2yr (155 cfs)
WS 70 cfs
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1232.688
Legend
WS 25yr (670 cfs)
WS 70 cfs
WS 2yr (155 cfs)
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1148.996
Legend
WS 25yr (670 cfs)
WS 2yr (155 cfs)
WS 70 cfs
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 1106.071
Legend
WS 25yr (670 cfs)
WS 2yr (155 cfs)
WS 70 cfs
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)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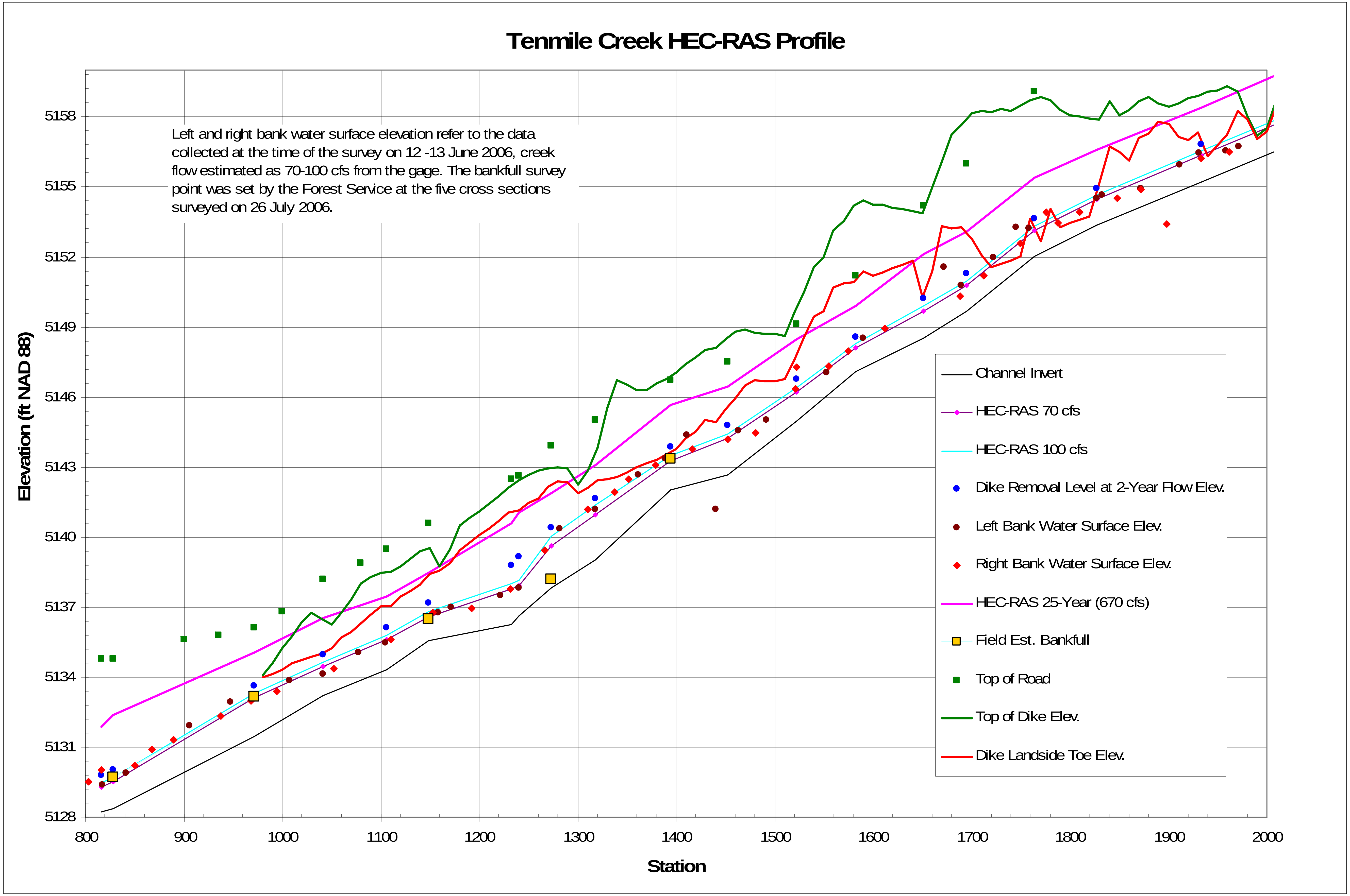
River = Tenmile Creek Reach = Nr Rimini RS = 1041.169
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 971.5099
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 827.9595
Geom: tenmile_base with boulders2
River = Tenmile Creek Reach = Nr Rimini RS = 816.4163
.05
.036
Legend
WS 25yr (670 cfs)
WS 2yr (155 cfs)
WS 70 cfs
Ground
Ineff
Bank Sta
OWS 70 cfs
Elevation (ft)
Station (ft)


Tenmile Creek HEC-RAS Profile
Left and right bank water surface elevation refer to the data collected at the time of the survey on 12 -13 June 2006, creek flow estimated as 70-100 cfs from the gage. The bankfull survey point was set by the Forest Service at the five cross sections surveyed on 26 July 2006.
Elevation (ft NAD 88)
5128
5131
5134
5137
5140
5143
5146
5149
5152
5155
5158
Station
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Channel Invert
HEC-RAS 70 cfs
HEC-RAS 100 cfs
Dike Removal Level at 2-Year Flow Elev.
Left Bank Water Surface Elev.
Right Bank Water Surface Elev.
HEC-RAS 25-Year (670 cfs)
Field Est. Bankfull
Top of Road
Top of Dike Elev.
Dike Landside Toe Elev.

HEC-RAS Plan: boulder 2 River: Tenmile Creek Reach: Nr Rimini

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # C
Nr Rimini	2036.071	70 cfs	70	5157.01	5158.17	5158.16	5158.48	0.020746	4.47	15.65	23.78	0.97
Nr Rimini	2036.071	100 cfs	100	5157.01	5158.33	5158.33	5158.74	0.020794	5.13	19.57	26.24	1.01
Nr Rimini	2036.071	2yr (155 cfs)	155	5157.01	5158.64	5158.64	5159.14	0.016997	5.74	27.71	33.97	0.96
Nr Rimini	2036.071	25yr (670 cfs)	670	5157.01	5160.29	5160.29	5161.45	0.012468	9.03	84.9	63.91	0.96
Nr Rimini	1933.438	70 cfs	70	5155.21	5156.38	5156.31	5156.62	0.015702	3.93	17.82	31.94	0.85
Nr Rimini	1933.438	100 cfs	100	5155.21	5156.56	5156.47	5156.86	0.014897	4.41	22.69	35.48	0.85
Nr Rimini	1933.438	2yr (155 cfs)	155	5155.21	5156.8	5156.75	5157.23	0.01588	5.32	29.29	40.39	0.92
Nr Rimini	1933.438	25yr (670 cfs)	670	5155.21	5157.91	5158.37	5159.64	0.02469	10.75	67.04	73.81	1.29
Nr Rimini	1827.538	70 cfs	70	5153.34	5154.48	5154.46	5154.78	0.019429	4.36	16.13	34.84	0.94
Nr Rimini	1827.538	100 cfs	100	5153.34	5154.64	5154.64	5155.03	0.019946	5.04	20.02	37.86	0.99
Nr Rimini	1827.538	2yr (155 cfs)	155	5153.34	5154.91	5154.91	5155.43	0.018235	5.84	27.11	43.09	0.99
Nr Rimini	1827.538	25yr (670 cfs)	670	5153.34	5156.6	5156.6	5157.87	0.013208	9.31	79.39	107.53	0.99
Nr Rimini	1763.91	70 cfs	70	5152.03	5153.14	5153.14	5153.47	0.021874	4.64	15.1	57.52	1
Nr Rimini	1763.91	100 cfs	100	5152.03	5153.33	5153.33	5153.73	0.020614	5.11	19.57	66.89	1
Nr Rimini	1763.91	2yr (155 cfs)	155	5152.03	5153.55	5153.61	5154.15	0.022188	6.22	25.02	76.61	1.08
Nr Rimini	1763.91	25yr (670 cfs)	670	5152.03	5154.97	5155.39	5156.76	0.021294	10.9	65.57	145.14	1.23
Nr Rimini	1694.716	70 cfs	70	5149.69	5150.61	5150.8	5151.22	0.051914	6.23	11.24	44.73	1.49
Nr Rimini	1694.716	100 cfs	100	5149.69	5150.75	5150.98	5151.52	0.053967	7	14.28	49	1.56
Nr Rimini	1694.716	2yr (155 cfs)	155	5149.69	5150.98	5151.27	5151.96	0.046917	7.92	19.63	54.07	1.52
Nr Rimini	1694.716	25yr (670 cfs)	670	5149.69	5152.3	5153.07	5154.82	0.035347	12.91	55.01	82.92	1.55
Nr Rimini	1651.4	70 cfs	70	5148.53	5149.68	5149.68	5150.04	0.01946	4.86	14.82	59.22	0.97
Nr Rimini	1651.4	100 cfs	100	5148.53	5149.88	5149.88	5150.33	0.017954	5.45	19.27	74.31	0.97
Nr Rimini	1651.4	2yr (155 cfs)	155	5148.53	5150.16	5150.21	5150.78	0.018099	6.46	25.82	87.44	1.01
Nr Rimini	1651.4	25yr (670 cfs)	670	5148.53	5151.75	5152.1	5153.52	0.018631	11.27	68.75	138.45	1.18
Nr Rimini	1583.046	70 cfs	70	5147.1	5148.05	5148.1	5148.39	0.030282	4.71	14.86	45.68	1.14
Nr Rimini	1583.046	100 cfs	100	5147.1	5148.15	5148.27	5148.64	0.036187	5.59	17.88	51.98	1.27
Nr Rimini	1583.046	2yr (155 cfs)	155	5147.1	5148.34	5148.52	5149.01	0.040223	6.56	23.63	62.54	1.37
Nr Rimini	1583.046	25yr (670 cfs)	670	5147.1	5149.2	5149.91	5151.49	0.050961	12.19	55.92	111.26	1.75
Nr Rimini	1522.303	70 cfs	70	5144.97	5146.14	5146.21	5146.58	0.029173	5.33	13.13	67.21	1.15
Nr Rimini	1522.303	100 cfs	100	5144.97	5146.38	5146.42	5146.84	0.024556	5.46	18.32	75.1	1.09
Nr Rimini	1522.303	2yr (155 cfs)	155	5144.97	5146.66	5146.73	5147.25	0.021254	6.22	25.3	83.34	1.06
Nr Rimini	1522.303	25yr (670 cfs)	670	5144.97	5148.21	5148.48	5149.61	0.016314	9.92	79.34	205.56	1.08
Nr Rimini	1452.848	70 cfs	70	5142.68	5144.21	5143.94	5144.39	0.008069	3.44	20.42	52.41	0.64
Nr Rimini	1452.848	100 cfs	100	5142.68	5144.43	5144.15	5144.67	0.007991	3.95	25.75	59.95	0.66
Nr Rimini	1452.848	2yr (155 cfs)	155	5142.68	5144.17	5144.44	5145.15	0.044496	7.92	19.62	51.13	1.49
Nr Rimini	1452.848	25yr (670 cfs)	670	5142.68	5145.54	5146.43	5147.93	0.033208	12.72	60.71	129.35	1.5
Nr Rimini	1394.091	70 cfs	70	5142	5143.27	5143.27	5143.65	0.020853	4.97	14.08	45.12	0.99
Nr Rimini	1394.091	100 cfs	100	5142	5143.49	5143.49	5143.95	0.019213	5.45	18.41	55.42	0.99
Nr Rimini	1394.091	2yr (155 cfs)	155	5142	5143.82	5143.82	5144.42	0.017076	6.25	25.45	83.55	0.98
Nr Rimini	1394.091	25yr (670 cfs)	670	5142	5145.28	5145.65	5146.32	0.013945	9.41	130.02	286.52	1
Nr Rimini	1318.209	70 cfs	70	5139.02	5140.95	5140.63	5141.3	0.044243	4.73	14.8	10.7	0.71
Nr Rimini	1318.209	100 cfs	100	5139.02	5141.39	5140.98	5141.72	0.042749	4.64	21.65	25.98	0.77
Nr Rimini	1318.209	2yr (155 cfs)	155	5139.02	5141.54	5141.66	5142.14	0.06572	6.26	25.69	36.21	0.97
Nr Rimini	1318.209	25yr (670 cfs)	670	5139.02	5142.42	5142.96	5143.97	0.10784	11.3	75.8	144.09	1.35
Nr Rimini	1273.222	70 cfs	70	5137.82	5139.6	5139.11	5139.78	0.025035	3.37	20.78	16.49	0.53
Nr Rimini	1273.222	100 cfs	100	5137.82	5140.02	5139.34	5140.19	0.026204	3.39	29.72	30.03	0.58
Nr Rimini	1273.222	2yr (155 cfs)	155	5137.82	5140.38	5139.86	5140.61	0.022519	3.83	41.39	33.43	0.56
Nr Rimini	1273.222	25yr (670 cfs)	670	5137.82	5141.87	5141.87	5142.4	0.024688	6.43	131.34	151.71	0.66
Nr Rimini	1240	70 cfs	70	5136.62	5137.9	5137.9	5138.34	0.086682	5.36	13.05	14.34	0.99
Nr Rimini	1240	100 cfs	100	5136.62	5138.16	5138.16	5138.7	0.086704	5.89	16.99	15.36	0.99
Nr Rimini	1240	2yr (155 cfs)	155	5136.62	5138.58	5138.58	5139.23	0.090302	6.45	24.05	19.77	1.02
Nr Rimini	1240	25yr (670 cfs)	670	5136.62	5141.05	5140.33	5141.51	0.016552	5.72	126.15	97.51	0.55
Nr Rimini	1232.688	70 cfs	70	5136.27	5137.77	5137.48	5137.97	0.007742	3.59	19.51	19.26	0.63
Nr Rimini	1232.688	100 cfs	100	5136.27	5138	5137.69	5138.27	0.008141	4.18	24.06	20.93	0.66
Nr Rimini	1232.688	2yr (155 cfs)	155	5136.27	5137.76	5138.05	5138.77	0.039637	8.07	19.21	19.12	1.42
Nr Rimini	1232.688	25yr (670 cfs)	670	5136.27	5140.61	5140.61	5141.41	0.006019	7.68	124.63	140.73	0.69
Nr Rimini	1148.996	70 cfs	70	5135.56	5136.59	5136.59	5136.96	0.02123	4.85	14.42	19.44	0.99
Nr Rimini	1148.996	100 cfs	100	5135.56	5136.81	5136.81	5137.24	0.019608	5.28	18.95	21.61	0.98
Nr Rimini	1148.996	2yr (155 cfs)	155	5135.56	5137.15	5137.15	5137.68	0.016373	5.85	27.52	32.18	0.94
Nr Rimini	1148.996	25yr (670 cfs)	670	5135.56	5137.94	5138.7	5140.21	0.040935	13	70.64	78.05	1.63
Nr Rimini	1106.071	70 cfs	70	5134.32	5135.46	5135.54	5135.85	0.032021	5.03	13.92	24.52	1.18
Nr Rimini	1106.071	100 cfs	100	5134.32	5135.58	5135.71	5136.11	0.036817	5.86	17.16	29.33	1.29
Nr Rimini	1106.071	2yr (155 cfs)	155	5134.32	5135.72	5135.99	5136.56	0.044547	7.38	21.7	33.92	1.47
Nr Rimini	1106.071	25yr (670 cfs)	670	5134.32	5136.81	5137.36	5138.47	0.032347	11.21	79.88	78.38	1.44
Nr Rimini	1041.169	70 cfs	70	5133.2	5134.45	5134.39	5134.78	0.01575	4.59	15.34	20.02	0.88
Nr Rimini	1041.169	100 cfs	100	5133.2	5134.62	5134.62	5135.08	0.017702	5.47	18.87	23.11	0.96
Nr Rimini	1041.169	2yr (155 cfs)	155	5133.2	5134.94	5134.94	5135.53	0.01592	6.25	26.59	24.35	0.95
Nr Rimini	1041.169	25yr (670 cfs)	670	5133.2	5136.48	5136.55	5137.24	0.010353	8.38	125.52	84.76	0.87
Nr Rimini	971.5099	70 cfs	70	5131.47	5133.1	5133.1	5133.43	0.024223	4.6	15.2	23.69	1.01
Nr Rimini	971.5099	100 cfs	100	5131.47	5133.28	5133.3	5133.69	0.022103	5.14	19.58	26.65	1.01
Nr Rimini	971.5099	2yr (155 cfs)	155	5131.47	5133.46	5133.59	5134.11	0.02715	6.5	24.63	30.14	1.15
Nr Rimini	971.5099	25yr (670 cfs)	670	5131.47	5134.71	5135.06	5136.14	0.023246	10.37	82.45	59.63	1.22
Nr Rimini	827.9595	70 cfs	70	5128.37	5129.45	5129.48	5129.86	0.025295	5.14	13.61	18.98	1.07
Nr Rimini	827.9595	100 cfs	100	5128.37	5129.62	5129.7	5130.17	0.02717	5.96	16.79	19.7	1.14
Nr Rimini	827.9595	2yr (155 cfs)	155	5128.37	5129.96	5130.01	5130.62	0.021852	6.52	23.82	21.13	1.07
Nr Rimini	827.9595	25yr (670 cfs)	670	5128.37	5132.36	5132.01	5133.45	0.008544	8.61	86.93	31.63	0.8
Nr Rimini	816.4163	70 cfs	70	5128.21	5129.19	5129.23	5129.63	0.028209	5.36	13.07	18.86	1.13

CURRENT DATE: 09-20-2006 FILE DATE: 09-20-2006
CURRENT TIME: 12:53:45 FILE NAME: SINGLE

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ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ FHWA CULVERT ANALYSIS ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ HY-8, VERSION 6.1 ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

CULV NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	5000.00	4999.80	50.00	1 RCPA	3.02	1.88	.012	CONVENTIONAL
2								
3								
4								
5								
6								

ÄÄ
SUMMARY OF CULVERT FLOWS (cfs) FILE: SINGLE DATE: 09-20-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
5000.25	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5000.68	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5000.81	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5001.28	12.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5001.68	16.3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5001.94	20.3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5002.21	24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5002.50	28.1	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5002.84	32.1	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5003.25	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
5003.71	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

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ÄÄ
SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: SINGLE DATE: 09-20-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
5000.25	0.000	0.50	0.00	0.00
5000.68	0.000	4.45	0.00	0.00
5000.81	0.000	6.00	0.00	0.00
5001.28	0.000	12.35	0.00	0.00
5001.68	0.000	16.30	0.00	0.00
5001.94	0.000	20.25	0.00	0.00
5002.21	0.000	24.20	0.00	0.00
5002.50	0.000	28.15	0.00	0.00
5002.84	0.000	32.10	0.00	0.00
5003.25	0.000	36.05	0.00	0.00
5003.71	0.000	40.00	0.00	0.00

ÄÄ
<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000
ÄÄ
ÄÄ
PERFORMANCE CURVE FOR CULVERT 1 - 1(3.02 (ft) BY 1.88 (ft)) RCPA
ÄÄ
DIS- HEAD- INLET OUTLET

CHARGE FLOW (cfs)	WATER ELEV. (ft)	CONTROL DEPTH (ft)	CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.50	5000.25	0.20	0.25	3-M1t	0.15	0.15	0.20	0.20	1.61	0.00
4.45	5000.68	0.68	0.68	1-S2n	0.48	0.51	0.41	0.20	4.90	0.00
6.00	5000.81	0.81	0.81	1-S2n	0.57	0.60	0.50	0.20	5.04	0.00
12.35	5001.28	1.28	1.28	1-S2n	0.88	0.90	0.80	0.20	5.91	0.00
16.30	5001.68	1.57	1.68	2-M2c	1.06	1.06	1.06	0.20	5.79	0.00
20.25	5001.94	1.85	1.94	2-M2c	1.26	1.20	1.20	0.20	6.36	0.00
24.20	5002.21	2.15	2.21	2-M2c	1.53	1.32	1.32	0.20	6.89	0.00
28.15	5002.50	2.48	2.50	2-M2c	1.88	1.43	1.43	0.20	7.51	0.00
32.10	5002.84	2.84	2.69	2-M2c	1.88	1.53	1.53	0.20	8.10	0.00
36.05	5003.26	3.23	3.26	2-M2c	1.88	1.60	1.60	0.20	8.83	0.00
40.00	5003.71	3.66	3.71	2-M2c	1.88	1.68	1.68	0.20	9.49	0.00

ÄÄ

El. inlet face invert 5000.00 ft El. outlet invert 4999.80 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

ÄÄ

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***** SITE DATA ***** CULVERT INVERT **************
      INLET STATION                          100.00 ft
      INLET ELEVATION                       5000.00 ft
      OUTLET STATION                          50.00 ft
      OUTLET ELEVATION                      4999.80 ft
      NUMBER OF BARRELS                         1
      SLOPE (V/H)                               0.0040
      CULVERT LENGTH ALONG SLOPE              50.00 ft

***** CULVERT DATA SUMMARY ************************
      BARREL SHAPE         PIPE ARCH
      BARREL SPAN            3.02 ft
      BARREL RISE            1.88 ft
      BARREL MATERIAL      CONCRETE
      BARREL MANNING'S n   0.012
      INLET TYPE           CONVENTIONAL
      INLET EDGE AND WALL  GROOVED END WITH HEADWALL
      INLET DEPRESSION     NONE
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ÄÄ
ÄÄÄ
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ TAILWATER
ÄÄ

CONSTANT WATER SURFACE ELEVATION
5000.00

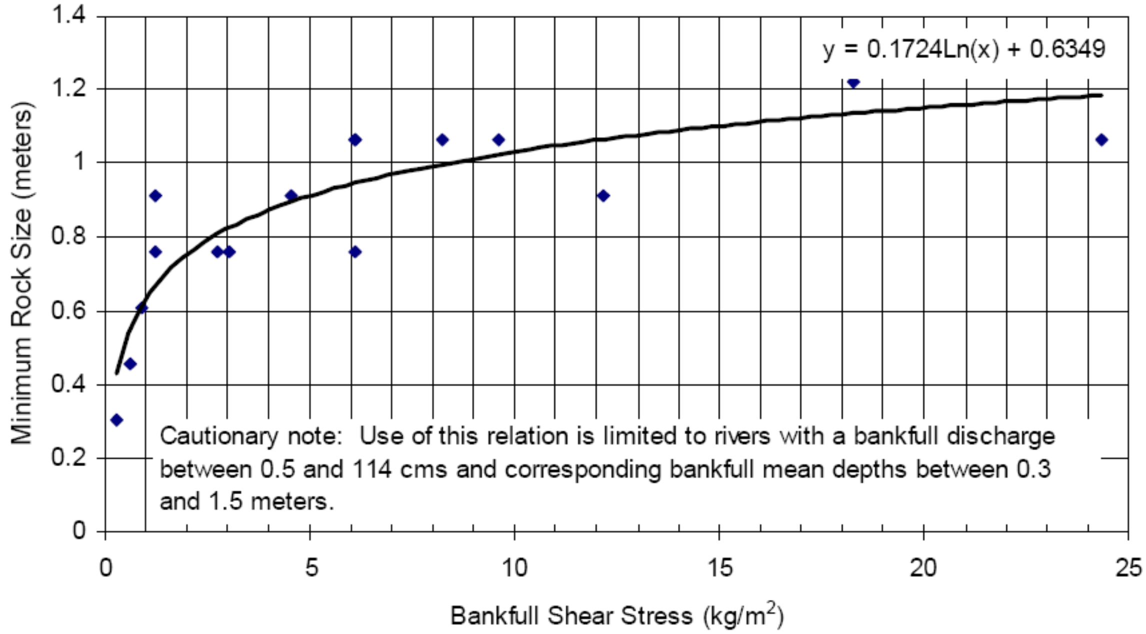

Figure 10. Minimum rock size as a function of bankfull shear stress

Reference: Rosgen, D.L., *The Cross-Vane, W-Weir and J-Hook Structures, Their Description, Design and Application for Stream Stabilization and River Restoration,* Proceedings of the 2001 Wetlands Engineering & River Restoration Conference, Reno, NV, Aug 2001.

Table 1. Limiting Shear Stress and Ve locity for Uniform Noncohesive Sediments

Class name	d_s (in)	ϕ (deg)	τ_c	τ_{cr} (lb/sf)	V_{*c} (ft/s)
Boulder					
Very large	>80	42	0.054	37.4	4.36
Large	>40	42	0.054	18.7	3.08
Medium	>20	42	0.054	9.3	2.20
Small	>10	42	0.054	4.7	1.54
Cobble					
Large	>5	42	0.054	2.3	1.08
Small	>2.5	41	0.052	1.1	0.75

Reference: Fischenich, C., *Stability Thresholds for Stream Restoration Materials*, ERDC TN-EMRRP-SR-20, May 2001.

Table 1 provides limits for idealized conditions or the stability of sediments in the bed. Therefore, these values represent a minimum stability threshold. For application at the site, rock exposure, turbulence, and other variable will reduce stability. Table 1 values are not representative of a single exposed rock above the bed surface.

Trip Report

RAMS Project: Rimini Wetland Restoration and Amphibian Habitat Enhancement Project

Location: Adjacent to Tenmile Creek, Downstream of Rimini, West of Helena, MT

Site Visit: 12 – 13 June, 2006.

Personnel: Kim Mulhern (Geotech), Gordon Lewis (Geotech), Kristine Nemec (Environmental), Daniel Pridal (Hydraulics)

State of MT Coordinator: Jesse Aber, Montana Dept. of Natural Resources and Conservation, Water Management Bureau, Helena MT

1. Activities.

Arrived at the site on the afternoon of 12 June. COE surveyors present on site and discussed survey extents. Briefly toured site and observed channel conditions. Met with forest service, state and local agency representatives and discussed project at length. State of Montana volunteered to collect channel cross sections and pebble count since stream flow velocity precluded safe data collection by COE surveyors at this time. Returned to the site on 13 June. Further coordinated with COE surveyors regarding survey extents at site. Toured site and collected photos and observations. Located cross section markers at 6 locations for future MT state survey effort. Conducted pebble count of sediment plume on right bank across Rimini Road that was presumed deposited from the 1981 flood. Performed preliminary field location of project features.

2. Observations.

Observations of noted features include:

New Bridge Crossing:
A newly constructed bridge and twin culvert crossing located west of the bridge in the left overbank has been installed just downstream of the site.

Town of Rimini Septic Field:
The newly constructed town of Rimini septic field is located on the right bank downstream of the new road and bridge. The project should be designed to provide stability protection and not pose a flood threat to this area.

Sediment Flow:
Numerous sediment deposition areas consisting of cobbles and gravels are present throughout the overbank area. Discussion indicated that a major flood occurred in 1981. Plans were furnished by the County that illustrate flood repair work following the 1981 flood. Based on the plans and photos of the site, it appears that the channel was temporarily flowing down the road and in the right overbank (east of Rimini Road) location. Repair work was conducted to remove sediment blockage and reconstruct the channel. Verbal accounts indicated that Rimini residents were airlifted from the town.

Tenmile Creek:
During the site visit, streamflow recorded at Tenmile Creek near Rimini Gage (retrieved from the USGS web site for gage 06062500, located about 1.5 miles downstream of the site:

12 June, 2006 – Gage Height 2.63, flow 104 cfs
13 June, 2006 – Gage Height 2.53, flow 89 cfs

Streamflow at the time of the site visit appeared to be roughly near bankfull based on the submerged vegetation and waterline. No direct overbank flow was occurring although seepage resulted in numerous wet areas. Viewed through the occurring streamflow, the channel appeared to consist of medium to large cobbles with many intermittent boulders. Many log debris jams were observed through the site and downstream. Channel conditions through the site appear stable with no observed bank failure sections. The channel width through the site may be constricted in some locations. The rock berm prevents significant overbank flow on the right side although the left bank is available with observed flow sections. Downstream of the site, a large mid-channel bar is present that may indicate some deposition. This may be related to the upstream rock berm and channel constriction.

EPA Superfund Project:
An active superfund project is located upstream of the site. A construction contractor trailer is located adjacent to Rimini Road within the site.

Right Overbank East of Rimini Road:
The right overbank east of Rimini Road contains undulating topography with what appears to be a constructed small diversion canal. However, the sediment deposition plume located toward the downstream end of the project has filled the canal. Since this material was not excavated, the diversion canal is presumed to be inactive.

Chessman Road Crossing.
Within the right overbank downstream of the site on the east side of Rimini Road, the topography includes what appears to be an old channel segment. The old channel terminates at Chessman Road with a 12 to 18” diameter culvert. The culvert is mostly blocked with debris and sediment, an outlet on the downstream side could not be located. A noticeably inflow was observed. The pasture on the downstream side has an undrained low spot.

Looking upstream from road at channel in reach below project.

From right bank looking downstream at stream channel and snags, in reach below project. Is noticeable drop through this reach that includes the mid-channel bar.

From right bank looking downstream at mid channel bar/snag and wsel drop. Snag is located on large boulder rapid across channel.

Further upstream looking from right bank at snag and drop.

From downstream right bank looking upstream at new bridge.

From right bank looking downstream at rock berm, just below trailer.

From right bank looking upstream at rock berm and work trailer.

From right bank, just upstream of trailer looking at rapid section and rock berm on right bank.

From right bank looking upstream at rapids with close up, and bend above drop reach. Notice large size rock and turbulence.

On east side of Rimini Road (away from stream) looking at sediment plume deposition from flood.

From Chessman road turnoff looking northwest, standing near culvert entrance. Looking at pasture with no located culvert outlet, ponds in corner near road. Stream is across road.

From channel looking at culvert entrance. Appeared to be an 12 to 18” culvert mostly blocked by vegetation and sediment. Culvert at base of slope near photo center. Top of road visible at photo top.

From Chessman road looking upstream at old channel above culvert entrance.

From top of left bank near XS#6 point (upstream end of project) looking downstream.

From top of left bank near XS#6, looking downstream with focus upstream of previous photo.

From top of left bank near XS#6, looking downstream with focus upstream of previous photo, looking at opposite bank.

From top of left bank near XS#6, looking downstream with focus upstream of previous photo, looking at opposite bank and low saddle in rock berm. Evergreen tree area is natural high spot, near possible culvert location beneath Rimini Road for wetlands on east side.

Looking at lathe marker for XS#6, typical marker for all six cross section endpoints.


On left bank just upstream of XS#5 marker, looking upstream at approaching channel.


On left bank near XS#5 marker, looking downstream.

Looking upstream on left bank, lathe for XS# 5, large boulder to big Aspen on left bank is straight reach, potential widening reach, swing back to join channel at top of rapids.

Looking downstream from same point as previous photo at top of rapids from left bank.

Looking from left bank near XS#5 toward natural overall reach that drains to culverts.

Two 42” diameter CMP beneath new road crossing that provides outlet for left bank overland flow.

From road looking downstream at outlet for 2 42” culverts.

From road centerline of culvert crossing looking toward bridge and main channel.

From right bank near opposite of XS#6 looking upstream at rock berm, looks to be built of river sediment with gravel and cobbles.

On right bank near upstream end of possible diversion to wetland, toe of left bank hill slope starts just upstream, dike height decreases to about 4 ft in this area (8 ft d/s).


On right bank, same location as previous looking further downstream at main dike with 8 ft height compared to lower dike of 4 ft in upstream area.

Appendix D
Information for Permit Application

Rimini Wetland Restoration and Amphibian Habitat Enhancement
Tenmile Creek Near Rimini, Montana

Draft Report
September 2006

US Army Corps
of Engineers ®
Omaha District

INFORMATION FOR APPLICANT

Instructions for filling out the Joint Application for Proposed Work in Montana's Streams, Wetlands, Floodplains, and Other Water Bodies

Please Read Carefully

This application form can be used to obtain permits from the local, state, and federal agencies listed in the box below. Use the box below to determine which permits you may need for your project (contact information is provided); to determine the number of copies of the application to send; to determine what additional information is needed; and to determine what fees, if any, apply.

After completing this form, send the required number of copies, with original signatures, to each applicable agency. Each agency issues separate permits. You must obtain individual authorizations or permits from each agency to which you apply before conducting your work.

For more information about permitting requirements, review "*A Guide to Stream Permitting in Montana,*" available from all participating agencies or on line at www.dnrc.state.mt.us/permit.html. Please note: permits from agencies other than those listed on this application form may be required. You must apply to those agencies on separate forms if the law applies.

Do not submit fees with this application. Fees listed are for information only. The responsible agency will contact you when a fee applies.

√	PERMIT/ WHO MUST APPLY	AGENCY	AGENCY CONTACTS / ADDRESSES AND ADDITIONAL INFORMATION	REVIEW TIME	FEES – DO NOT SEND PAYMENT
	310 Permit Private citizens and companies working in or near perennial streams.	Local Conservation District	Submit three copies of application, maps, and plans to conservation district. To locate local office, call MT Assoc. of Conservation Districts (406) 443-5711 or Conservation Districts Bureau, DNRC (406) 444-6667; or visit www.dnrc.state.mt.us/conserve.html.	30 – 60 days	No fee
	SPA 124 Permit Governmental entities working in any stream.	Montana Department of Fish, Wildlife & Parks (DFWP)	Submit a set of preliminary plans or sketches with application. To locate appropriate office, call DFWP in Helena (406) 444-2449. For projects sponsored by DOT, send two sets of plans to Helena DFWP, Box 200701, Helena MT 59620-2701.	60 days	No fee
	Floodplain Permit Applicants proposing new construction within designated floodplains.	County Floodplain Administrator	Prior to submitting this application form, contact local floodplain administrator at the county office or locate appropriate office by calling DNRC Water Resources Division (406) 444-6601. Applicant may be required to hire a professional engineer.	60 days	Varies ($25 - $400)
	Section 404 Permit Applicants working in any stream and in wetlands. **Section 10 Permit** Applicants working on Yellowstone, Missouri, or Kootenai Rivers or their reservoirs.	U.S. Army Corps of Engineers (COE)	Submit one copy of application plus a set of construction plans or sketches of the proposed project, if available. See special signature requirements following "Information for Applicant". US Army Corps of Engineers, 10 West 15th Street Suite 2200, Helena MT 59626; (406) 441-1375.	30 -- 120 days	Varies ($0 - $100) You will be contacted if fee applies.
	318 Authorization Activities that cause temporary turbidity in any state water.	Montana Department of Environmental Quality (DEQ)	Do not send this form directly to DEQ if applying for a 310 or 124 permit. You will be notified if you must apply on the 310 or 124 permit you receive. Dept. of Environmental Quality, Permitting and Compliance Division, Water Protection Bureau, Box 200901, Helena MT 59620-0901; (406) 444-3080.	30 days after application and fee are received.	$150
	Navigable Rivers Land Use License/ Easement -- Projects in, on, under, or over navigable waters.	Montana Department of Natural Resources and Conservation (DNRC)	Additional fees, a land survey, and other information will be required. Contact the local DNRC land office for information. To locate appropriate Land Office, call Special Use Management Bureau at (406) 444-2074. To determine if your project is on a navigable waterway, visit: www.dnrc.state.mt.us/trust/tlmdhome.htm.	License – up to 60 days. Easements – up to 90 days.	License $25 Easement $50

GUIDELINES FOR COMPLETING THE JOINT APPLICATION

The sections indicated below refer to the corresponding sections on the application form. Sections A, B, and C must be completed for all applications. Section D is to be completed only if you are applying for a Floodplain Permit, Section 404 Permit, or Section 10 permit.

A. APPLICANT INFORMATION. The applicant can be the landowner or any authorized agent of the landowner. The name and address of the owner of the land where the project will be constructed are required if different from the applicant. Be aware that the issuance of any permit does not give permission to carry out a project on land that is not owned by the applicant. The applicant has the duty to secure necessary landowner authorization.

B. PROJECT SITE INFORMATION. This information is required to locate the site and the water body where the work will be completed. Be sure to include directions to the site. Attach an additional sheet or site map that clearly shows the project location and any identifying landmarks. Geocodes help locate the property where the project will be constructed and are available online at: **www.gis.doa.state.mt.us/cadastral/textsearch.html** Leave the Geocode line blank if you don't have access to the internet.

C. PROJECT INFORMATION. This section provides space for you to describe your project and the steps you will take to minimize impacts. Projects must be constructed in a way that minimizes impacts to the water body. Some agencies and conservation districts may require you to follow specific standards for project design, materials used, or re-vegetation.

1. Be sure to attach a plan or drawing that includes the information requested. Your application will be rejected if project plan or drawing is not provided.

2. Type of Project. Check all boxes that apply to the proposed work.

3. Purpose. Describe the need and purpose of the proposed work. What will it be used for and why?

4. Annual Maintenance. Conservation districts may authorize minor maintenance activities for up to ten years. If the proposed work will be conducted each year, check this box. An annual plan of operation would include the nature and extent of work to be conducted each year. It should include, at minimum, a detailed description of the work to be done, the timing of the work proposed, and the amount of streambed materials to be removed, as well as other information required by the district. If the conservation district authorizes an annual maintenance permit, the application still may be required to seek approval from other agencies prior to doing work each year.

5. Proposed Construction Date. The timing of construction is an important factor in determining impacts to water quality, fish, and aquatic life. Authorizations/permits may contain timing restrictions on construction activities.

6. Dimensions of the Project. Generally describe the impact area of your project and provide the dimensions listed. Use the high water mark as a point of measure. If you are unsure of the high water mark, specify another point of measure.

7. Vegetation. Vegetation is important for bank stability and maintaining water quality. Most agencies require that only the vegetation necessary to conduct the work be removed. Describe the vegetation present at the site. Reseeding and replanting is usually required; describe your plan to re-vegetate the area. USDA, Natural Resources and Conservation Service standards are usually accepted standards for re-vegetation.

8. Materials. What materials are going to be used for your project? Where were they obtained? How much are you planning to use. All materials used must be of adequate size and dimension for the project and be free of pollutants. If streambed or other materials are removed from the bed of a stream, they must be removed from the area so they don't reenter the stream.

9. Equipment. List all equipment that will be used for construction of the project. Make sure your equipment is clean and free of excess grease, weeds, and weed seeds before using it in the waterway. To prevent the spread of whirling disease, remove all mud and aquatic plants from heavy machinery and other equipment before moving between waters and work sites. Drain water from machinery and let machinery dry before moving to another location.

10. Steps during construction and after to minimize impacts. Use the space provided to describe what you plan to do to minimize the impact of the proposed project during and after construction. Examples would include sediment fences along the bank or below the proposed work, coffer dams to direct flow away from the project area, fish friendly diversions or stream crossings, re-vegetating disturbed areas, timing of the project, or care in selection of sites and methods used to

construct the project.

D. ADDITIONAL INFORMATION FOR SECTION 404, SECTION 10, AND FLOODPLAIN PERMITS

Information in Section D is specific to Section 404, Section 10, and Floodplain permits. Answer Questions 1-4 if you are applying for a Section 404 or Section 10 permit from the US Army Corps of Engineers. Answer Questions 4-6 if you are applying for a Floodplain Permit from the local floodplain administrator. (Question 4 is required for both.)

1. See definitions listed below for aquatic areas, wetlands, fill material, and how to calculate materials and impacted areas.
2. Indicate names and addresses and addresses of any nearby landowner(s) who may be affected by your project.
3. See definition of mitigation and compensatory mitigation below.
4. For floodplain permits, all permits must be in place before a floodplain permit can be issued.
5. If your project site is in a designated floodplain, the waterway will have a FEMA map number. Contact the county government in which your project will take place to obtain the number.
6. Check with the county government to see if there are special planning or zoning regulations.

Definitions:

- **Aquatic areas** include (but are not limited to) rivers, streams, creeks, lakes, reservoirs, wetlands, wet meadows, oxbows, and sloughs. Named and unnamed drainages that flow intermittently, as well as streams with perennial flow, are aquatic areas (waters of the United States).
- **Fill material** refers to rock, sand, dirt, or any material that replaces an aquatic area with dry land, or changes the bottom elevation of a water body. Prohibited fill material includes junk metal, car bodies, construction debris, trash, etc.
- **Mitigation** means avoiding and/or minimizing impacts to aquatic areas, and compensating for unavoidable impacts. **Compensatory mitigation** refers to replacing aquatic resources that have been lost, with similar aquatic resources. Compensatory mitigation may include creating new, restoring degraded, or enhancing existing aquatic areas.
- **Wetlands** include areas that are inundated or saturated with water long enough to support vegetation typically adapted for life in saturated conditions. Wetlands are generally determined on a site-by-site basis. If you are not sure whether a wetland will be impacted by your proposed project, contact the Corps of Engineers.
- **To calculate impacted area**, measure the length and width that the fill material will occupy. Length x width = area, usually expressed in square feet, square yards or acres. If your project involves a stream, measure the length of bank that will be affected on both sides of the stream.
- **To calculate the volume of material**, measure the length, width, and depth of the fill material. Length x width x depth = volume, usually stated in cubic feet or cubic yards.

SIGNATURE REQUIREMENTS FOR THE U.S. ARMY CORPS OF ENGINEERS
(Section 404 or Section 10 Permit Applications)

Applications submitted to the U.S. Army Corps of Engineers have certain signature/authorization requirements. On the signature portion of the application form, there are three signature lines. The Corps requires the signature of the applicant, landowner, and any agent acting on their behalf.

***If you are a landowner** submitting this application and proposing to undertake a project on your own behalf, please sign and date both the “Signature of Landowner” and “Signature of Applicant” lines.

***If you are a consultant/contractor** acting as an agent on behalf of a landowner, please sign and date only the line designated “Signature of Agent” and indicate your title. The landowner must sign and date the “Signature of Landowner” and “Signature of Applicant” lines to indicate authorization for you to act on his/her behalf.

***If a utility company submits this application**, a representative of the company should sign and date the “Signature of Applicant” line. Landowner signatures are not required.

Application Revised: 09/24/03 Form may be downloaded from: www.dnrc.state.mt.us/permit.html	**AGENCY USE ONLY**: Application # ___________ Date Received ____________ Date Accepted ________________ Date Forwarded to DFWP ______________

JOINT APPLICATION FOR PROPOSED WORK IN MONTANA'S STREAMS, WETLANDS, FLOODPLAINS, AND OTHER WATER BODIES

Use this form to apply for one or all of the local, state, or federal permits listed below. The insert titled "Information to Applicant" includes agency contact information and instructions on how to complete this application. After completing the form, make the required number of copies and sign each copy. Send the copies, with original signatures and additional information required, directly to each applicable agency. T**o expedite your application**, be sure all required information, including **a project site map and drawings** are included. Incomplete applications will be rejected. **Note: other laws may apply**. It is your responsibility to obtain all permits and landowner permission, if applicable, before beginning work.

✓	PERMIT	AGENCY	FEE
	310 Permit	Local Conservation District	No Fee
	SPA 124 Permit	Department of Fish, Wildlife and Parks	No Fee
	Floodplain Permit	County Floodplain Administrator	Varies ($25 - $400)
	Section 404 Permit, Section 10 Permit	U. S. Army Corps of Engineers	Varies ($0 - $100)
	318 Authorization	Department of Environmental Quality	$150
	Navigable Rivers Land Use License or Easement	Department of Natural Resources and Conservation	License $25; Easement $50

A. APPLICANT INFORMATION

NAME OF **LANDOWNER** at project location:____
Mailing Address: ____Day Phone: __________________________
Physical Address: ____Evening Phone: ______________________
City/State/Zip: ____

NAME OF **APPLICANT** (if different from landowner): ____
Applicant is: □ Landowner □ Contractor □ Other (explain)
□ Government Agency □ Landowner's Agent (title)
Has the landowner consented to this project? □ Yes □ No
Mailing Address: ____Day Phone: ________________________
Physical Address: ____ Evening phone: ______________________
City/State/Zip: ____

B. PROJECT SITE INFORMATION

NAME OF **STREAM** or **WATER BODY** at project location _____________ Nearest Town ______________
Address/Location:________________________________Geocode (if available): _________________________
____1/4 ____1/4 ____1/4, Section ________, Township _________, Range _________ County ____________
Longitude _____________________, Latitude _________________________________ (if available)

ATTACH A MAP OR A SKETCH of the project site that includes: 1) the water body where the project will take place, roads, tributaries, landmarks; 2) directions to the site; 3) a circled "X" representing the exact project location.

This space is for all Department of Transportation and SPA 124 permits (government projects)..
Project Name _______________________________________
Control Number _____________________________ Contract letting date ____
MEPA/NEPA Compliance ☐ Yes ☐ No

C. PROJECT INFORMATION

1. In addition to the information requested below, a **PLAN OR DRAWING** of the proposed project **MUST** be attached. **This plan or drawing must include**: 1) a plan view (looking at the project from above; 2) an elevation view (looking at the project from either the right or left; 3) dimensions of the project; 4) dimensions and location of fill or excavation sites; 5) location of storage or stockpile materials; 6) location of existing or proposed structures, such as buildings, utilities, roads, or bridges; 7) drainage facilities; 8) an arrow indicating north. Floodplain permit applicants are encouraged to inquire locally since additional information is usually required.

2. TYPE OF PROJECT (check all that apply)

- ☐ 1. Stream Crossing (bridges, culverts, fords)
- ☐ 2. Bridge/Culvert Removal
- ☐ 3. Road Construction/Maintenance
- ☐ 4. Bank Stabilization
- ☐ 5. Flood Protection
- ☐ 6. Channel Alteration
- ☐ 7. Irrigation Structure
- ☐ 8. Water Well/Cistern
- ☐ 9. Fish Habitat
- ☐ 10. Recreation (docks, marinas, etc.)
- ☐ 11. New Residential Structure
- ☐ 12. Manufactured Home
- ☐ 13. Improvement to Existing Structure
- ☐ 14. Commercial Structure
- ☐ 15. Wetland Alteration
- ☐ 16. Temporary Construction Access
- ☐ 17. Mining
- ☐ 18. Dredging
- ☐ 19. Core Drill
- ☐ 20. Placement of Fill
- ☐ 21. Diversion Dam
- ☐ 22. Utilities
- ☐ 23. Pond
- ☐ 24. Other _______

3. WHAT IS THE PURPOSE of the proposed project?

4. IS THIS APPLICATION FOR an annual maintenance permit? ☐ Yes ☐ No
(If yes, an annual plan of operation must be attached to this application – see "Information for Applicant")

5. PROPOSED CONSTRUCTION DATE: Start _____/_____/_____ Finish _____/_____/_____
Is any portion of the work already completed? ☐ Yes -- If yes, describe the completed work. ☐ No

6. DIMENSIONS OF THE PROJECT. Describe the impacted area. How many linear feet of bank will be impacted? How far will the proposed project extend into and away from the water body?

7. VEGETATION. Describe the vegetation at the site. What type and how much vegetation will be removed or covered with fill material? How will the disturbed area be revegetated?

8. MATERIALS. Describe the materials to be used and how much (cubic yards, linear feet, size, type, source of each).

9. EQUIPMENT. What equipment will be used for the proposed work?

10. WHAT STEPS WILL BE TAKEN DURING AND AFTER CONSTRUCTION TO MINIMIZE:

- Erosion, sedimentation, or turbidity?
- Stream channel alterations?
- Effects of stream flow or water quality caused by materials used or removal of ground cover?
- Effects on fish and aquatic habitat?
- Risks of flooding or erosion problems upstream and downstream?

D. ADDITIONAL INFORMATION FOR SECTION 404, SECTION 10, AND FLOODPLAIN PERMITS
If you are applying for a Section 404 or Section 10 permit, fill out questions 1-4. If you are applying for a Floodplain Permit, fill out questions 4-6. (Question 4 is required for Section 404, Section 10, and floodplain permits.)

1. Will the project involve placement of fill material in a wetland? If yes, describe. How much wetland area will be filled? Calculation the impacted area. Note: A delineation of the wetland may be required.

2. List the names and address of landowners adjacent to and across from the project site. (At its discretion, the permitting agency may contact these landowners.)

 ____

 ____

 ____

3. If there is a plan for compensatory mitigation, describe the location, nature, and amount of proposed mitigation on an attached sheet.

4. If you have already applied for any permits, list them and indicate whether they were issued, denied, or are pending. (Required for Section 404, Section 10, and Floodplain Permits.)

5. FEMA Map Number (if available)____________________________

6. Does this project comply with local planning or zoning regulations? ☐ Yes ☐ No

E. SIGNATURES/AUTHORIZATIONS

Each copy submitted to an agency must have original signature(s).

I certify that the above statements are true and correct. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the landowner. I authorize the inspection of the project site by inspection authorities. Both the landowner and the person doing the work have the duty to comply with the stipulations of permits and laws.

*Signature of Landowner	Date	Signature of Applicant	Date

**(May be waived by agency for utilities and other easement holders)*
For Section 404/Section 10 applications, see signature Requirements for US Army Corps of Engineers in the "Guidelines For Completing Application."

Contractor/Agent	Date

DISPUTE RESOLUTION – 310 PERMIT APPLICANTS ONLY

As the applicant, if you disagree with the conservation district's decision on this application and wish to seek formal resolution, you may ask for a judicial review by filing a petition in district court **or** you may request a review by a three-member arbitration panel. **You are not required to make the choice** between judicial review and arbitration unless you disagree with the conservation district's final action on this application and want to take formal action. The conservation district will provide you with information about resolving disputes when the 310 permit is issued. However, you may choose arbitration when you file this application or wait until you receive the permit decision. By choosing arbitration at the time of filing this application, you waive your right to have the final decision reviewed by district court.

If **you wish** to elect **arbitration**, please **check** the box. If you wish to **decide later** and retain your right for judicial review, **do not check** this box.

☐ I agree to arbitration as the exclusive means of review of a conservation district's decision on a 310 permit. I elect to sign an arbitration agreement as part of this application process and request a copy of the agreement. _________ (Initial)