Dominguez Canyon Wilderness

Fisheries Report

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
NATIONAL SYSTEM OF PUBLIC LANDS

Introduction

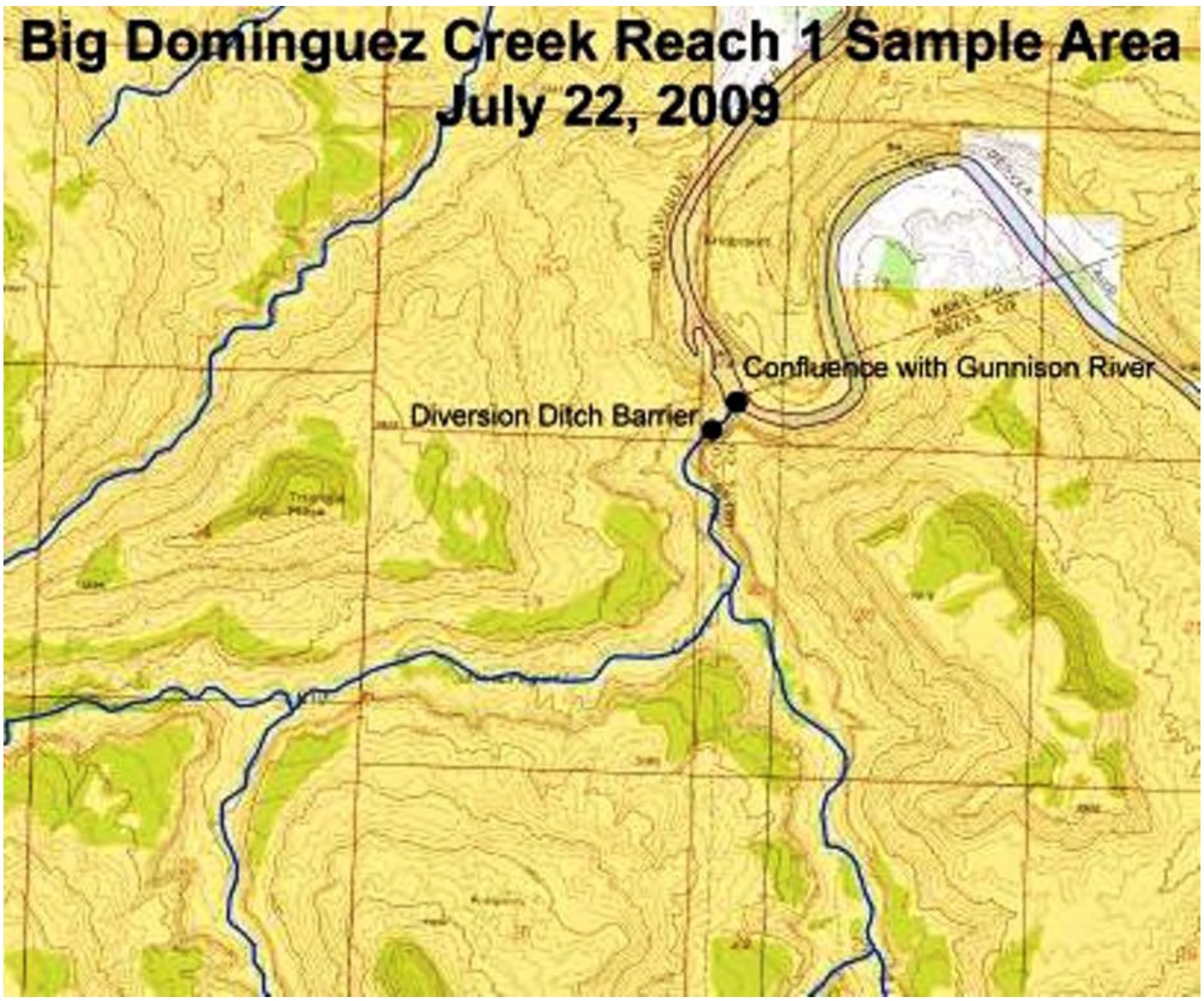
This report is organized into two sections. Section 1 provides fisheries information concerning Big Dominguez Creek. Section 2 provides fisheries information concerning Little Dominguez Creek. The fisheries in the two streams are related, because Little Dominguez Creek enters Big Dominguez Creek approximately one mile upstream from the Gunnison River, and there are no physical barriers to prevent movement of fishes between the two streams.

The objective of this report is to document the species found in the two creeks, document locations in which the various fish are found, and document limiting factors on the fish populations. The fisheries populations in these two creeks are unique. There are very few lower elevation creeks on the western slope of Colorado which support three different species of fish, in which each species isolated from other species in the creek by physical barriers.

Section 1 – Big Dominguez Creek

Big Dominguez Creek, located south of Grand Junction, Colorado on lands managed by the BLM Grand Junction Field Office, was sampled on June 24, 2008 and July 22 and 23, 2009. Big Dominguez Creek is tributary to the Gunnison River. Fish sampling was conducted in four different reaches to determine fisheries composition and relative abundance. Reach 1 is located from the confluence with the Gunnison River upstream approximately 150 yards to a diversion ditch barrier. Reach 2 is located between the diversion ditch barrier and the confluence with Little Dominguez Creek. Reach 3 is located between the confluence with Little Dominguez Creek and a point located approximately approximately 2.5 miles upstream. Reach 4 is located between a point just below BLM's Dominguez Campground to a point approximately 2.5 miles downstream. All sampling was conducted via backpack electro-shocker.

Reach 1



STREAM SURVEY FISH SAMPLING FORM

WATER: Big Dominguez Creek H2O CODE: 39811 DATE: 7/22/2009

GEAR: Backpack Electroshocker EFFORT: ~ 425 ft. STATION # 1 PASS # 1

CREW: Fresques, CDOW seasonal DRAINAGE: Gunnison River LOCATION: From confluence with the Gunnison River upstream to the diversion ditch barrier –See Map.

Reach 1 Pass 1

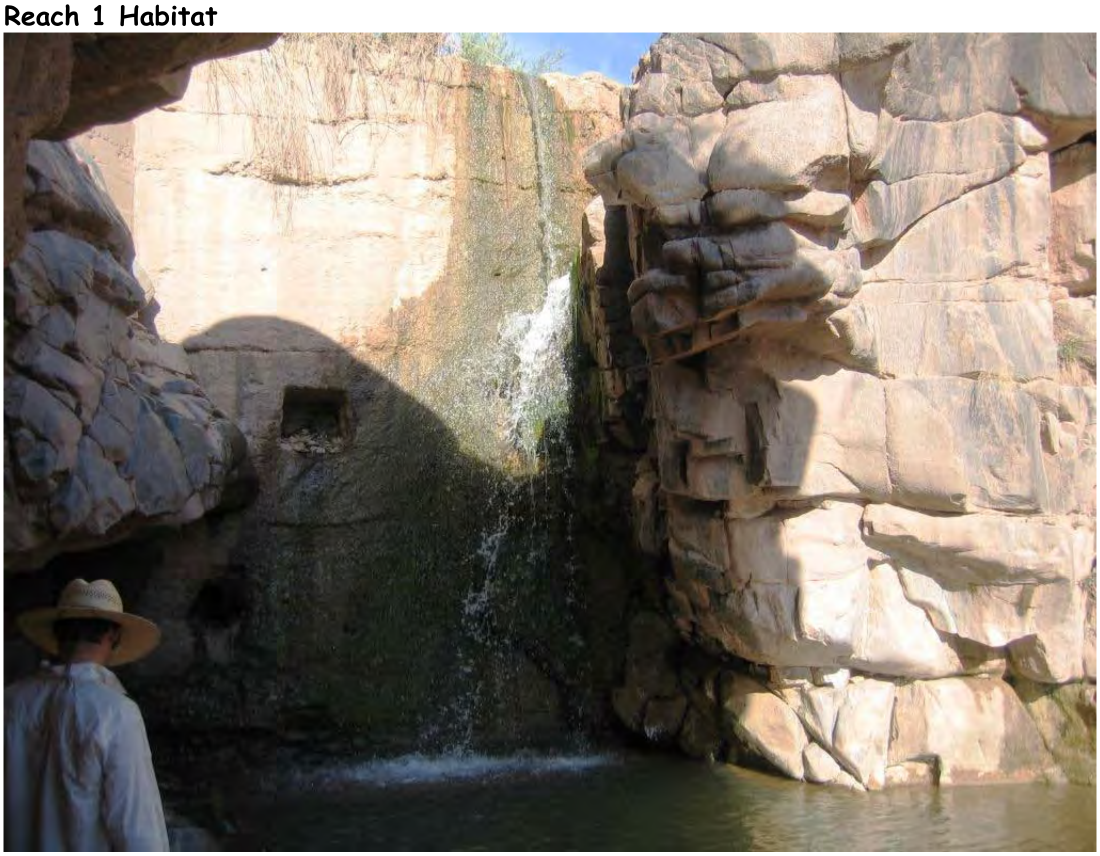
species	length	weight	mark		species	length	weight	mark
RTC	62				RTC	61		
RTC	55				RTC	66		
RTC	56				RTC	66		
RTC	58				RTC	51		
RTC	57				RTC	58		
RTC	59				RTC	114	5	
RTC	63				RTC	71		
RTC	68				RTC	63		
RTC	77				RTC	106	5	
RTC	66				RTC	60		
RTC	59				RTC	55		
RTC	65				RTC	53		
RTC	75				RTC	67		
RTC	65				RTC	60		
RTC	71				RTC	99	6	
RTC	69				RTC	62		
RTC	66				RTC	72		
RTC	72				RTC	81	3	
RTC	51				RTC	58		
RTC	64				RTC	65		
RTC	55				RTC	104	7	

RTC	107	6			RTC	64		
RTC	90	4			RTC	107	8	
RTC	57				RTC	65		
RTC	69				RTC	54		
RTC	61				RTC	121	14	
RTC	59				RTC	104	5	
RTC	70				RTC	111	8	
RTC	75				RTC	55		
RTC	61				RTC	110	7	
RTC	88	5			RTC	74		
RTC	85	4			SPD	44		
SPD	31				SPD	70		
SPD	45				SPD	61		
SPD	50				SPD	52		
SPD	32				SPD	63		
SPD	60				SPD	62		
SPD	55				RSH	58		
SPD	64				RSH	52		
SPD	45				RSH	59		
SPD	61				RSH	50		
SPD	65				RSH	51		
SPD	58				RSH	51		
FMS	52				RSH	56		
FMS	56				RSH	50		
FMS	60				GSF	115		
FMS	67				GSF	96		
FMS	71				GSF	78		
FMS	57				CCP	39		
FMS	58				CCP	58		
FMS	63				CCP	44		
FMS	60				CCP	53		

FMS	68				CCP	52		
FMS	70				CCP	50		
FMS	61				CCP	52		
FMS	59				CCP	51		
FMS	60				FHM	70		
FMS	75				BGF	104		
FMS	55							
FMS	71							
RSH	58							
RSH	67							
RSH	54							
RSH	57							
RSH	63							
RSH	57							

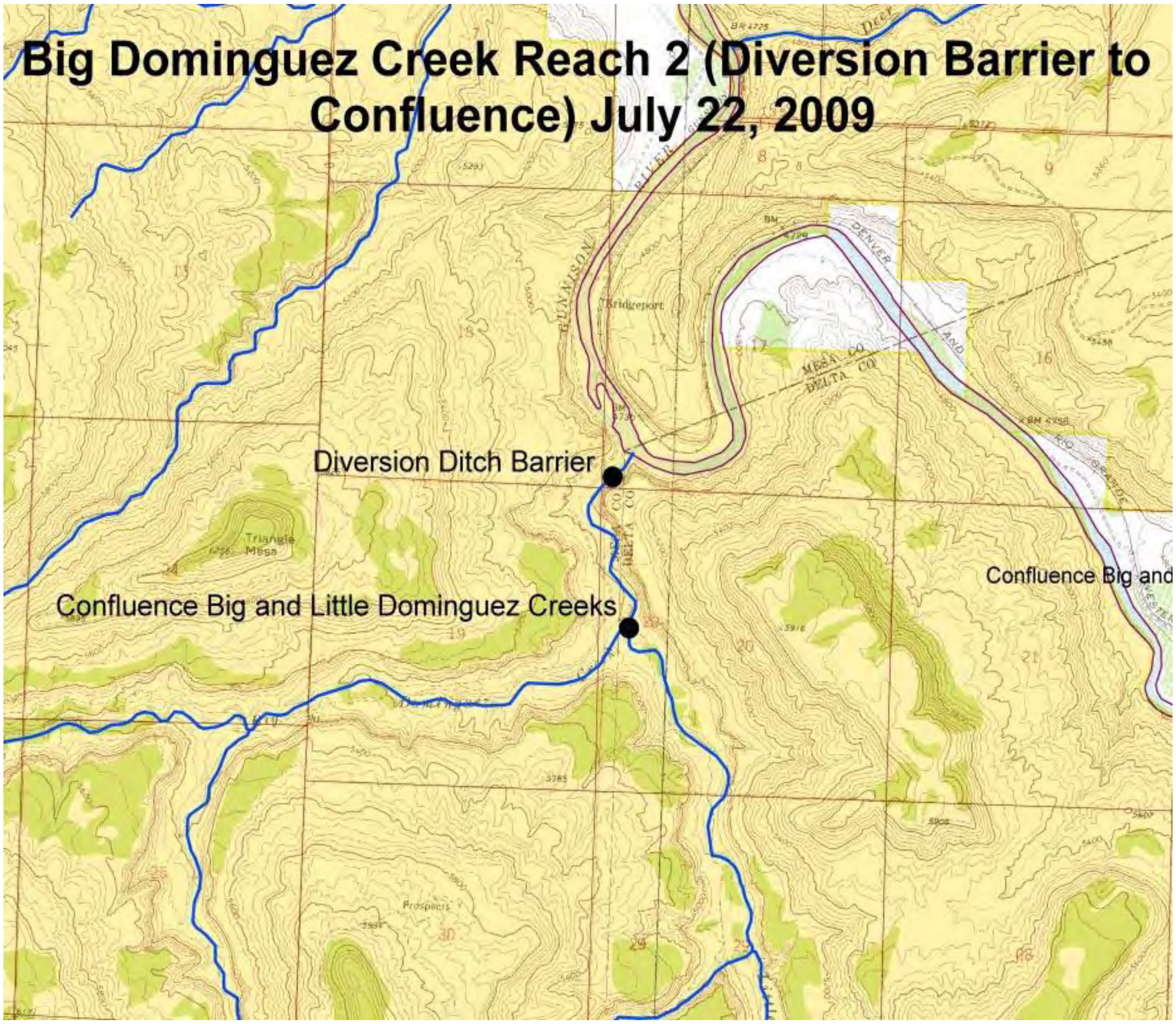
RTC= Roundtail Chub, FMS=Flannelmouth Sucker, RSH=Red Shiner, SPD=Speckled Dace, FHM=Fathead Minnow, GSF=Green Sunfish, CCP=Common Carp, BGF=Bluegill


Reach 1 at confluence with Gunnison River


Reach 1 Habitat

Reach 1 Diversion Barrier

Reach 1 Discussion:
This reach was sampled to determine species composition and relative abundance. The entire reach was spot sampled within the variety of habitats present (pools, riffles, runs). Several species were collected but roundtail chubs were the most prominent species observed. This portion of the creek appears to be an important roundtail chub rearing area. Several age classes of chub were noted included a majority of young-of-year fish.

Reach 2



STREAM SURVEY FISH SAMPLING FORM

WATER: Big Dominguez Creek H2O CODE: 39811 DATE: 7/22/2009

GEAR: Backpack Electroshocker EFFORT: ~ 5/8 mile Reach # 2 PASS # 1

CREW: Ramey, Dekleva, Fresques, DRAINAGE: Gunnison River LOCATION: From the Diversion ditch barrier upstream to the confluence with Little Dominguez Creek –See Map.

Reach 2 Pass 1

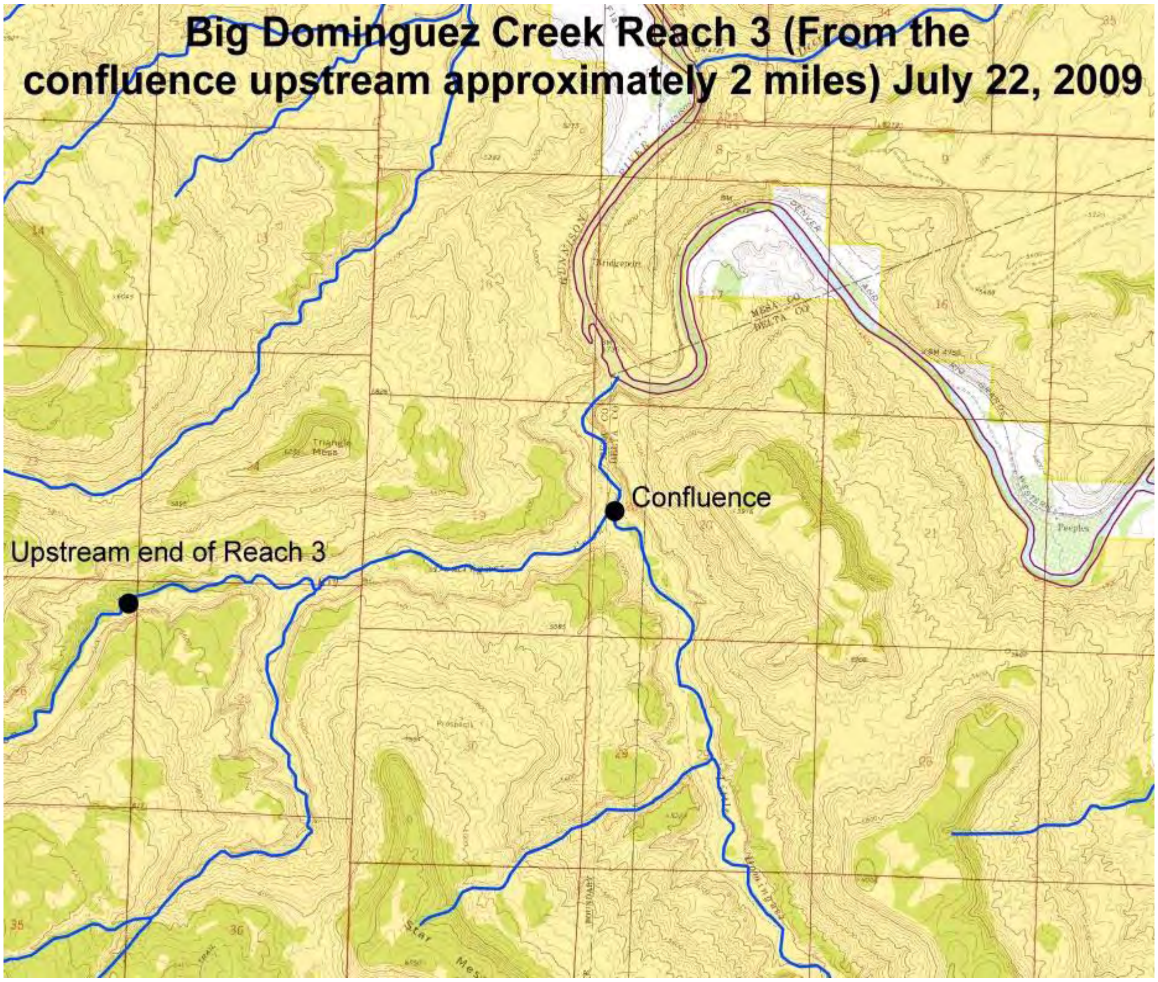
species	length	weight	mark		species	length	weight	mark
SPD								

Only Speckled dace were collected. This species was abundant and several hundred fish were observed and collected via spot sampling within this reach. Fish ranged in size from approximately 40 millimeters to 110 millimeters total length.


Reach 2

Reach 2 Discussion:
This reach was spot sampled to determine species composition and relative abundance. The variety of habitats present (pools, riffles, runs) were sampled. One species of fish were collected, native speckled dace. A variety of age classes were present and this species was very abundant.

Reach 3



STREAM SURVEY FISH SAMPLING FORM

WATER: Big Dominguez Creek H2O CODE: 39811 DATE: 7/23/2009

GEAR: Backpack Electroshocker EFFORT: ~ 2 miles STATION # 3 PASS # 1

CREW: Ramey, Dekleva, Kowalski, Jones DRAINAGE: Gunnison River LOCATION: From the confluence with Little Dominguez Creek upstream approximately 2 miles –See Map.

Reach 3 Pass 1

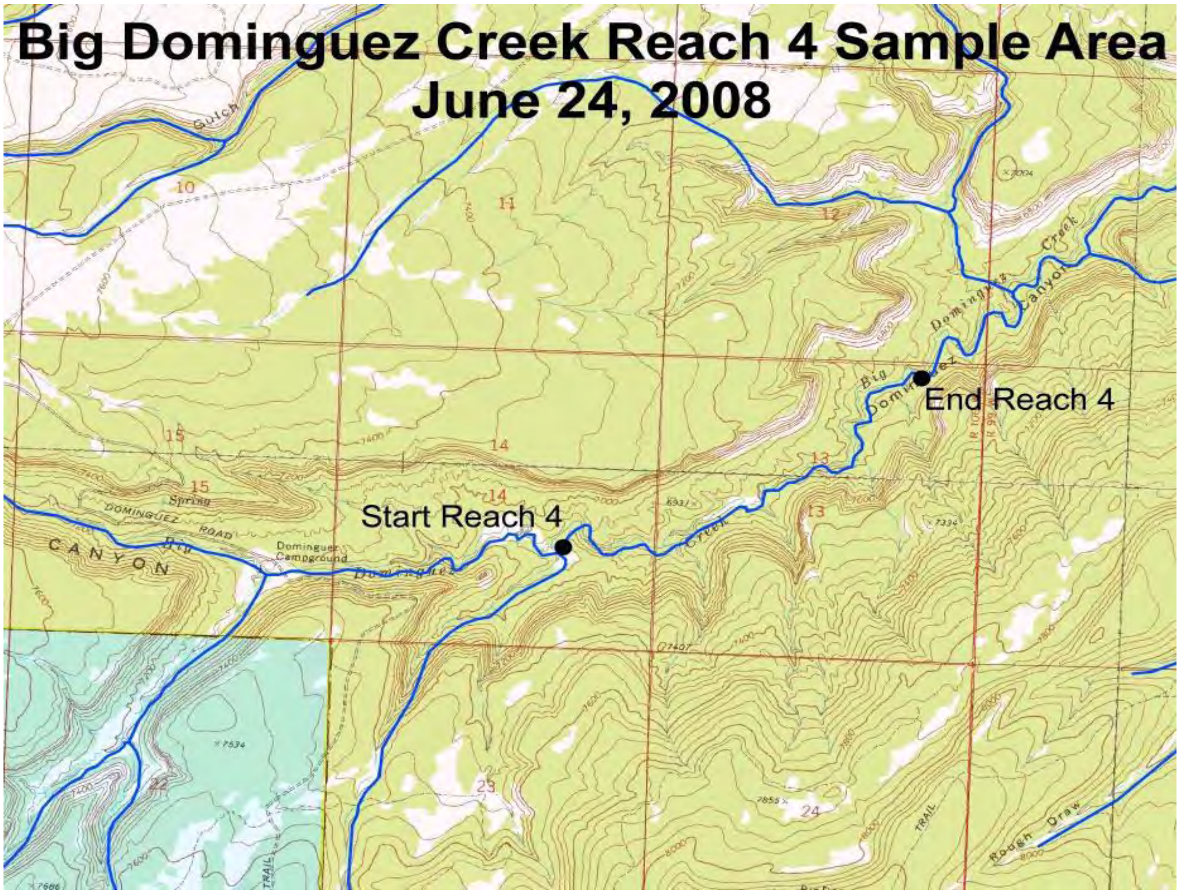
species	length	weight	mark		species	length	weight	mark

No fish collected


Reach 3 Isolated Pool

Reach 3 Discussion:
This reach was sampled to determine species composition and relative abundance. The entire reach was sampled from the confluence with Little Dominguez Creek up to the point where the crew gave up looking for perennial flow. Only a few isolated pools were present in this reach because of extraordinarily dry conditions (lack of monsoonal flow) during late summer 2009. During normal water supply conditions, speckled dace would be expected to be present in this reach.

Reach 4



STREAM SURVEY FISH SAMPLING FORM

WATER: Big Dominguez Creek H2O CODE: 39811 DATE: 6/24/2008

GEAR: Backpack Electroshocker EFFORT: ~ 2.5 miles STATION # 4 PASS # 1

CREW: Fresques, Adam, Dekleva, DRAINAGE: Gunnison River LOCATION: Below BLM's Dominguez Campground downstream approximately 2.5 miles –See Map.

Reach 4 Pass 1

species	length	weight	mark		species	length	weight	mark
RBT	180							
RBT	120							
RBT	162							
RBT	123							
RBT	124							
RBT	122							
RBT	104							


Typical shaded habitat in Reach 4

Rainbow Trout Reach 4

Reach 4 Discussion:
This reach was sampled on June 24, 2008. The reach was spot sampled to determine downstream distribution of resident rainbow trout and also to determine species composition and relative abundance. Only rainbow trout were observed or collected. In addition to those measured, several other rainbow trout were noted in the sample. This segment, as well as portions of the creek that extend upstream on to lands managed by the Forest Service, contain a self-reproducing population of wild rainbow trout.

Big Dominguez Creek Summary:
The majority of the BLM portions of this stream are located in designated wilderness and currently contain a self-sustaining wild rainbow trout population within Reach 4, native speckled dace in Reach 2, and a predominantly native fishery and important roundtail chub rearing area in Reach 1. It is unusual to have three distinact and self-reproducing fish populations separated by physical barriers in the same creek. The Colorado Division of Wildlife, in cooperation with the USFS and BLM, is examining the possibility of reclaiming Reach 4 of the stream and replacing rainbow trout with native cutthroat trout.

Riparian habitat is in excellent condition. Primary species included willows, alder, sedges, rushes, and cottonwood. Based on land form geology and stream channel type, the stream appears to have excellent sinuosity and a good mix of pools, riffles, and runs. This stream provides exemplary habitat for fish. The stream is highly productive, as evidenced by the high biomass of trout relative to stream size. This stream is a good candidate for reclamation, because native cutthroat would flourish where rainbow trout productivity is outstanding.

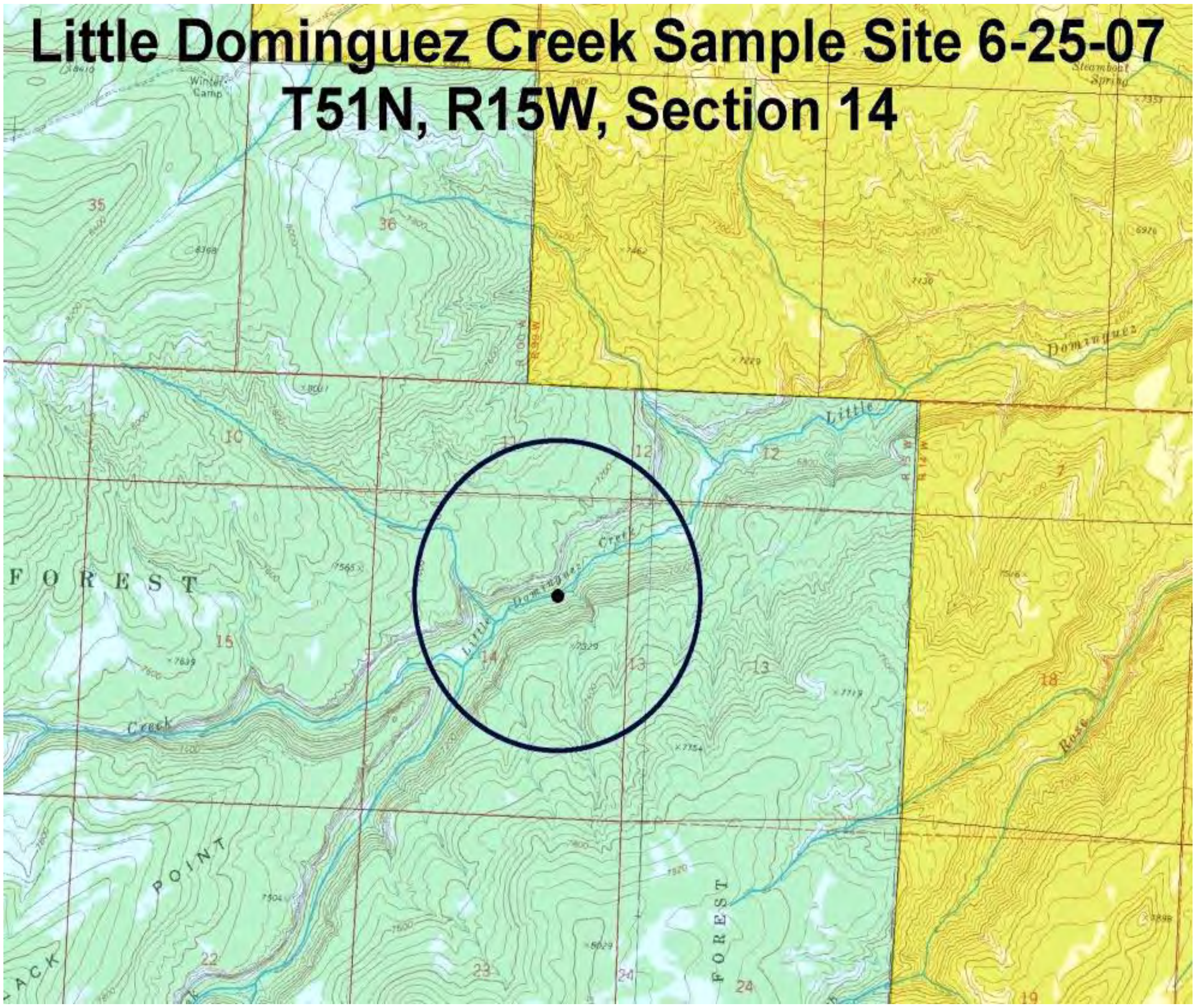
Water quality data was collected by BLM in mid July, 2008 and data indicated excellent water quality for support of fish populations. Macroinvertebrates are also abundant, providing an excellent food supply for fish populations. Water temperature is certainly a factor regarding trout distribution, particularly in the late summer months, but only in the lower elevation reaches.

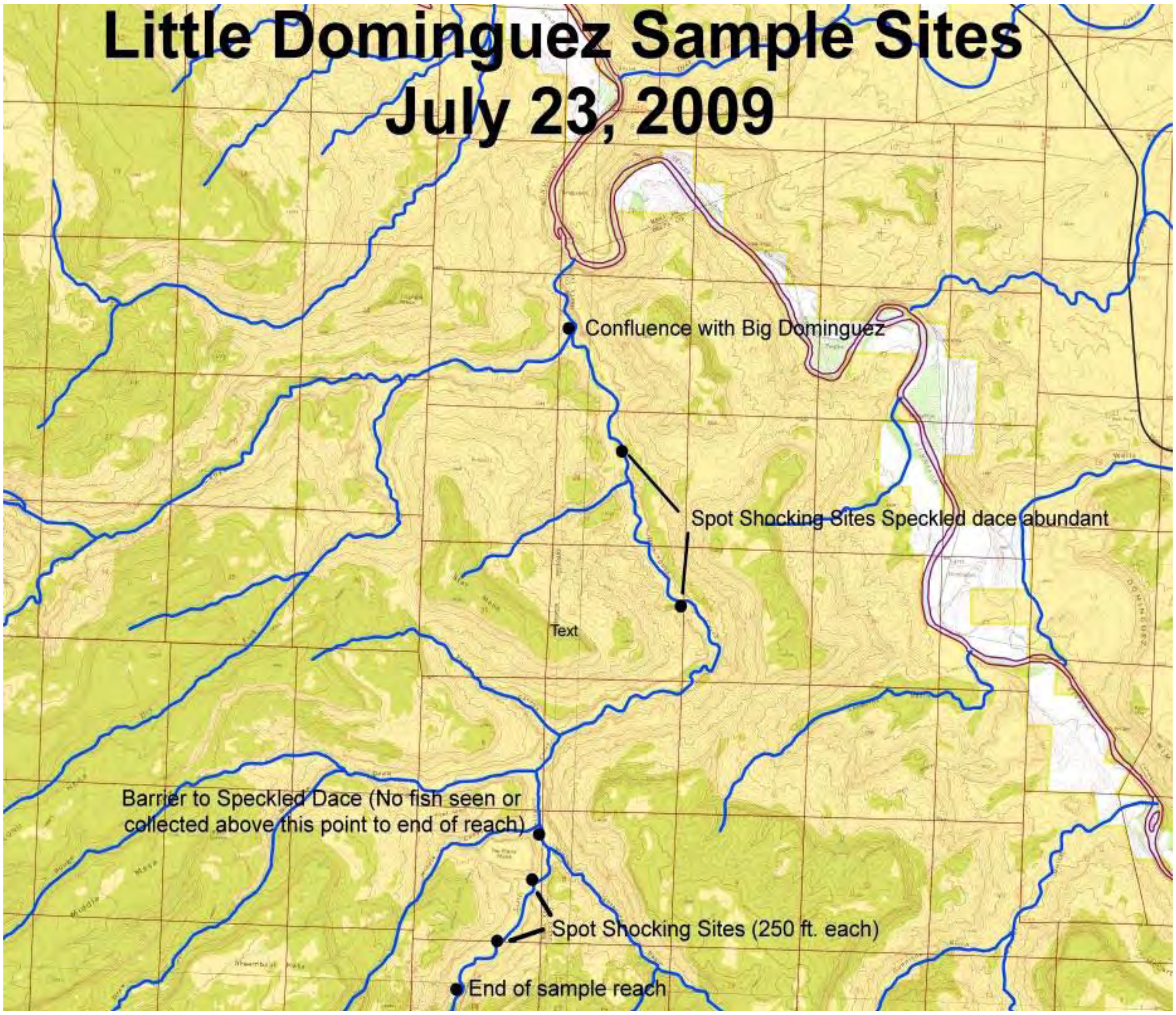
Section 2 – Little Dominguez Creek

Little Dominguez Creek, located south of Grand Junction, CO on lands managed by the BLM Grand Junction Field Office, was sampled on June 25, 2007 by CDOW personnel and on July 23, 2009 by BLM staff. Little Dominguez Creek is tributary to Big Dominguez Creek and then the Gunnison River.

The June 25, 2007 effort was conducted on USFS lands located 1.5 miles upstream from BLM lands. A two-pass removal population estimate was completed at that time and rainbow trout were the only fish collected. BLM personnel have confirmed that rainbow trout are also found on BLM lands at least 5.0 miles downstream from the sample site on USFS lands.

The July 23, 2009 effort was conducted on BLM lands from the confluence with Big Dominguez Creek to a point approximately 7.5 miles upstream. This effort consisted of spot sampling to determine fisheries composition and relative abundance. A two-pass removal population estimate was not completed and the only species collected were speckled dace. All sampling was conducted via backpack electro-shocker.


Little Dominguez Creek Sample Site 6-25-07
T51N, R15W, Section 14
Little Dominguez Creek
FOREST
POINT
FOREST
Dominguez
Little
Creek


Little Dominguez Sample Sites
July 23, 2009
Confluence with Big Dominguez
Spot Shocking Sites Speckled dace abundant
Text
Barrier to Speckled Dace (No fish seen or
collected above this point to end of reach)
Spot Shocking Sites (250 ft. each)
End of sample reach

STREAM SURVEY FISH SAMPLING DATA

Upper Little Dominguez Creek

Water: Little Dominguez Creek
Date: **6/25/2007**
Location: "Little Dominguez, 0.5 m below Keith Creek Confluence"
Drainage: Gunnison
Water Code: 45185
UTM Zone: 13S
UTM X: 125 m
UTM Y: 4285096 m
Station Length = 190 ft
Station Width = 5.3 ft
Crew: "D. Kowalski, R. Swygman, M. hill"
Notes:

OBJECTIVE:
Little Dominguez Creek was sampled with a SR LR24 backpack electrofisher to monitor fish populations and evaluate stream for possible cutthroat reclamation.

RESULTS:
Healthy, wild rainbow trout population with multiple year classes and good numbers of YOY observed. High density and biomass. Fish continued up lower end of Keith Creek. Water temperature was 14.5 C at 12 PM.

MANAGEMENT RECOMMENDATIONS:
Little Dominguez supports a health wild RBT population and would be a good site for CRN re-introduction. Access is difficult.

Species	Count	Length (mm)	Weight (g)	Status	Mark	TagID
RBT	1	219	95	1		
RBT	1	225	74	1		
RBT	1	151	37	1		
RBT	1	239	118	1		
RBT	1	132	23	1		
RBT	1	232	97	1		
RBT	1	183	52	1		
RBT	1	157	39	1		
RBT	1	120	19	1		
RBT	1	119	15	1		
RBT	1	227	111	1		
RBT	1	115	16	1		
RBT	1	120	17	1		
RBT	1	145	32	1		
RBT	1	91	7	1		
RBT	1	146	30	1		
RBT	1	165	44	1		
RBT	1	150	35	1		
RBT	1	105	15	1		
RBT	1	190	65	1		
RBT	1	115	20	1		
RBT	1	156	40	1		
RBT	1	91	11	1		
RBT	1	149	32	1		
RBT	1	100	10	1		
RBT	1	164	43	1		
RBT	1	135	24	1		

RBT	1	110	14	1
RBT	1	108	13	1
RBT	1	106	11	1
RBT	1	102	12	1
RBT	1	96	9	1
RBT	1	105	12	1
RBT	1	114	15	1
RBT	1	113	16	1
RBT	1	109	14	1
RBT	1	101	11	1
RBT	1	103	13	1
RBT	1	114	15	1
RBT	1	73	5	1
RBT	1	166	50	1
RBT	1	100	14	1
RBT	1	104	16	1
RBT	1	122	25	1
RBT	1	144	30	1
RBT	1	88	6	1
RBT	1	104	12	1
RBT	1	116	18	1
RBT	1	95	8	1
RBT	1	112	16	1
RBT	1	97	9	1
RBT	1	91	6	1
RBT	1	110	13	1
RBT	1	105	11	1
RBT	1	131	24	1
RBT	1	115	15	1
RBT	1	100	12	1
RBT	1	132	23	1
RBT	1	101	11	1
RBT	1	93	9	1
RBT	1	107	15	1
RBT	1	116	17	1
RBT	1	104	12	1
RBT	1	120	16	1
RBT	1	116	17	1
RBT	1	105	11	1
RBT	1	106	13	1
RBT	1	88	7	1
RBT	1	112	14	1
RBT	1	93	9	1
RBT	1	90	7	1
RBT	1	104	12	1
RBT	1	105	12	1
RBT	1	115	17	1
RBT	1	101	10	1
RBT	1	90	7	1
RBT	1	106	14	1
RBT	1	82	6	1
RBT	1	96	11	1
RBT	1	98	10	1
RBT	1	90	9	1
RBT	1	104	11	1
RBT	1	116	14	1
RBT	1	104	9	1
RBT	1	96	9	1
RBT	1	110	14	1
RBT	1	100	9	1
RBT	1	102	12	1
RBT	1	96	11	1
RBT	1	102	13	1

RBT	1	93	11	1
RBT	1	98	9	1
RBT	1	104	7	1
RBT	1	93	8	1
RBT	1	97	10	1
RBT	1	95	12	1
RBT	1	82	6	1
RBT	1	104	10	1
RBT	1	86	5	1
RBT	1	88	4	1
RBT	1	85	4	1
RBT	1	200	72	2
RBT	1	152	31	2
RBT	1	93	8	2
RBT	1	112	14	2
RBT	1	100	6	2
RBT	1	115	14	2
RBT	1	97	6	2
RBT	1	112	12	2
RBT	1	91	7	2
RBT	1	101	15	2
RBT	1	113	15	2
RBT	1	102	14	2
RBT	1	91	9	2

RBT = Rainbow Trout

Little Dominguez Creek upper reach – Trout Habitat


Little Dominguez Creek upper reach Trout Habitat

STREAM SURVEY FISH SAMPLING DATA

Lower Little Dominguez Creek

WATER: Little Dominguez Creek H2O CODE: 45185 DATE: **7/23/2009**

GEAR: Backpack Electroshocker EFFORT: ~ 7 miles STATION # 1 PASS # 1

CREW: Fresques, Dekleva, Ramey DRAINAGE: Gunnison River LOCATION: From confluence with Big Dominguez Creek upstream approximately 7 miles –See Map.

Reach 1 Pass 1

species	length	weight	mark		species	length	weight	mark
SPD								

SPD = Speckled Dace

Only speckled dace were seen or collected from the confluence of Big Dominguez Creek upstream to a small natural barrier – see photo and map. Fish were abundant with hundreds of fish captured and several hundred more seen. Fish ranged in size from approximately 40 millimeters up to 110 millimeters.


Little Dominguez Creek – lower reach Speckled Dace Habitat

Little Dominguez Creek – lower reach Speckled Dace Habitat


Apparent natural barrier to speckled dace movement upstream

Little Dominguez Creek Discussion:
The upper reach of Little Dominguez Creek, which extends from the headwaters located on USFS lands downstream approximately 3.5 miles on to BLM managed lands, contains a self-sustaining rainbow trout fishery. The lower reach, from the confluence with Big Dominguez Creek to a point approximately 7 miles upstream, contains a native speckled dace fishery. Speckled dace are abundant from the confluence to a point upstream where a small natural barrier appears to prevent upstream movement of these fish. Visual observation and spot sampling above the barrier to the end of the sample reach resulted in the detection of no fish. It appears that the creek lacks fish between where the lower distribution of rainbow trout ends and the upper distribution of speckled dace, a distance of approximately five miles. Habitat condition and water quality do not appear to be limiting factors with regard to the lack of fish in this middle reach. Temperature is the likely causal factor prohibiting further downstream use by trout. However, temperatures are suitable for native speckled dace in this reach, and the small physical barrier appears to be the reason for the lack of fish. It is likely that speckled

dace would thrive in the portion of the reach that presently supports no fish, if BLM and CDOW elected to move some of the speckled dace population upstream from the barrier.

It is unusual to have three distinct and self-reproducing fish populations separated by physical barriers in the same creek. The Colorado Division of Wildlife, in cooperation with the USFS and BLM, is examining the possibility of reclaiming the upper portion the stream and replacing rainbow trout with native cutthroat trout.

Riparian habitat is in excellent condition. Primary species included willows, alder, sedges, rushes, and cottonwood. Based on land form geology and stream channel type, the stream appears to have excellent sinuosity and a good mix of pools, riffles, and runs. This stream provides exemplary habitat for fish. The stream is highly productive, as evidenced by the high biomass of trout relative to stream size. This stream is a good candidate for reclamation, because native cutthroat would flourish where rainbow trout productivity is outstanding.

Water quality data was collected by BLM in mid July, 2008 and data indicated excellent water quality for support of fish populations. Macroinvertebrates are also abundant, providing an excellent food supply for fish populations. Water temperature is certainly a factor regarding trout distribution, particularly in the late summer months, but only in the lower elevation reaches.

Dominguez Canyon Wilderness

Hydrologic Modeling Report

NATIONAL SYSTEM OF PUBLIC LANDS

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT

Introduction

This report provides analysis in support of BLM's instream flow recommendation for the Dominguez Canyon Wilderness, which includes a recommendation for protection of a range of flows. Specifically, BLM recommended protection of the following flow types in support of various water-dependent values:

- Base flows (typically July through February) – Maintenance of water quality and habitat necessary to support fish populations and aquatic macroinvertebrate communities, as well as provision of groundwater for riparian communities during low flow periods.

- Bankfull flows (typically associated with snow melt runoff, which occurs March through June)– Maintenance of fish habitat, including spawning gravels, and recharge of alluvial aquifer to create conditions that favor and support riparian communities.

- Overbank flows (typically occur on an annual basis during the July through September thunderstorm period)– Sediment deposition that provides habitat and nutrients for shrubby riparian species, and maintenance of width of riparian zone by providing a moisture regime unsuitable for upland plants. These flows also recharge alluvial aquifers, which is important for maintaining base flows during periods of little precipitation.

- Periodic large flood events (typically occur once every three to ten years, during the July – September thunderstorm season)– Supports establishment of disturbed areas for establishment of new riparian plants, andcreates soil moisture conditions necessary for establishment of new cottonwood age classes.

To analyze the flow rates needed to provide these functions, the report is divided into two sections. The first section is an analysis utilizing the R2Cross model, which identifies the flow rates needed to provide base flow functions. The second section is an analysis utilizing the U.S. Army Corps of Engineers HEC RAS (Hydrologic Engineering Center River Analysis System) model. The modeling effort estimated the flows needed to provide the ecological functions associated with bankfull flows, overbank flows, and periodic large flood events.

Section 1 - R2Cross Analysis

Methodology Overview

R2Cross analysis is a method utilized by the Colorado Water Conservation Board to identify minimum flows needed to support cold water fisheries.   R2Cross is a hydraulic model that analyzes riffle habitat to identify flow rates needed to meet three criteria:

1. One foot per second velocity
2. 0.2 feet average depth
3. 50% wetted perimeter

Typically, the CWCB selects a flow that meets three of three criteria for flow rates during snowmelt runoff and during the warm weather months from May through October. A flow that meets two of three criteria is selected for the cold weather months from November through April.   Appropriations may be adjusted based on a water availability analysis that examines natural hydrology and impacts to flows from water facilities. The R2Cross model is not designed to directly identify flow rates needed for channel-forming processes or riparian species.

The current 1.5 cubic feet per second instream flow water right on Big Dominguez Creek was established by the CWCB in 1984. This time period was early in the history of the instream flow program, and the scientific methodology used to for making instream flow recommendations has been further developed since that time.

Data Collection and Analysis

BLM staff collected cross section from Big Dominguez and Little Dominguez Creek at multiple times from 2003 to 2009.   As specified by the R2Cross manual, sites selected for analysis are "critical riffles." This means that the riffles are generally representative of all riffles in the channel in terms of depth, width, and substrate.   These riffles are also one of the first locations in the stream channel that would go dry at low flows, thereby preventing fish passage. Riffles are also important spawning locations and food sources for fish.

The cross section data was processed by using the October 31, 2008 version of the model. BLM utilized the standard instream flow criteria for analyzing the modeling runs, because Big Dominguez Creek and Little Dominguez Creek support rainbow trout and speckled dace, both of which are cold water salmonid species.

Cross section measurements taken by BLM at low and high elevations along both streams revealed that the channel width doesn't change dramatically between the top and the bottom of the stream system. This indicates that large, channel forming events are mainly derived from snowmelt runoff or from large thunderstorms high in the watershed. Input from tributaries lower in the system may contribute significant sediment to the system, but typically are not significant enough to be channel-forming events.

R2Cross data collection site on Little Dominguez Creek

<u>Results – Big Dominguez Creek</u>

When the stream model output from the seven cross sections is averaged, the results demonstrate that 1.53 cfs is needed to meet two of three instream flow criteria. Model results suggest that 3.86 is needed to meet 3 of 3 instream flow criteria. Results from the individual cross sections are displayed below.

Big Dominguez Creek R2Cross Surveys

Location	**Date**	**Channel Width**	**Flow needed to meet 2 of 3 instream criteria (winter)**	**Flow needed to meet 3 of 3 instream criteria (summer)**
BLM Campground - 400 ft. upstream from bridge	6-18-03	13 feet	1.42 cfs	out of confidence interval
BLM Campground - 200 ft. upstream from bridge	6-18-03	12 feet	1.15 cfs	out of confidence interval
BLM Campground – near bridge	6-16-05	18 feet	1.64 cfs	4.00 cfs
BLM Campground – near bridge	7-15-08	16 feet	1.41 cfs	4.89 cfs
0.3 miles upstream from Gunnison River	2-23-07	14 feet	1.47 cfs	1.79 cfs
0.4 miles upstream from Gunnison River	2-23-07	20 feet	2.14 cfs	5.78 cfs
300 ft. upstream from confluence with Little Dominguez Creek	7-15-08	16 feet	1.45 cfs	2.82 cfs
AVERAGES		16 feet	1.53 cfs	3.86 cfs

Results – Little Dominguez Creek

When the stream model output from the three cross sections is averaged, the results demonstrate that 1.20 cfs is needed to meet two of three instream flow criteria. Model results suggest that 2.15 cfs is needed to meet 3 of 3 instream flow criteria. Results from the individual cross sections are displayed below.

Little Dominguez Creek R2Cross Surveys

Location	**Date**	**Channel Width**	**Flow needed to meet 2 of 3 instream criteria (winter)**	**Flow needed to meet 3 of 3 instream criteria (summer)**
500 feet downstream from confluence with Red Creek	7-16-2008	11 feet	1.37 cfs	1.53 cfs
200 ft. upstream from confluence with Big Dominguez Creek	7-15-2008	11 feet	0.53 cfs	3.14 cfs
500 ft. upstream from confluence with Big Dominguez Creek	11-03-2009	12 feet	1.32 cfs	1.38 cfs
900 ft. upstream from confluence with Big Dominguez Creek	11-03-2009	13 feet	1.60 cfs	2.57 cfs
AVERAGES		11.75 feet	1.20 cfs	2.15 cfs

Conclusion

The results of the surveys conform with known hydrologic characteristics of the two watersheds. Big Dominguez Creek is a slightly large water sheds, and it drains a watershed with significantly more high-altitude drainage acreage near the crest of the Uncompahgre Plateau. The Big Dominguez Creek watershed would be expected to have higher volume of snowmelt runoff. Accordingly, a larger channel has been formed to carry that runoff. The flows necessary to meet the instream flow criteria are larger in Big Dominguez Creek than in Little Dominguez Creek.

Section 2 - HEC RAS Analysis

Introduction

BLM utilized the HEC RAS (Hydrologic Engineering Center River Analysis System) model, created by the U.S. Army Corps of Engineers, to analyze the flow rates needed to perform stream functions that are necessary for the maintenance of aquatic and riparian systems. These stream functions include:

- Deposition of finely-textured sediments on floodplain terraces, which provides locations for establishment of new riparian plants, such as cottonwood seedlings.
- Exposing portions of the stream bed that were previously vegetated, creating conditions that allow for establishment of new plants and a variety of age classes.
- Wetting of floodplain riparian soils, which provides a moisture regime that will support establishment of new riparian plants.
- Recharge of alluvial aquifers, which provide a critical water supply for riparian plants during periods of low flow and high evapotranspiration.
- Maintenance of fish habitat, including cleaning of spawning gravels and prevention of channel "cementing," in which algae and fine sediments clog in the channel substrate to the detriment of macroinvertebrate communities.

HEC RAS Modeling Procedure

HEC RAS is a stream hydraulics model that determines the elevation and width of the stream water surface at various flow rates. The model can be used to determine the flow rate necessary to create bankfull conditions, to move water into the shrubby riparian zone immediately above bankfull, or the flow necessary to move water into the floodplain where riparian trees, such as cottonwood galleries, occur. The model is also often used for formal floodplain determinations by government agencies, and it is a widely accepted tool among professional engineers.

Running the HEC RAS model requires a field survey to establish a series of cross sections across the stream channel. At each cross section, the user conducts an elevation survey to establish:

- shape of the channel
- water surface elevation at a given flow rate
- elevation of the cross section relative to the next cross section downstream.

At each cross section, the user also evaluates the "roughness" of the cross sections, based on materials found within the cross section, such as rocks, shrubs, trees, and grasses. The “roughness” evaluation is converted into a coefficient called “Manning’s n,” which is an indicator of how much resistance water will encounter as it flows through the cross section. The primary procedure used by HEC-RAS to determine water surface elevations for various flow rates utilizes a tool that analyzes gradually increasing flow rates, which is called the direct step method. For each gradually increasing flow rate, the model calculates the change in stream energy between cross sections, based upon change in elevation and the roughness of the channel. Based upon a known water surface elevation and flow rate from the field survey, the model calculates the expected water surface elevation at other flow rates, based on the shape of the channel, channel roughness, change in elevation, and stream energy.

<u>Application of HEC RAS Modeling Procedure to Little Dominguez Creek and Big Dominguez Creek</u>

BLM selected three stream reaches for running the HEC RAS model. BLM’s goal was to represent the two primary types of stream reaches found within the wilderness – reaches with broad floodplains and reaches that are confined by canyons. At each stream reach, BLM collected a sufficient number of cross sections to represent the morphology of the stream section, and then conducted an elevation survey of numerous points within each cross section. At each cross section, BLM also took photographs documenting materials found within the cross section, such as trees, shrubs, grass, and rock. BLM used these photographs to select a Manning’s n roughness coefficient for each cross section. References used to select Manning’s n values include:

- Ven Te Chow, *Open Channel Hydraulics*, McGraw Hill Civil Engineering Series, 1959.
- Robert D. Jarret, *United States Geological Survey Water Resources Investigation Report 85-4004*, 1985.

For all three stream reaches, Manning’s N values varied on one side of the stream compared to the opposite bank, because one side of the creek typically exhibited denser willow and hence higher roughness. These differences were accounted for in the modeling effort.

After the field data were collected, BLM entered cross section elevation values, stream widith, Manning’s n roughness coefficients, and water surface elevations into the HEC RAS model. Where necessary, BLM instructed the model to insert interpolated cross sections if hydraulic differences between the cross sections collected in the field were significant. BLM then ran various flow rates through the model to identify the flow rates need to achieve water surface elevations at bankfull, to inundate the shrub-based riparian community, and to inundate the elevation where cottonwood communities occur. Graphs showing the results of this procedure are provided at the end of this report.

Stream Reach Analysis

Lower Little Dominguez Creek. The first stream reach was selected on lower little Dominguez Creek, slightly upstream from the confluence with Big Dominguez Creek. This stream reach was selected because it is represents a broad floodplain with a cottonwood community containing multiple age classes. BLM utilized elevation and roughness data from six cross sections within this stream reach. Representative photographs from this reach are displayed below.

In the photos above, note the willow community close to the active channel and intermediate size riparian shrubs on the floodplain above bankfull. The large, older cottonwoods that are a significant distance from the channel were established during large flood events.

Lower Big Dominguez Creek. The second stream reach was selected on lower Big Dominguez Creek, slightly upstream from the confluence with Big Dominguez Creek. This stream reach was selected because it is represents a floodplain with a cottonwood community containing multiple age classes, but it has a narrower floodplain than Little Dominguez Creek and also has a higher gradient. BLM utilized elevation and roughness data from three cross sections within this stream reach. Representative photographs from this reach are displayed below.

In the photos above, note the high density of the willow community adjacent to the creek. Also note that the mature cottonwoods (upper photo, at the center top of the photo) are closer to the active channel because of the narrower floodplain available to the creek.

Big Dominguez Creek Above Falls. The third stream reach was selected on Big Dominguez Creek approximately one mile upstream from the confluence of Big Dominguez Creek and Little Dominguez Creek. This stream reach was selected because it represents a stream reach confined by canyon geology that supports a cottonwood community. BLM collected elevation and roughness data at six cross sections within this stream reach. Representative photographs from this reach are displayed below.

In the photographs above, notice the black granite (behind the yellow willows) that acts to confine this stream channel. Also note the very distinct line of mature cottonwood trees on the left side of the upper photo.

HEC RAS Modeling Results

Little Dominguez Creek. The HEC RAS analysis revealed that the following flow rates are needed for ecologic functions on Little Dominguez Creek:

- 65 cubic feet per second – bankfull flow
- 200 cubic feet per second – inundation of shrubby riparian zone
- 500 cubic feet per second – inundation of cottonwood galleries

Big Dominguez Creek. The HEC RAS analysis revealed that the following flow rates are needed for ecologic functions on Big Dominguez Creek:

- 75 cubic feet per second – bankfull flow
- 250 cubic feet per second – inundation of shrubby riparian zone
- 725 cubic feet per second – inuncation of cottonwood galleries

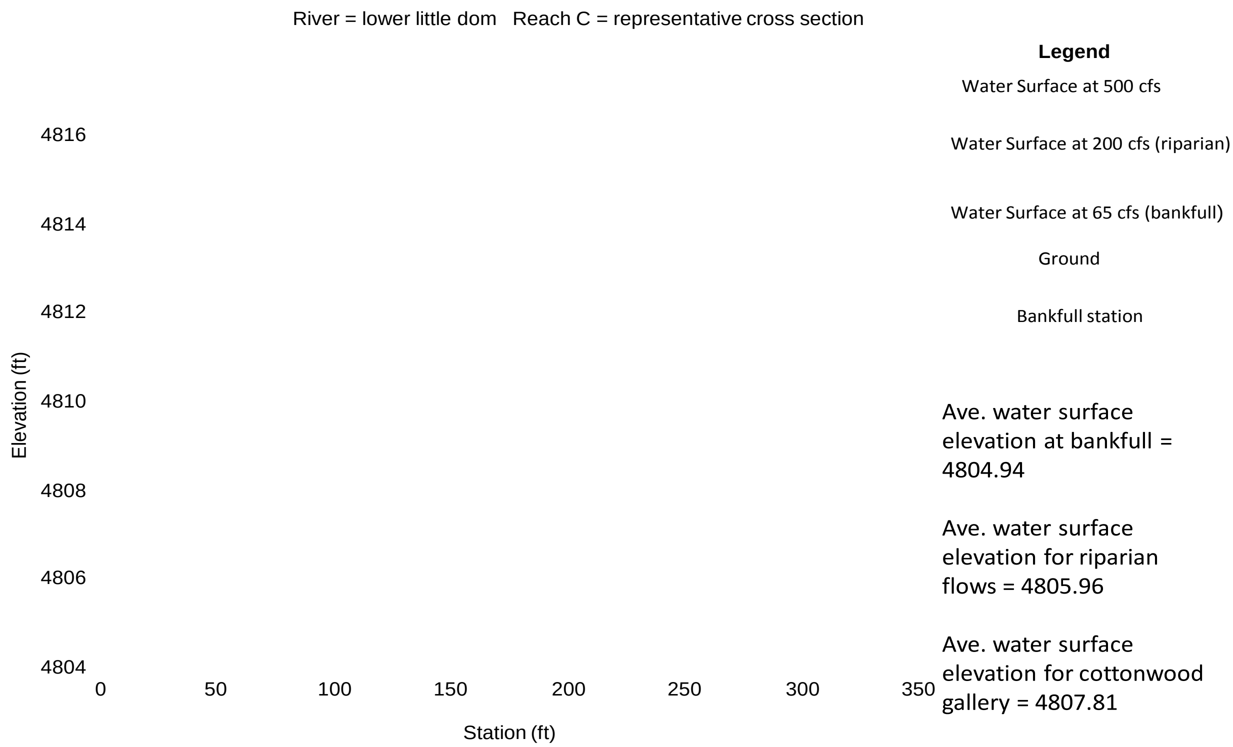
The following pages provide output from the HECRAS model that is designed to assist the reader in interpretion of the HECRAS results. The first page for each stream reach displays a cross section view of the stream reach that allows the reader to view the shape of the channel and floodplain. The first page also provides a graphical indication of the water surface elevation needed to move water to bankfull, into the shrubby riparian zone, and into the floodplain where cottonwood galleries occur.

The pages following the each cross section are a graphical depiction of the same stream reach from a bird's eye viewpoint. These pages allow the reader to view the flow rate and water surface width needed to reach bankfull, to reach the shrubby riparian zone, and to reach the floodplain where cottonwood galleries occur. These pages also allow the reader to view the areal extent of the water surface at various flow rates. The horizontal black lines in each page represent ground surface locations generated by the model. The black line represents elevation changes on the ground surface, but the variations in elevation are not apparent from the bird's eye viewpoint.

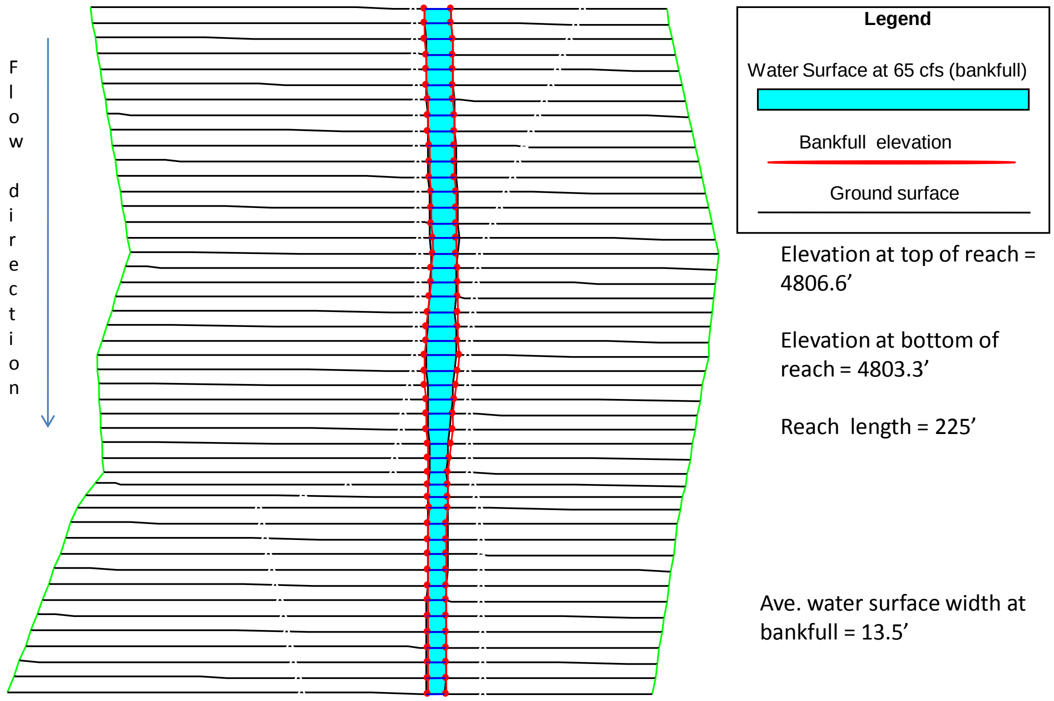
HEC RAS Modeling Conclusions

The HEC RAS modeling procedure provided results that conform with the hydrologic characteristics of the two creeks. The calculated flows needed to produce bankfull conditions are within the range of annual peak snowmelt runoff flows that were identified by BLM's statistical hydrology analysis. Flow rates required to inundate the shrubby riparian zone on each creek are approximately three times higher than the bankfull flow. This result is expected given the hydrology of these streams, in which very large but short duration thunderstorm driven events are common during the summer monsoon season. Finally, flow rates needed to move water into the floodplain where cottonwood galleries occur are seven to nine times greater than bankfull events. Flood events of this size have been observed on these two stream systems, but do not occur annually. Finally, analysis of two different reaches on Big Dominguez Creek produced very similar results, verifying the accuracy of the modeling effort.

Lower Little Dominguez Creek – elevations/flows for bankfull, shrubby riparian and cottonwood gallery



Lower Little Dominguez Creek – 65 cfs bankfull flow
Plan View



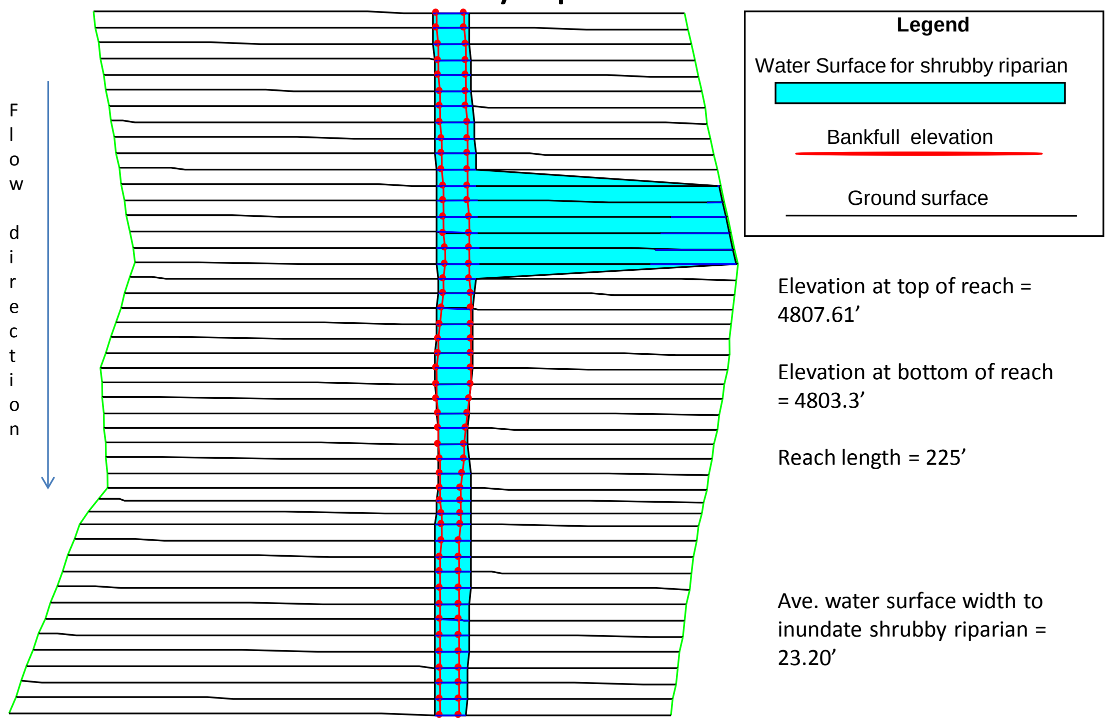
Elevation at top of reach = 4806.6’

Elevation at bottom of reach = 4803.3’

Reach length = 225’

Ave. water surface width at bankfull = 13.5’

Lower Little Dominguez Creek – 200 cfs to inundate shrubby riparian



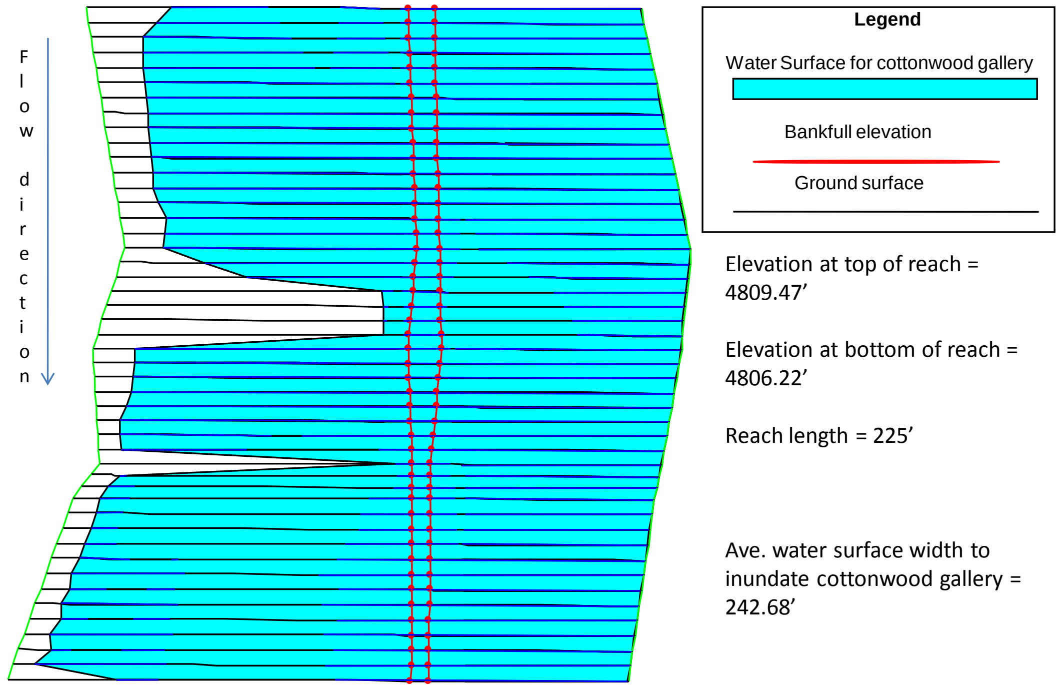
Elevation at top of reach = 4807.61’

Elevation at bottom of reach = 4803.3’

Reach length = 225’

Ave. water surface width to inundate shrubby riparian = 23.20’

Lower Little Dominguez Creek – 500 cfs flow to inundate cottonwood gallery



Elevation at top of reach = 4809.47’

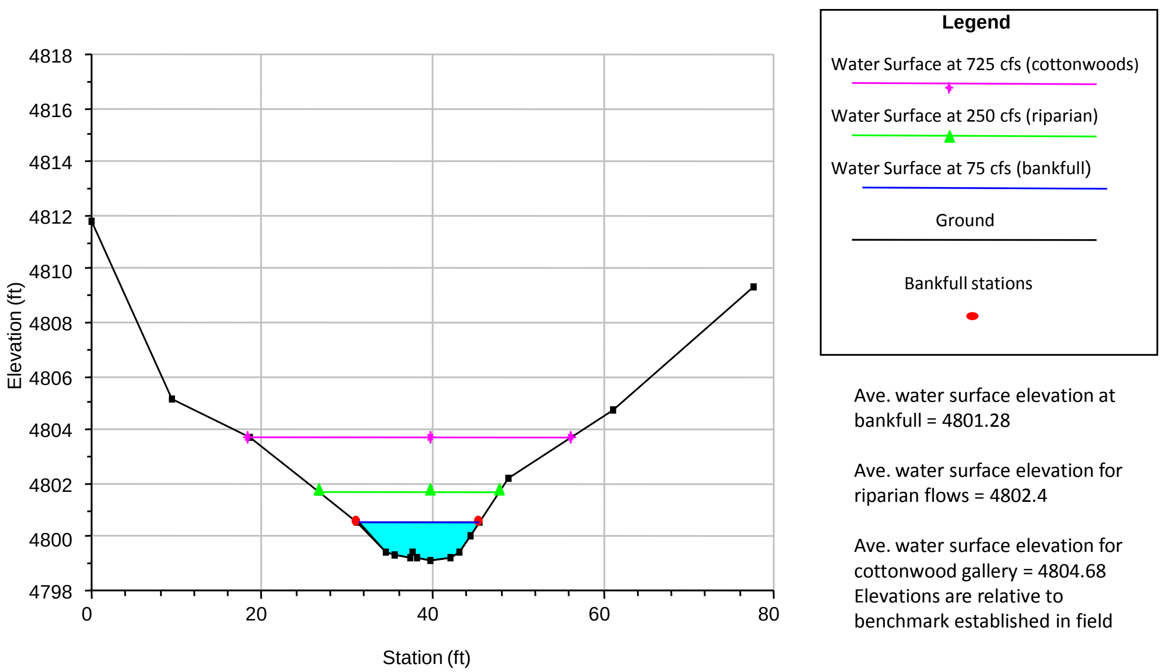
Elevation at bottom of reach = 4806.22’

Reach length = 225’

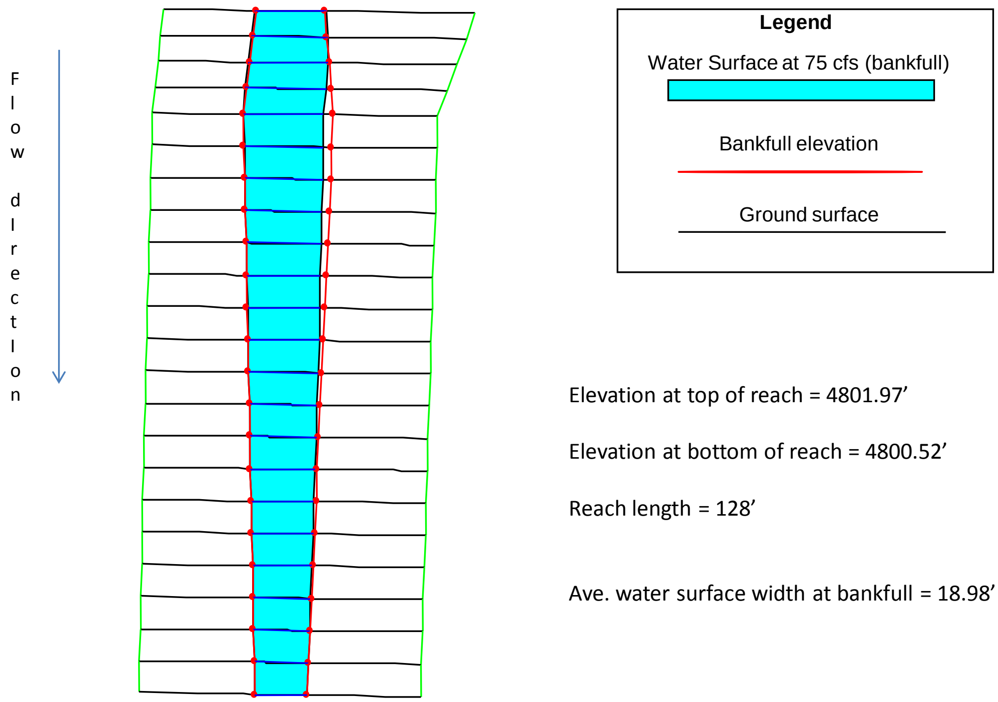
Ave. water surface width to inundate cottonwood gallery = 242.68’

Lower Big Dominguez Creek – elevations/flows for bankfull, shrubby riparian and cottonwood gallery

River = Lower Big Doming   Reach A, cross section E - furthest ds x sec of the reach and a representative cross section



Lower Big Dominguez Creek – 75 cfs bankfull flow



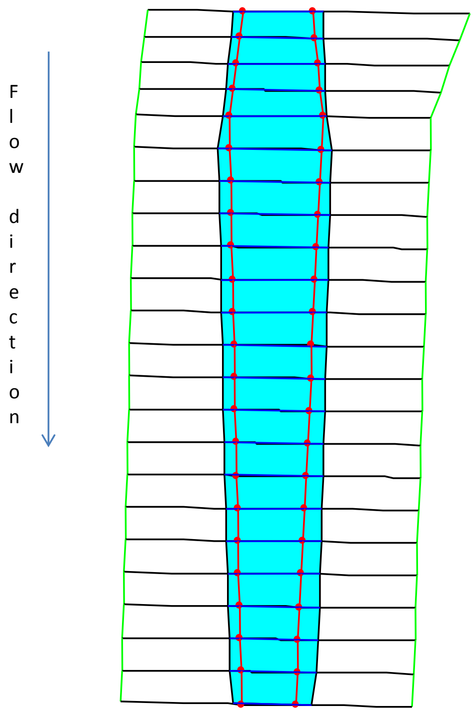
Elevation at top of reach = 4801.97’

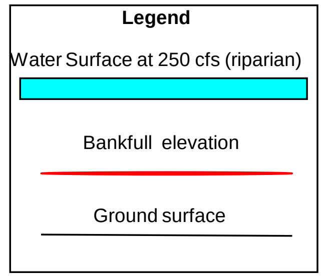
Elevation at bottom of reach = 4800.52’

Reach length = 128’

Ave. water surface width at bankfull = 18.98’

Lower Big Dominguez Creek – 250 cfs to inundate shrubby riparian





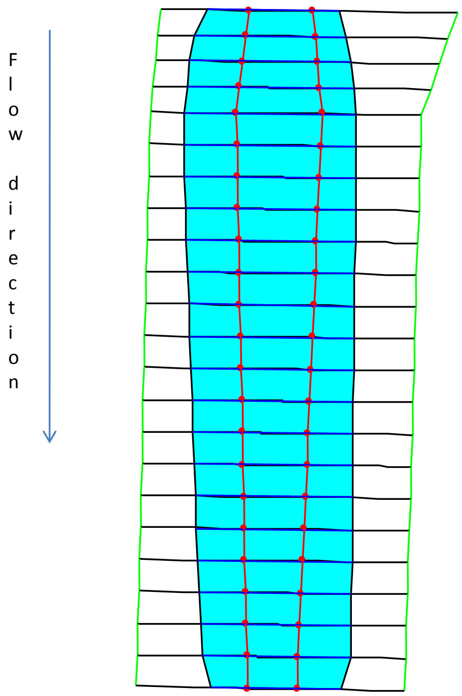
Elevation at top of reach = 4802.79’

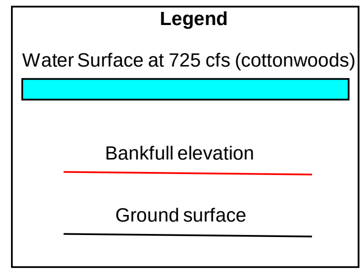
Elevation at bottom of reach = 4801.68’

Reach length = 128’

Ave. water surface width to inundate shrubby riparian = 26.34’

Lower Big Dominguez Creek – 725 cfs to inundate cottonwood gallery





Elevation at top of reach = 4804.23’

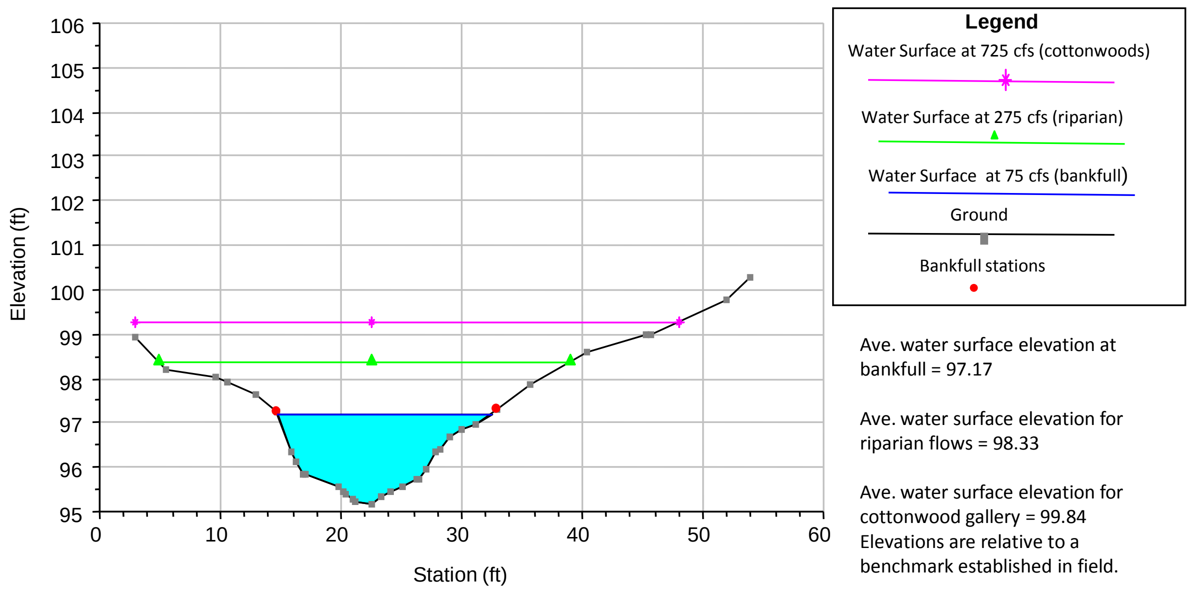
Elevation at bottom of reach = 4803.69’

Reach length = 128’

Ave. water surface width to reach cottonwood gallery = 46.05’

Big Dominguez Creek above falls – elevations/flows for bankfull, shrubby riparian and cottonwood gallery

River = lower big doming   Reach = B is a representative cross section

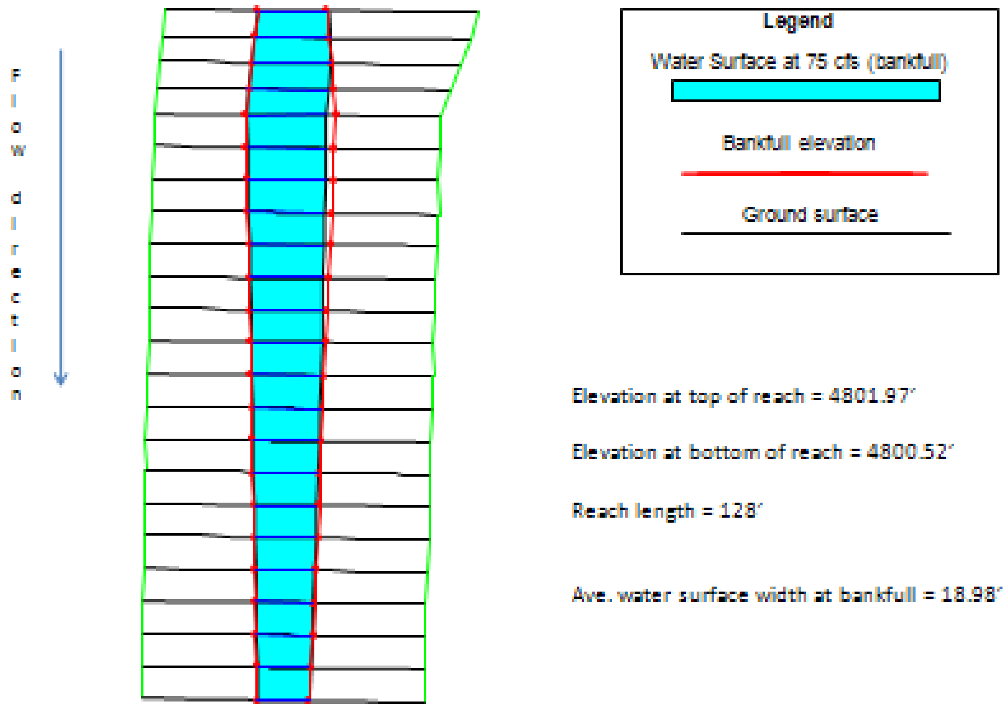


Ave. water surface elevation at bankfull = 97.17

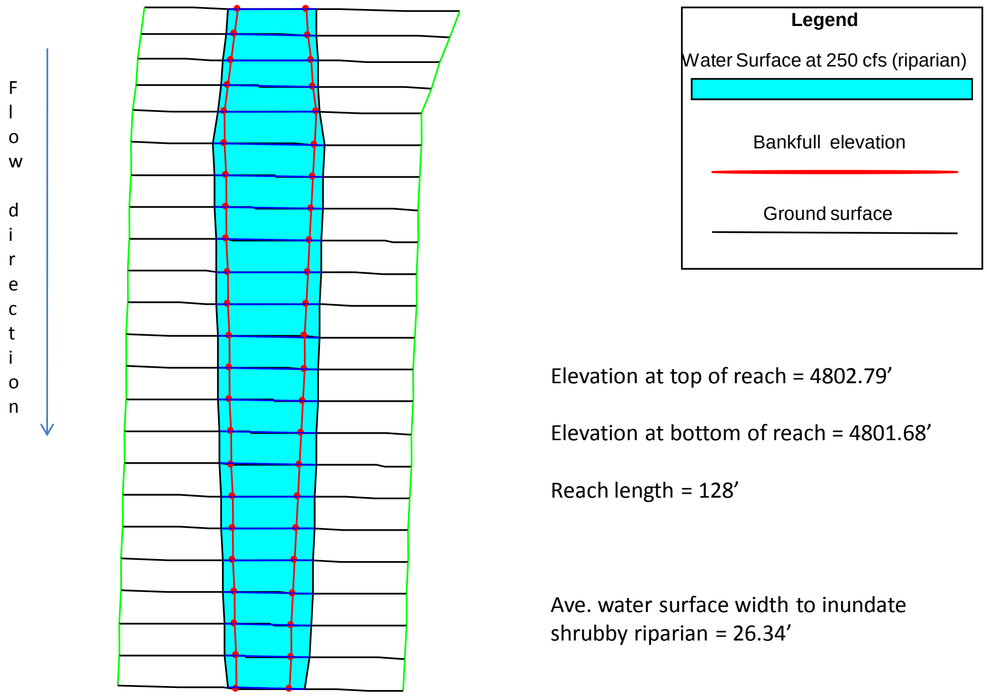
Ave. water surface elevation for riparian flows = 98.33

Ave. water surface elevation for cottonwood gallery = 99.84
Elevations are relative to a benchmark established in field.

Lower Big Dominguez Creek – 75 cfs bankfull flow



Lower Big Dominguez Creek – 250 cfs to inundate shrubby riparian



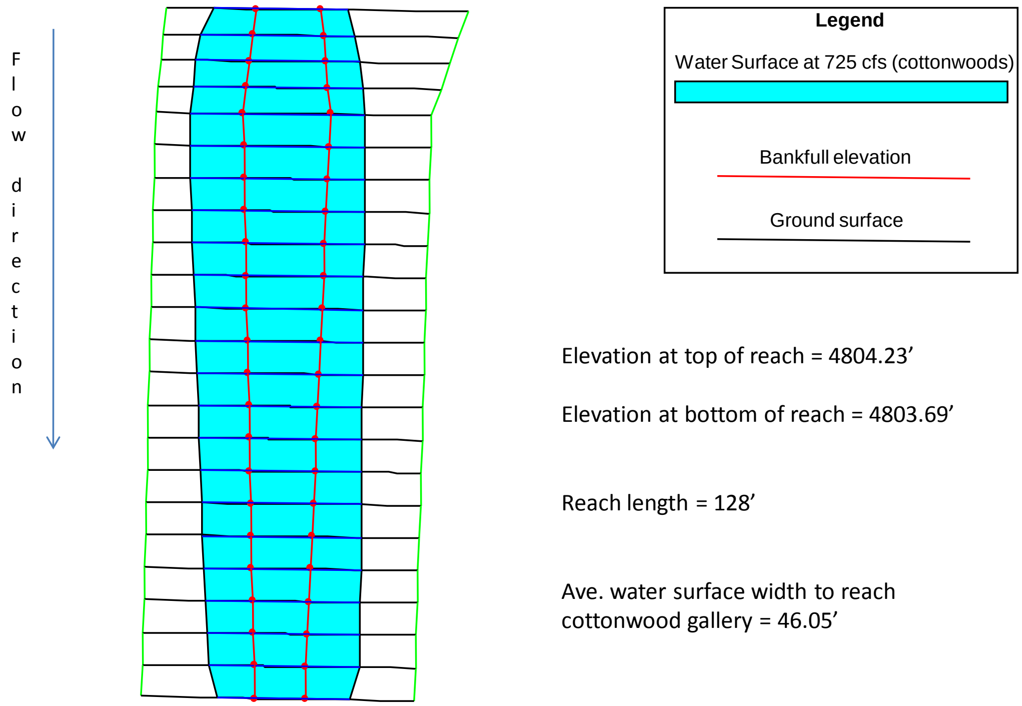
Elevation at top of reach = 4802.79’

Elevation at bottom of reach = 4801.68’

Reach length = 128’

Ave. water surface width to inundate shrubby riparian = 26.34’

Lower Big Dominguez Creek – 725 cfs to inundate cottonwood gallery



Elevation at top of reach = 4804.23'

Elevation at bottom of reach = 4803.69'

Reach length = 128'

Ave. water surface width to reach cottonwood gallery = 46.05'

Dominguez Canyon Wilderness

Hydrology Report

Executive Summary

Using stream flow data from gages located elsewhere on the Uncompahgre Plateau, BLM has developed an analytical procedure to estimate stream flow for Big Dominguez Creek and Little Dominguez Creek based on the watershed characteristics of watershed acreage and elevation. This procedure has been previously accepted by the CWCB to estimate flows for other streams on the Uncompahgre Plateau in cases where BLM has submitted instream flow recommendations to the CWCB. The analytic procedure predicts the following peak flows and base flows:

Location	Peak Flow Range (April-June)	Base Flow Range (July-March)
Big Dominguez Creek at Gunnison River	66to 242 cfs	1.4 to 5.7 cfs
Big Dom. Ck. above conf. w/ Little Dom.	42 to 155 cfs	0.9 to 3.6 cfs
Little Dom. Ck. above conf. w/ Big. Dom.	27 to 98 cfs	0.6 to 2.3 cfs

Between 1981 and 1994, BLM also collected periodic measurements of stream flows on these two creeks. Comparison of these historic discharge measurements with the statistical hydrology analysis suggests that the statistical hydrology is effective for estimating mean base flows.

However, the statistical hydrology may overestimate or underestimate mean snowmelt runoff flows in April and May in any given year. The potential for overestimation of flow occurs because the equation used to predict flows is designed to predict long-term flow rate averages. The statistical hydrology does not reflect antecedent conditions within the watershed, such as soil moisture, nor does it reflect current year weather conditions that can drive flow rates. Accordingly, the statistical hydrology peak flow estimates may contain a high error rate. The mean standard error associated with the equation used to produce the estimates is 56 percent. This means that if the equation predicts a specific runoff volume, the actual runoff may be up to 56% higher or 56% lower than the predicted runoff volume.

Statistical hydrology analysis conducted by BLM also suggests a predictable relationship between snowmelt runoff volume and peak flows in Big Dominguez Creek and Little Dominguez Creek.. Specifically, BLM calculates that during average water supply conditions, snowmelt runoff volumes in Little Dominguez Creek should be approximately 80% of the values found in Big Dominguez Creek. Peak flow rates in Little Dominguez Creek should be slightly less than 80% of the peak flow rates in Big Dominguez Creek. This relationship occurs because the average elevation of the Big Dominguez Creek watershed is higher than the Little Dominguez Creek watershed, resulting in a larger snowpack in the Big Dominguez Creek watershed.

BLM installed pressure transducers with high capacity data loggers at two locations on Big Dominguez Creek and two locations on Little Dominguez Creek in 2008. The pressure transducers record stream flow stage levels. Stream stage values were then paired with time-corresponding, measured stream flow rates to develop a stage/discharge relationship. The

mathematical function that best predicts the stage-discharge relationship was then used to estimate stream flow during the last year from the collected stage record at each site. During 2009, the calculated flow rates from this data set were as follows:

Location	Range of Measured and Calculated Flows
Big Dominguez Creek – lower	0.0 cfs to 33 cfs
Big Dominguez Creek – upper	0.61 cfs to 26.05 cfs
Little Dominguez Creek – lower	0.61 cfs to 9.60 cfs (Note; transducer data not usable at higher flows)
Little Dominguez Creek – upper	0.54 cfs to 4.0 cfs (Note: no field confirmation of peak flow rates.)

Review of the 2009 weather pattern, precipitation, and snowpack on the Uncompahgre Plateau suggests the total flow volume for Big and Little Dominguez Creeks was about average, However, the timing of runoff and extremes associated with the 2009 runoff were atypical. Runoff generated from snowmelt started earlier than normal because of warm weather in March, and then peak flows were moderated by cool weather in April. May and June had slightly above normal precipitation. This weather pattern resulted in an extended snowmelt runoff period with lower peak flows than average. The summer period was marked by a lack of monsoon moisture, so base flows were significantly lower than normal. August was marked by the some of the lowest flows ever recorded on Big Dominguez Creek, and some portions of the lower part of the creek went dry for a few weeks. Even with the abnormally dry August, Big Dominguez Creek had continuous flow from the confluence of Big Dominguez Creek and Little Dominguez Creek down to the confluence with the Gunnison River. Most of the flow during late July and August was contributed by Little Dominguez Creek.

Introduction

This report is submitted in support of the Bureau of Land Management instream flow recommendation to the Colorado Water Conservation Board for the portions of Big Dominguez Creek and Little Dominguez Creek located within the Dominguez Canyon Wilderness. Stream flow gages have never been installed on either of these creeks. Accordingly, this report is designed to provide multiple analyses that can assist the CWCB in developing the most accurate estimation possible for the range of flows experienced in these stream systems. The report is divided into the following sections:

Section 1 - Statistical Hydrology Analysis – BLM performed two types of analysis:

- **Section 1A - Monthly Stream Flow Estimates**. Using stream flow data from gages located elsewhere on the Uncompahgre Plateau, BLM has developed an analytical procedure to estimate stream flow based on the watershed characteristics of watershed size and elevation . This procedure has been previously accepted by the CWCB to estimate flows for other streams on the Uncompahgre Plateau in cases where BLM has submitted instream flow recommendations to the CWCB. This analysis provides a prediction of an estimated monthly flow for average water supply conditions, and can be compared to historic, on-site flow measurements.

- **Section 1B - Comparison of Peak Flow Rates and Runoff Volumes.** Using precipitation data from sites on the Uncompahgre Plateau and land surface elevation data, BLM estimated the snow water equivalent for 2009 for the Big Dominguez Creek watershed and Little Dominguez Creek watershed. This analysis can be used to draw a relationship between between Big Dominguez Creek and Little Dominguez, with respect to peak flow rates and snowmelt runoff water volumes during years with average water supply conditions.

Section 2 - Historic Flow Data – BLM has periodically collected instantaneous stream discharge measurements on upper and lower Big Dominguez Creek. This data has been arranged by month, so that the reader can obtain an idea of the range of flows that the creek experiences for months in which data has been collected.

Section 3 - Stage/Discharge Relationship To Develop Hydrographs – BLM installed pressure transducers with high capacity data loggers at two locations on Big Dominguez Creek and two locations on Little Dominguez Creek in 2008. The pressure transducers record stream flow stage levels. Stream stage values were then paired with time-corresponding, measured stream flow rates to develop a stage/discharge relationship. The mathematical function that best predicts the stage-discharge relationship was then used to estimate stream flow during the last year from the collected stage record at each site. The pressure transducer results are accompanied by a weather and snowpack analysis for 2008-2009, so that the reader has a context for interpreting this data, which is limited to a single year.

Section 1 - Statistical Hydrology Analysis

Section 1 A - Monthly Stream Flow Estimates

Although there is a substantial amount of stream flow gage data available for the Uncompahgre Plateau and Glade Park, none of these gages have been located on Big Dominguez Creek or Little Dominguez Creek. In addition, most of existing gage data for the Uncompahgre Plateau is severely impacted by diversions and irrigation use. This situation makes it difficult to estimate the natural flow regime for the watersheds on the Uncompahgre Plateau. Without specific gage data to evaluate, the next best approach is a regional equation that estimates annual flow characteristics. The US Geological Survey has developed regional equations (Estimation of Natural Streamflow Characteristics in Western Colorado, Water Resources Investigations Report 85-4086, 1985) that apply to the Uncompahgre Plateau and Glade Park. The equation from the "Northwest Region" of the report that applies to Big Dominguez Creek and Little Dominguez Creek watersheds is as follows:

$$Q_{ann} = 2.05x10^{-2}(A^{0.973})(E_b^{2.63})(1.98)(365)$$

Q_{ann} = mean annual volume in acre - feet

A= drainage area in square miles

E_b = (mean basin elevation –5000)/1000

The mean standard error associated with the equation used to produce the estimates is 56 percent. This means that if the equation predicts a specific runoff volume, the actual runoff may be up to 56% higher or 56% lower than the predicted runoff volume. In order to verify the validity of this equation, the results were checked against historic stream flow gages on the Uncompahgre Plateau gages that provide estimates of the natural annual discharge. Three gages were located that provide a diversion-free estimate of a natural hydrograph. Each of these gages has a very short period of record, but are useful in verifying the accuracy of the equation.

- Spring Creek near Beaver Hill: Period of record; 1978 -1980
- Potter Creek near Olathe: Period of record; 1980
- Hay Press Creek above Fruita Reservoir #3: Period of record; 1984 – 1987

Using the period of record for each of the gages, a mean annual volume was calculated and compared to the results obtained using the regional equation.

- Spring Creek near Beaver Hill:

Mean annual gage volume: 11,100 ac-ft

Annual volume regional equation: 11,300 ac-ft

- Potter Creek near Olathe:

  Mean annual gage volume: 5,000 ac-ft

  Annual volume regional equation: 6,000 ac-ft

- Hay Press Creek above Fruita Reservoir #3:

  Mean annual gage volume: 575 ac-ft

  Annual volume regional equation: 625 ac-ft

The largest comparative difference in these gages is Potter Creek at about 17%. This is well within the standard error of the regional equation. However, the gage record for each of these creeks is limited. Therefore, two other creeks with a longer representative period of record were chosen to compare with the regional equations.

- Escalante Creek near Delta: Period of record; 1977 – 1988
- Tabeguache Creek near Nucla: Period of record; 1947 –1952

Both of these gages are affected by diversions and irrigation. Using data obtained from Colorado River Decision Support Systems (Colorado Water Conservation Board, Department of Water Resources) that reflects diversion volumes, along with local estimates of irrigated acreage and return flows, the annual gage volumes were adjusted for diversions and irrigation to estimate a natural annual volume.

- Escalante Creek near Delta:

  Mean annual adjusted gage volume: 84,000 ac-ft

  Annual volume regional equation: 75,000 ac-ft

- Tabeguache Creek near Nucla:

  Mean annual adjusted gage volume: 15,000 ac-ft

  Annual volume regional equation: 13,900 ac-ft

The comparison between gage data and regional equations for the Escalante Creek and Tabeguache Creek gages, coupled with the results from Potter Creek, Hay Creek, and Spring Creek, indicates that the regional equations apparently provide a reasonably accurate estimate of the total annual flow volume.

Once total annual volumes can be estimated, the question then becomes how to allocate this volume over a 12-month period. A mean annual monthly distribution was calculated using the annual hydrographs from Potter Creek, Spring Creek, and Hay Press Creek. These three creeks were used since they are the best unaltered representations of a natural plateau flow regime. The monthly distribution of volume based on a percentage of annual total volume is as follows:

January 0.32%	April 14.7%	July 1.3%	October 0.39%
February 0.6%	May 55.4%	August 0.55%	November 0.35%
March 1.0%	June 24.6%	September 0.45%	December 0.34%

To portray mean monthly flows, BLM developed a spreadsheet calculation that represents the factors from the USGS equation – drainage area and mean basin elevation – to calculate an annual discharge volume. These annual volumes were then distributed according to the monthly distributions above and converted into flow rates.

The spreadsheet calculation below shows estimated monthly average streamflows for Big Dominguez at its confluence with the Gunnison River.

Water Yield Estimates from Equation for NW Region as defined in USGS WRI-85-4086

Watershed: **Big Dominguez at conf. w Gunnison R.**
Location:

Drainage Area Square Miles	166
Mean Basin Elev. Ft.	7613
Mean Basin Elev. -5000 ft/1000 ft	2.613
Mean Annual Flow cfs	37.068
Mean Annual Yield AF	26836

	%of flow	AF/Month	AF/Day	Mean Monthly flow cfs
Jan	0.0032	85.892	2.771	1.399
Feb	0.0065	174.469	6.016	3.038
Mar	0.0100	268.413	8.658	4.373
Apr	0.1470	3945.678	131.523	66.426
May	0.5541	14870.106	479.681	242.263
Jun	0.2461	6602.971	220.099	111.161
Jul	0.0130	348.938	11.256	5.685
Aug	0.0050	134.207	4.329	2.186
Sep	0.0040	107.365	3.579	1.807

Oct	0.0039	104.681	3.377	1.705
Nov	0.0037	99.313	3.310	1.672
Dec	0.0035	93.945	3.030	1.531

The spreadsheet calculation below shows estimated monthly average streamflows for Big Dominguez Creek immediately upstream from where Big Dominguez Creek joins Little Dominguez Creek.

Water Yield Estimates from Equation for NW Region as defined in USGS WRI-85-4086

Watershed: **Big Dominguez Creek at confluence with Little Dominguez**
Location:

Drainage Area Square Miles	81.46
Mean Basin Elev. Ft.	7872
Mean Basin Elev. -5000 ft/1000 ft	2.872
Mean Annual Flow cfs	23.775
Mean Annual Yield AF	17213

	%of flow	AF/Month	AF/Day	Mean Monthly flow cfs
Jan	0.0032	55.092	1.777	0.898
Feb	0.0065	111.905	3.859	1.949
Mar	0.0100	172.162	5.554	2.805
Apr	0.1470	2530.777	84.359	42.606
May	0.5541	9537.756	307.670	155.389
Jun	0.2461	4235.177	141.173	71.299
Jul	0.0130	223.810	7.220	3.646
Aug	0.0050	86.081	2.777	1.402
Sep	0.0040	68.865	2.295	1.159
Oct	0.0039	67.143	2.166	1.094
Nov	0.0037	63.700	2.123	1.072
Dec	0.0035	60.257	1.944	0.982

The spreadsheet calculation below shows estimated monthly average streamflows for Little Dominguez Creek immediately upstream from where Little Dominguez Creek joins Big Dominguez Creek.

Water Yield Estimates from Equation for NW Region as defined in USGS WRI-85-4086

Watershed: **Little Dominguez Creek at conf. w Big Dominguez**
Location:

Drainage Area Square Miles	84.34
Mean Basin Elev. Ft.	7384
Mean Basin Elev. -5000 ft/1000 ft	2.384

Mean Annual Flow cfs	15.070
Mean Annual Yield AF	10910

	%of flow	AF/Month	AF/Day	Mean Monthly flow cfs
Jan	0.0032	34.919	1.126	0.569
Feb	0.0065	70.929	2.446	1.235
Mar	0.0100	109.121	3.520	1.778
Apr	0.1470	1604.080	53.469	27.005
May	0.5541	6045.307	195.010	98.490
Jun	0.2461	2684.378	89.479	45.192
Jul	0.0130	141.857	4.576	2.311
Aug	0.0050	54.561	1.760	0.889
Sep	0.0040	43.648	1.455	0.735
Oct	0.0039	42.557	1.373	0.693
Nov	0.0037	40.375	1.346	0.680
Dec	0.0035	38.192	1.232	0.622

Section 1-B Comparison of Peak Flow Rates and Flow Volumes

The second type of statistical hydrology performed by BLM was an evaluation of the expected differences in snowmelt water yield between Big Dominguez Creek and Little Dominguez Creek, using a specific water year as an example. The following analysis calculates an estimated snow water equivalent within the two watersheds for 2009, based upon the aerial distribution of land surface elevation of the two watersheds. BLM assumed that any differences in snowmelt runoff between the two watersheds would largely be driven by snow water equivalent, because the two watersheds are not statistically different in terms of aspect (percentage of land slopes facing east, west, north, or south), and because the two watersheds have very similar soils, geology, and surface slope. In addition, the two watersheds are very similar in size. The Big Dominguez Creek watershed (down to the confluence with Little Dominguez Creek) contains 52,135 acres, while the Little Dominguez Creek watershed contains 53,983 acres.

To determine snow water equivalent for the two watersheds in 2009, BLM started with data from the nearest long-term weather station site to the two watersheds, which is located at Columbine Pass, approximately 15 miles to the south at the crest of the Uncompahgre Plateau. The weather station is also a SNOTEL site, with continuous recording of snow water equivalent. The data from this station are presented below.

Columbine Pass (Elevation 9,400') (Snotel Station)

Monthly Climate Summary[1]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Temperature (F)	21.63	24.47	31.02	37.24	45.46	54.97	60.20	57.71	50.86	40.92	28.32	21.53	39.53
Average Total Precipitation (in.)	4.20	3.80	4.30	3.50	2.10	0.90	1.80	1.90	2.00	2.90	3.30	3.50	34.2

1. Snotel climate station data obtained from the USDA, Natural Resource Conservation Service website, at: http://www.wcc.nrcs.usda.gov/snow/update.html

To better define the variation in precipitation across the Uncompahgre Plateau according to elevation, BLM precipitation monitoring data that was collected in the 1980s were reviewed. Four BLM monitoring locations on the Uncompahgre Plateau had precipitation totals for at least two periods of twelve consecutive months. These data are summarized in the following table. Since the data were from storage type precipitation gages, the distribution of precipitation can only be assessed as totals in the time interval between gage readings. In most cases, the period of record is short of a full year by a few days. However, after assessing daily precipitation data for Montrose for these short data gaps, no significant changes (>0.10") in precipitation data resulted. Additionally, the BLM data are not on a calendar or water year basis. However, data is available from the Montrose Climate Station (Colorado State University) for the same monthly periods that allowed the BLM data to be normalized with this station. (Note: the Delta climate station had several periods of missing data and could not be used for this analysis). The normalized twelve month precipitation amounts were then averaged for each BLM data station. These data are summarized in the last column of the following table.

Historic Precipitation Record for the Uncompahgre Plateau Normalized with Montrose, Colorado Precipitation Data

Site	Location	Period of Record	Elevation Feet	Precipitation Inches	Montrose % of Normal	Normalized Totals	Normalized Average
Dry Creek	T48N, R11W, SESE Sec. 17	5/6/1980-4/24/1981	7285	11.80	80	14.75	
		8/20/1982-8/3/1983	7285	20.80	135	15.41	
		8/29/1984-8/20/1985	7285	22.86	119	19.21	16.46
Lower Roubideau	T51N, R12W, NENW Sec. 24	5/11/1983-5/7/1984	5300	7.15	139	5.14	
		5/7/1984-5/9/1985	5300	7.75	144	5.38	
		5/9/1985-5/13/1986	5300	5.65	96	5.89	
		5/13/1986-5/7/1987	5300	8.41	162	5.19	
		5/7/1987-5/11/1988	5300	6.90	103	6.70	5.66

25 Mesa Road	T50N, R13W, NWNE Sec. 25	5/11/1983-5/7/1984	7200	16.50	139	11.87	
		5/16/1985-5/13/1986	7200	13.85	96	14.43	
		5/7/1987-5/11/1988	7200	12.00	103	11.65	12.65
Potter Basin	T49N, R13W, SWNW Sec. 27	8/12/1985-8/21/1986	8000	28.19	127	22.20	
		8/21/1986-8/26/1987	8000	29.06	140	20.76	21.48

1. Precipitation Data on file at the BLM-Uncompahgre Field Office.

The normalized, average precipitation totals in the table of BLM precipitation data and the corresponding precipitation averages from the three long term climate stations (Delta, Montrose, and Columbine Pass) were then plotted against station elevation (Figure below). A trend line was established that produced an R squared of 0.8973, which implies that 90% of the variation in precipitation on the Uncompahgre Plateau is explained by elevation. Some station to station variation also occurs due to the occurrence of small, localized convective storms during the summer months associated with monsoonal air flow.

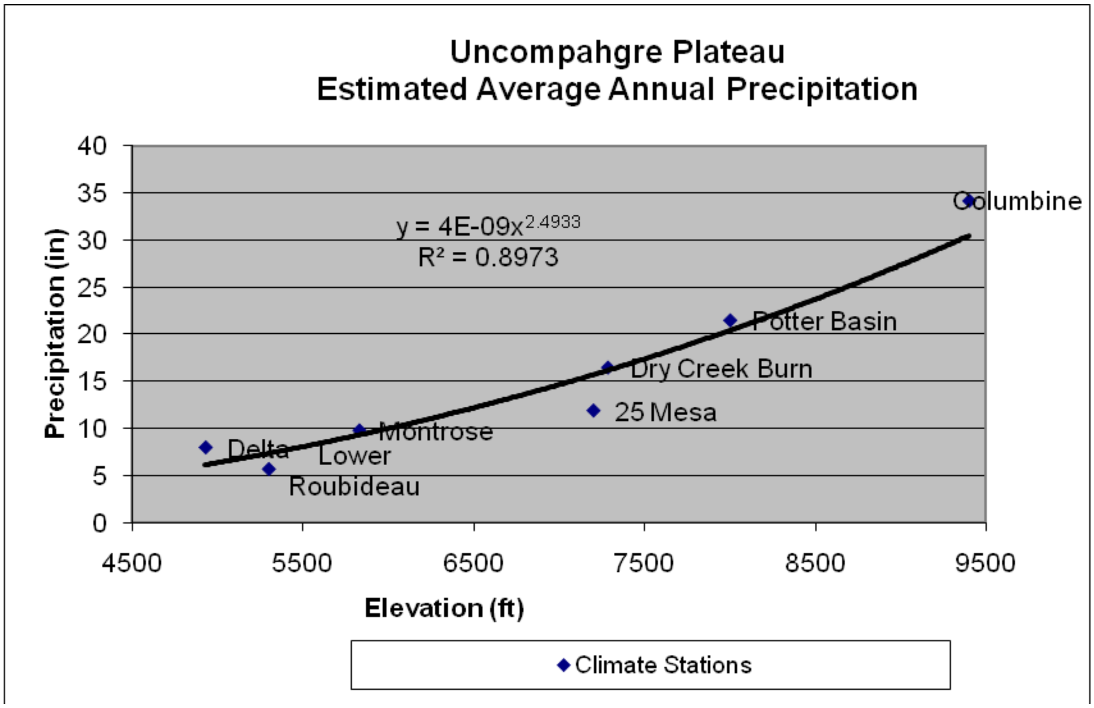


Figure 1 Annual Precipitation Variation with Elevation

Using the power line function above, estimated average annual precipitation for elevation intervals on the Uncompahgre Plateau is presented in table below.

Elevation Band	Mean Annual Precipitation (MAP)	Percent of MAP at Columbine Pass
5000-6000	8.5 inches	24.9%
6000-7000	13.0 inches	38.0%
7000-8000	18.5 inches	54.1%
8000-9000	23.5 inches	68.7%
9000-9500	28.0 inches	81.8%

BLM checked the results above against precipitation maps for the Uncompahgre Plateau produced by the PRISM Climate Center at Oregon State University. The comparison found general agreement between the mean annual precipitation for the elevation bands outlined above and the PRISM climate maps.

To derive the estimated snow water equivalent within the Big Dominguez Creek and Little Dominguez Creek watersheds for 2009, BLM identified the maximum snow water equivalent for Columbine Pass station for 2009. This occurred on April 7, 2009, when the snow water equivalent within the snowpack was 17.4 inches. BLM then applied the percentages in the table above to calculate estimated snow water equivalents for the various elevation bands on the Uncompahgre Plateau. The results of this calculation are displayed in the table below. Note that BLM did not calculate a snow water equivalent for elevations below 7000 feet, because on average, there is no snowpack below this elevation in early April, when snowmelt runoff begins.

Elevation Band	Percent of Columbine Pass Station	2009 Snow Water Equivalent
5000-6000	24.9%	No snowpack
6000-7000	38.0%	No snowpack
7000-8000	54.1%	9.41 inches (0.78 feet)
8000-9000	68.7%	11.95 inches (0.99 feet)
9000-9500	81.8%	14.23 inches (1.19 feet)

The following table applies the snow water equivalent calculations for 2009 in the table above to the distribution of land surface elevations within the Big Dominguez Creek watershed and the Little Dominguez Creek watershed.

Big Dominguez Creek Watershed

Elevation Band	Acres	% of watershed	Snow Water Equivalent	Volumetric Water Equivalent
7000-8000	14,226	27.28	9.41 inches (0.78 feet)	11,096.3 acre feet
8000-9000	27,341	52.44	11.95 inches (0.99 feet)	27,067.6 acre feet
9000-9500	1,512	2.90	14.23 inches (1.19 feet)	1,799.3 acre feet

Estimated Total Volumetric Snow Water Equivalent as of April 7, 2009 = 39,963.2 acre feet

Little Dominguez Creek Watershed

Elevation Band	Acres	% of watershed	Snow Water Equivalent	Volumetric Water Equivalent
7000-8000	20,025	37.09	9.41 inches (0.78 feet)	15,619.5 acre feet
8000-9000	16,562	30.68	11.95 inches (0.99 feet)	16,396.4 acre feet
9000-9500	171	00.31	14.23 inches (1.19 feet)	172.2 acre feet

Estimated Total Volumetric Snow Water Equivalent as of April 7, 2009 = 32,188.1 acre feet

Conclusions

The foregoing analysis allows BLM to draw several conclusions about the Big Dominguez Creek watershed in relationship to the Little Dominguez Creek watershed.

- The Big Dominguez Creek watershed has significantly more acreage than the Little Dominguez Creek watershed in the 8,000 foot to 9,000 foot elevation band and within the 9,000 foot to 9,500 foot elevation band. These elevation bands are where the most snowpack occurs, so BLM would expect that Big Dominguez Creek will produce significantly higher flows during snowmelt runoff than will occur in Little Dominguez Creek.

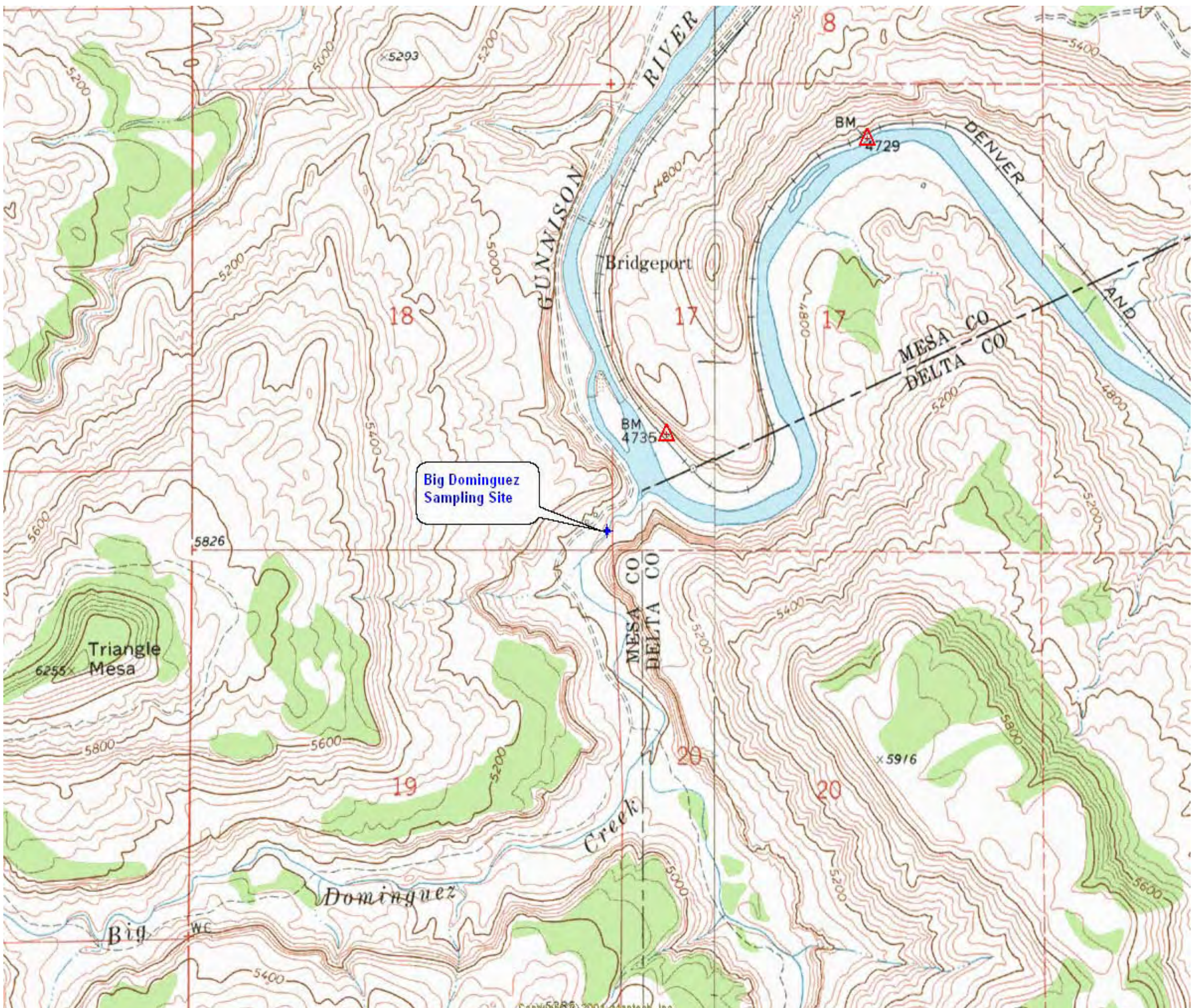
- BLM concluded that 2009 was an average snowpack year on the Uncompahgre Plateau. For the 1987 to 2009 period at the Columbine Pass SNOTEL site, the average of the maximum snow water equivalent readings, taken from each year in the record, is 18.7 inches. As stated previously, the maximum snow water equivalent reading for 2009 was 17.4 inches on April 7, which is within 10% of the long-term average. For the Columbine Pass weather station, the maximum snow water equivalent typically occurs in late March or early April, and this same pattern occurred during 2009.

- During years with average snowpack such as 2009, BLM would anticipate that the aggregate volume of snowmelt runoff flows in Little Dominguez Creek will be approximately 80% of the flow volume in Big Dominguez Creek. BLM reaches this conclusion because the estimated total volumetric snow water equivalent for Little Dominguez Creek watershed, at 32,188 acre feet, was 80% of the estimate for the Big Dominguez Creek watershed, at 39,963.2 acre feet.

- Peak flow rates in Little Dominguez Creek are predicted to be slightly less than 80% of the peak flow rates in Big Dominguez Creek. In Big Dominguez Creek, more than 55% of the watershed is above 8000 feet, while in Little Dominguez Creek, only 31% of the watershed is above 8,000 feet. Since the snowpack in Little Dominguez Creek is distributed across a greater range of elevation, snowmelt runoff would be expected to occur gradually. In contrast, a very high percentage of the snowpack in Big Dominguez Creek is concentrated at high elevation. When temperatures reach the point capable of producing snowmelt above 8,000, a large surge of snowmelt runoff will occur.

Section 2 - Historical Flow Data

BLM staff collected periodic discharge measurements from Big Dominguez Creek in the period from 1981 to 1994. One location for data collection was approximately one mile downstream from the confluence of Big Dominguez Creek and Little Dominguez Creek. Refer to the following map for the sample location.



Scale |--|1 mile ⇑ North

Map of Historic Big Dominguez Sampling Site

The following table presents the historic discharge data grouped by month. Note that the historic record for this location lacks any discharge measurements for April and only two discharge measurements for May, the two months that typically experience the highest flow rates. Data collection during these periods was constrained by high flow rates, which often create conditions that are unsafe for flow measurements with a wading rod.

Lower Big Dominguez Creek Historic Data		
Name	Date	Discharge (cfs)
BIG DOMINGUEZ CREEK	3/6/1984	3.2
BIG DOMINGUEZ CREEK	5/30/1989	2.7
BIG DOMINGUEZ CREEK	5/13/1983	93
BIG DOMINGUEZ CREEK	6/28/1990	0.47
BIG DOMINGUEZ CREEK	6/26/1991	0.53
BIG DOMINGUEZ CREEK	6/8/1994	1.4
BIG DOMINGUEZ CREEK	6/22/1988	3.8
BIG DOMINGUEZ CREEK	6/14/1985	10
BIG DOMINGUEZ CREEK	7/22/1982	0.50
BIG DOMINGUEZ CREEK	7/28/1987	10
BIG DOMINGUEZ CREEK	8/3/1993	0.10
BIG DOMINGUEZ CREEK	8/12/1981	2.3
BIG DOMINGUEZ CREEK	8/30/1983	3.0
BIG DOMINGUEZ CREEK	8/9/1984	3.3
BIG DOMINGUEZ CREEK	9/21/1994	1.1
BIG DOMINGUEZ CREEK	9/15/1983	1.2
BIG DOMINGUEZ CREEK	9/29/1993	1.2
BIG DOMINGUEZ CREEK	9/7/1989	1.2
BIG DOMINGUEZ CREEK	9/10/1985	1.6
BIG DOMINGUEZ CREEK	9/13/1991	1.8

BIG DOMINGUEZ CREEK	9/21/1988	2.2
BIG DOMINGUEZ CREEK	9/7/1982	2.3

In addition to the historic data, BLM continued to collect data at the Lower Big Dominguez site during the last year. This data is displayed below.

Calculated Flow Near the Mouth of Big Dominguez Creek							
Date	Discharge cfs	Date	Discharge cfs	Date	Discharge cfs	Date	Discharge cfs
9/23/2008	1.2	5/19/2009	3.4	6/17/2009	2.2	7/28/2009	1.1
12/5/2008	1.2	5/26/2009	6.0	6/29/2009	2.6	8/11/2009	0.61
4/21/2009	37	6/2/2009	4.9	7/14/2009	0.89	8/25/2009	1.1

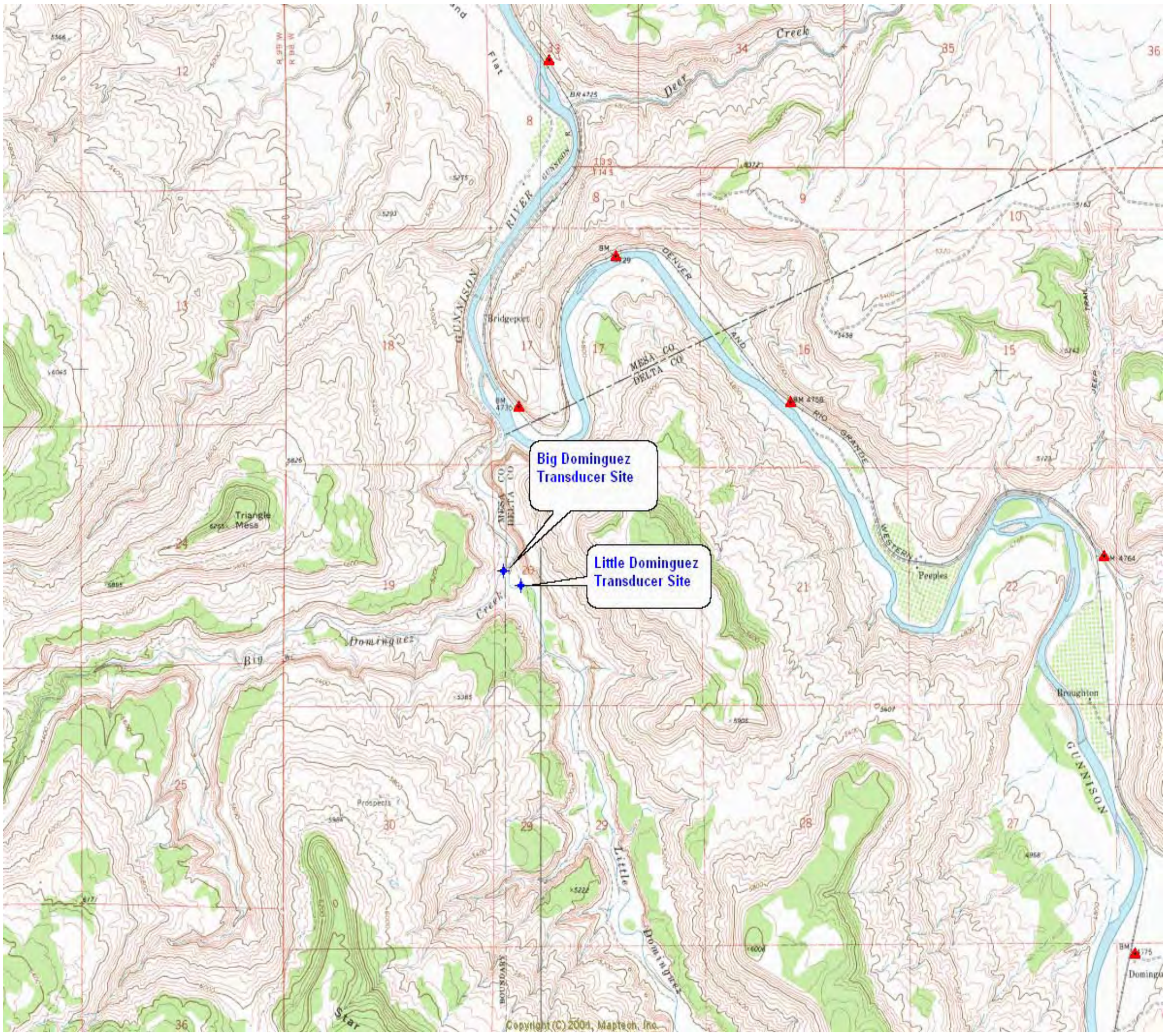
BLM's second historic data collection site was in the upper portion of Big Dominguez Creek, near the BLM campground. Note that the historical flow record contains no flow measurements earlier than mid-May, which is typically after peak flows occur. This is because the road to the measurement site is typically not clear of snow until mid-May. The following table presents the historic discharge data arranged by month.

Upper Big Dominguez Creek Historic Discharge Data		
Name	Date	Discharge (cfs)
Upper Big Dominguez	5/27/1994	3.3
Upper Big Dominguez	5/19/1989	3.6
Upper Big Dominguez	5/28/1992	6.8
Upper Big Dominguez	5/12/1983	48
Upper Big Dominguez	6/26/1990	0.26
Upper Big Dominguez	6/20/1988	2.2
Upper Big Dominguez	6/20/1985	5.1
Upper Big Dominguez	6/5/1986	7.1

Upper Big Dominguez	7/29/1993	0.46
Upper Big Dominguez	7/11/1991	0.48
Upper Big Dominguez	7/14/1987	1.4
Upper Big Dominguez	7/8/1982	1.8
Name	Date	Discharge (cfs)
Upper Big Dominguez	7/18/1995	2.0
Upper Big Dominguez	8/9/1984	1.4
Upper Big Dominguez	8/26/1983	1.4
Upper Big Dominguez	9/1/1989	0.41
Upper Big Dominguez	9/12/1995	0.46
Upper Big Dominguez	9/10/1992	0.48
Upper Big Dominguez	9/12/1991	0.50
Upper Big Dominguez	9/1/1982	0.58
Upper Big Dominguez	8/28/1981	0.60
Upper Big Dominguez	9/23/1993	0.22
Upper Big Dominguez	9/20/1990	0.66
Upper Big Dominguez	9/20/1988	0.75
Upper Big Dominguez	9/11/1985	0.78
Upper Big Dominguez	9/15/1994	0.84
Upper Big Dominguez	9/29/1987	1.0
Upper Big Dominguez	9/15/1983	1.1
Upper Big Dominguez	9/11/1986	2.1

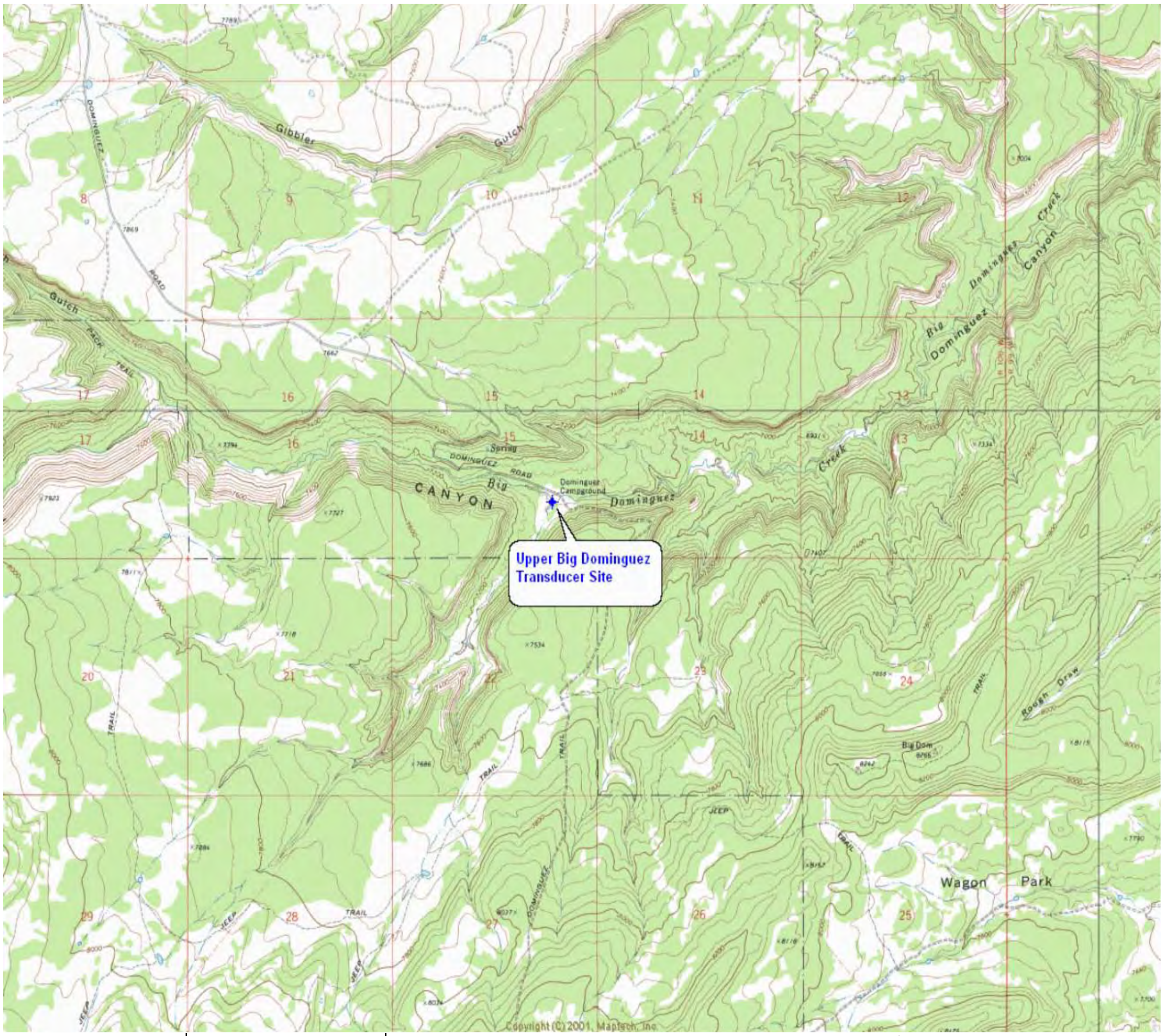
Section 3 - Stage/Discharge Relationship to Develop Hydrographs

Pressure Transducer Methodology. To obtain stream stage data for developing a flow rating curve and ultimately a hydrograph, pressure transducers were installed in Big and Little Dominguez Creeks in September 2008. Each creek received two transducers. One transducer was installed on each creek near the confluence of Big Dominguez Creek and Little Dominguez Creek. An additional transducer was installed on each creek near the location where the creek enters BLM lands from US Forest Service lands. Refer to the following maps for the locations of the transducers. Refer to Figure 1 for a map of the lower Big and Little Dominguez sites,



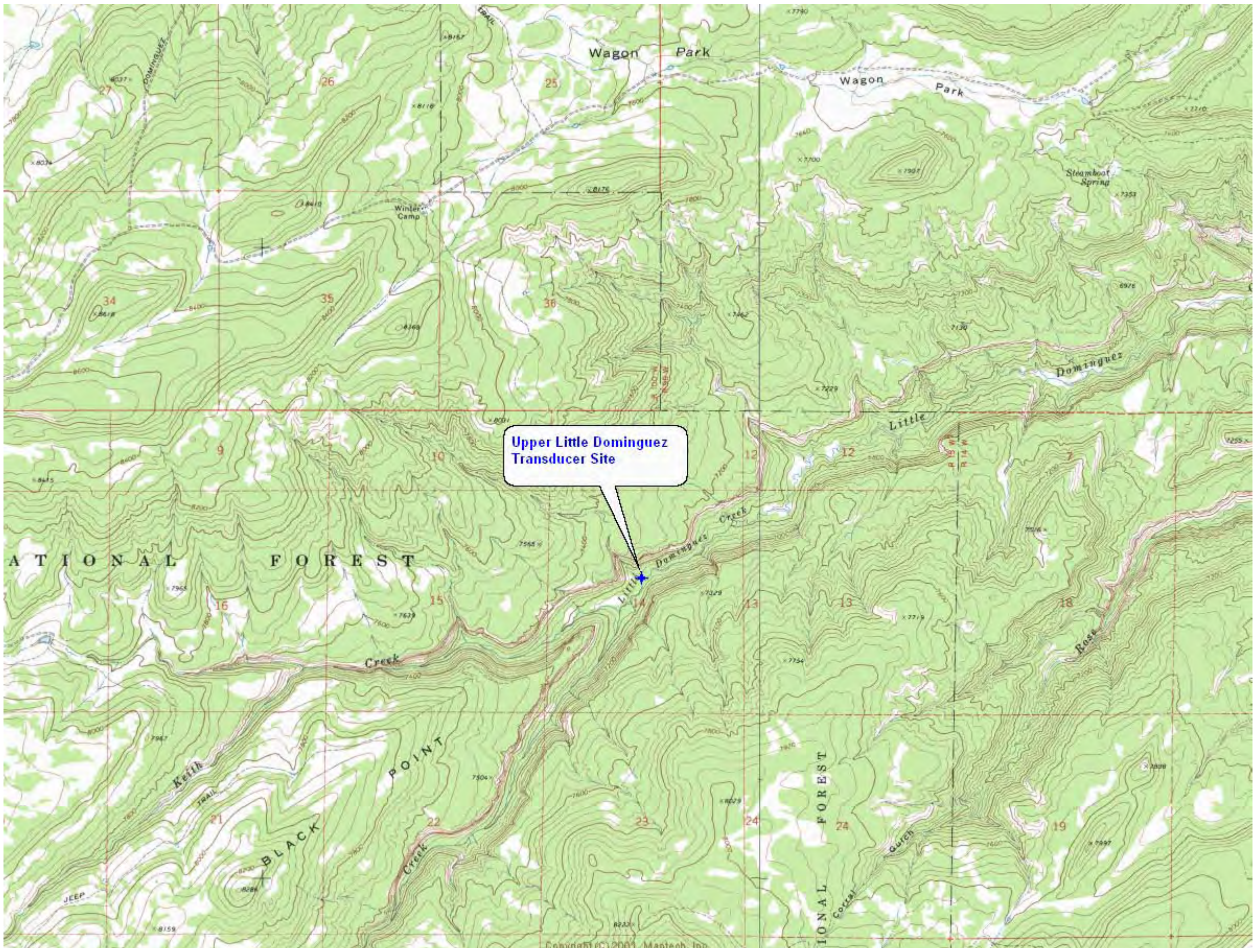
Scale: |------------------------------| 1 mile ⇑ North

Figure 1 - Map of the lower Little Dominguez and Big Dominguez Transducer Sites



Scale: |----------------------| 1 mile ⇑ North

Figure 2 - Map of Upper Big Dominguez Transducer Site



Scale: |----------------------| 1 mile ⇑ North

Figure 3 – Map of upper Little Dominguez Creek Transducer Site

These transducers provided for collection of stage data during the crucial snowmelt period and summer lower flow period. Periodic field visits were made to each transducer location to download data from the data loggers, measure stage from rebar stage gages, and measure flow following the standard USGS protocol. These streams had less than 2.5 foot depth at times of measurement, so velocities were measured with a Marsh-McBirney meter at 60% of the depth, the 0.6 method. Discharge measurements notes were recorded on US Geological Survey Form 9-275G for most of the site visits.

Use of the USGS form provides for a subjective evaluation of quality of the flow measurement. Excellent measurements are within 2% of actual flow, good within 5%, fair within 8% and poor over 8% difference from actual flow. Excellent measurements have sections with adequate width to divide the stream into 20 or more sections, in which each section has no more than 5% of the flow. Each section should have adequate depth a good depth measurement, generally over 0.2 feet depth, and something close to laminar flow. As these criteria are compromised, the quality of the discharge measurement is reduced. For example, a fair evaluation may be given for a measurement that has numerous rocks that can not be moved creating backwater areas (negative velocity readings on the meter), is shallow with numerous sections of perhaps 0.1 feet depth or less, and a total width of a few feet.

Discharge data were collected for a period of slightly less than one year. Most discharge measurements were made during low flow periods with only a few made during the rising or falling limb of the hydrograph. With a concentration of measurements at low flows and limited measurements at moderate and higher flow, the development of a good rating curve and hydrograph is somewhat challenging. Overestimation of base flows and moderate flow can result when the curve is fit to just one high flow. There were episodes of channel scour and filling at the lower Little Dominguez site that also affected the stage data. The transducer was covered with stream cobble on one occasion and was suspended above the streambed during some of the rating period. Consequently, stage data at this location for a portion of the evaluation period may not be very accurate.

Rebar was driven into the stream near the transducers at all locations. The rebar posts were to function as stage gages, allowing for correction of transducer stage data. Unfortunately, high flood flows took out the rebar at the lower Little Dominguez location, the location with the most channel movement. Consequently, adjusting stage based on rebar post readings to improve data accuracy was not possible because the reference point was washed away.

Stage data recorded by the transducers were downloaded into an Excel spreadsheet. A relationship was developed using measured discharge and stage data. Using best-fit trend line analysis, either a linear function or a power function was developed to estimate the discharge to all stage values. When the transducer recorded several readings in a day equivalent to no flow, all values for that day were changed to that minimum value. The assumption is flow was not starting and then stopping after a few hours within a day. Discharge, based on stage readings, was estimated using the regression equations. The estimated discharge values were plotted against time to generate the hydrograph.

Lower Big Dominguez Creek – Results. The transducer is located in a relatively stable stream section. Minimal bed movement was observed. The highest stage reading recorded was 1.24 feet, and a discharge measurement was made at that level.

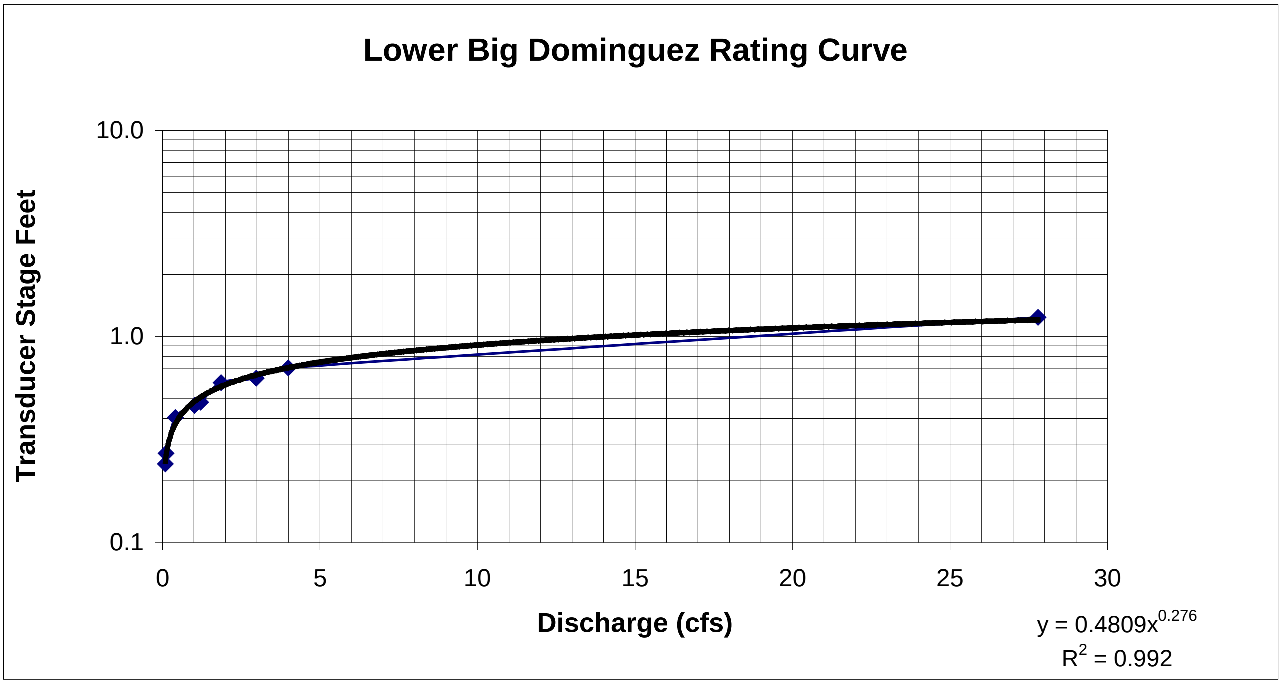
Twelve discharge measurements were made ranging from between 0 flow (mid July to late Aug) to 28 cfs in late April. Transducer recording interval is 2 or 6 hours, so peak values could have been missed. Discharge measurements at medium to higher flows are rated good, within 5% of actual value, while lower flow measurement are rated fair (within 8% of actual flow). Rating at lower flow was reduced primarily because of shallow depths, low velocities, and non-laminar flow.

Comparison of rebar (staff gage) and transducer indicated stage differences ranging from 0.01 to 0.07 feet (0.12 to 0.84 inches).

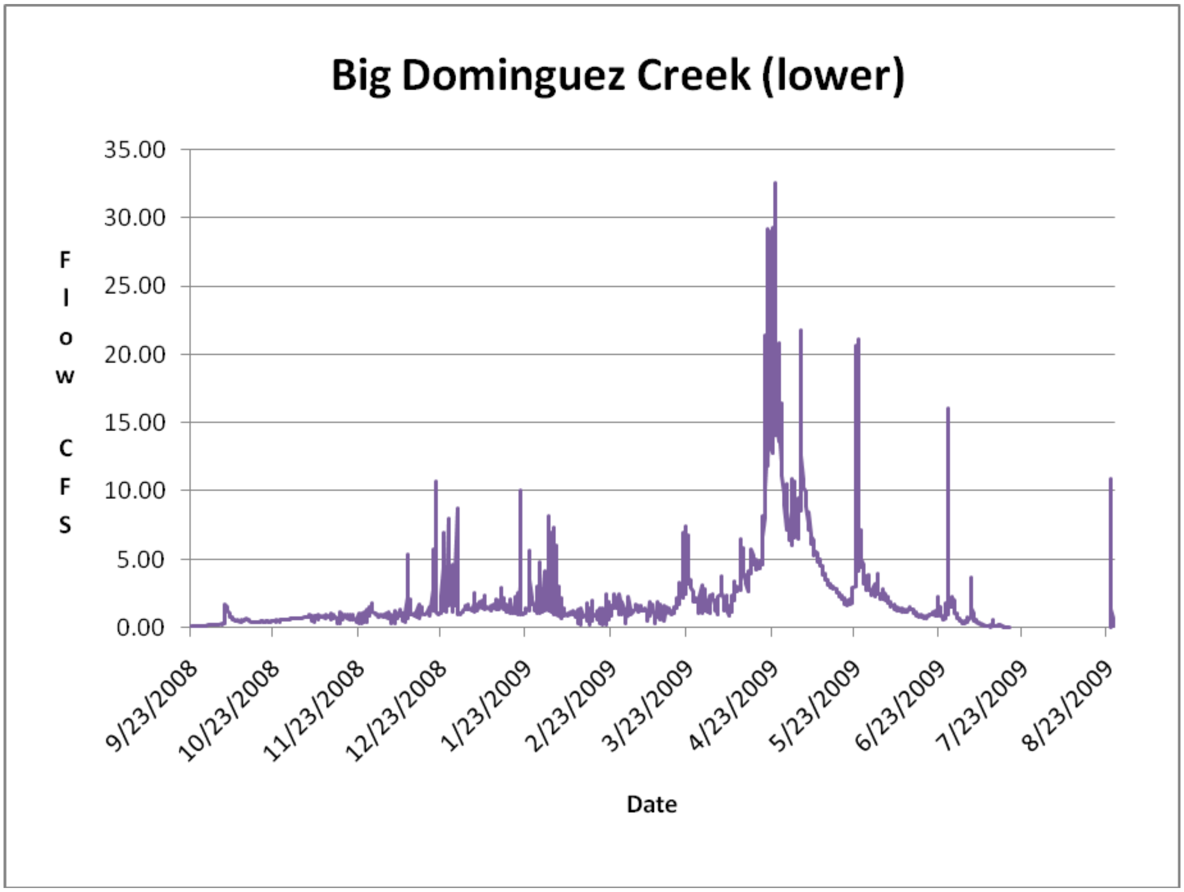
The following table presents the stage and discharge measurements made during the evaluation period.

Lower Big Dominguez Creek			
Date	Time	Discharge (cfs)	Transducer Stage (feet)
9/23/2008	13:32	0.11	0.26
12/5/2008	10:51	0.41	0.39
4/21/2009	9:35	28	1.24
5/19/2009	10:19	1.9	0.60
5/26/2009	9:50	4.0	0.70
6/2/2009	10:10	3.0	0.63
6/17/2009	9:50	1.0	0.46
6/29/2009	9:03	1.2	0.48
7/14/2009	9:30	0.09	0.24
7/28/2009	9:30	0	0.00
8/11/2009	9:50	0	0.00
8/25/2009	9:05	0.11	0.27

A rating curve relating the transducer stage data to measured discharge is presented in the following graph.



A hydrograph relating transducer stage to discharge is presented below. While there is an excellent coefficient of determination (0.99), there is a lack of data between approximately 4 and 28 cfs that may compromise prediction accuracy within that flow range. The best fit for the data is a power function.



Upper Big Dominguez Creek-Results. This transducer is located on the inside of a meander and just downstream of a generally dry tributary. The channel appears relatively stable since minimal bed movement was observed during field visits. A transducer stage of nearly 2 feet was recorded but discharge measurements didn't correspond to the time that the 2 feet reading occurred.

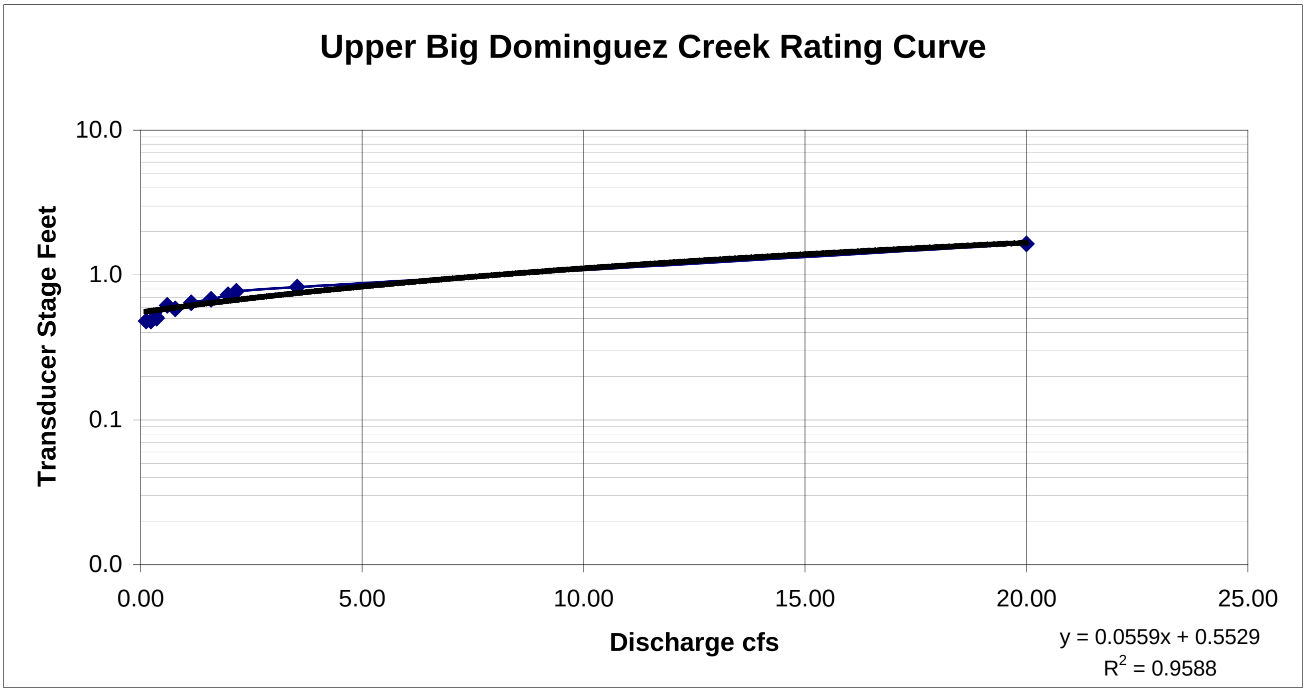
Twelve visits were made and flows ranging between 0.12 cfs in mid-August to 20 cfs in late April were measured. The highest flow measurement was made at a 1.64 feet stage. Transducer recording interval is 2 or 6 hours, so peak values could have been missed. Discharge measurements at medium to higher flows are rated good, within 5% of actual value, while lower flow measurement are rated fair, within 8% of actual flow. Rating at lower flow was reduced because of shallow depth, low velocity, and non-laminar flow.

Comparison of rebar (staff gage) and transducer indicated differences ranging from 0 to 0.24 feet (up to 2.9 inches). Both the December 2008 and May 2009 rod/stage relationships indicate an error. Those data were not used in the development of the rating curve.

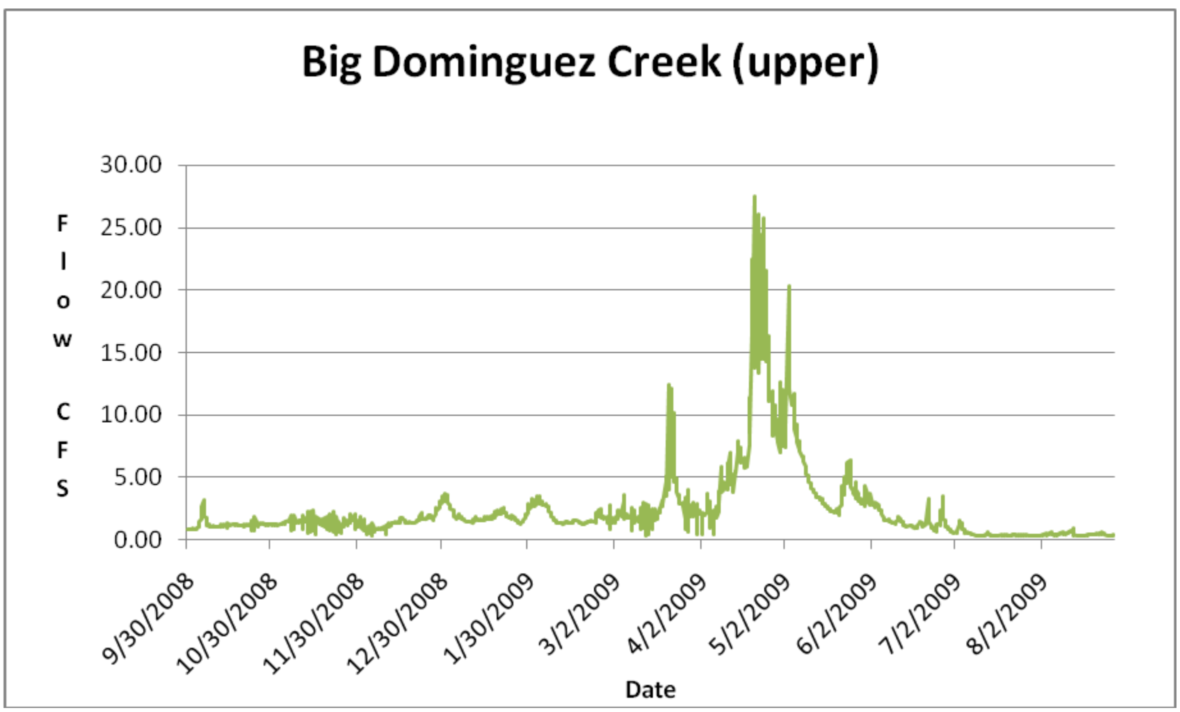
These data indicate the lowest flow measured this water year was the lowest flow of record. The highest flow measured (1983) was nearly 2 1/2 times the high flow measured this year. Both 1983 and 1984 are recognized as historically wet water years. The following table presents the stage and discharge measured during this water year plus the September 2008 data.

Upper Big Dominguez Creek			
Date	**Time**	**Stage feet**	**Discharge cfs**
9/30/2008	12:49	0.62	0.60
12/4/2008	10:30	0.62	1.1
4/23/2009	10:16	1.64	20
5/21/2009	8:22	0.73	2.0
5/28/2009	9:15	0.82	3.5
6/4/2009	9:25	0.77	2.2
6/19/2009	8:40	0.68	1.6
7/1/2009	8:52	0.58	0.78
7/16/2009	13:21	0.52	0.34
7/30/2009	14:00	0.50	0.36
8/13/2009	13:40	0.48	0.12
8/27/2009	13:20	0.48	0.23

A rating curve relating the transducer stage data to measured discharge is presented below.



A hydrograph relating transducer stage to discharge is presented below. The best fit for the Upper Big Dominguez site is a least squares fit. The coefficient of determination is very high (0.96).



Lower Little Dominguez Creek – Results. The transducer is located in a straight riffle pool section of the stream. While the channel appears stable, field observations indicate considerable movement of the substrate occurred primarily during flash flood events. Those events created times the transducer was buried under cobble sized bed material. There was one site visit where the transducer was suspended over the streambed.

During the thirteen site visits, flows ranging from 0.61 cfs in mid-August to 9.6 cfs in late April were measured. A stage reading of 2.8 feet was recorded, but the timing discharge measurements did not correspond with that stage reading. The highest flow measurement was made at a 0.74 feet stage. Transducer recording interval is 2 or 6 hours, so peak values could have been missed. Discharge measurements at medium to higher flows are rated excellent within 2% of actual value, while lower flow measurements are rated good (within 5% of flow).

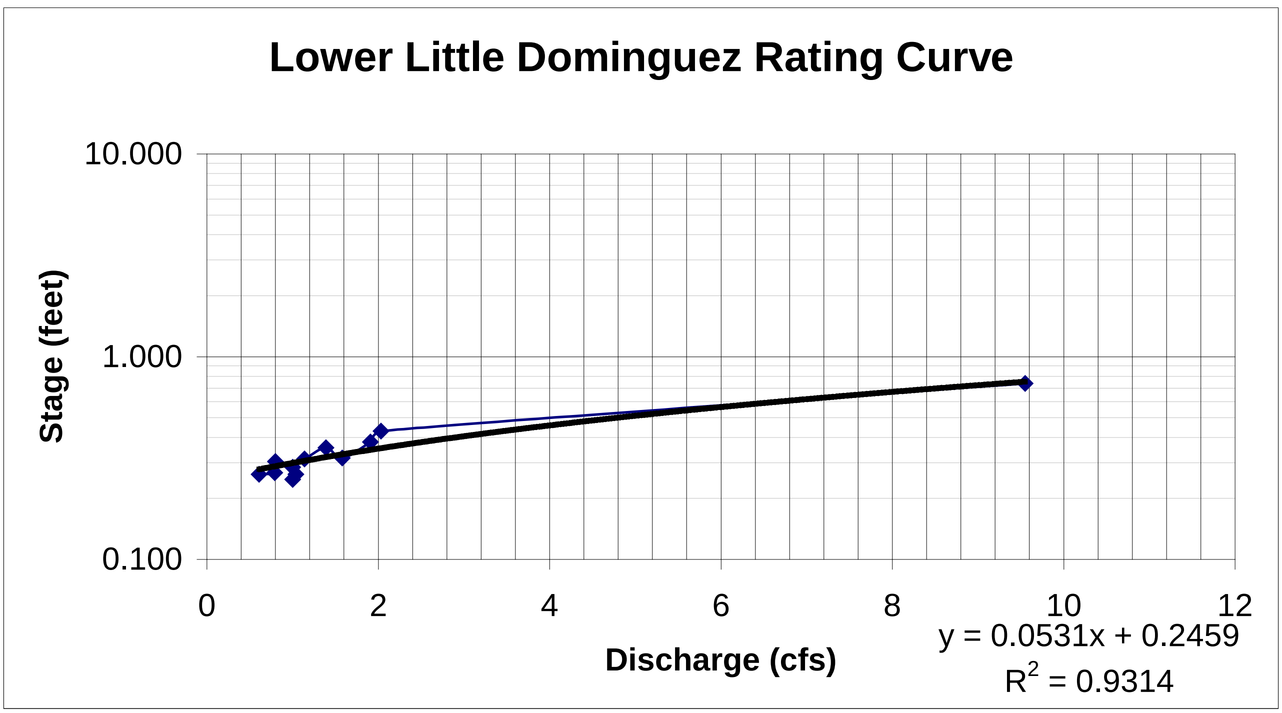
Comparison of rebar (staff gage) and transducer was not possible because the rod was washed away by a flash flood in late May 2009. For the three measurements made before being the rod was washed away, the stage data were very consistent.

The following table presents the transducer stage and discharge measurements made from September 2008 to present.

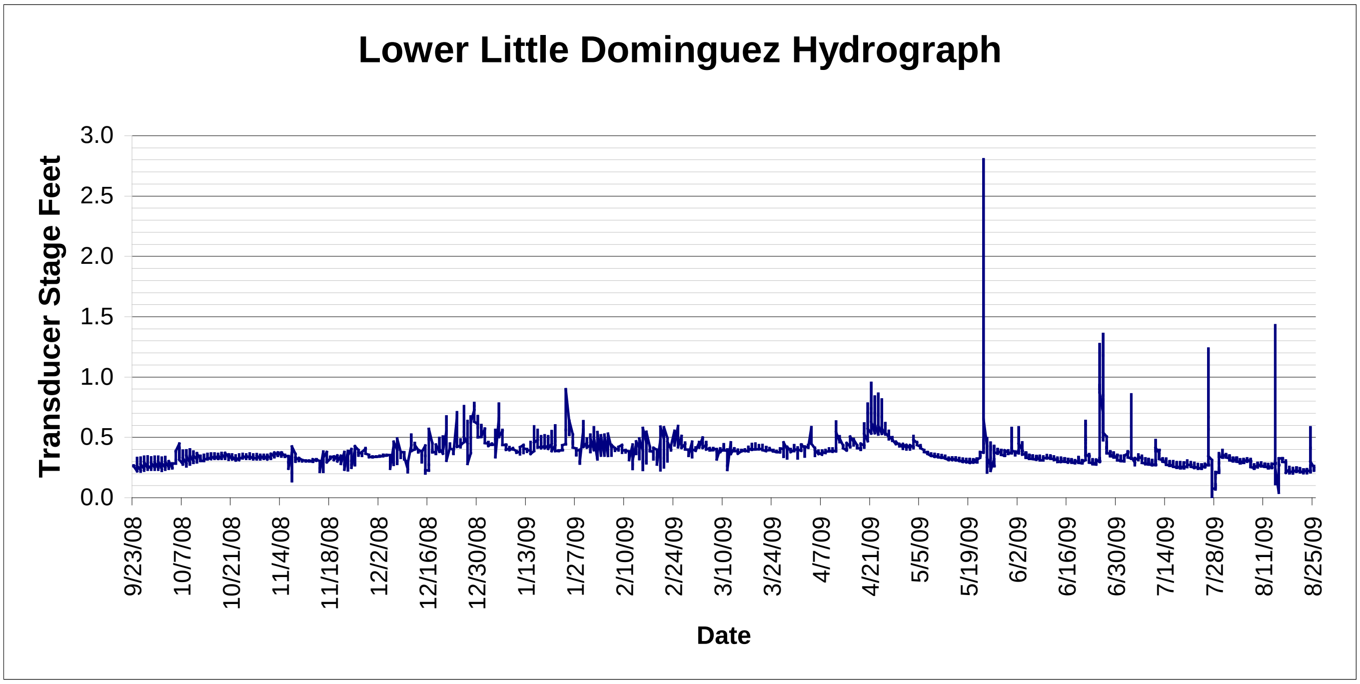
Lower Little Dominguez Creek		
Date	**Stage (ft)**	**Discharge cfs**
9/23/2008	0.26	1.0
12/5/2008	0.27	0.79
4/21/2009	0.74	9.6
5/19/2009	0.32	1.6
5/26/2009	0.43	2.0
6/2/2009	0.38	1.9
6/17/2009	0.31	1.1
6/29/2009	0.36	1.4
7/14/2009	0.30	0.80
7/28/2009	0.11	1.1
7/29/2009	0.28	1.0
8/11/2009	0.26	0.61
8/25/2009	0.25	1.0

The accuracy of the following rating curve may be compromised by the movement of the pressure transducer during the late May 2009 flood event. Values appear to be reasonable from the beginning of the record until mid-May. There are data problems beginning May 26 and there is not a method available to correct these errors because the staff gage was washed away. The data were plotted by removing the stage discharges with obvious error, but the relationship between stage and discharge data to the end of record May still contains errors. This is the result of the transducer being buried under cobble, the stream flowing high and muddy, and no way to find and clean the transducer during a visit. When the stream cleared and transducer could be located, the transducer was cleared of the cobble and cleaned off. By moving and replacing the transducer, it is possible that recorded stage levels could change significantly to levels that do not correspond to earlier stage recordings taken at a similar discharge.

In addition, the cross section at the transducer site probably changed shape, which would make the data less reliable. Another possible source of error was introduced when a flood event caused the transducer to be suspended over the streambed. Again, the transducer was cleaned and moved back to what was believed to be the original location. The above table shows discharges of approximately one cfs with stages varying from 0.11 feet to 0.31 feet.



The following hydrograph was produced using the transducer stage data versus time. Stage data from mid-May to the end of the record likely contains errors, although the flash floods and timing of those events were confirmed with field visits.



BLM did not produce a hydrograph showing the relationship between recorded stage data and projected discharge for the lower site on Little Dominguez Creek because of the extremely high likelihood of errors in the transducer data produced by the movement of the transducer during flood events.

Upper Little Dominguez Creek-Results. Ten visits were made to the transducer site. Flows ranging from 0.54 cfs in mid July to 0.92 cfs in early June were measured.

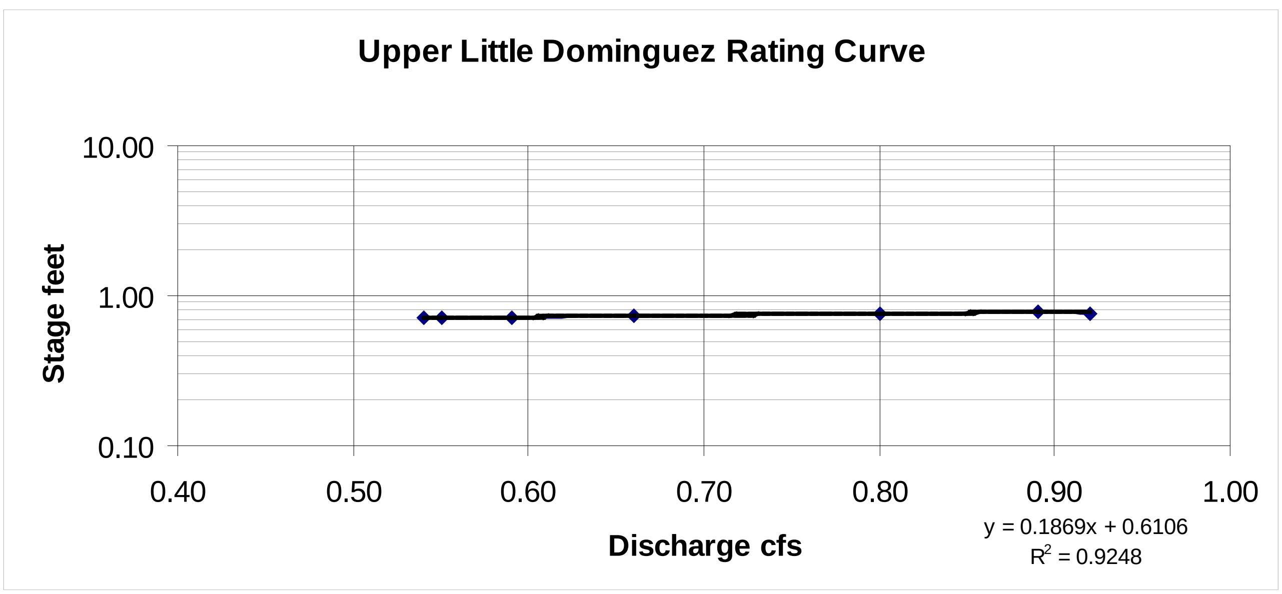
The transducer is located just below the confluence with a spring-fed tributary. The channel appears relatively stable. A stage reading ranging up to 1.35 feet was recorded, but discharge measurements didn't correspond with the highest stage reading. The highest flow measurement was made at a 0.74 feet stage. The transducer recording interval is 2 to 6 hours, so peak values could have been missed. Discharge measurements are rated fair to good, within 5 to 8% of actual flow. The rating is based primarily on the very narrow and shallow stream channel. Comparison of rebar (staff gage) and transducer was not possible because the rod was in place for just one measurement period before being washed out by a flood event in late May 2009.

Access to this site in the winter and during snowmelt is problematic. It is behind a locked gate controlled by the US Forest Service. The gate is locked once the snow falls and it is not opened until snowpack on the road melts, usually around May 15th.

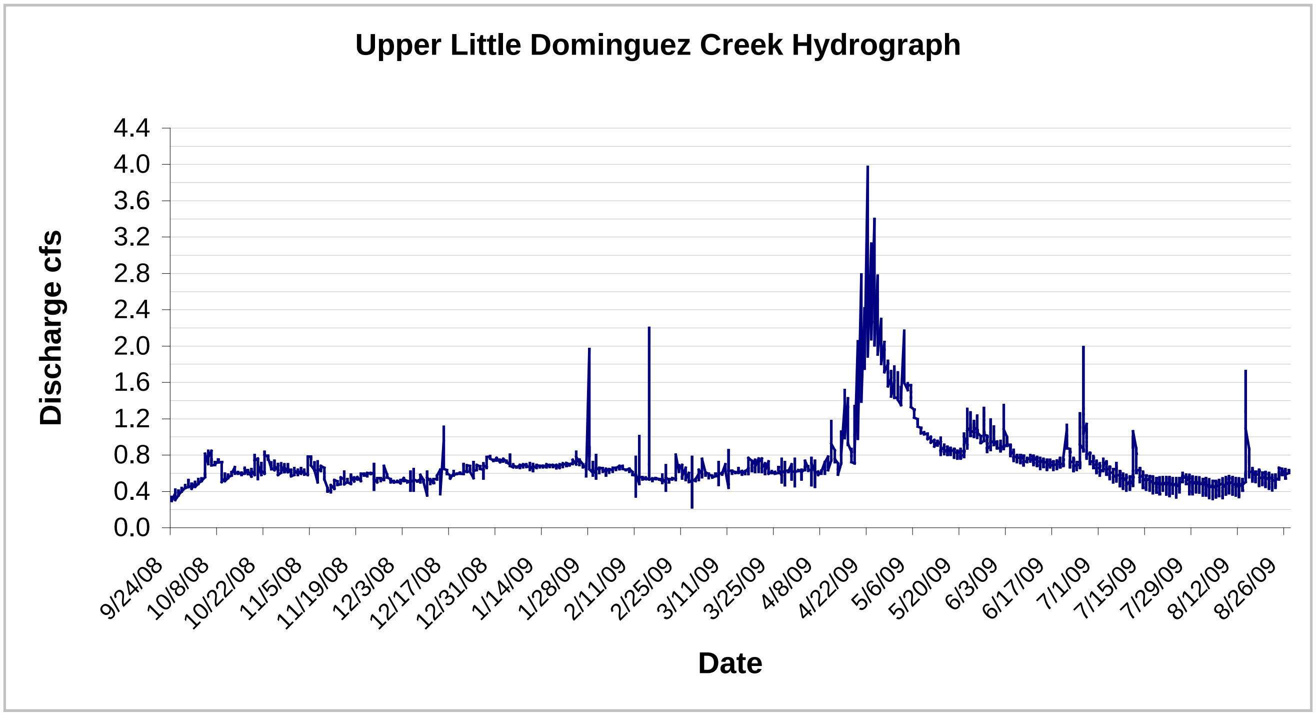
The following table presents the transducer stage and discharge measurements made during the evaluation period.

Date	Stage	Discharge
9/24/2008	0.67	0.61
5/14/2009	0.77	0.80
5/28/2009	0.78	0.89
6/4/2009	0.77	0.92
6/19/2009	0.75	0.66
7/1/2009	0.74	0.66
7/16/2009	0.72	0.54
7/30/2009	0.71	0.55
8/13/2009	0.71	0.59
8/27/2009	0.73	0.55

The rating curve was developed using only seven of the ten stage discharge data. Given the error with the discharge measurements (up to 8%), very limited variation in flow (less than ½ cfs), those with obvious error were not used. The best fit was a power function with a coefficient of determination of 0.93. A discharge vs. time hydrograph with the linear equation was used and is presented below.



The following hydrograph was generated using 7 stage-discharge measurements that ranged from approximately ½ to less than 1 cfs.



The lack of actual discharge measurements at high flow for the pressure transducer station on upper Little Dominguez Creek may produce an underestimate of high flow rates. However, it appears that the data is useful in confirming the timing of runoff. BLM notes that the highest stage readings recorded at the upper Big Dominguez Creek transducer, which occurred from April 22 through April 24, very closely match the highest stage readings recorded at the transducer on upper Little Dominguez Creek.

Uncompahgre Plateau Weather During 2009

The pressure transducer data and discharge measurements discussed above should be interpreted in the context of 2009 weather conditions relative to long-term averages.

Snowpack in west central Colorado was relatively normal during the winter of 2008-2009, but snowmelt began earlier than normal during March. April temperatures were below average, slowing snowmelt runoff. Above normal May temperatures and dust layers in the snow reduced the snowpack to near 75% of normal by the end of May. High winds that lifted dust from the red-rock canyon country of eastern Utah and deposited it on the Colorado Mountains occurred at least 12 times during the winter of 2008-2009, according to the Center for Snow and Avalanche Studies. That dust increased the solar radiation absorbed by the snow, resulting in an accelerated rate of melt.

Adding to the snowmelt was above normal precipitation during May and June. Below normal June temperatures sustained the runoff period. This pattern provided for an earlier than normal runoff, so many streams ran above either mean or median flow from mid-April through June.

Most years a monsoon patterns sets up in mid-July, providing for convective storms in late July and August. During 2009, monsoons never really developed until September. On average, August is one the wettest months of the year at the Grand Junction weather station. This year it was one of the driest on record.

Dominguez Canyon Wilderness

Aquatic Macroinvertebrate Report

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT
NATIONAL SYSTEM OF PUBLIC LANDS

Introduction

BLM investigated the aquatic macroinvertebrate population on Big Dominguez Creek and Little Dominguez Creek to meet three objectives. First, the abundance, diversity, and species of macroinvertebrates are an important indicator of water quality. Second, aquatic macroinvertebrates are a critical component of stream, riparian and terrestrial ecosystems, providing important food supplies for resident fish populations and other aquatic species, and a host of terrestrial species, including spiders, reptiles, birds, and bats. Finally, aquatic macroinvertebrates are important components of genetic and natural diversity that merit protection, even in the absence of fish species.

Data Collection – BLM staff collected invertebrate samples from two locations in each creek. One sample was taken at lower elevation near the confluence of the two creeks, at approximately 4,900 feet. Another sample was taken at higher elevation portions of each creek at approximately 6,900 feet. The samples were collected on July 15 and July 16, 2008. Riffle habitats were sampled with a 500 micron mesh net. Samples were sent for analysis to the National Aquatic Monitoring Center, which is located within the Department of Watershed and Sciences at Utah State University.

Macroinvertebrate sampling location on lower Big Dominguez Creek.

Results -- The analysis revealed that, when compared to other streams on the Colorado Plateau (245 streams sampled between 1990 and 2008 and analyzed by the National Aquatic Monitoring Center), Big Dominguez Creek and Little Dominguez Creek support above average abundance and diversity of aquatic macroinvertebrates, according to multiple analytic criteria. A summary of these measures follows:

- *Ephemeroptera-Plecoptera-Tricoptera (EPT) Abundance* – All of the sampled sites were significantly above average.
- *Sample Abundance* – All sites were above average. Upper Little Dominguez exhibited very high total abundance.
- *Total Number of Taxa* – All sites were above average.
- *Nuwmber of Families* – All sites were above average.
- *Shannon Diversity Index* – Lower Dominguez Creek was near average. Upper Little Dominguez Creek and Lower Little Dominguez Creek were above average. Upper Big Dominguez Creek was near the top of the diversity index.
- *Taxonomic Richness* – The four sites exhibited above average richness in three taxonomic groups: Coleoptera (water beetles), Diptera (true flies), Ephmeroptera (mayfly).
- *Tolerant Taxa* – The overwhelming number of taxa in the creeks are intolerant of water pollution, indicating excellent water quality.

Caddisfly observed on large channel substrate in upper Little Dominguez Creek.

Copies of the lab analysis sheets from the National Aquatic Monitoring Center have been provided to the Colorado Water Conservation Board, and are available for public review.

Conclusions – As BLM expected, aquatic macroinvertebrate populations in Big Dominguez Creek and Little Dominguez Creek respond to watershed health, stream flow characteristics, and elevation. The greatest abundance and diversity of macroinvertebrates were found in portions of the creek that always have perennial flow, even in extreme drought conditions. Abundance and diversity were also higher in higher elevation locations with cooler temperatures are greater stream shading. In lower elevation locations subject to large flood events and higher stream temperatures, the aquatic macroinvertebrate exhibits lower abundance and diversity than high elevation locations, but abundance and diversity measures are still above average when compared to other streams on the Colorado Plateau. This likely occurs because of the good watershed health and high water quality found within the wilderness area.

Dominguez Canyon Wilderness

Riparian Report

NATIONAL SYSTEM OF PUBLIC LANDS

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT

Introduction

This report is organized into two sections:

Section 1 summarizes scientific literature that identifies stream hydrology characteristics that are critical for supporting the structure and composition of the riparian communities, including shrubby riparian communities and cottonwood galleries. These stream flow characteristics include the timing and magnitude flow, presence of base flows, and natural variability of flow rates over time.

Section 2 provides a summary of the riparian species and riparian communities that are specific to Big Dominguez Creek and Little Dominguez Creek within the Wilderness. Because of the range of flows and range of altitude associated with these two creeks, there are a high number of riparian species and riparian community types. BLM has not yet asked the Colorado Natural Heritage to perform a comprehensive inventory of the riparian communities and species on these two creeks, but BLM staff members have surveyed the entire length of the two creeks to assess riparian conditions and generally vegetation types.

Section 1 – Streamflow Characteristics Critical to Functioning of Riparian Communities

Data Acquisition - The following conclusions were gleaned from a search of the current scientific literature regarding relationships between riparian communities, flood flows and groundwater levels in alluvial aquifers. Applicable research was narrowed to studies conducted in arid environments in the intermountain west, and includes some studies conducted within Colorado or within Utah very close to the Colorado border. Copies of the scientific articles have been provided to the CWCB and are available for review by the public.

Establishment of Riparian Seedlings

- Establishment of cottonwood seedlings is generally restricted to bare, moist sites protected from intense physical disturbance. (Scott, Auble, & Freidman, 1997).

- Bottomland trees and shrubs, including species of cottonwood, poplar, and willow, require bare, moist surfaces protected from large disturbance for successful establishment. (Scott, Friedman, and Auble, 1996).

- Floods can produce tree establishment by creating bare, moist deposits high enough above the channel bed to minimize future flow- or ice-related disturbance. (Scott, Auble, & Freidman, 1997).

- Flood deposition, either from main stem floods or tributary floods, is particularly important for tree establishment where channel movement is constrained by a narrow valley. The trees establish on elevated flood deposits. (Scott, Auble, & Freidman, 1997).

- Exposed portions of the bed are ideal sites for establishment of vegetation, including cottonwood. This vegetation promotes deposition of fine sediment and increases resistance to erosion, thus stabilizing the channel to a narrower width. (Scott, Auble, & Freidman, 1997).

- Deposition of additional fine-textured soils behind newly established cottonwoods allows additional seedlings to establish. (Cooper, Merritt, Andersen, and Chimner, 1999)

Linda Bassi stands at the upper extent of sediment deposition from a spring 2009 flood event on Big Dominguez Creek.

Recruitment of Riparian Seedlings

- Cottonwood recruitment is constrained to bare areas that contain fine-textured alluvial soils, saturated by flood events, to provide the soil moisture necessary for seedling survival. Fine-textured soil provide enhance survival due to their higher water-holding capacity. (Cooper, Merritt, Andersen, and Chimner, 1999)

- Along the Animas River, establishment of new narrowleaf Cottonwood galleries occurs about once every ten years, when peak snowmelt flows coincide with cool, wet weather. (Baker, 1990)

- Cottonwood establishment and recruitment typically occurs during floods with a frequency of once every ten years on the Colorado River near Moab, Utah. (Rood, et al, 1997)

- Studies have consistently suggested that cottonwood recruitment is associated with 1 in 5 to 1 in 10 year flood event. (Mahoney & Rood, 1998)

- Bottomland tree seedlings, including willows, poplars, and cottonwoods, will tolerate burial, and can sprout from roots or stems. (Scott, Friedman, and Auble, 1996).

Fremont cottonwood seedlings in the riparian zone along Little Dominguez Creek.

Riparian Dependency Upon Alluvial Groundwater Tables

- Cottonwood seedlings typically require four years to grow roots to the depth of the late summer groundwater table. (Cooper, Merritt, Andersen, and Chimner, 1999)

- During the first growing season, bottomland tree seedlings are capable of extending tap roots as deep as one meter. (Scott, Friedman, and Auble, 1996). Typically, cottonwood, poplar, and willow seedlings cannot survive water table declines more rapid than 2.5 centimeters per day. This rate typically occurs on the descending limb of the hydrograph, toward the end of the snowmelt runoff period. (Mahoney and Rood, 1998)

- Cottonwood seedlings survive based on rapid establishment of a tap root, combined with capillary fringe action in the soil above the groundwater table. Depending on soil type, the capillary fringe can extend from 5 to 130 centimeters above the groundwater table. (Mahoney & Rood, 1998).

- Water tables in alluvial soils that are less than 1.5 meters from ground surface are required for successful seeding establishment of woody riparian plants. Species in the poplar and willow families require shallow water tables. Water table declines can lead to plant mortality. (Shaffroth, Stromberg, and Patten, 2000)

The presence of lush and unstressed riparian vegetation along Big Dominguez Creek during a brief period of no surface flow demonstrates the importance of alluvial groundwater to the riparian community.

<u>Relationship between riparian vigor/abundance/diversity and stream flows</u>

- The riparian water table is the primary water source for many riparian trees. (Stromberg, 1993)

- Stream discharge (mean annual flow volume and median flow volume) is correlated with riparian tree growth, vigor, and abundance. Riparian tree diversity is correlated with flood flows. (Stromberg, 1993)

- Riparian trees on small streams are the most sensitive to reductions in stream flow volume, in terms of vigor and abundance. (Stromberg, 1993)

Riparian diversity, abundance, and production in Little Dominguez Creek is directly dependent on the volume of water in the creek.

Relationship Between Hydrologic Variability and Riparian Community Health

- The width of riparian communities along stream channels is heavily dependent on flow variability. Systematic reduction in flow variability reduces the width of riparian zones that are dependent upon moderate or infrequent inundation frequency. Lower flow variability will result in transition from riparian vegetation to upland vegetation at the edges of a riparian zone.

- Hydrologic variability that influences the width of riparian zones includes flood frequency, flood duration, flood height, and shear stress associated with floods.

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Section 2 – Riparian Community Summary

Big Dominguez Creek

General Stream Description: Big Dominguez Creek originates in the Uncompahgre National Forest at the crest of the Uncompahgre Plateau. The elevation of the creek at the Forest Service boundary is 7,400 feet. The creek generally runs east to the Gunnison River. At the creek's confluence with the Gunnison River, the elevation is 4,735 feet. The length of stream segment on BLM lands is 16.2 miles. The entire reach supports riparian habitat.

PFC Classification: Big Dominguez Creek was monitored for Properly Functioning Condition (PFC), which is BLM's analytic tool for assessing riparian community health, during the field seasons of 2007 and 2008. The entire 16.2 miles of riparian community was determined to be in proper functioning condition.

The photo above illustrates the changing geology that forms the riparian zone. The black colored rocks below are granite geology, while the red colored layer above is sandstone geology.

Channel Morphology: Classification of the stream type (using the Rosgen method) proved to be very complex because of the numerous changes in channel morphology. The stream alternates between the following stream types according to the Rosgen classification system:

- A-2 (single thread entrenched channel, low sinuousity, 5 to 10 % gradient, boulder substrate)
- B-3 (single thread moderately entrenched channel, moderate sinuousity, 2 to 4% gradient cobble substrate)
- C-3 (single thread, slightly entrenched, high sinuousity, 1 to 2% gradient, cobble substrate)

The changes in stream type are the result of the geology, which changes between sandstone and granite substrates. Overall, the stream is highly diverse in stream channel morphology and riparian vegetation. Throughout the middle section of the stream, where the stream has carved into the granite geology, there are spectacular gorges, cascades and waterfalls with plunge pools.

Riparian Species: Riparian species in the 6500 to 8000 feet range include Douglas-fir, ponderosa pine, narrow leaf cottonwood, aspen, water birch, alder red-osier dogwood, willows, cattails, equisetum and various grasses and sedges. Below 6,500 feet, tree and shrub species are less dense, with a dominant community of Fremont cottonwood, willows, grass and sedge species. Proceeding downstream, the width of the shrubby riparian corridor generally narrows, but the width of the floodplain occupied by cottonwood galleries generally expands. There are numerous well-established cottonwood galleries on the larger flood plains. The cottonwood community appears to be naturally reproducing, with a variety of age classes present.

The photo above illustrates the type of riparian zone that occurs in sandstone geology, where the channel is wider and the stream has greater sinuousity.

Grazing Management: This stream is within the Triangle Mesa allotment. Grazing use does occur within the canyon. All upland plant communities appeared to be lightly used (less than 10% utilization of standing forage). No areas of livestock concentration were found in upland or riparian areas.

Little Dominguez Creek

General Stream Description: Little Dominguez Creek originates in the Uncompahgre National Forest at the crest of the Uncompahgre Plateau. Elevation of the creek at the Forest Service boundary is 6,580 feet. The creek generally runs east to join with Big Dominguez approximately one mile upstream from the Gunnison River. At the confluence with Big Dominguez Creek, the elevation is 4,800 feet. The length of stream segment on BLM lands is 15.7 miles. The entire reach supports riparian habitat.

PFC Classification: Big Dominguez Creek was monitored for Properly Functioning Condition (PFC), which is BLM's analytic tool for assessing riparian community health.

Little Dominguez was initially classified for Properly Functioning Condition (PFC) in 1993 and some monitoring was performed during the 2007 field season. The entire segment was surveyed during summer 2009. The entire 16.2 miles of riparian community was determined to be in proper functioning condition.

The photo above illustrates a point in the riparian zone where the geology changes from granite geology (black rocks in foreground) to sandstone geology (red rock in background).

Channel Morphology: Classification of the stream type (using the Rosgen method) proved to be very complex because of the numerous changes in channel morphology. The stream alternates between the following stream types according to the Rosgen classification system:

- A-2 (single thread entrenched channel, low sinuousity, 5 to 10 % gradient, boulder substrate)
- B-3 (single thread moderately entrenched channel, moderate sinuousity, 2 to 4% gradient cobble substrate)

- B-4 (single thread moderately entrenched channel, moderate sinuousity, 2 to 4% gradient, gravel substrate)
- C-3 (single thread, slightly entrenched, high sinuousity, 1 to 2% gradient, cobble substrate)

The changes in stream type are the result of the geology, which changes between sandstone and granite substrates. Overall, the stream is highly diverse in stream channel morphology and riparian vegetation. Throughout the middle section of the stream, where the stream has carved into the granite geology, there are spectacular gorges, cascades and waterfalls with plunge pools.

The photo above illustrates a typical riparian community in the lower elevation portion of Little Dominguez Creek, consisting of cottonwoods, willows, grasses, and sedges.

Riparian Species: Riparian species in the elevations in the 6500 to 8000 feet range include Douglas-fir, ponderosa pine, narrow leaf cottonwood, aspen, water birch, alder red-osier dogwood, willows, cattails, equisetum and various grasses and sedges. Below 6,500 feet, tree and shrub species are less dense, with the dominant community of

Fremont cottonwood, willows, grass and sedge species. The Betula occidentalis/mesic forb community was noted in the upper reaches of Little Dominguez and may extend further downstream than on Big Dominguez Creek. This community typically indicates highly reliable flows.

Proceeding downstream, the width of the shrubby riparian corridor generally stays consistent, while the width of cottonwood galleries generally increases. There are numerous well-established cottonwood galleries on the larger flood plains located in the lower 4.5 miles of the segment. The cottonwood community appears to be naturally reproducing, with a variety of age classes present.

Grazing Management: This stream is within the Triangle Mesa allotment. Grazing use does occur within the canyon. All upland plant communities appeared to be lightly used (less than 10% standing forage utilization). No areas of livestock concentration were found in upland or riparian areas.

Dominguez Canyon Wilderness

Water Quality Report

Introduction

BLM conducted water quality investigation on Big Dominguez Creek and Little Dominguez Creek to meet objectives. First, water quality creates critical constraints on the diversity and abundance of water-dependent species in the two creeks. Second, compliance with the federal Clean Water Act, may require BLM to address specific water quality concerns with land management actions and management prescriptions. Finally, protection of high water quality is an important objective for management of federally-designated wilderness area.

Geologic Context for Water Quality

The canyon bottoms within the wilderness consist of crystalline, erosion resistant Proterozoic metamorphic and igneous rocks as old as 1.8 billion years old. These rock types include biotite schist, gneiss, hornblende-biotite granite, and amphibolite cross-cut by pegmatite and diabase dikes. Some of the contacts between these dikes along Big Dominguez Creek show sparse copper mineralization. The canyon walls are composed of nearly flat-lying to monoclinally folded Paleozoic and Mesozoic sedimentary rocks (66-570 million years old). There are two big northwest trending, high-angle, normal faults in the Wilderness Area, and many smaller high-angle normal faults along the western margin.

The younger sedimentary rocks include the slope forming, brick-red siltstones, shales and sandstones of the Triassic Chinle Formation up to 160 feet thick. The steep, slabby cliffs towering above the slopes of the Chinle as much as 100' high are composed of the Triassic Wingate Sandstone. Arches and dinosaur tracks can be found within this formation. The Jurassic Entrada Sandstone is the 'slick-rock' salmon pink band above the Wingate and is up to 120 feet thick. Above the Entrada lies the Jurassic Wanakah and Morrison Formations, the latter producing many scientifically important dinosaur fossils. The Cretaceous Burro Canyon Formation and Dakota Sandstone overlie the Morrison Formation.

Soils that have resulted from weathering of these geologic types include soils with very high sand content and occasionally high calcite content. Soils on slopes within the wilderness typically have high percentage stone and boulder content. Soils on valley bottoms are typically sandy loam or fine sandy loam, indicating a mix of particles eroded from sandstone formations with organic materials deposited by plant life. In most cases, the soils with high sand content are highly erodible, unless well anchored by a high percentage of plant cover.

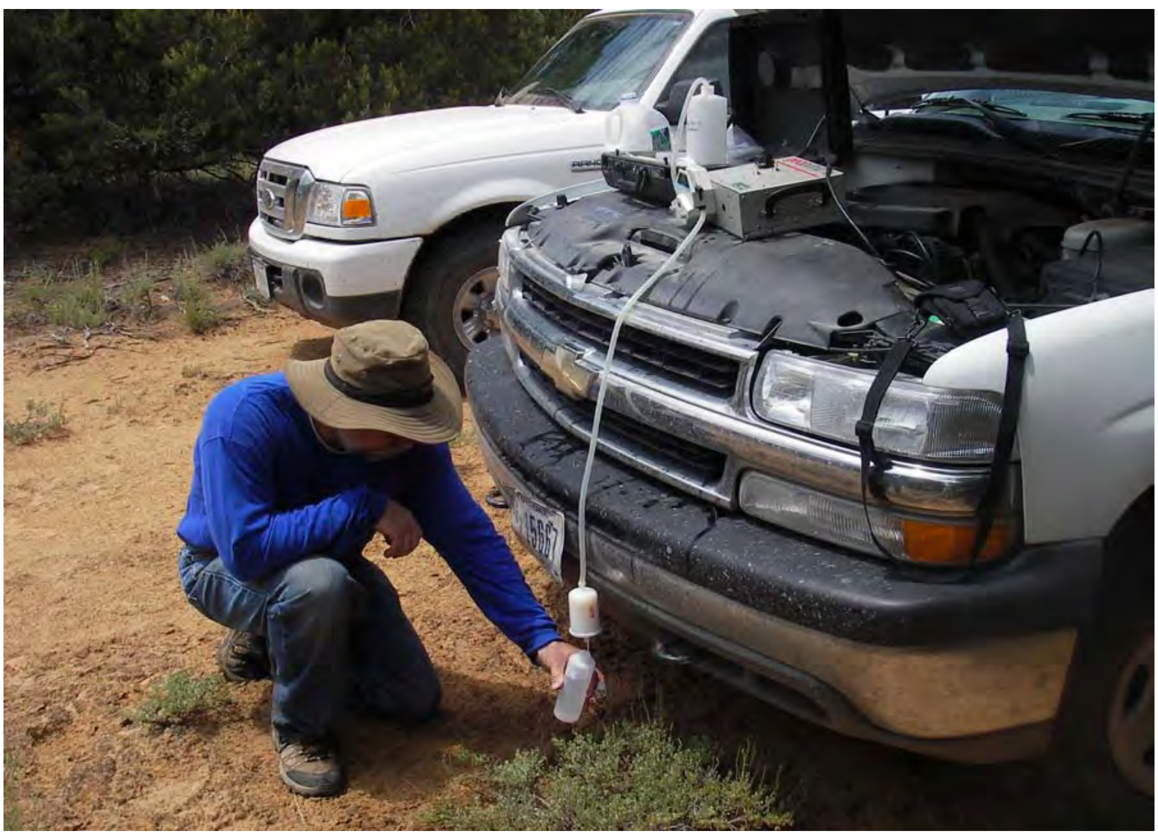
Water Quality Classifications

Under State of Colorado Use Classifications, Big Dominguez Creek and Little Dominguez Creek are regulated under the following classifications:

- Class 1 – Cold Water Aquatic Life. These are waters that are currently capable of sustaining a wide variety of cold water biota, including sensitive species. Physical habitat, water flows or level, and water quality conditions result in no substantial impairment of the abundance and diversity of species.

- Recreation – Class E – Existing Primary Contact Use. These waters are used for primary contact recreation.

- Agriculture – These waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado, and which are not hazardous when used as drinking water for livestock.



Processing water quality samples from Little Dominguez Creek.

Data Collection

BLM staff members collected grab samples from Big Dominguez Creek and Little Dominguez Creek on July 15 and July 16, 2008. Samples were sent to ACZ Laboratories in Steamboat Springs for analysis. Copies of lab reports have been provided to the CWCB and are available for public review.

BLM has not had sufficient time since designation of the wilderness to install temperature probes in the streams to identify the range of temperatures experienced throughout the year. However, instantaneous temperature readings indicate naturally higher water temperatures at lower elevation during summer months. Instantaneous readings of stream temperatures have ranged from near 32 degrees during winter months at high eleveation to above 70 degrees during summer months at low elevation. Temperatures in trout habitat during summer months have been measured in the 50 to 60 degree range.

Water quality sampling location on Little Dominguez Creek.

Water Quality Analysis Results

- Both creeks exhibit good water quality, as would be expected in area with minimal development and no known geologic sources of heavy metals.

- Big Dominguez Creek and Little Dominguez Creek meet and exceed all numeric standards for the classifications above, including physical and biological standards (dissolved oxygen, pH, and E. coli), inorganic standards (such as chlorides, nitrates, and nitrogen), and metals (such as cadmium, aluminum, and zinc.)

- The watershed in which Big Dominguez Creek and Little Dominguez Creek are located appears on the State of Colorado Clean Water Act Section 303 (d) list for potential issues with high levels of selenium. However, laboratory analysis of water quality samples demonstrated that selenium is not an issue in these creeks. Based upon the results of this investigation, BLM may petition the Colorado Department of Health and Environment to remove Big Dominguez Creek and Little Dominguez Creek from the 303 (d) list.

Conclusions

Water quality within Big Dominguez Creek and Little Dominguez is very good, and capable of supporting a wide array of water-dependent species and human uses. High summer temperatures limit the distribution of some aquatic species, but do not appear to have impacts on human uses of water. Significant diversions from the two creeks during summer months may have the effect of raising stream temperatures.