HALAZON DITCH DIVERSION RECONSTRUCTION PROJECT

PREPARED FOR:

Coal Creek Watershed Coalition
Crested Butte, Colorado

PREPARED BY:

CRANE ASSOCIATES

140 Ash Lane, Carbondale, CO 81623
(970) 510-7026

January 2011

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Prepared for:

Coal Creek Watershed Coalition
Protect and Restore

Anthony Poponi, Director
Coal Creek Watershed Coalition
PO Box 459
Crested Butte, Colorado 81224
(970) 349-5338
www.coalcreek.org

Prepared by:

Jeff Crane

CRANE ASSOCIATES

140 Ash Lane
Carbondale, CO 81623
(970) 510-7026
jeffcrane@paonia.com

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Halazon Ditch Diversion Reconstruction Project

Location & Background

The headwaters of Coal Creek begin north of the top of Kebler Pass near the historic Irwin Townsight and east of Lake Irwin and the Ruby Range at approximately 10,000 feet above sea level in northwest Gunnison County in the Gunnison National Forest. The creek flows east along County Road 12 (Kebler Pass Road) toward the Town of Crested Butte. Tributaries to Coal Creek before it reaches Crested Butte include Elk Creek, Splains Gulch and Wilcat Creek. The stream segment to be investigated begins approximately 7.5 miles downstream of Lake Irwin and approximately ¼ mile before it enters the Town of Crested Butte at approximately 8,900 above sea level. (See Figure 1).

Figure 1. Vicinity Map

The Coal Creek Watershed Coalition in Crested Butte contracted with Crane Associates in Carbondale, CO to produce a design package and budget for a sustainable irrigation diversion structure for the Halazon Ditch. The ditch is owned and operated by the Town of Crested Butte and has a 2.93 cfs absolute water right with a 1924 adjudication date to irrigate 105 acres in and around the Town. When there is no call on the system diversions have been as high as 5 cfs. The legal point of diversion on Coal Creek is located NW ¼ of the SE ¼ of the NW ¼ of Section 3 in Township 14 South, Range 86 West at Lattitude 38.868885° and Longitude -106.993321°. The structure ID number is 575 in Water District 59.

Crane Associates did an initial site visit on Oct 18th and reviewed the objectives of the project with Anthony Poponi, Director of the Coal Creek Watershed Coalition. It is understood that under the current conditions, the Halazon Ditch is not capable of delivering the necessary water for irrigation uses in the ditch service area without regular modification of the gravel push up dam used to divert water into the headgate. Modifications to the gravel pushup dam cause significant and regular releases of sediment to Coal Creek and destabilizes the stream bed and banks. Sediment loading to the river reduces water quality and increases the likelihood of the addition of sediment to the existing listing on the Clean Water Act Section 303(d) list of impairments for this creek. Destabilization of the creek bed causes accelerated degradation and requires continual excavation in the channel in order to divert irrigation water thus promulgating an unsustainable cycle of disruption.

The objectives of the conceptual irrigation diversion reconstruction design are to:

- Remove the existing dam and restore natural connectivity and morphology in Coal Creek;
- Construct a sustainable low-head diversion structure that delivers a full decree of irrigation water to the Halazon Ditch and minimizes the need for annual maintenance of the in-creek diversion

Existing Conditions

The stream segment in the vicinity of the existing diversion structure is a perennial single thread channel with low to moderate sinuosity and an average channel slope of 2.08%. It is a fairly step and continuous grade from the headwaters through the project and into town. The channel material is predominately large gravel and a healthy riparian community of willows, 3-leaf sumac and other native species is mostly continuous through the reach. The floodplain is thick with native vegetation and the channel is moderately entrenched. The creek is a second order stream situated in a moderately steep colluvial valley with average bankfull widths of 30 to 50 feet. Seasonal variation is streamflow is dominated by snowmelt runoff and depositional features are primarily point bars with no mid channel bars. The stream is classified under the Rosgen classification system as a B-4 stream type.

Coal Creek is classified by the Water Quality Control Commission as Recreation E, aquatic life cold, agriculture. The Halazon Ditch is located below the intake for the Town of Crested Butte's water supply. The creek is listed on the 303(d) list of impaired streams for for cadmium and zinc and has a temporary modification on for cadmium (2.3 ug/L) and zinc (518 ug/L) expiring 12/31/2012. Magnesium chloride and sediment are issues of concern from Kebler Pass Road.

Hydrologic Analysis

Coal Creek below the confluence with Wildcat Creek is a high mountain stream with a drainage area of approximately 20 square miles and an average basin slope of 31%. The peak flows on this stream are dominated by late spring / early summer snow melt runoff. The stream does not have any reported stream measurements or gaging stations. Mean annual precipitation is 31.83 inches at a mean basin elevation of 10,400 feet.

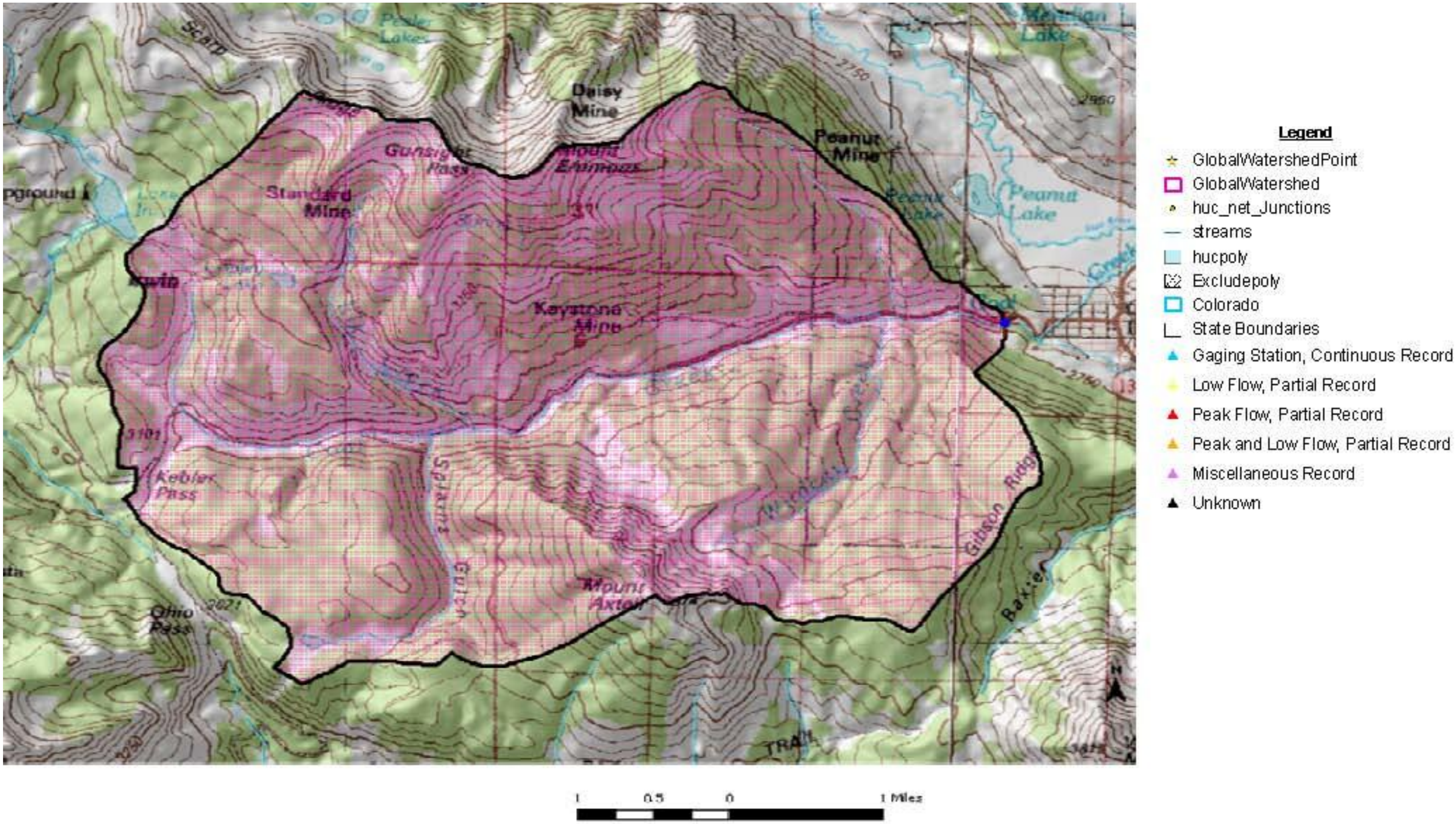
StreamStats was used to develop basin hydrology and stream flow statistics for the 2, 5, 10, 25, 50, 100, 200 and 500 year return events. StreamStats is an integrated GIS application developed through a cooperative effort of the USGS and ESRI, Inc. StreamStats makes the process of computing streamflow statistics for ungaged sites much faster, more accurate, and more consistent than previously used manual methods. The equations used to estimate streamflow statistics for ungaged sites were developed through a process known as regionalization. This process involves use of regression analysis to relate streamflow statistics computed for a group of selected streamgaging stations (usually within a state) to basin characteristics measured for the stations. Basin characteristics measured for ungaged sites can be entered into the resulting equations to obtain estimates of the streamflow statistics.

The StreamStats Web application provides access to automated procedures and very large, complex data sets. These data sets are known to contain occasional errors. Professional judgment based on bankfull field indicators had been exercised in evaluating the appropriateness and accuracy of the results for this application. Basin delineations, in particular, have been checked and verified. Estimates provided by StreamStats assume natural flow conditions at the site. There are no major human activities such as dam regulation and large water withdrawals that substantially affect the timing, magnitude, or duration of flows at a selected site.

Table 1: Summary of flow events calculated by StreamStats:

Peak-Flows Stream Flow Statistics		
Return event	Flow (cfs)	Prediction error (%)
Low flow	2	89
Mean flow	10.9	32
2	238	49
5	326	44
10	383	41
25	443	40
50	520	39
100	570	36
200	611	36
500	696	33

Figure 2: Coal Creek Watershed Map



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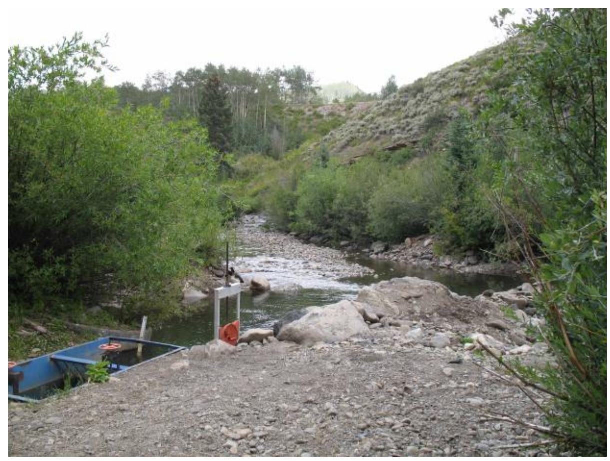
Hydraulic Analysis

Software (HEC-RAS) is used to perform a hydraulic analysis of the existing and proposed conditions.

Geometry in the existing conditions model is based on the 8 cross sections surveyed along the project reach in October 2010. The flows analyzed in the model are those listed in the hydrologic section above. This reach of Coal Creek is modeled with subcritical flows and the Manning's roughness coefficient selected for the channel is 0.038 and for the overbanks is 0.042. The USGS publication "Verified Roughness Characteristics of Natural Channels", which lists a variety of Manning's roughness values, was used along with engineering experience and judgment to help select these values. The Moyie River at Eastport, Idaho was selected from the USGS publication as the most representative of the Coal Creek project section. The Moyie River with a bed of gravel and well-rounded small boulders has a calibrated n-value of 0.038. (http://wwwrcamnl.wr.usgs.gov/sws/fieldmethods/Indirects/nvalues/0038.htm).

Moyie River (from USGS)



Coal Creek at Project Site(courtesy of Dr. Kevin Alexander, 2009)

The geometry for proposed conditions was determined by revising two existing cross sections and modeling the removal of the existing dam. Cross section 14 under the existing conditions illustrated the channel at the upstream face of the dam. That cross section was moved approximately 30' upstream to model the proposed diversion structure at a constant top of structure elevation of 8904'. Cross section 15 was revised in its existing location to model the removal of the dam. All other cross sections were unchanged from existing to proposed conditions.

The primary purpose of the HEC-RAS analysis for this project is to demonstrate that there is no more than 1' of rise in the calculated water surface during the 100-year event. Table 2 indicates a lowering of the water surface elevation during the 100-year event after replacing the existing dam with a low-head diversion structure upstream of the current one.

Table 2. Summary of Hydraulic Results of the 100-year Storm

Existing Conditions			**Proposed conditions**			**Water Surface Elev Difference (ft)**
River Station (ft)	Cross Section Name	Water Surface Elev (ft)	River Station (ft)	Cross Section Name	Water Surface Elev (ft)	
0+00	10	8900.44	0+00	10	8900.44	0.0
1+57	11	8903.90	1+57	11	8903.90	0.0
2+21	12	8905.15	2+21	12	8905.15	0.0
2+31	13	8907.21	2+31	13	8906.57	-0.64
2+41	14	8907.97	2+71	14	8907.56	-0.41
3+11	15	8907.70	3+11	15	8907.70	0.0
3+75	16	8908.86	3+75	16	8908.86	0.0
4+81	17	8912.27	4+81	17	8912.27	0.0

Purpose and Scope

The purpose of this project is to design a sustainable alternative to the existing in-stream diversion dam to minimize the need for regular disturbance of the creek substrate, deliver a full decree of irrigation water to the Halazon Ditch, allow for fish passage at all flow regimes and improve the physical morphology of the stream. Boulders and other materials will be placed upstream of the existing diversion to direct water toward the headgate. The project will be used as a demonstration project for the Coal Creek Watershed Coalition.

Tasks include:

- Survey multiple cross sections across the river to develop channel togography and prepare for a hydraulic analysis.
- Develop an existing conditions and proposed conditions hydraulic model of the area up and downstream of the diversion using HEC-RAS.
- Present conceptual designs and preliminary and construction documents to the CCWC Board of Directors for review and comment.
- Develop final designs, cost estimates and construction schedules.

Recommended Solutions

The existing diversion structure is made from old concrete jersey barriers, random boulders and gravel aligned perpendicular to the flow of the stream downstream of the intake structure. It ponds backwater in the stream and creates approximately 3 feet of head at the intake to divert water into a 12” PVC pipe that directs the water into town. The intake utilizes a 4’ x 4’ steel box with a screen in front of it to prevent trash from entering the pipeline. The existing in-stream diversion structure is over 4 feet high and is susceptible to high stresses during during times of high flows and has a history of washing out. It is then replaced with whatever material is convenient at the time requiring more disturbance in the stream.

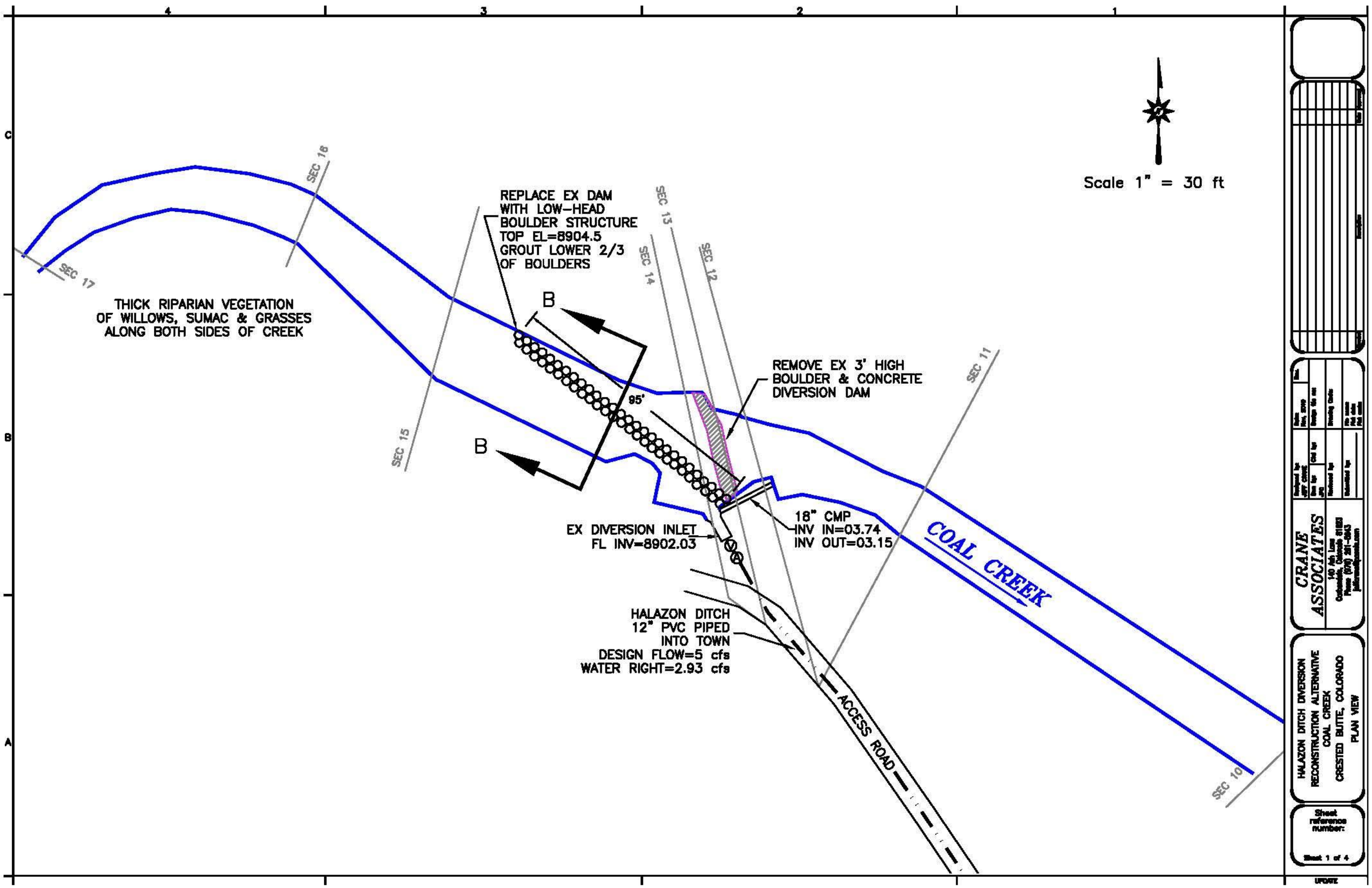
The recommendation of this study and design is to remove the existing dam and replace it with a boulder structure with a constant top of structure elevation of 8904.5 feet. That elevation is similar to the elevation of the existing structure and would deliver approximately the same head at the intake but the location of the proposed structure would be moved upstream and divert water gradually to the right side of the channel and into the existing irrigation intake structure. The intake structure would not be changed in any way and the new design would continue to provide the necessary head to feed the system.

The location and alignment of the proposed in-stream diversion structure will substantially reduce stresses and forces from high water flow events because most of the structure will be buried into the bottom of the channel. In essence, two thirds of the structure will be buried and act primarily as grade control to prevent headcutting up the stream. The structure along the right one third of the channel will have more exposure to high flow forces but the closer the structure is to the right bank the less the velocity of the water and thus the less stress on the structure. This is evidenced by the incremental velocity calculations provided by the HEC-RAS analysis.

The structure will incorporate an average of 3’ diameter boulders laid two to three across. This will reduce the chances of high flows scouring the downstream face of the structure and washing it out. In areas where 50% or more of the boulder is not buried, footer rocks will be installed. This will occur in the river right (facing downstream) 1/3 of the structure. Concrete grout at 3000 psi can also be added to the entire structure and placed up to two thirds the height of the rock. This will provide some void space at the top of the structure for potential fish habitat. It is unknown at this time the location of bedrock below the surface of the channel bed. The excavation of a couple of “pot holes” in the location of the proposed diversion structure is recommended to determine if a 3’ boulder can be placed in the creek at the designed elevation. It may be necessary to use a hammer drill on a trackhoe to excavate a trench deep enough to install the boulders or more angular and rectangular dimensioned boulders may need to be sought out that are broad and flat in nature while still meeting the size requirements. Each boulder should have its greatest dimension not greater than 3 times its least dimension and the stone is recommended to have a specific gravity of at least 2.5. Harder rocks such as granite and basalt are preferred over sandstone.

It is recommended that a surveyed monitoring program be established for this structure to determine any movement over time and to gauge the overall success of the project. There have been several rebar pins installed at the end points of a few cross sections. These can be used as horizontal control and benchmark elevations to accurately measure the structure following major flow events. Photo points with date stamps can also be established relative to the established benchmarks.

Figure 3. Proposed Conditions Schematic



Construction Scheduling

A comprehensive construction schedule can be developed once funding is secured for construction of this project. In general, it is recommended that construction begin in late summer when stream flows are low. It should be noted that construction may interrupt water delivery. A well organized construction schedule should take two to three weeks with the following tasks:

1. Mobilization and stockpiling of rock — 1 week
2. Removal of existing dam and development of water control — 1-2 days
3. Installation of rock structure and grout — 1-2 weeks
4. Implement monitoring plan — 1 day

Conclusion

Moving bedload through the system has been a challenge with the current dam in place and has required substantial maintenance. The proposed design will pass most of this bedload but a percentage of it may still be diverted toward the intake structure. However, this design will minimize maintenance and allow most of the mobilized bedload to pass.

The implementation of this design will reduce susceptibility of structural failure, minimize in-stream mechanical maintenance and improve the habitat and morphological characteristics of the channel.

References

H.H. Barnes, Jr., *Verified Roughness Characteristics of Natural Channels*
USGS Water Supply Paper 1849

Stream Classification and Water Quality Standards, Region 12, Water Quality Control Division
2009

Rosgen, Dave. *Applied River Morphology*, 1996

APPENDIX A(1)

Construction Budget

Halazon Ditch Diversion Project Budget

	ITEM DESCRIPTION	UNIT	QTY	UNIT COST	EST COST	SUB TOT COST
1	Mobilization/Demobilization					
	Equipment Transport (12)	LS	1	$1,000	$1,000	
	Best Management Practices Repair Staging Area	Acre	1	500	$500	$1,500
2	Diversion Structure					
	Demo and remove ex structure	CY	150	$5	$750	
	Excavation w/rock hammer	CY	200	$15	$3,000	
	3' boulders delivered & placed	CY	120	$100	$12,000	
	Grout boulders	CY	20	$250	$5,000	
	Water control	LS	1	$2,000	$2,000	
						$22,750
	SUBTOTAL					$24,250
	CONTINGENCY (15%)					$3,638
	CONSTRUCTION SUBTOTAL					$27,888
	Project administration (10%)					$2,789
	PRELIMINARY PROJECT COST					**$30,676**

APPENDIX B(1)

Existing Conditions HEC-RAS Report

HEC-RAS Plan: Plan 01 River: Coal Creek Reach: Lower Kebler

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lower Kebler	17	PF 1	2.00	8908.04	8908.52	8908.52	8908.64	0.041701	2.81	0.71	3.00	1.01
Lower Kebler	17	PF 2	10.90	8908.04	8908.97	8908.97	8909.23	0.030398	4.07	2.75	6.72	0.99
Lower Kebler	17	PF 3	238.00	8908.04	8911.25	8911.25	8911.89	0.014036	8.45	51.48	37.47	0.89
Lower Kebler	17	PF 4	326.00	8908.04	8911.57	8911.57	8912.31	0.014966	9.38	63.84	39.74	0.94
Lower Kebler	17	PF 5	383.00	8908.04	8911.75	8911.75	8912.56	0.015451	9.90	71.22	41.02	0.96
Lower Kebler	17	PF 6	443.00	8908.04	8911.91	8911.91	8912.80	0.016327	10.50	77.79	42.14	0.99
Lower Kebler	17	PF 7	520.00	8908.04	8912.13	8912.13	8913.09	0.016703	11.06	87.21	44.80	1.02
Lower Kebler	17	PF 8	570.00	8908.04	8912.27	8912.27	8913.26	0.016611	11.32	93.90	47.09	1.02
Lower Kebler	17	PF 9	696.00	8908.04	8912.64	8912.64	8913.66	0.015802	11.73	112.10	52.83	1.01
Lower Kebler	16	PF 1	2.00	8905.29	8905.65		8905.66	0.002152	0.71	2.83	10.72	0.24
Lower Kebler	16	PF 2	10.90	8905.29	8906.05		8906.08	0.003178	1.38	7.91	14.66	0.33
Lower Kebler	16	PF 3	238.00	8905.29	8907.75	8907.43	8908.18	0.008430	5.50	54.46	45.58	0.67
Lower Kebler	16	PF 4	326.00	8905.29	8908.09	8907.81	8908.60	0.008667	6.16	71.09	53.98	0.70
Lower Kebler	16	PF 5	383.00	8905.29	8908.29	8908.02	8908.83	0.008528	6.45	82.63	59.12	0.70
Lower Kebler	16	PF 6	443.00	8905.29	8908.48	8908.21	8909.06	0.008440	6.73	94.47	63.96	0.71
Lower Kebler	16	PF 7	520.00	8905.29	8908.72	8908.43	8909.32	0.008162	6.99	110.49	69.98	0.71
Lower Kebler	16	PF 8	570.00	8905.29	8908.86	8908.57	8909.48	0.008065	7.16	120.44	73.46	0.71
Lower Kebler	16	PF 9	696.00	8905.29	8909.21	8908.86	8909.84	0.007592	7.44	147.34	82.16	0.70
Lower Kebler	15	PF 1	2.00	8904.97	8905.22	8905.22	8905.28	0.045932	1.99	1.00	7.98	0.99
Lower Kebler	15	PF 2	10.90	8904.97	8905.46	8905.46	8905.58	0.038034	2.80	3.89	16.06	1.00
Lower Kebler	15	PF 3	238.00	8904.97	8906.72	8906.72	8907.33	0.022366	6.25	38.09	31.43	1.00
Lower Kebler	15	PF 4	326.00	8904.97	8907.02	8907.02	8907.75	0.021298	6.83	47.74	33.15	1.00
Lower Kebler	15	PF 5	383.00	8904.97	8907.19	8907.19	8907.99	0.021154	7.18	53.32	34.11	1.01
Lower Kebler	15	PF 6	443.00	8904.97	8907.37	8907.37	8908.23	0.020354	7.44	59.52	35.56	1.01
Lower Kebler	15	PF 7	520.00	8904.97	8907.56	8907.56	8908.51	0.019447	7.82	66.90	38.82	1.00
Lower Kebler	15	PF 8	570.00	8904.97	8907.70	8907.70	8908.69	0.018410	7.97	72.43	41.05	0.99
Lower Kebler	15	PF 9	696.00	8904.97	8908.02	8908.02	8909.10	0.016730	8.37	86.23	46.15	0.96
Lower Kebler	14	PF 1	2.00	8901.00	8904.84		8904.84	0.000000	0.02	94.59	46.83	0.00
Lower Kebler	14	PF 2	8.20	8901.00	8905.14		8905.14	0.000001	0.08	109.11	48.12	0.01
Lower Kebler	14	PF 3	233.00	8901.00	8907.02		8907.04	0.000160	1.12	223.23	92.73	0.10
Lower Kebler	14	PF 4	321.00	8901.00	8907.33		8907.36	0.000229	1.41	254.77	112.95	0.12
Lower Kebler	14	PF 5	378.00	8901.00	8907.50		8907.53	0.000275	1.58	274.19	123.77	0.13
Lower Kebler	14	PF 6	438.00	8901.00	8907.65		8907.70	0.000320	1.75	294.24	131.01	0.15
Lower Kebler	14	PF 7	515.00	8901.00	8907.85		8907.90	0.000373	1.94	320.53	139.56	0.16
Lower Kebler	14	PF 8	565.00	8901.00	8907.97		8908.03	0.000405	2.05	337.61	144.85	0.17
Lower Kebler	14	PF 9	691.00	8901.00	8908.16		8908.24	0.000513	2.37	365.84	148.01	0.19
Lower Kebler	13	PF 1	2.00	8904.43	8904.75	8904.75	8904.83	0.041211	2.23	0.90	5.56	0.98
Lower Kebler	13	PF 2	8.20	8904.43	8904.99	8904.99	8905.13	0.038722	3.05	2.69	9.93	1.03
Lower Kebler	13	PF 3	233.00	8904.43	8906.52	8906.52	8906.99	0.015938	5.87	51.67	65.08	0.87
Lower Kebler	13	PF 4	321.00	8904.43	8906.78	8906.78	8907.31	0.014849	6.35	70.33	76.43	0.86
Lower Kebler	13	PF 5	378.00	8904.43	8906.94	8906.94	8907.48	0.014037	6.55	82.65	81.71	0.85
Lower Kebler	13	PF 6	438.00	8904.43	8907.08	8907.08	8907.64	0.013775	6.81	94.08	89.58	0.86
Lower Kebler	13	PF 7	515.00	8904.43	8907.26	8907.26	8907.84	0.012921	7.01	113.36	112.33	0.84
Lower Kebler	13	PF 8	565.00	8904.43	8907.21	8907.21	8907.95	0.017076	7.92	107.43	108.58	0.96
Lower Kebler	13	PF 9	691.00	8904.43	8907.60	8907.60	8908.18	0.011600	7.31	154.60	129.58	0.82
Lower Kebler	12	PF 1	2.00	8902.01	8902.34		8902.36	0.011879	1.21	1.66	10.16	0.53
Lower Kebler	12	PF 2	8.20	8902.01	8902.52		8902.58	0.018329	2.09	3.93	14.69	0.71
Lower Kebler	12	PF 3	233.00	8902.01	8904.20		8904.67	0.013653	5.47	42.59	29.66	0.80
Lower Kebler	12	PF 4	321.00	8902.01	8904.50	8904.30	8905.10	0.014731	6.20	51.80	31.61	0.85
Lower Kebler	12	PF 5	378.00	8902.01	8904.67	8904.51	8905.35	0.015346	6.61	57.21	32.65	0.88
Lower Kebler	12	PF 6	438.00	8902.01	8904.83	8904.68	8905.60	0.015696	7.00	62.58	33.24	0.90
Lower Kebler	12	PF 7	515.00	8902.01	8905.02	8904.90	8905.89	0.016181	7.47	68.97	33.94	0.92
Lower Kebler	12	PF 8	565.00	8902.01	8905.15	8905.03	8906.07	0.016307	7.72	73.18	34.38	0.93
Lower Kebler	12	PF 9	691.00	8902.01	8905.43	8905.35	8906.51	0.016649	8.31	83.17	35.43	0.96
Lower Kebler	11	PF 1	2.00	8900.99	8901.27		8901.31	0.023837	1.62	1.24	8.26	0.74
Lower Kebler	11	PF 2	8.20	8900.99	8901.54		8901.60	0.012858	1.88	4.37	14.61	0.61
Lower Kebler	11	PF 3	233.00	8900.99	8902.90	8902.90	8903.53	0.023367	6.33	36.82	30.98	1.02
Lower Kebler	11	PF 4	321.00	8900.99	8903.20	8903.20	8903.96	0.021430	7.00	45.98	31.96	1.01
Lower Kebler	11	PF 5	378.00	8900.99	8903.38	8903.38	8904.21	0.020204	7.34	51.81	32.56	1.00
Lower Kebler	11	PF 6	438.00	8900.99	8903.55	8903.55	8904.47	0.019384	7.69	57.55	33.13	1.00
Lower Kebler	11	PF 7	515.00	8900.99	8903.77	8903.77	8904.77	0.018399	8.07	64.81	33.85	0.99
Lower Kebler	11	PF 8	565.00	8900.99	8903.90	8903.90	8904.97	0.017945	8.30	69.30	34.28	0.99
Lower Kebler	11	PF 9	691.00	8900.99	8904.22	8904.22	8905.42	0.016927	8.83	80.38	35.33	0.98
Lower Kebler	10	PF 1	2.00	8897.41	8897.78	8897.72	8897.82	0.020777	1.72	1.16	6.36	0.71
Lower Kebler	10	PF 2	8.20	8897.41	8897.98	8897.98	8898.08	0.048290	2.44	3.36	20.51	1.06
Lower Kebler	10	PF 3	233.00	8897.41	8899.34	8899.34	8899.99	0.018480	6.59	39.58	36.95	0.95
Lower Kebler	10	PF 4	321.00	8897.41	8899.74	8899.74	8900.40	0.014528	6.84	57.86	54.62	0.88
Lower Kebler	10	PF 5	378.00	8897.41	8899.94	8899.94	8900.62	0.013502	7.05	69.48	62.60	0.86
Lower Kebler	10	PF 6	438.00	8897.41	8900.12	8900.12	8900.83	0.012884	7.27	81.38	69.84	0.85
Lower Kebler	10	PF 7	515.00	8897.41	8900.32	8900.32	8901.06	0.012432	7.56	96.17	77.90	0.85
Lower Kebler	10	PF 8	565.00	8897.41	8900.44	8900.44	8901.19	0.012135	7.71	105.98	82.81	0.84
Lower Kebler	10	PF 9	691.00	8897.41	8900.74	8900.74	8901.50	0.011193	7.96	132.43	94.81	0.82

APPENDIX B(2)

Proposed Conditions HEC-RAS Report

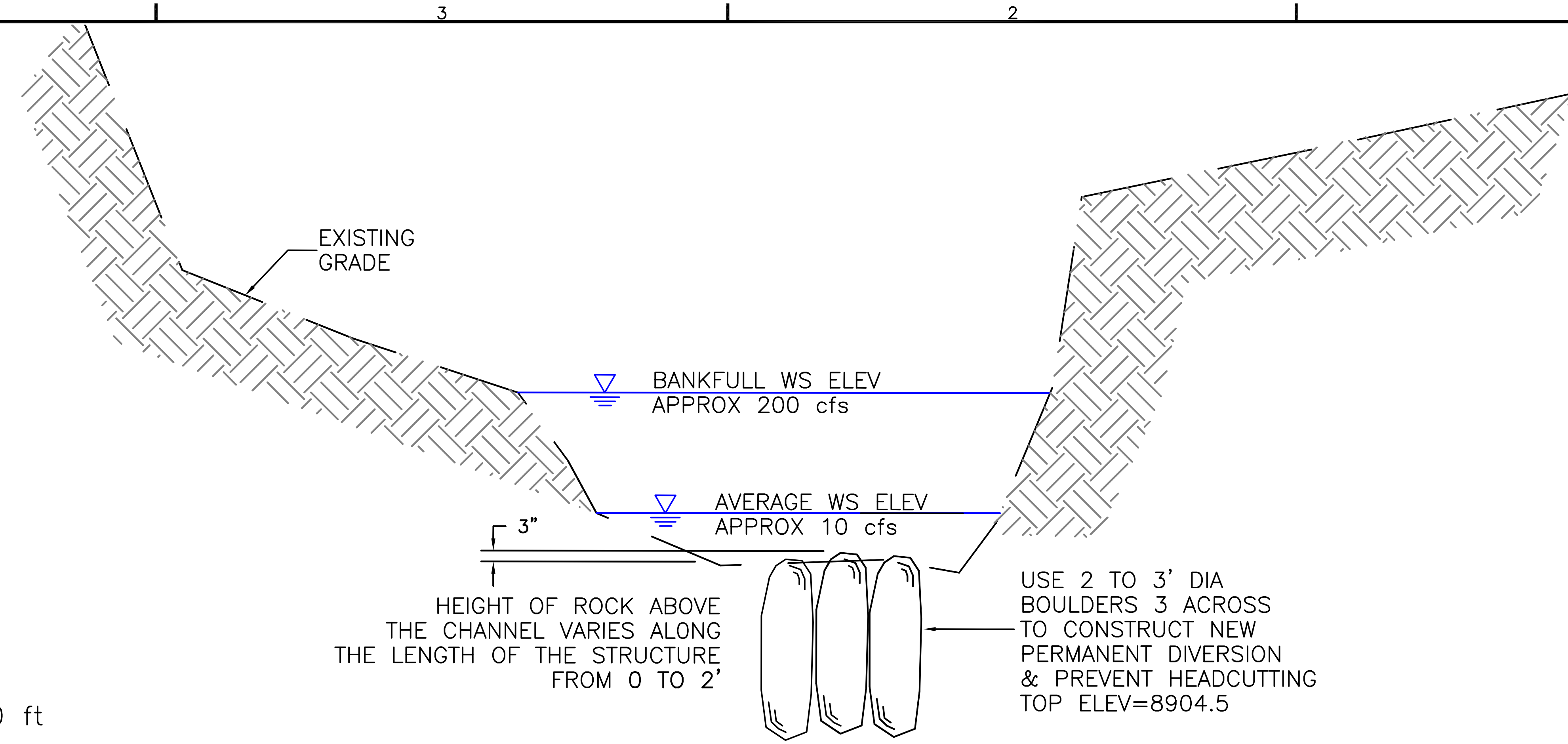
HEC-RAS Plan: Plan 02 River: Coal Creek Reach: Lower Kebler

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lower Kebler	17	PF 1	2.00	8908.04	8908.52	8908.52	8908.64	0.041701	2.81	0.71	3.00	1.01
Lower Kebler	17	PF 2	10.90	8908.04	8908.97	8908.97	8909.23	0.030398	4.07	2.75	6.72	0.99
Lower Kebler	17	PF 3	238.00	8908.04	8911.25	8911.25	8911.89	0.014036	8.45	51.48	37.47	0.89
Lower Kebler	17	PF 4	326.00	8908.04	8911.57	8911.57	8912.31	0.014966	9.38	63.84	39.74	0.94
Lower Kebler	17	PF 5	383.00	8908.04	8911.75	8911.75	8912.56	0.015451	9.90	71.22	41.02	0.96
Lower Kebler	17	PF 6	443.00	8908.04	8911.91	8911.91	8912.80	0.016327	10.50	77.79	42.14	0.99
Lower Kebler	17	PF 7	520.00	8908.04	8912.13	8912.13	8913.09	0.016703	11.06	87.21	44.80	1.02
Lower Kebler	17	PF 8	570.00	8908.04	8912.27	8912.27	8913.26	0.016611	11.32	93.90	47.09	1.02
Lower Kebler	17	PF 9	696.00	8908.04	8912.64	8912.64	8913.66	0.015802	11.73	112.10	52.83	1.01
Lower Kebler	16	PF 1	2.00	8905.29	8905.61		8905.62	0.003778	0.85	2.35	10.26	0.31
Lower Kebler	16	PF 2	10.90	8905.29	8905.99		8906.03	0.004479	1.55	7.01	14.05	0.39
Lower Kebler	16	PF 3	238.00	8905.29	8907.76	8907.43	8908.18	0.008321	5.48	54.77	45.76	0.67
Lower Kebler	16	PF 4	326.00	8905.29	8908.09	8907.81	8908.60	0.008681	6.17	71.04	53.96	0.70
Lower Kebler	16	PF 5	383.00	8905.29	8908.29	8908.02	8908.83	0.008528	6.45	82.63	59.12	0.70
Lower Kebler	16	PF 6	443.00	8905.29	8908.48	8908.21	8909.06	0.008440	6.73	94.47	63.96	0.71
Lower Kebler	16	PF 7	520.00	8905.29	8908.72	8908.43	8909.32	0.008162	6.99	110.49	69.98	0.71
Lower Kebler	16	PF 8	570.00	8905.29	8908.86	8908.57	8909.48	0.008065	7.16	120.44	73.46	0.71
Lower Kebler	16	PF 9	696.00	8905.29	8909.21	8908.86	8909.84	0.007592	7.44	147.34	82.16	0.70
Lower Kebler	15	PF 1	2.00	8904.97	8905.36	8905.22	8905.37	0.004240	0.82	2.45	12.37	0.32
Lower Kebler	15	PF 2	10.90	8904.97	8905.64		8905.68	0.007022	1.47	7.41	22.72	0.45
Lower Kebler	15	PF 3	238.00	8904.97	8906.71	8906.71	8907.33	0.023032	6.31	37.72	31.36	1.01
Lower Kebler	15	PF 4	326.00	8904.97	8907.02	8907.02	8907.75	0.021298	6.83	47.74	33.15	1.00
Lower Kebler	15	PF 5	383.00	8904.97	8907.19	8907.19	8907.99	0.021154	7.18	53.32	34.11	1.01
Lower Kebler	15	PF 6	443.00	8904.97	8907.37	8907.37	8908.23	0.020354	7.44	59.52	35.56	1.01
Lower Kebler	15	PF 7	520.00	8904.97	8907.56	8907.56	8908.51	0.019447	7.82	66.90	38.82	1.00
Lower Kebler	15	PF 8	570.00	8904.97	8907.70	8907.70	8908.69	0.018410	7.97	72.43	41.05	0.99
Lower Kebler	15	PF 9	696.00	8904.97	8908.02	8908.02	8909.10	0.016730	8.37	86.23	46.15	0.96
Lower Kebler	14	PF 1	2.00	8904.50	8904.54	8904.54	8904.56	0.089622	1.27	1.57	40.49	1.14
Lower Kebler	14	PF 2	10.90	8904.50	8904.64	8904.64	8904.70	0.040412	1.95	5.60	41.98	0.94
Lower Kebler	14	PF 3	238.00	8904.50	8906.09		8906.24	0.004390	3.15	76.08	56.48	0.46
Lower Kebler	14	PF 4	326.00	8904.50	8906.59		8906.74	0.003107	3.16	107.73	69.87	0.40
Lower Kebler	14	PF 5	383.00	8904.50	8906.88		8907.03	0.002625	3.18	129.75	83.67	0.38
Lower Kebler	14	PF 6	443.00	8904.50	8907.13		8907.29	0.002363	3.25	153.10	99.94	0.37
Lower Kebler	14	PF 7	520.00	8904.50	8907.40		8907.57	0.002207	3.36	182.21	117.58	0.36
Lower Kebler	14	PF 8	570.00	8904.50	8907.56		8907.73	0.002135	3.43	201.24	126.80	0.36
Lower Kebler	14	PF 9	696.00	8904.50	8907.89		8908.07	0.002044	3.61	245.49	141.32	0.36
Lower Kebler	13	PF 1	2.00	8902.50	8902.78	8902.78	8902.85	0.045180	2.13	0.94	6.68	1.00
Lower Kebler	13	PF 2	5.90	8902.50	8902.93	8902.93	8903.06	0.040653	2.90	2.04	8.42	1.04
Lower Kebler	13	PF 3	233.00	8902.50	8905.03	8905.03	8905.85	0.021211	7.26	32.10	19.78	1.00
Lower Kebler	13	PF 4	321.00	8902.50	8905.46	8905.46	8906.41	0.020568	7.80	41.13	22.16	1.01
Lower Kebler	13	PF 5	378.00	8902.50	8905.72	8905.72	8906.72	0.020123	8.05	46.98	23.77	1.01
Lower Kebler	13	PF 6	438.00	8902.50	8906.06	8906.06	8907.02	0.016038	7.86	58.43	45.32	0.92
Lower Kebler	13	PF 7	515.00	8902.50	8906.40	8906.40	8907.31	0.013090	7.80	76.37	60.00	0.85
Lower Kebler	13	PF 8	565.00	8902.50	8906.57	8906.57	8907.48	0.012253	7.86	87.12	67.27	0.83
Lower Kebler	13	PF 9	691.00	8902.50	8906.95	8906.95	8907.84	0.010573	7.96	115.94	82.14	0.79
Lower Kebler	12	PF 1	2.00	8902.01	8902.34		8902.36	0.011879	1.21	1.66	10.16	0.53
Lower Kebler	12	PF 2	5.90	8902.01	8902.46		8902.51	0.019047	1.90	3.10	13.68	0.70
Lower Kebler	12	PF 3	233.00	8902.01	8904.20		8904.67	0.013653	5.47	42.59	29.66	0.80
Lower Kebler	12	PF 4	321.00	8902.01	8904.50	8904.30	8905.10	0.014731	6.20	51.80	31.61	0.85
Lower Kebler	12	PF 5	378.00	8902.01	8904.67	8904.51	8905.35	0.015346	6.61	57.21	32.65	0.88
Lower Kebler	12	PF 6	438.00	8902.01	8904.83	8904.68	8905.60	0.015696	7.00	62.58	33.24	0.90
Lower Kebler	12	PF 7	515.00	8902.01	8905.02	8904.90	8905.89	0.016181	7.47	68.97	33.94	0.92
Lower Kebler	12	PF 8	565.00	8902.01	8905.15	8905.03	8906.07	0.016307	7.72	73.18	34.38	0.93
Lower Kebler	12	PF 9	691.00	8902.01	8905.43	8905.35	8906.51	0.016649	8.31	83.17	35.43	0.96
Lower Kebler	11	PF 1	2.00	8900.99	8901.27		8901.31	0.023837	1.62	1.24	8.26	0.74
Lower Kebler	11	PF 2	5.90	8900.99	8901.47		8901.52	0.013001	1.73	3.41	13.00	0.60
Lower Kebler	11	PF 3	233.00	8900.99	8902.90	8902.90	8903.53	0.023367	6.33	36.82	30.98	1.02
Lower Kebler	11	PF 4	321.00	8900.99	8903.20	8903.20	8903.96	0.021430	7.00	45.98	31.96	1.01
Lower Kebler	11	PF 5	378.00	8900.99	8903.38	8903.38	8904.21	0.020204	7.34	51.81	32.56	1.00
Lower Kebler	11	PF 6	438.00	8900.99	8903.55	8903.55	8904.47	0.019384	7.69	57.55	33.13	1.00
Lower Kebler	11	PF 7	515.00	8900.99	8903.77	8903.77	8904.77	0.018399	8.07	64.81	33.85	0.99
Lower Kebler	11	PF 8	565.00	8900.99	8903.90	8903.90	8904.97	0.017945	8.30	69.30	34.28	0.99
Lower Kebler	11	PF 9	691.00	8900.99	8904.22	8904.22	8905.42	0.016927	8.83	80.38	35.33	0.98
Lower Kebler	10	PF 1	2.00	8897.41	8897.78	8897.72	8897.82	0.020777	1.72	1.16	6.36	0.71
Lower Kebler	10	PF 2	5.90	8897.41	8897.88	8897.88	8898.03	0.046368	3.04	1.94	8.21	1.10
Lower Kebler	10	PF 3	233.00	8897.41	8899.34	8899.34	8899.99	0.018480	6.59	39.58	36.95	0.95

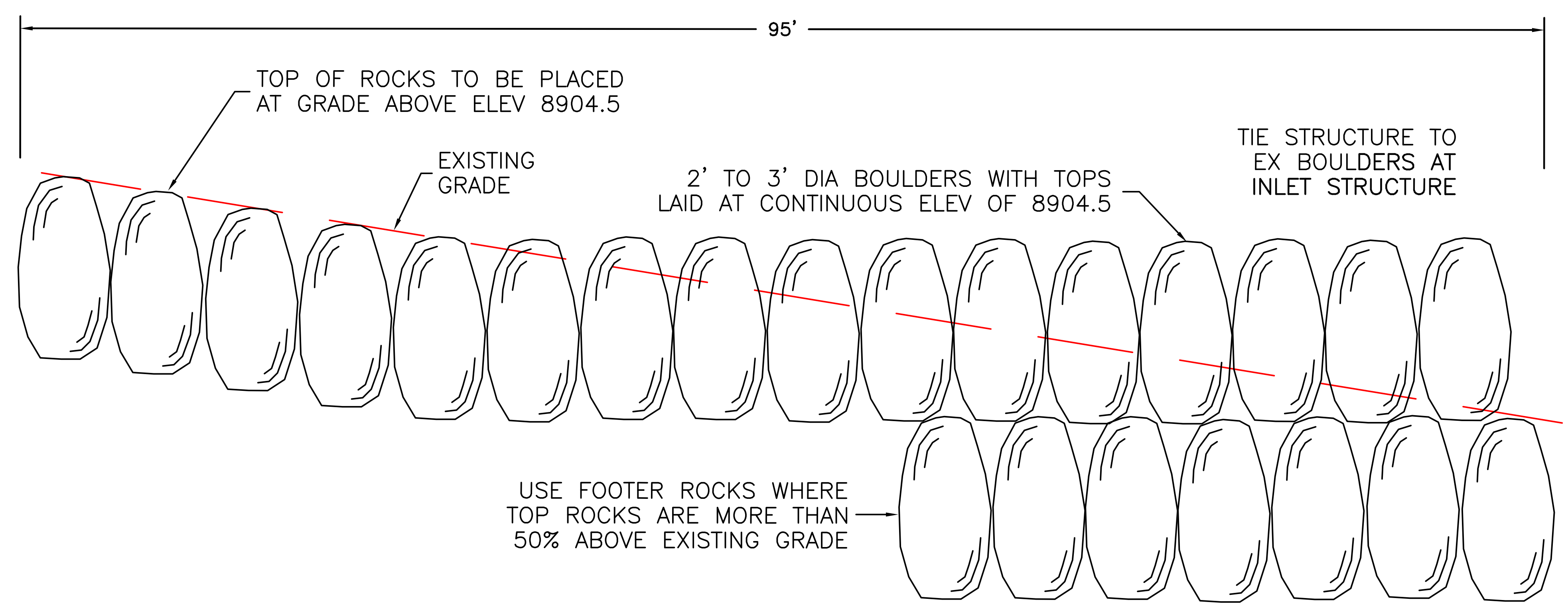
HEC-RAS Plan: Plan 02 River: Coal Creek Reach: Lower Kebler (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lower Kebler	10	PF 4	321.00	8897.41	8899.74	8899.74	8900.40	0.014528	6.84	57.86	54.62	0.88
Lower Kebler	10	PF 5	378.00	8897.41	8899.94	8899.94	8900.62	0.013502	7.05	69.48	62.60	0.86
Lower Kebler	10	PF 6	438.00	8897.41	8900.12	8900.12	8900.83	0.012884	7.27	81.38	69.84	0.85
Lower Kebler	10	PF 7	515.00	8897.41	8900.32	8900.32	8901.06	0.012432	7.56	96.17	77.90	0.85
Lower Kebler	10	PF 8	565.00	8897.41	8900.44	8900.44	8901.19	0.012135	7.71	105.98	82.81	0.84
Lower Kebler	10	PF 9	691.00	8897.41	8900.74	8900.74	8901.50	0.011193	7.96	132.43	94.81	0.82

Horizontal Scale 1" = 10 ft
Vertical Scale 1" = 2 ft



SECTION B-B



DIVERSION STRUCTURE PROFILE

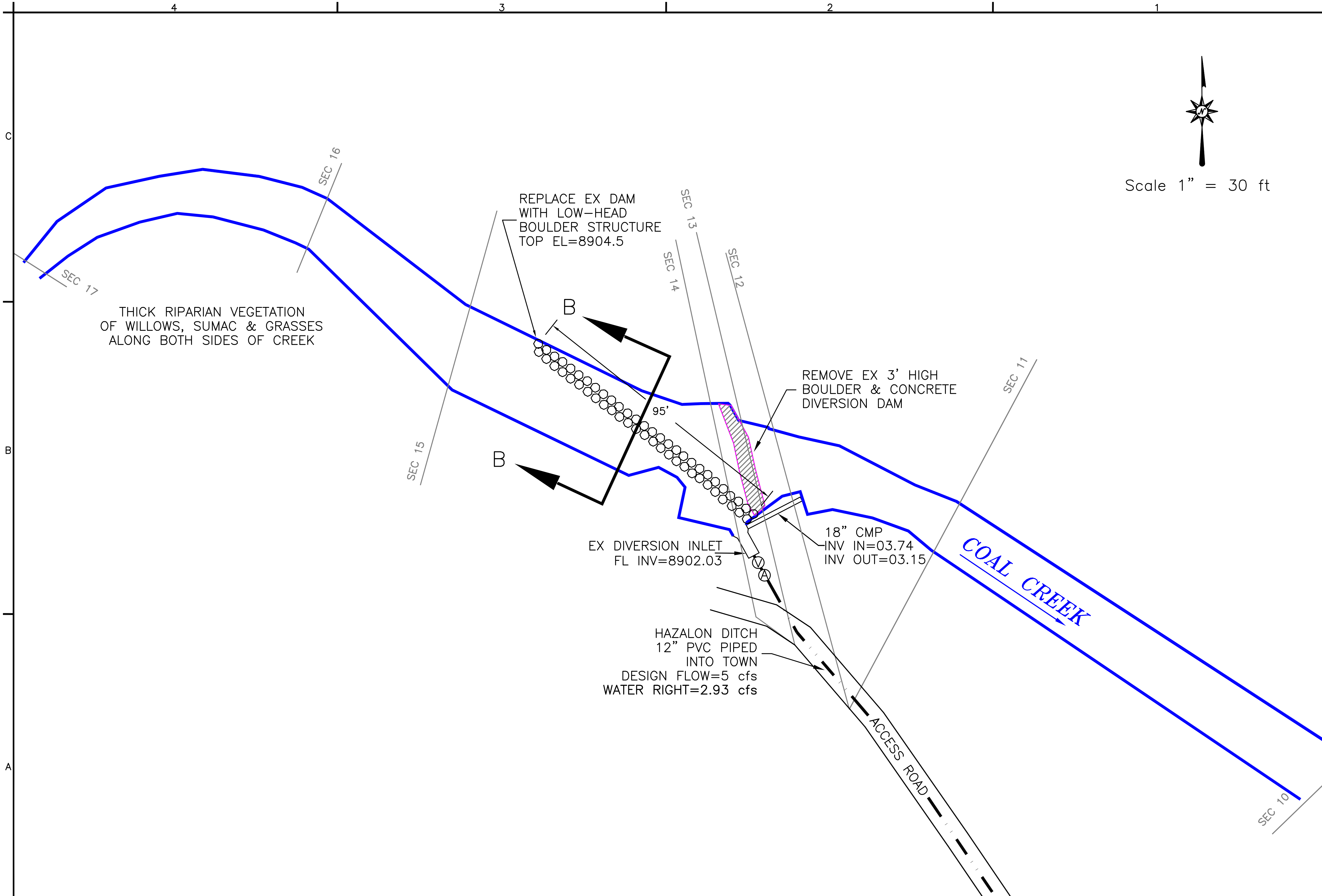
HAZALON DITCH DIVERSION
RECONSTRUCTION ALTERNATIVE
COAL CREEK
CRESTED BUTTE, COLORADO
PROFILE & SECTION DETAILS

CRANE ASSOCIATES
140 Ash Lane
Carbondale, Colorado 81623
Phone (970) 261-5043
jeffcrane@paonia.com

Designed by: JEFF CRANE
Dwn by: JPC
Ckd by:
Reviewed by:
Submitted by:
Date: Nov, 2010
Rev.
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:

Symbol	Description	Date	Approved

Sheet reference number:
Sheet 2 of 4
UPDATE



HAZALON DITCH DIVERSION
RECONSTRUCTION ALTERNATIVE
COAL CREEK
CRESTED BUTTE, COLORADO
PLAN VIEW

CRANE ASSOCIATES
140 Ash Lane
Carbondale, Colorado 81623
Phone (970) 261-5043
jeffcrane@paonia.com

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Reviewed by:	Drawing Code:	
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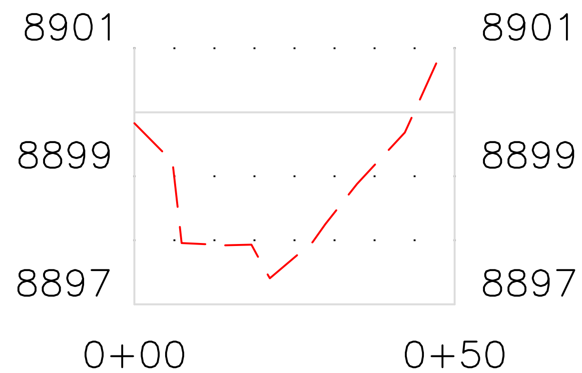
Symbol	Description	Date	Approved

Sheet reference number:
Sheet 1 of 4

UPDATE



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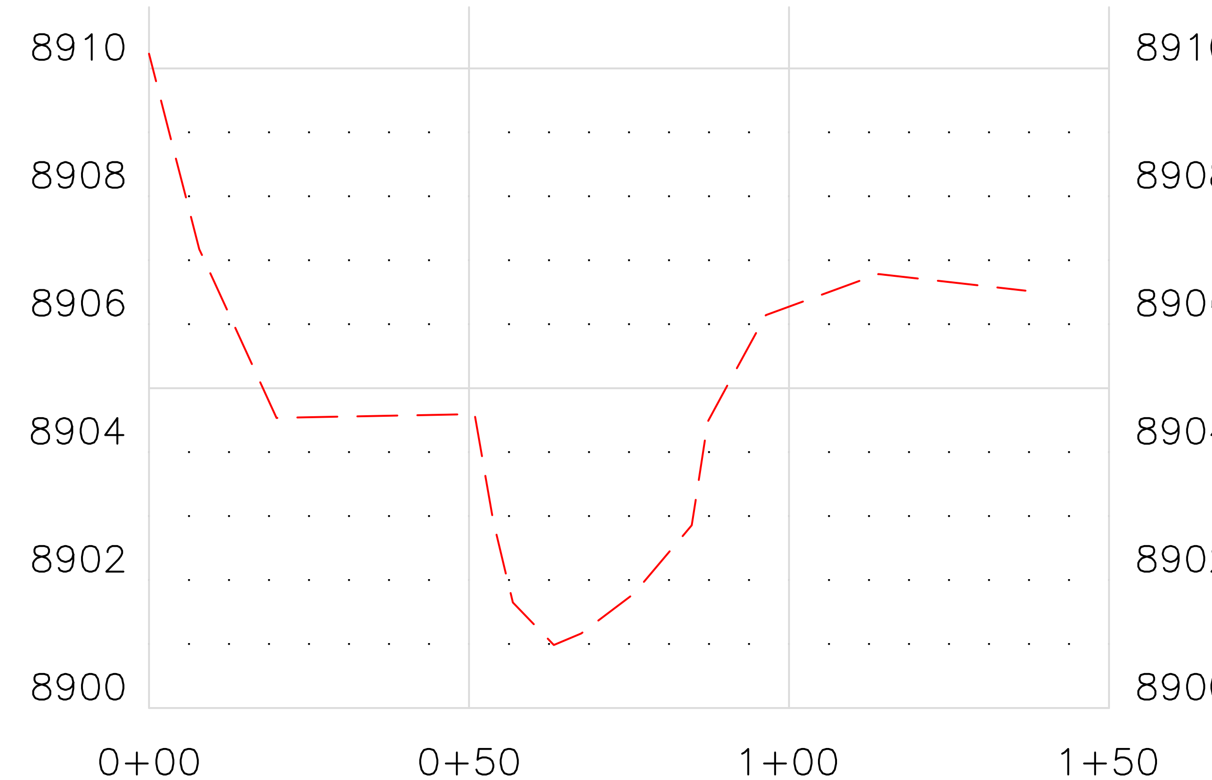

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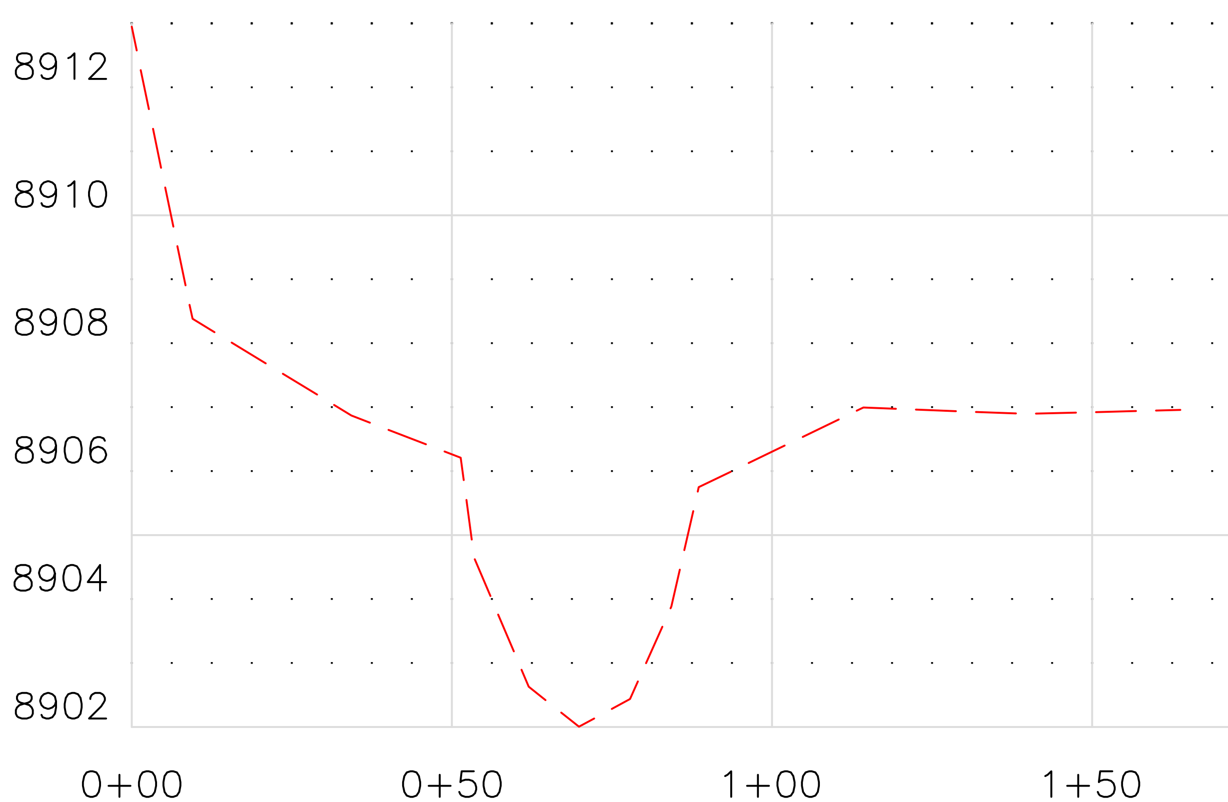

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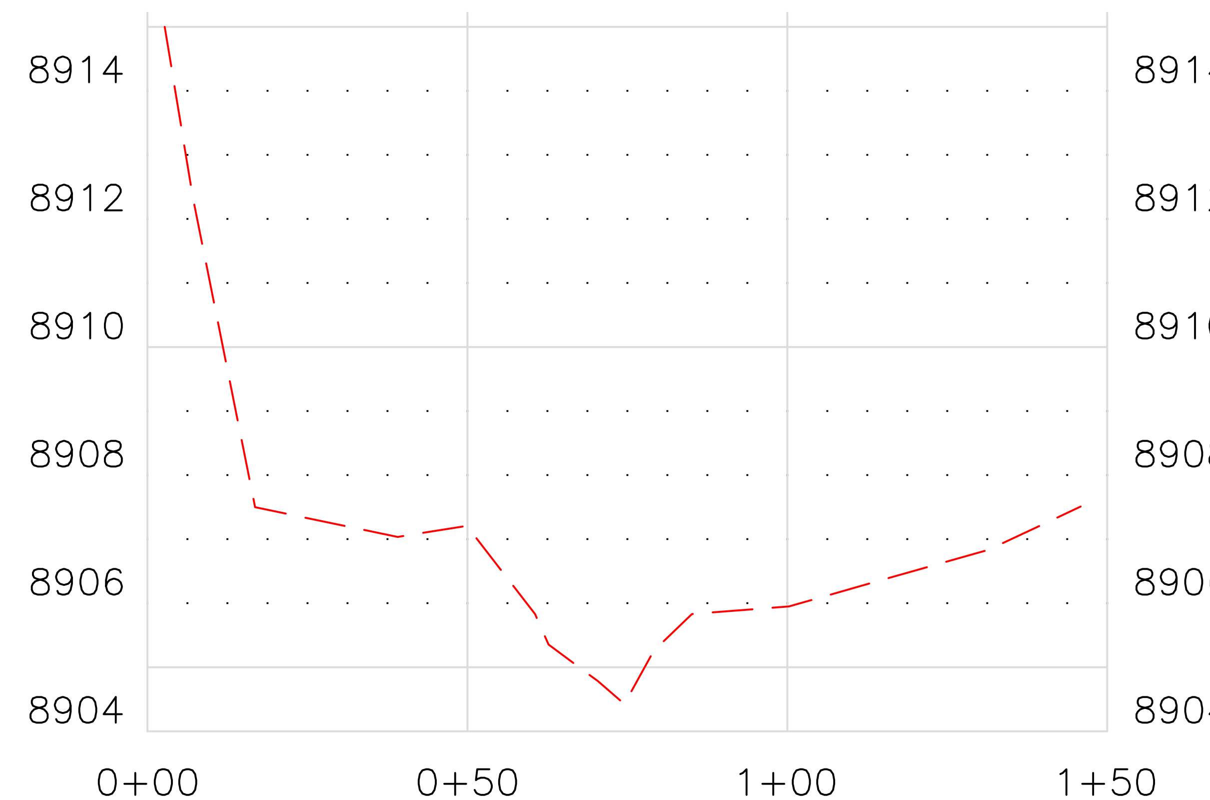

CROSS SECTION 13

Symbol	Description	Date	Approved

Designed by: JEFF CRANE
Dwn by: JPC
Ckd by:
Reviewed by:
Submitted by:
Date: Nov, 2010
Rev.
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File name:
Plot date:
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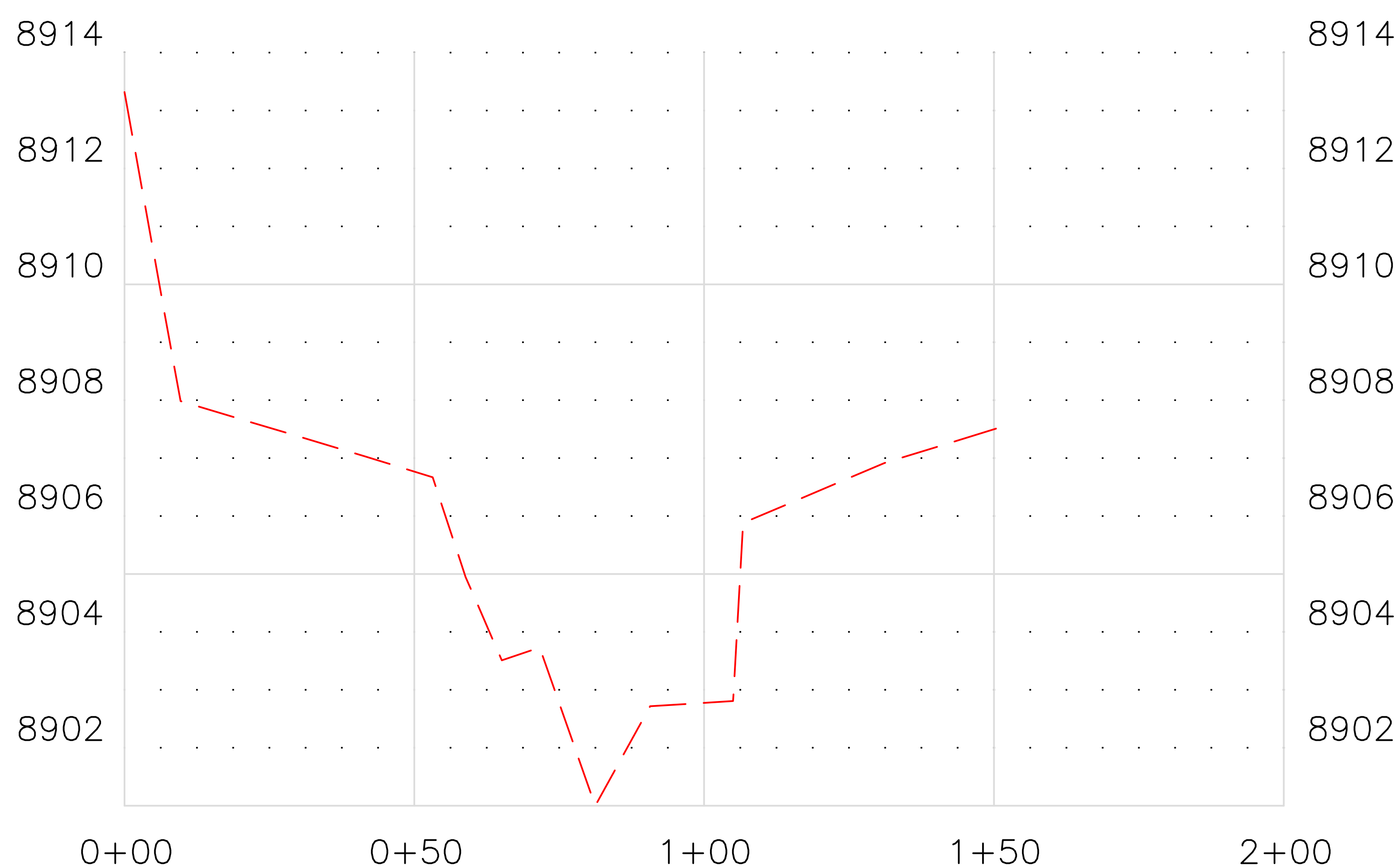
CRANE ASSOCIATES
140 Ash Lane
Carbondale, Colorado 81623
Phone (970) 261-5043
jeffcrane@paonia.com

HAZALON DITCH DIVERSION
RECONSTRUCTION ALTERNATIVE
COAL CREEK
CRESTED BUTTE, COLORADO
EXISTING CROSS SECTIONS

Sheet reference number:

Sheet 3 of 4

UPDATE



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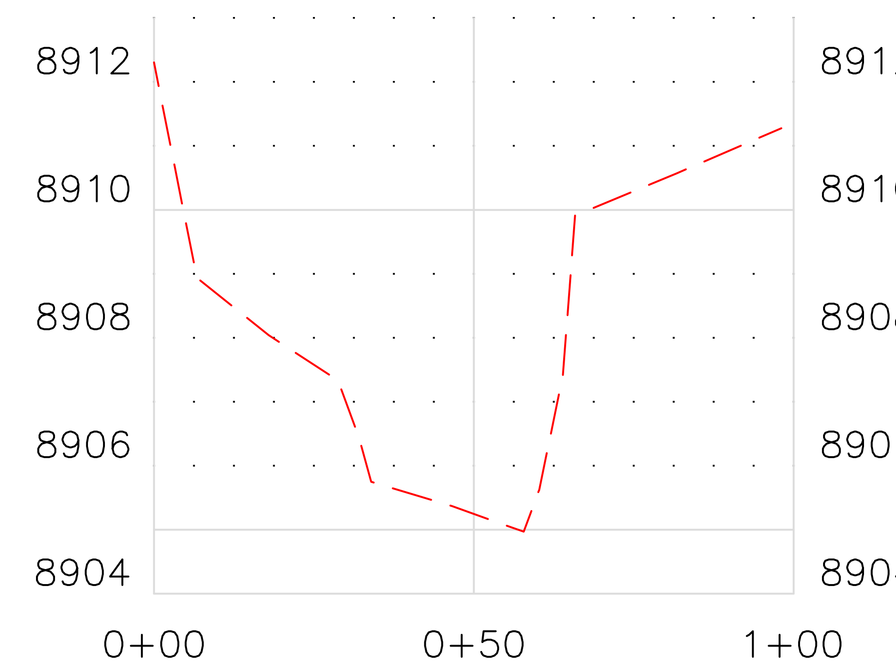

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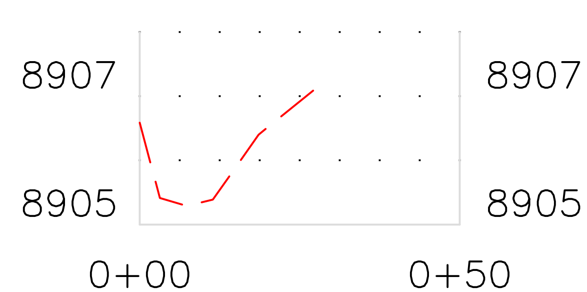

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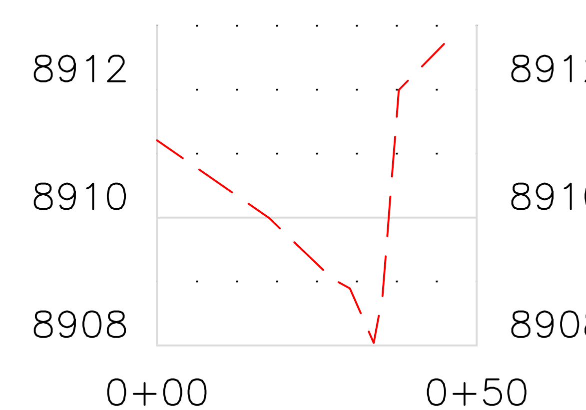


CROSS SECTION 17

Horizontal Scale 1" = 30 ft
Vertical Scale 1" = 3 ft

Symbol	Description	Date	Approved	

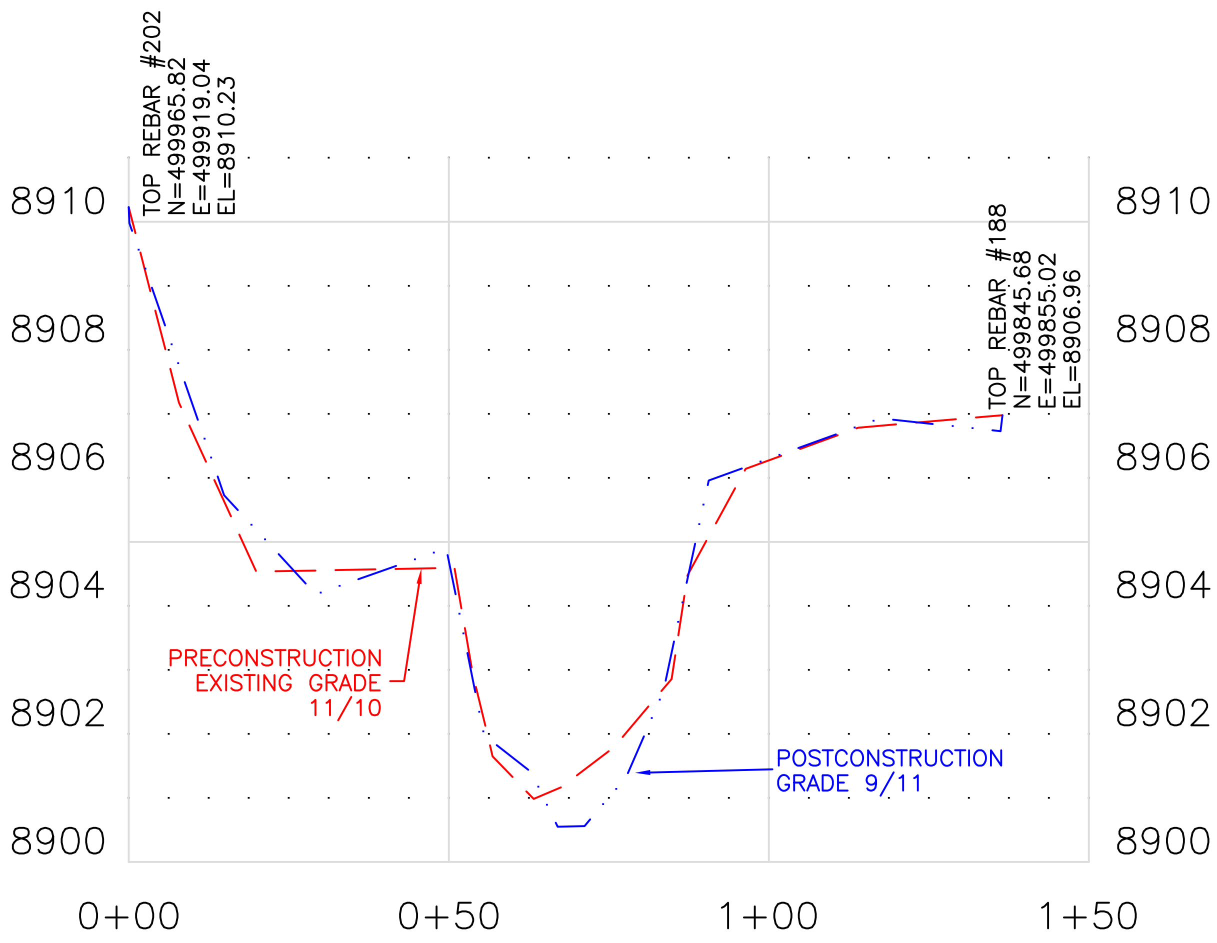
Designed by: JEFF CRANE	Date: Nov, 2010	Rev.
Dwn by: JPC / Ckd by:	Design file no:	
Reviewed by:	Drawing Code:	
Submitted by:	File name: Plot date: Plot scale:	

CRANE ASSOCIATES
140 Ash Lane
Carbondale, Colorado 81623
Phone (970) 261-5043
jeffcrane@paonia.com

HAZALON DITCH DIVERSION
RECONSTRUCTION ALTERNATIVE
COAL CREEK
CRESTED BUTTE, COLORADO
EXISTING CROSS SECTIONS

Sheet reference number:
Sheet 4 of 4

UPDATE



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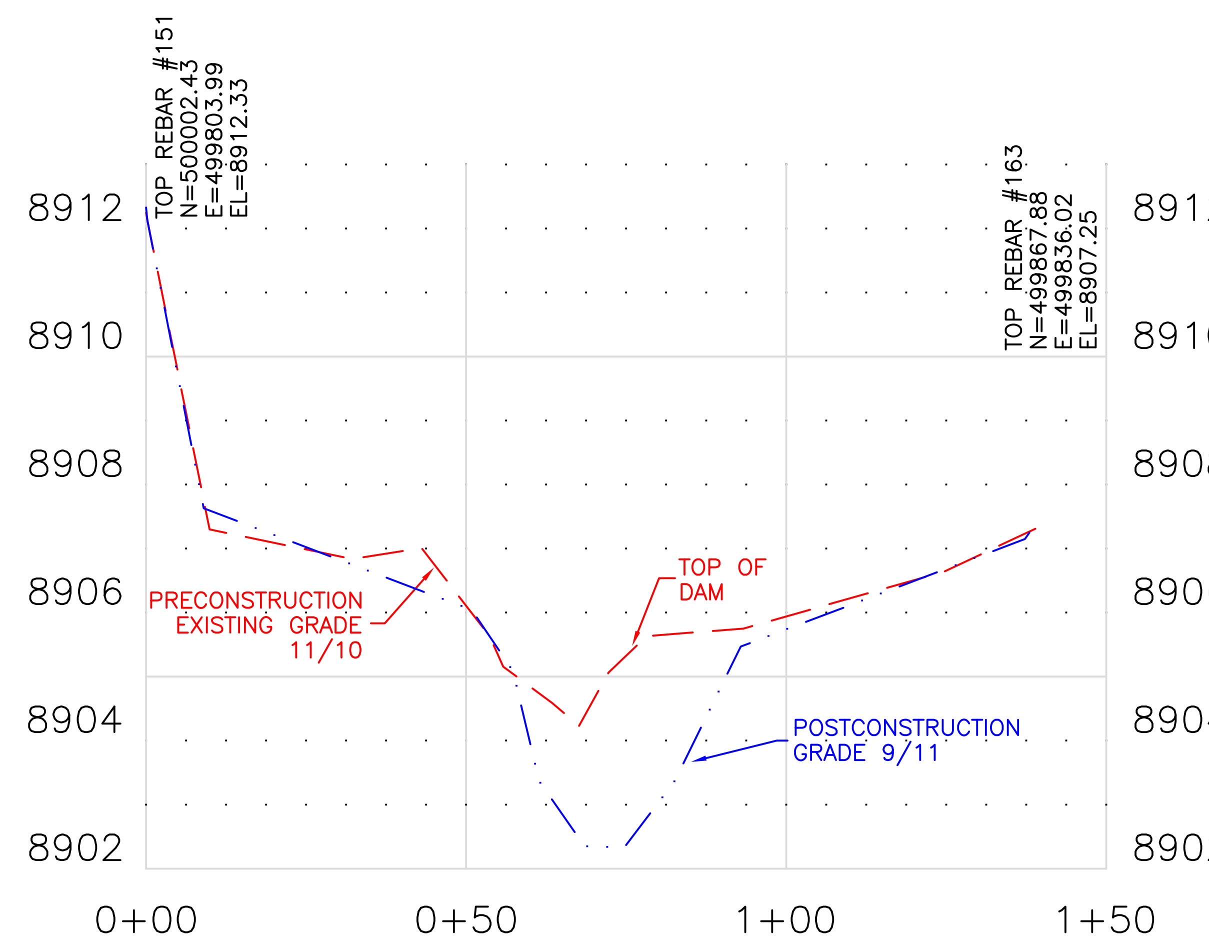

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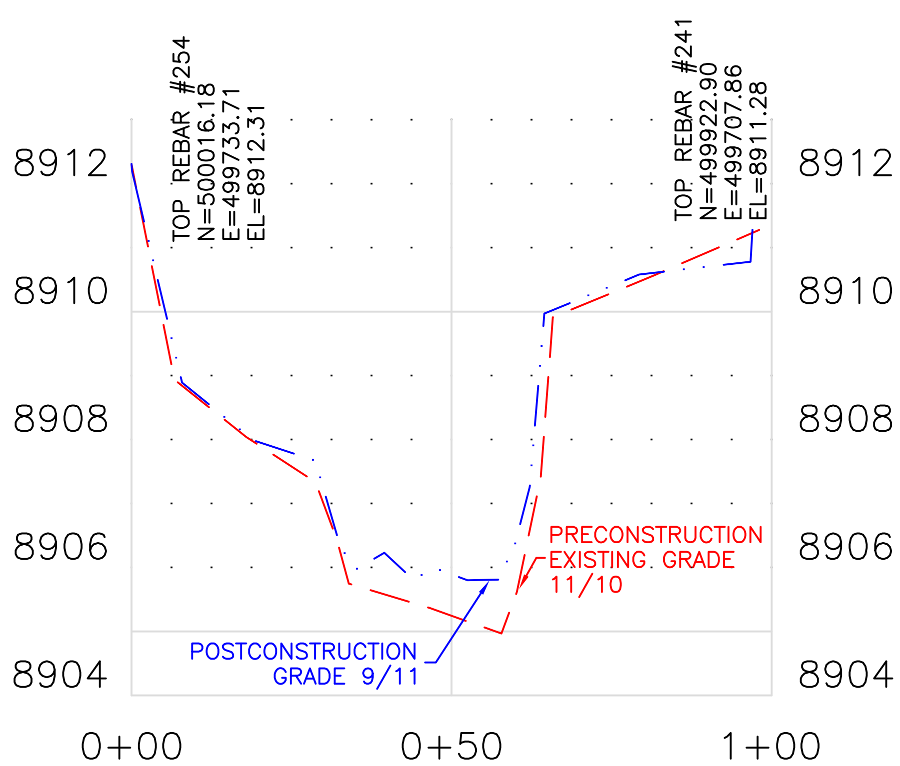

CROSS SECTION 15

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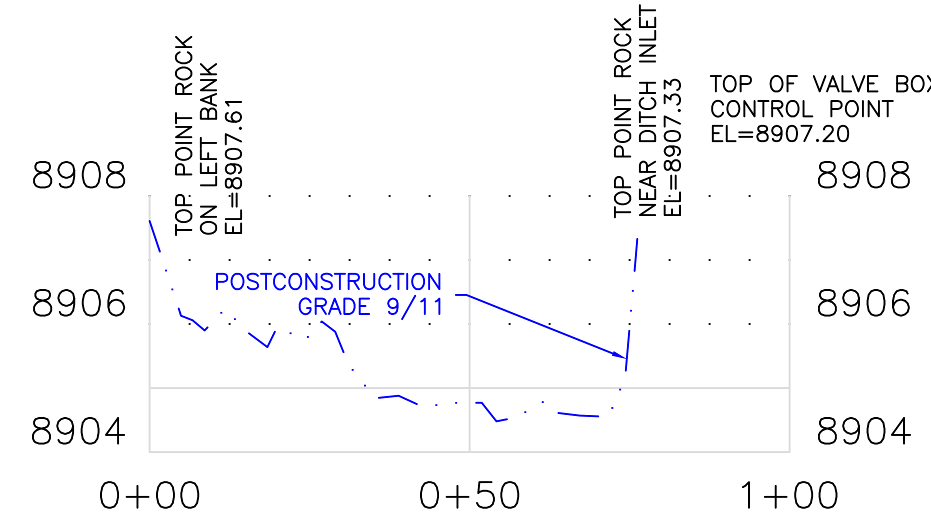
Vertical Scale 1" = 3 ft



TOP OF STRUCTURE

No	Description	Date
1	POST–CONSTRUCTION MONITORING	9/27/11

Designed by: JEFF CRANE		Date: Nov, 2010
Dwn by: JPC	Ckd by:	Design file no:
Reviewed by:		Drawing Code:
Submitted by:		File name: Plot date: Plot scale:

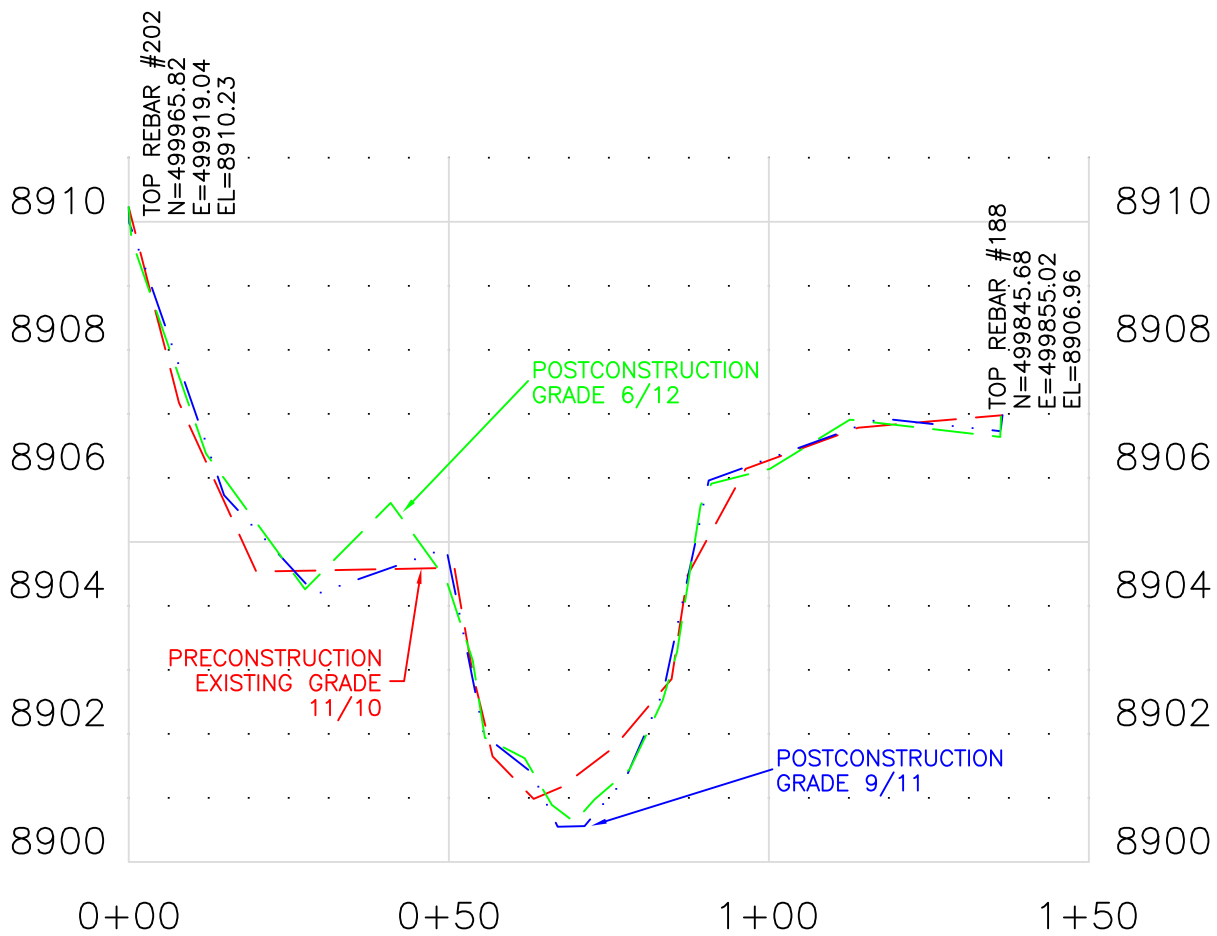
Rev.

CRANE ASSOCIATES
140 Ash Lane
Carbondale, Colorado 81623
Phone (970) 261–5043
jeffcrane@paonia.com

HALAZON DITCH DIVERSION
RECONSTRUCTION ALTERNATIVE
COAL CREEK
CRESTED BUTTE, COLORADO
MONITORED CROSS SECTIONS

Sheet reference number:
Sheet 2 of 2

UPDATE



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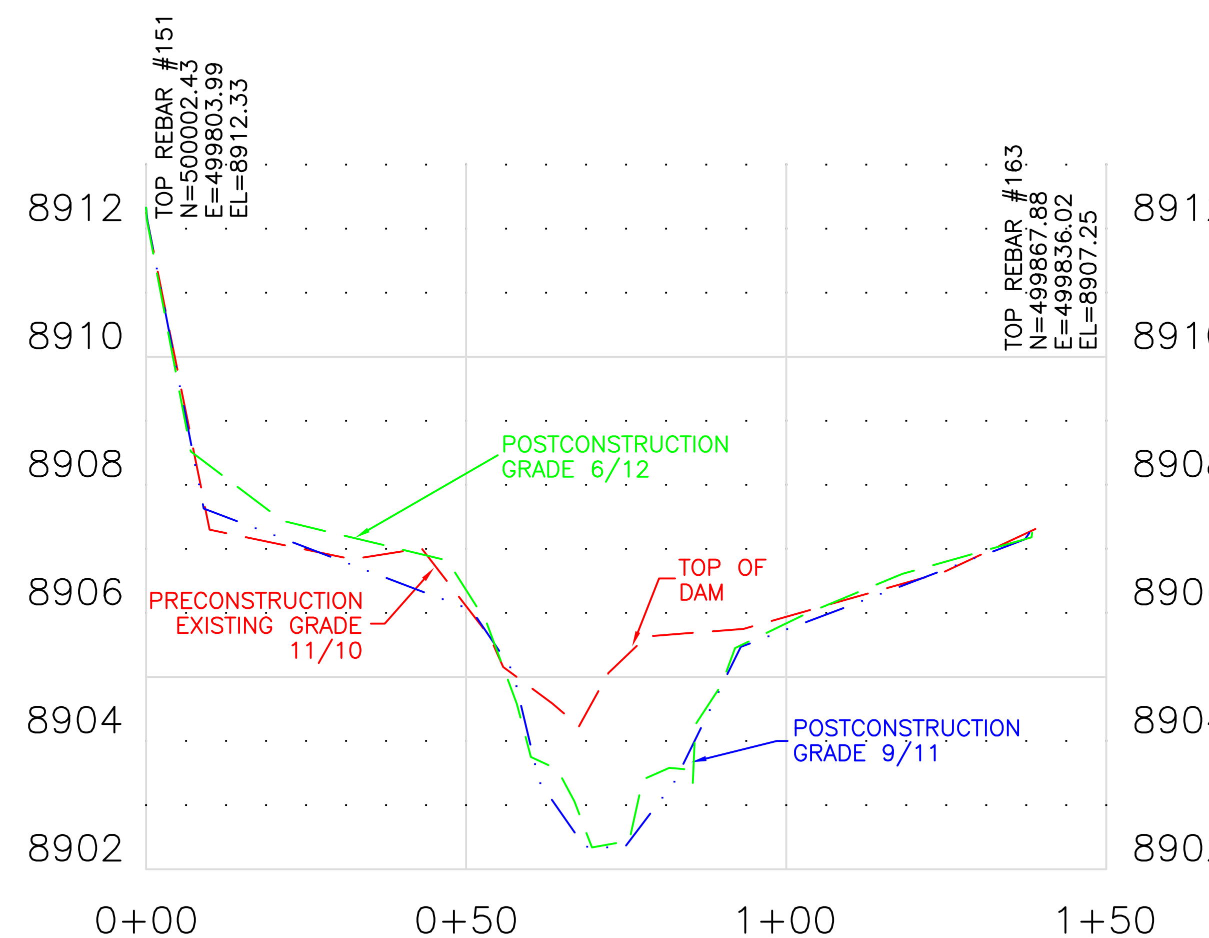

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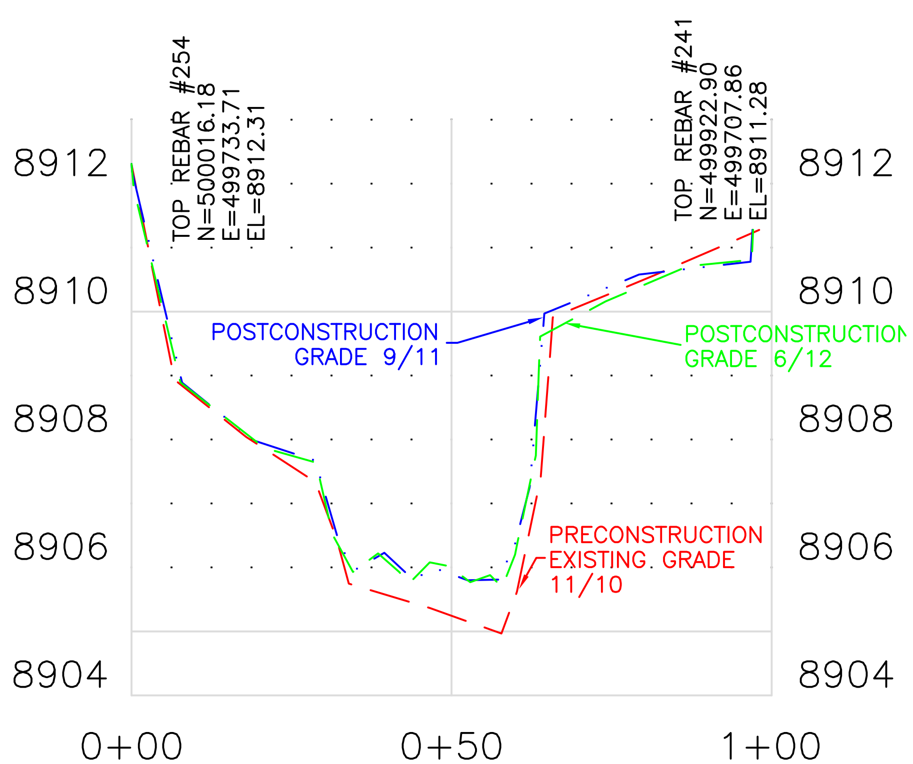
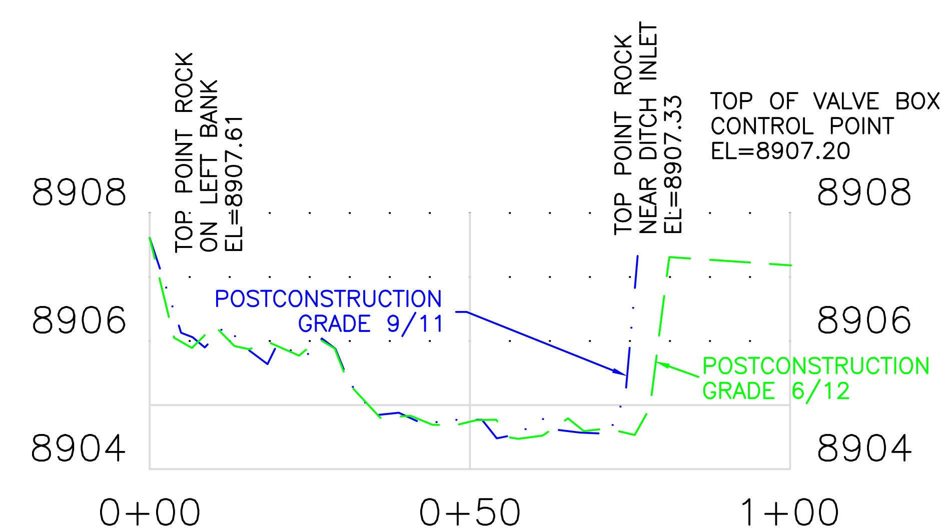


CROSS SECTION 15

Horizontal Scale 1" = 30 ft
Vertical Scale 1" = 3 ft



TOP OF STRUCTURE

No	Description	Date
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1	POST-CONSTRUCTION MONITORING	9/27/11

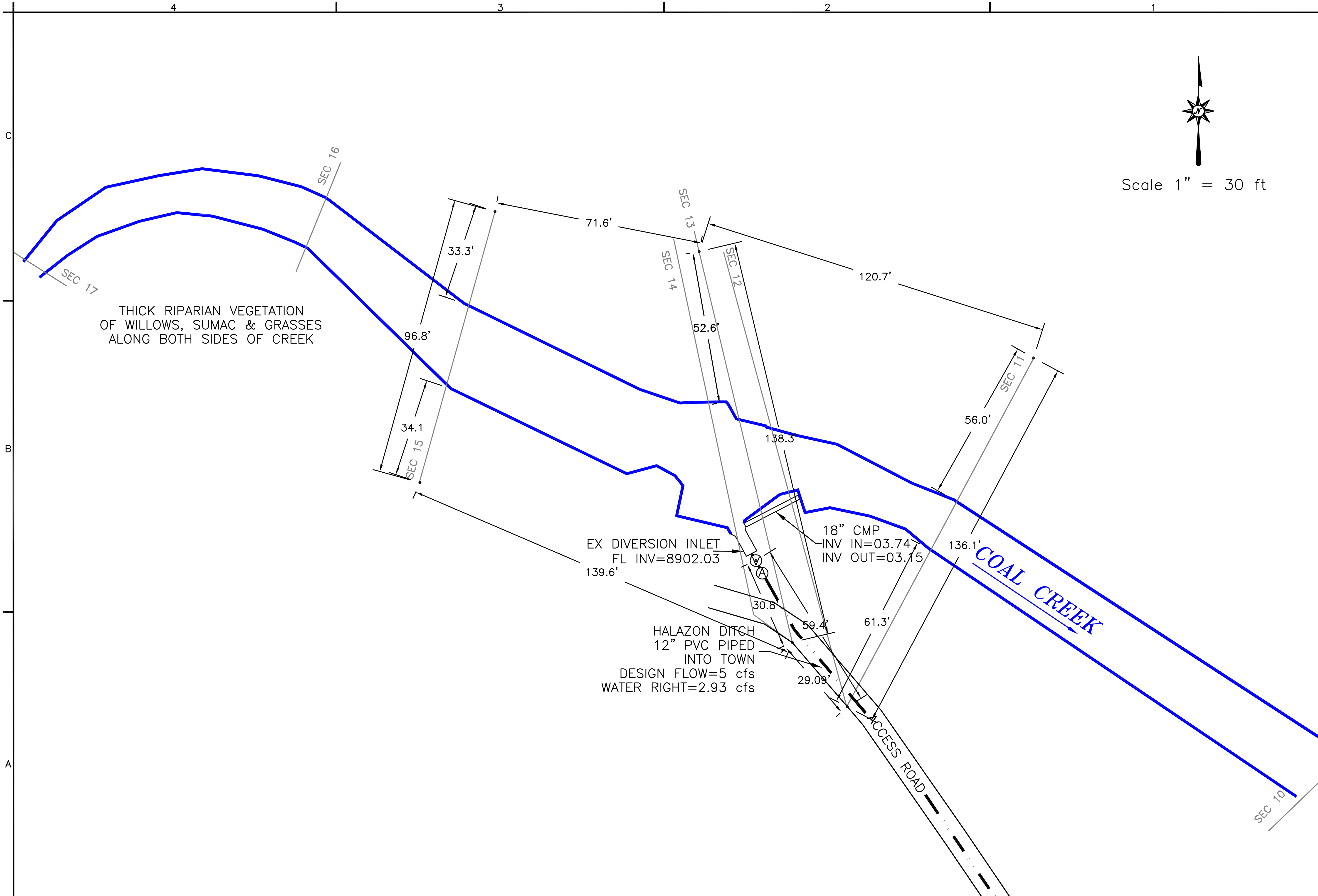
Designed by: JEFF CRANE
Dwn by: JPC
Ckd by:
Reviewed by:
Submitted by:
Date: Nov, 2010
Rev.
Design file no:
Drawing Code:
File name:
Plot date:
Plot scale:

CRANE ASSOCIATES
140 Ash Lane
Carbondale, Colorado 81623
Phone (970) 261-5043
jeffcrane@paonia.com

HALAZON DITCH DIVERSION
RECONSTRUCTION ALTERNATIVE
COAL CREEK
CRESTED BUTTE, COLORADO
MONITORED CROSS SECTIONS

Sheet reference number:
Sheet 2 of 2

UPDATE



Symbol	Description	Date
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1	POST-CONSTRUCTION MONITORING	9/27/11

Designed by: JEFF CRANE
Dwn by: JPC
Ckd by:
Reviewed by:
Submitted by:
Date: Nov, 2010
Rev.
Design file no:
Drawing Code:
File name:
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Plot scale:

CRANE ASSOCIATES
140 Ash Lane
Carbondale, Colorado 81623
Phone (970) 261-5043
jeffcrane@paonia.com

HALAZON DITCH DIVERSION
RECONSTRUCTION ALTERNATIVE
COAL CREEK
CRESTED BUTTE, COLORADO
PLAN VIEW

Sheet reference number:
Sheet 1 of 2

UPDATE

Town of Crested Butte Drinking Water Diversion Project Final Report

Prepared For:
Colorado Watershed Restoration Program
Attn: Chris Sturm
Colorado Water Conservation Board

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Prepared and Authored by:
The Coal Creek Watershed Coalition - Crested Butte, CO
Zach Vaughter, Executive Director

Coal Creek Watershed Coalition
Protect and Restore

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Project Summary

The Board of Directors for the Coal Creek Watershed Coalition (CCWC) initiated a project to improve and restore the Town of Crested Butte's drinking water diversion ditch in the spring of 2012. The CCWC partnered with the Town of Crested Butte (Town) to complete this project.

This project sought the following outcomes:

- Reduce the frequent maintenance of the existing structure, which disturbs instream habitat by releasing accumulated sediment into Coal Creek and disrupts adjacent riparian habitat;
- Construction of a more reliable diversion structure to withstand changing flows and improve water quality, instream habitat, and adjacent riparian habitat;
- Certification of no-rise structures using HEC-RAS modeling, and
- Improved longitudinal connectivity of Coal Creek.

The CCWC was awarded funding in the amount of $4,280 from the *Colorado Healthy Rivers Fund* grant program to draft a Request for Qualifications to hire an independent contractor to develop and implement an appropriate engineering design. An additional $1,000 was awarded to the CCWC from Trout Unlimited to assist in covering design costs. In September 2012, the CCWC hired Crane and Associates LLC to develop and implement the conceptual design. Crane and Associates LLC finalized and presented their "Crested Butte Municipal Water Diversion Reconstruction Project" engineering plan in January 2013. The work contained the necessary elements for the CCWC and the Town to seek grant money. The estimated total cost of the project was $25,743, not including the $4,280 to be utilized for the conceptual design.

Funding for design implementation was awarded from the Upper Gunnison River Water Conservancy District in the amount of $12,872 in the fall of 2012. Additionally, Chris Sturm of the Colorado Watershed Restoration Program, approved re-allocation of $6,630 remaining project funds following completion of the Halazon Ditch Reconstruction project (PO-12-20) by the CCWC and the Town of Crested Butte in September, 2011. This $6,630 was approved for implementation of the design.

The in-stream work began on October 7th 2013 and was completed on October 10th, 2013. Jeff Crane of Crane and Associates oversaw the implementation and construction of the design and the Town of Crested Butte provided staff, staff time, and equipment in the form of an in-kind donation. Additional structural monitoring will occur in the spring 2014 during high flows to assess proper engineering and stability. Monitoring work will be undertaken by Crane and Associates, as indicated in their contract.

It should be noted that during this 2-year project the CCWC experienced two changes in Executive Director and project leader. Following the initial design period, the CCWC's Executive Director and project developer, Anthony Poponi left the organization to pursue a career opportunity in Honolulu, HI. Following Anthony's departure, the CCWC hired Cathy Fornaris to be the organization's Executive Director. Cathy resigned from the organization in July 2013, at which point the current Executive Director, Zach Vaughter, assumed finalizing the on the ground implementation and culmination of the project. Rodney Due, the Director of Public Works for the Town of Crested Butte, was instrumental in acting as project lead during the organization's time of transition, as well as assisting Zach in finalizing the project.

Background

At a CCWC Board of Directors meeting in the spring of 2012, a discussion developed pertaining to the success of the Halazon Ditch Reconstruction project undertaken by the CCWC the previous fall, and the applicability of developing a project similar in nature for the town's drinking water diversion, which sits 6.5 miles downstream of Lake Irwin and approximately 1.5 miles upstream of the Town of Crested Butte. The state of the diversion ditch at that time, required regular maintenance by the Town of Crested Butte Public Works department to clear the ditch and diversion pipeline of accumulated sediment, often times by utilizing heavy machinery in Coal Creek to excavate the sediment. Sediment accumulation was exacerbated by the existing diversion structure, which caused the deposition of sediment at the site during seasonal flows, thus negatively impacted water quality, instream habitat, and adjacent riparian habitat. With partial project funding already available from remaining funds from the Halazon Ditch Reconstruction project and partnership with the Town, the CCWC Board of Directors approved the project and additional funding was sought from appropriate entities.

Project Approach and Implementation

Following project approval, the Board of Directors directed Anthony Poponi, CCWC Executive Director at that time, to begin seeking funding for an engineering design from an outside independent contractor. The CCWC was awarded funding in the amount of $4,280 from the *Colorado Healthy Rivers Fund* grant program to draft a Request for Qualifications to hire an independent contractor to develop and implement an appropriate engineering design. An additional $1,000 was awarded to the CCWC from Trout Unlimited to assist in covering design costs. In September 2012, the CCWC hired Crane and Associates LLC to develop and implement the conceptual design. Crane and Associates LLC finalized and presented their "Crested Butte Municipal Water Diversion Reconstruction Project" engineering plan to the CCWC Board of Directors in January 2013. The engineering design contained the necessary elements for the CCWC and the Town to seek additional grant money required to carry out project implementation.

The CCWC Board of Directors was pleased with the conceptual design work products and project costs were deemed reasonable. During the design period, applicable US Forest Service 2720 Special Use permitting and design oversight was not taken into account by the CCWC, or factored into implementation costs. The Town subsequently picked up the cost of these unanticipated expenses during implementation. The total cost of US Forest Service processing of the 2720 Special Use permit and reconstruction oversight totaled $1,183. This cost will be reimbursed to the Town by the CCWC upon receipt of reimbursement from the Colorado Watershed Restoration Program grant (PO-12-20). This issue is discussed in more detail in the "Lessons Learned" section of this report. The Town also had to apply for a U.S. Army Corps of Engineers 404 permit for conducting activities in the stream. That permit cost was also unanticipated.

Funding for design implementation was awarded from the Upper Gunnison River Water Conservancy District in the amount of $12,872 in the fall of 2012. Additional funding came from the Town. Additionally the Town of Crested Butte Public Works Department agreed to provide department staff and time, as well as equipment in the form of an in-kind donation.

The in-stream work began on October 7th 2013 and was completed on October 10th, 2013. Jeff Crane of Crane and Associates oversaw the implementation and construction of the design and the Town provided staff, staff time, and equipment.

Project Budget

	Crested Butte Water Ditch Diversion Project Budget					
	ITEM DESCRIPTION	UNIT	QTY	UNIT COST	EST COST	SUB TOT COST
1	Mobilization/Demobilization					
	Equipment Transport (12)	LS	1	$1,000	$1,000	
	Best Management Practices					
	Repair Staging Area	Acre	1	500	$500	$1,500
2	Diversion Structure					
	Demo and remove ex structure	CY	150	$5	$750	
	Excavation w/rock hammer	CY	70	$15	$1,050	
	3' boulders delivered & placed for structure	CY	75	$100	$7,500	
	Grout boulders	CY	15	$250	$3,750	
	2' boulders delivered and installed for toe rock	CY	25	$100	$2,500	
	Cabled logs	EA	5	$200	$1,000	
	Floodplain backfill	CY	60	$5	$300	
	Water control	LS	1	$2,000	$2,000	
						$18,850
	SUBTOTAL					$20,350
	CONTINGENCY (15%)					$3,053
	CONSTRUCTION SUBTOTAL					$23,403
	Project supervision (10%)					$2,340
	PRELIMINARY PROJECT COST					**$25,743**

Construction Implementation and Deliverables

To satisfy the requirements of the Colorado Healthy Rivers Fund and Colorado Watershed Restoration Program grants, as well as the desires of all those concerned, the instream re-engineering of the diversion ditch and structure was designed and implemented to withstand naturally occurring seasonal flows.

The conceptual design called for 75 cubic yards of 3' diameter round rock/boulders and 25 cubic yards of 2' diameter round rock/boulders. The site did not have an immediate rock source and therefore an off-site rock source was identified prior to October 7th, and delivered the Friday prior to excavation. In addition to in-kind matching services from the Town, Rodney Due-director of Public Works, coordinated all heavy machinery rentals, machine mobilization, identified rock sources, and coordinated off site rock delivery and donation. The Crested Butte Nordic Center donated 25 cubic yards of rock towards the project, which was left over from a Nordic trail expansion project they had undertaken earlier in the summer.

After some technical difficulties with the initial excavator (a pin on the track snapped while mobilizing to the site) a new excavator was mobilized to the site and decommission of the existing diversion structure began. The previous diversion structure was created by erecting two Jersey Barriers downstream of the diversion ditch in the center of Coal Creek, and allowing woody debris and large rocks deposited at high flow to accumulate. This structure was susceptible to high stress during times of high flows and had a history of washing out. Following decommission of the existing diversion structure, the accumulated sediment present in the diversion ditch was excavated and stored on site to be used as native bedload material.

Following decommission of the existing diversion structure and excavation of accumulated sediment from the drinking water diversion ditch, Jeff Crane of Crane and Associates oversaw implementation of the conceptual design and supervised construction of the new diversion structure. The previous diversion structure was replaced with a boulder structure with a constant top grade of 9245 feet, which was a similar elevation of the previous diversion structure and delivers the same head at the intake.

The excavated diversion ditch was lined and reinforced with 3' boulders, additionally a boulder J-hook was constructed extending upstream from the existing diversion ditch approximately five feet into the main stem of Coal Creek. This provided a more gradual diversion of water to the right side of the existing intake ditch. Rocks utilized in the J-hook were anchored with cables to maintain design integrity during seasonal high flows. The diagonal alignment of the new structure provided a constant slope of 0.75% and reduces sediment deposition before the structure and ditch. This alignment provided improved stability and allows for fish migration past the diversion. Additionally, the new diversion structure reduces erosion on the right bank before entering into the diversion ditch and on the left bank during peak seasonal flows.

Implementation was completed on Thursday, October 10th 2013. Above and below the project site, creek conditions were near optimal. Construction at each end of the project was carefully blended into the two end points so as to eliminate any visual discontinuities.

The Town Drinking Water Diversion design implementation achieved the desired deliverables as outlined in the scope of work:

- Reduced need for frequent maintenance of the existing structure.
- Constructed a more reliable diversion structure to withstand changing flows and improve water quality, instream habitat, and adjacent riparian habitat;
- Constructed a certified no-rise diversion structure using HEC-RAS modeling, and
- Improved longitudinal connectivity of Coal Creek.

Lessons Learned

The Town Drinking Water Diversion project on Coal Creek was the second project of its type implemented by the CCWC in partnership with the Town of Crested Butte. The Halazon Ditch Reconstruction of 2011 provided useful experiences and references applicable to undertaking this project from an organizational level. However, one lesson that the CCWC learned through this project is the importance of thoroughly researching all applicable and necessary permitting requirements before undertaking a project similar in size on US Forest Service land.

The previous Executive Director, and project lead, was under the impression that no outside permitting was needed due to the fact that the Town of Crested Butte municipality operated the diversion and additionally held water rights as a 6 cfs direct flow right from Coal Creek and Wildcat Creek with a 1893 appropriation date and a 1933 administrative date with a 367 acre-foot storage right in Lake Irwin, which sits 6.5 miles west of the Town's Drinking Water Diversion. The Town covered all applicable permitting costs with the US Forest Service's Gunnison Field Office. They will be reimbursed for these associated costs.

Moving forward, the CCWC will conduct the proper research and apply for all applicable permitting as it relates to respective water quality and riparian improvement projects.

Conclusion

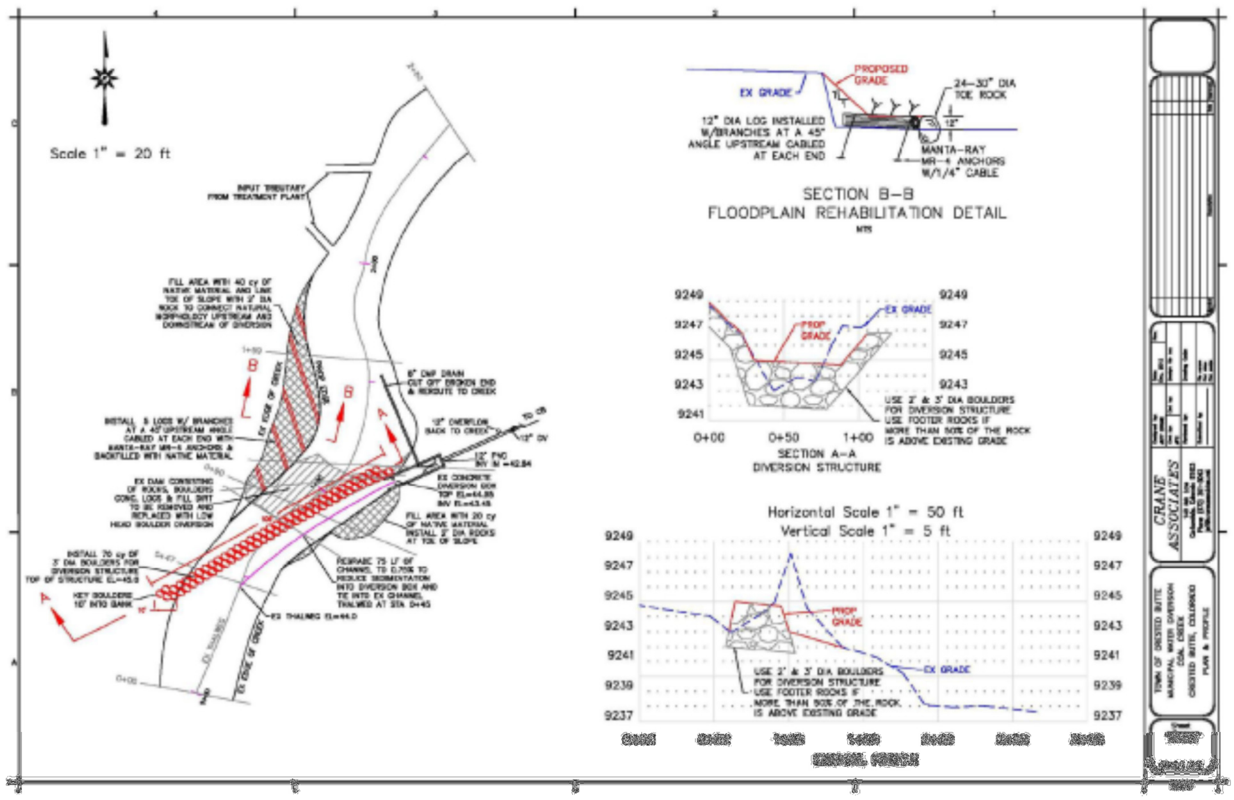
The Town Drinking Water Diversion project resulted in a major improvement from the previous diversion structure and ditch. The final cost of the project came in under budget by approximately $9,500, the final cost of the project was $16,123.92 compared to the original estimate of $25,743. This can be attributed to donations from the Town in the form of in-kind donation/match, rock donated by the Crested Butte Nordic Center, as well as an in-kind donation from Al's Backhoe Service and Lacy Constuction, both of Crested Butte.

Additionally, the Town Drinking Water Diversion design implementation achieved the desired deliverables on Coal Creek as outlined in the scope of work provided to the Colorado Watershed Restoration Program, in that this project:

- Reduced need for frequent maintenance of the existing structure.
- Constructed a more reliable diversion structure to withstand changing flows and improve water quality, instream habitat, and adjacent riparian habitat;
- Improved instream fish habitat;
- Constructed a certified no-rise diversion structure using HEC-RAS modeling, and
- Improved longitudinal connectivity of Coal Creek.

Appendix

The following are representative pictures showing "Before & After" shots of the project. Pictures do not do justice to the work that was performed, however an attempt was made to show the changes as accurately as possible.



Proposed Conditions as presented By Crane and Associates

Photo Point 1
Looking Northeast (downstream) from Ditch Bank

Before

After

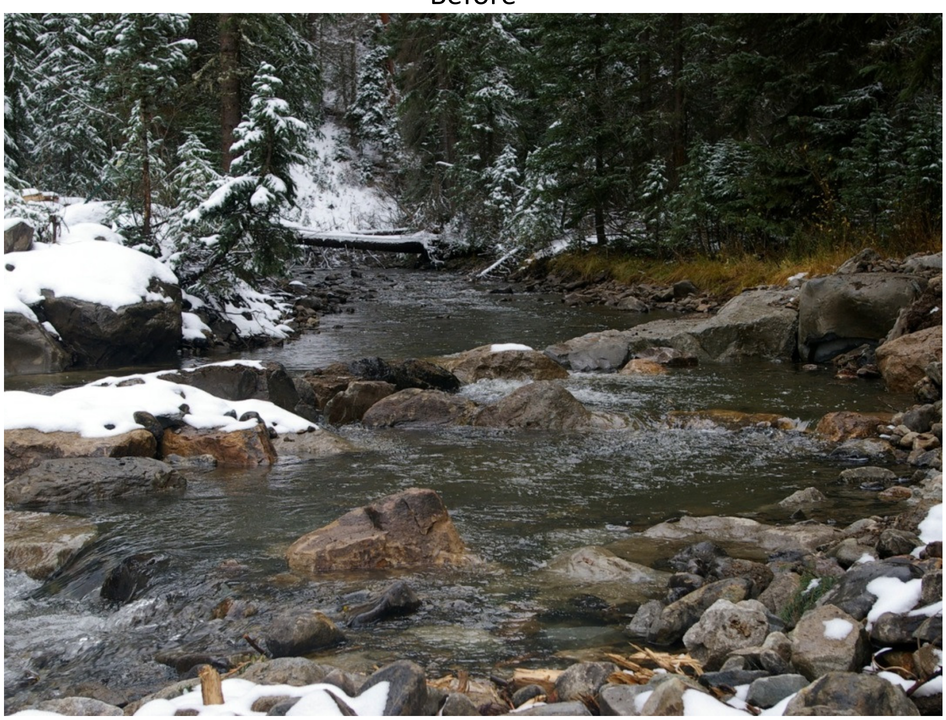
Photo Point 2
Looking South from River Left Bank

Before

After

Photo Point 3
Downstream of Structure looking upstream

Before



After

Photo Point 4
Looking Northwest from Ditch Bank

Before

After

Photo Point 5
In Coal Creek Looking East at Diversion Ditch

Before

After