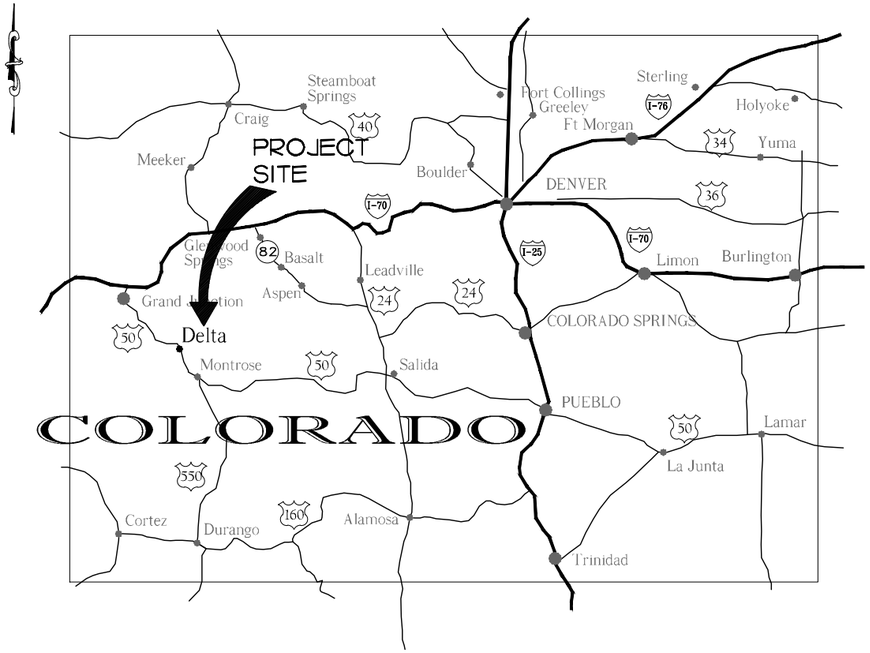
Painted Sky Resource Conservation and Development Council, Inc.

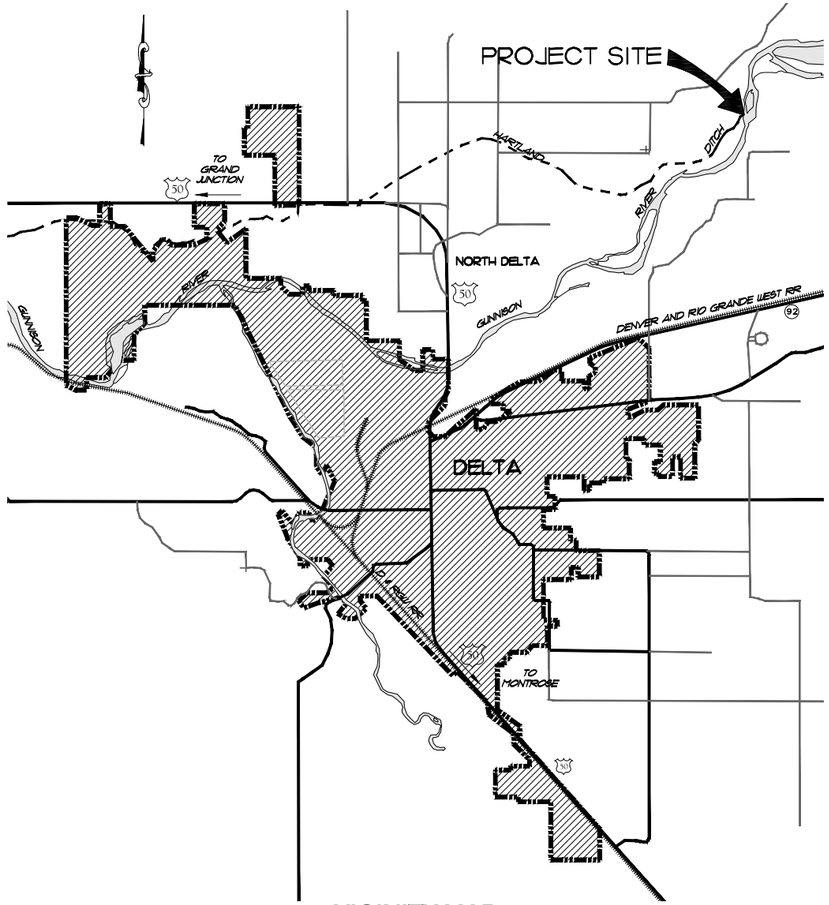
Delta, Colorado

Hartland Diversion Dam Fish Passage

November, 2010



LOCATION MAP
N.T.S.



VICINITY MAP
2000 0 2000 4000
1 inch = 2000 feet

INDEX OF DRAWINGS

No.	DESCRIPTION
1	COVER SHEET
2	DEMOLITION AND HARVEST PLAN
3	PLAN AND PROFILE AT CENTER CHANNEL
4	PROFILES AT RIGHT CHANNEL AND CHEVRON CHANNEL
5	DROP 1 PLAN
6	DROP 2 THRU 5 PLAN
7	DROP 1 THRU 5 SECTIONS
8	CHEVRON PLANS, SECTIONS AND TABLE
9	SHEET PILE PLAN, SECTIONS AND TABLES
10	SHEET PILE SECTIONS
11	SHEET PILE SECTIONS AND DETAILS
12	RIPRAP AND LOOSE BOULDER - TYPICAL DETAILS
13	GROUTED BOULDER -TYPICAL DETAILS
14	JETTY - TYPICAL DETAILS
15	xx
16	

PRELIMINARY
NOT FOR CONSTRUCTION

Prepared By:

McLaughlin Water Engineers, Ltd.
2400 Alcott Street
Denver, Colorado 80211
T 303.964.3333
F 303.964.3355

PAINTED SKY RC&D / ACAD2010_HART-COVER.DWG / NOVEMBER 15, 2010 / PROJ 10-08-01

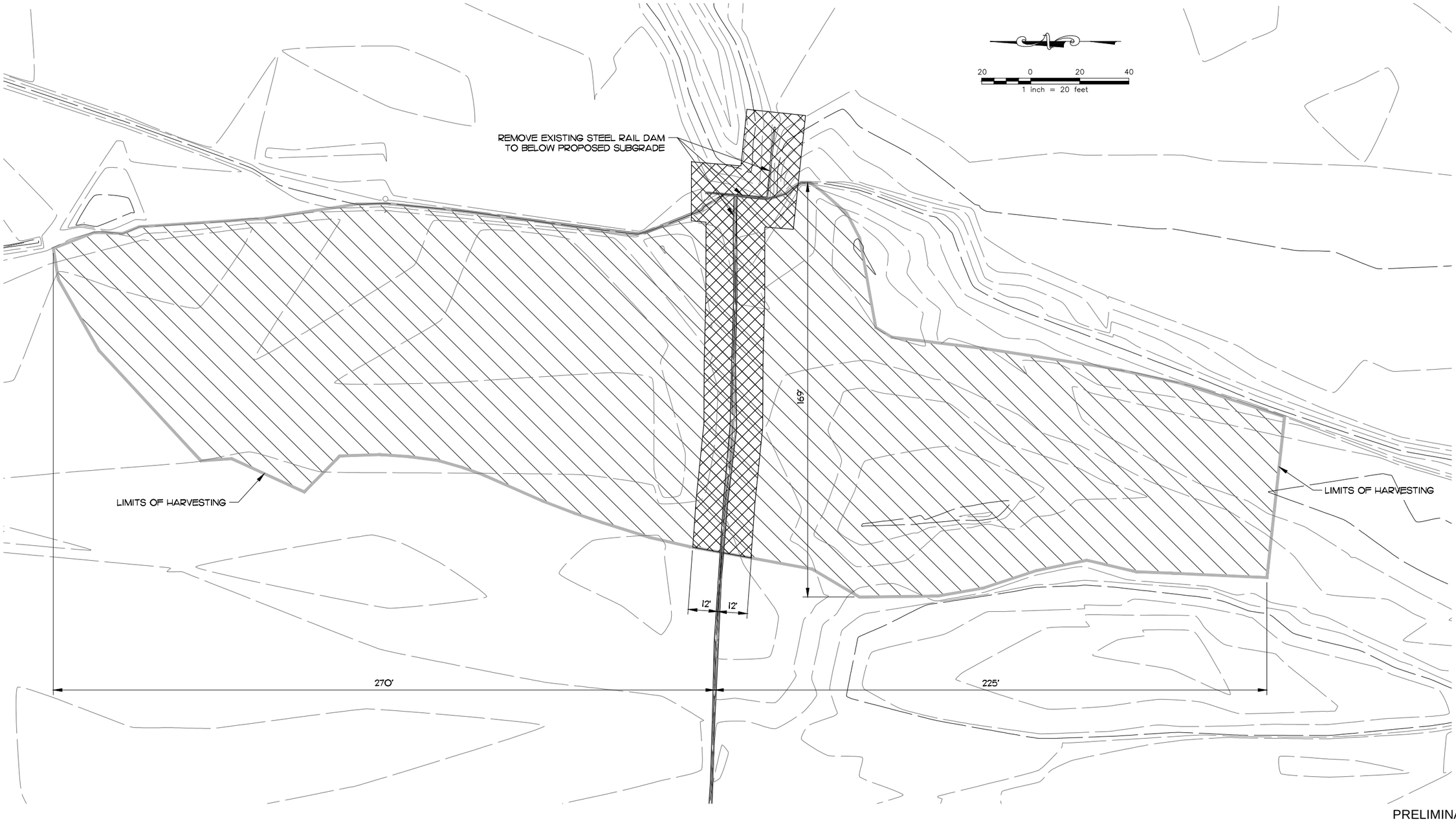
LEGEND

HARVEST TOP 18" OF EXISTING RIVERBED COBBLE AND STOCKPILE ON SITE

DEMOLISH AND REMOVE EXISTING DAM

20 0 20 40

1 inch = 20 feet



PRELIMINARY
NOT FOR CONSTRUCTION

Number	Revision Description	By	Date

PAINTED SKY RC& D
DELTA, COLORADO

HARTLAND DIVERSION
FISH PASSAGE

HARVESTING AND
DEMOLITION PLAN

McLaughlin Water Engineers, Ltd.
2420 Alcott Street
Denver, Colorado 80211
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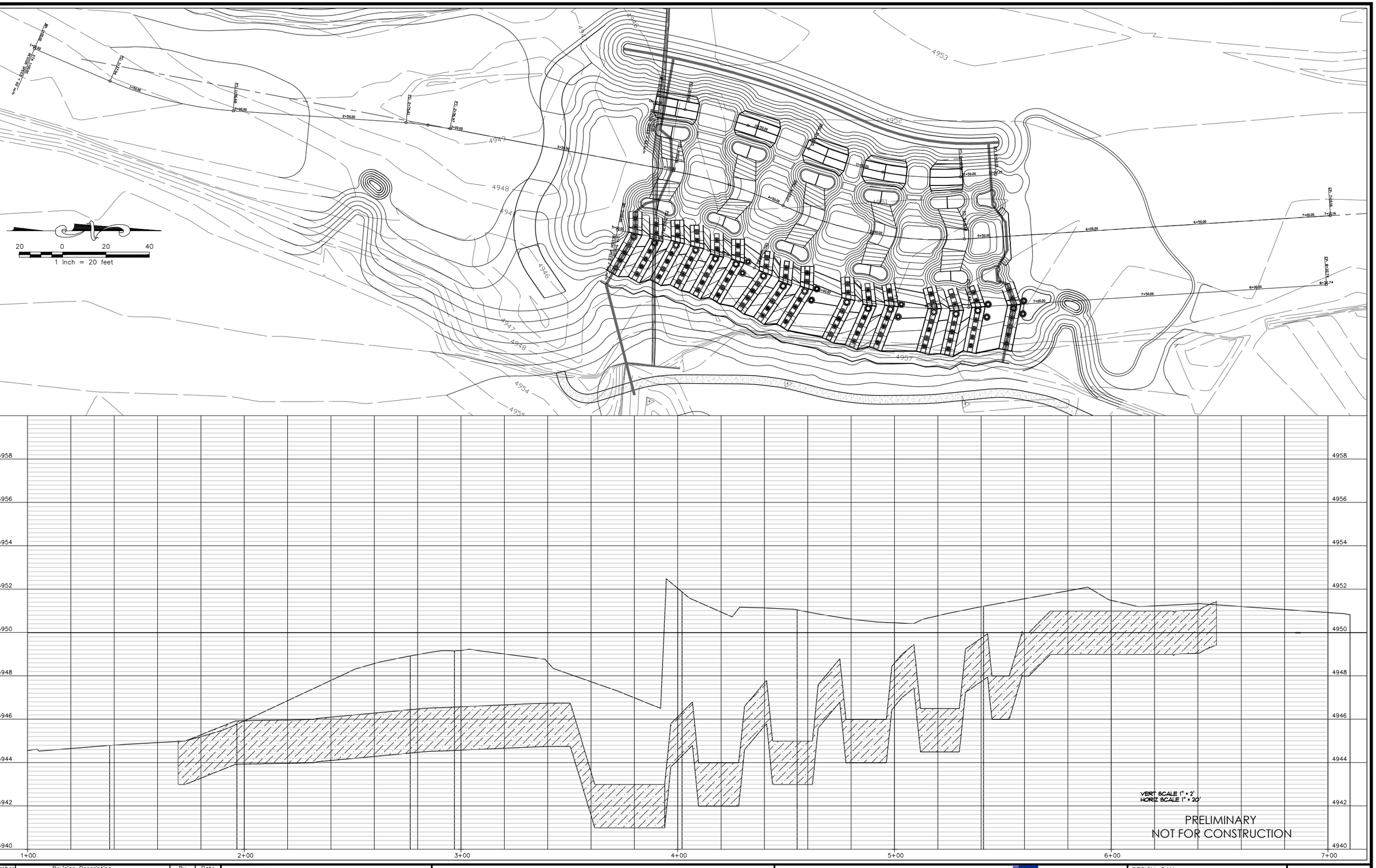
DESIGN: BAN
DETAIL: BAN, RDL
CHECK: XXX
DATE: NOVEMBER, 2010

PROJECT NUMBER
10-06-01

Drawing Number:
2

I:\1 MWDG ACTIVE JOBS\PAINTED SKY 10-06\DRAWINGS\2_ACAD2010_HART-PROP-DEMO.DWG / NOVEMBER 15, 2010 / PROJ. 10-06-01



PRELIMINARY
NOT FOR CONSTRUCTION

Number	Revision Description	By	Date

PAINTED SKY RC& D
DELTA, COLORADO

HARTLAND DIVERSION
FISH PASSAGE

PLAN AND PROFILE
AT CENTER CHANNEL

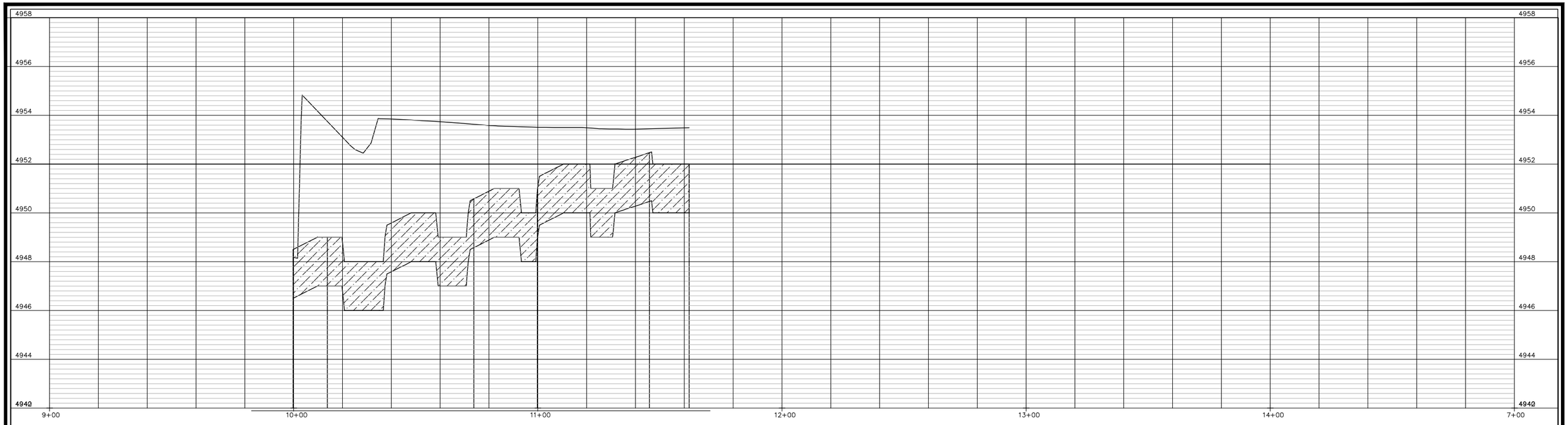
McLaughlin Water Engineers, Ltd.
2420 Alcott Street
Denver, Colorado 80211
T 303.964.3333
F 303.964.3355

DESIGN: BAN
DETAIL: BAN, RDL
CHECK: XXX
DATE: NOVEMBER, 2010

PROJECT NUMBER
10-06-01

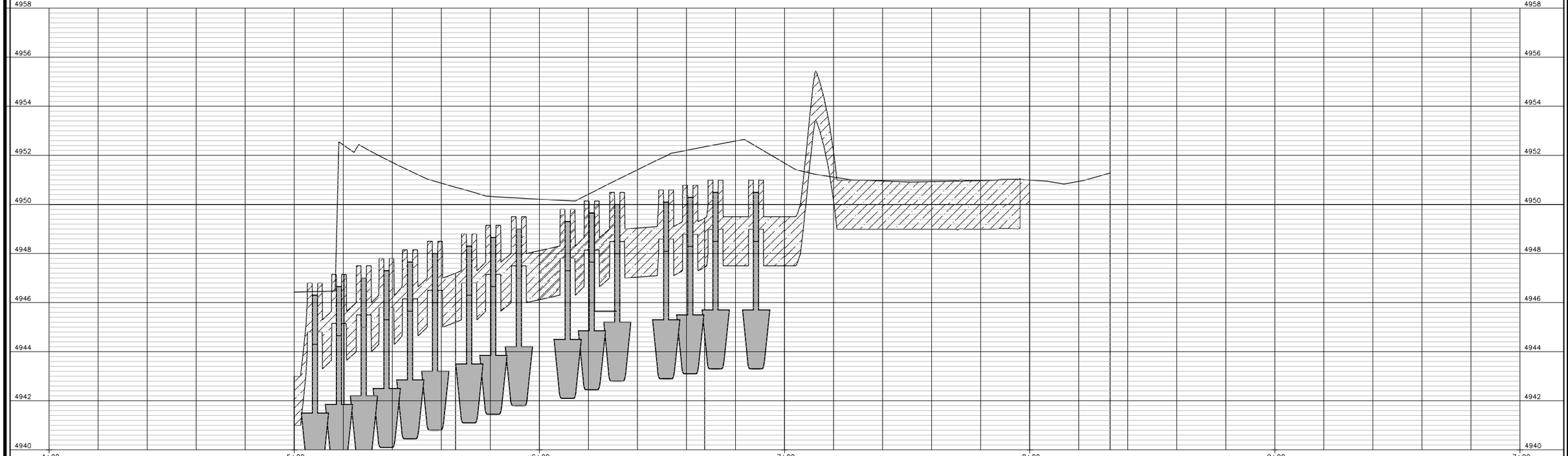
Drawing Number:
3

PAINTED SKY RC&D / ACAD2010_HART_PROFILES.DWG / NOVEMBER 15, 2010 / PROJ. 10-06-01



PROFILE AT RIGHT CHANNEL

VERT SCALE 1" = 2'
HORIZ SCALE 1" = 20'



PROFILE AT CHEVRON CHANNEL

VERT SCALE 1" = 2'
HORIZ SCALE 1" = 20'

PRELIMINARY
NOT FOR CONSTRUCTION

Number	Revision Description	By	Date

PAINTED SKY RC& D
DELTA, COLORADO

HARTLAND DIVERSION
FISH PASSAGE

PROFILES AT RIGHT CHANNEL
AND CHEVRON CHANNEL

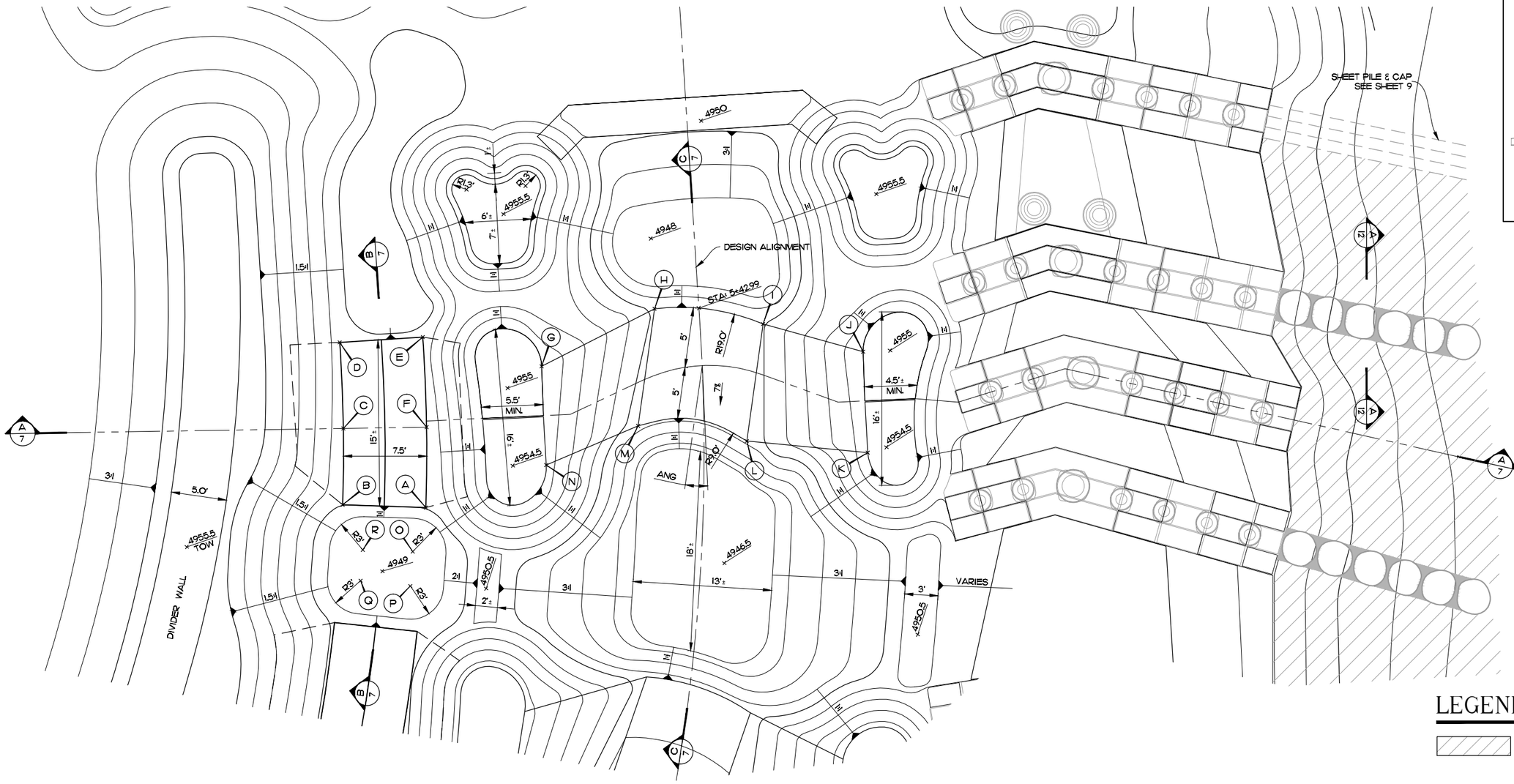
McLaughlin Water Engineers, Ltd.
2420 Alcott Street
Denver, Colorado 80211
T 303.964.3333
F 303.964.3355

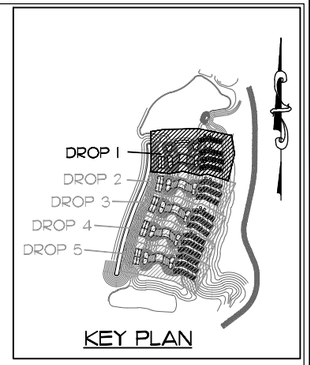
DESIGN: BAN
DETAIL: BAN, RDL
CHECK: XXX
DATE: NOVEMBER, 2010

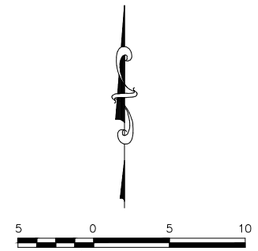
PROJECT NUMBER
10-06-01

Drawing Number:
4

PAINTED SKY RC&D / ACAD2010_HART_PROFILES.DWG / NOVEMBER 15, 2010 / PROJ. 10-06-01







LEGEND

BURIED RIPRAP
SEE DETAIL B ON SHEET 12

PRELIMINARY
NOT FOR CONSTRUCTION

	FISH PASSAGE AND CENTER CHANNEL			
DROP	POINT	NORTHING	EASTING	ELEVATION
1	A	1351026.70	2275621.69	50.00
	B	1351026.95	2275614.19	50.00
	C	1351033.84	2275614.25	50.25
	D	1351041.59	2275613.92	50.50
	E	1351042.07	2275621.41	50.50
	F	1351033.95	2275621.75	50.25
	G	1351039.43	2275632.12	55.00
	H	1351044.61	2275642.29	49.95
	I	1351043.24	2275652.08	49.95
	J	1351040.75	2275661.10	55.00
	K	1351031.65	2275661.51	54.50
	L	1351032.69	2275650.61	49.25
	M	1351034.07	2275640.81	49.25
	N	1351030.53	2275632.53	54.50
	O	1351022.74	2275620.50	49.00
	P	1351019.63	2275620.28	49.00
	Q	1351020.11	2275615.81	49.00
	R	1351022.89	2275616.00	49.00
	ANG = 10°31'28"			

Number	Revision Description	By	Date

PAINTED SKY RC& D
DELTA, COLORADO

HARTLAND DIVERSION
FISH PASSAGE

DROP 1
TYPICAL PLAN

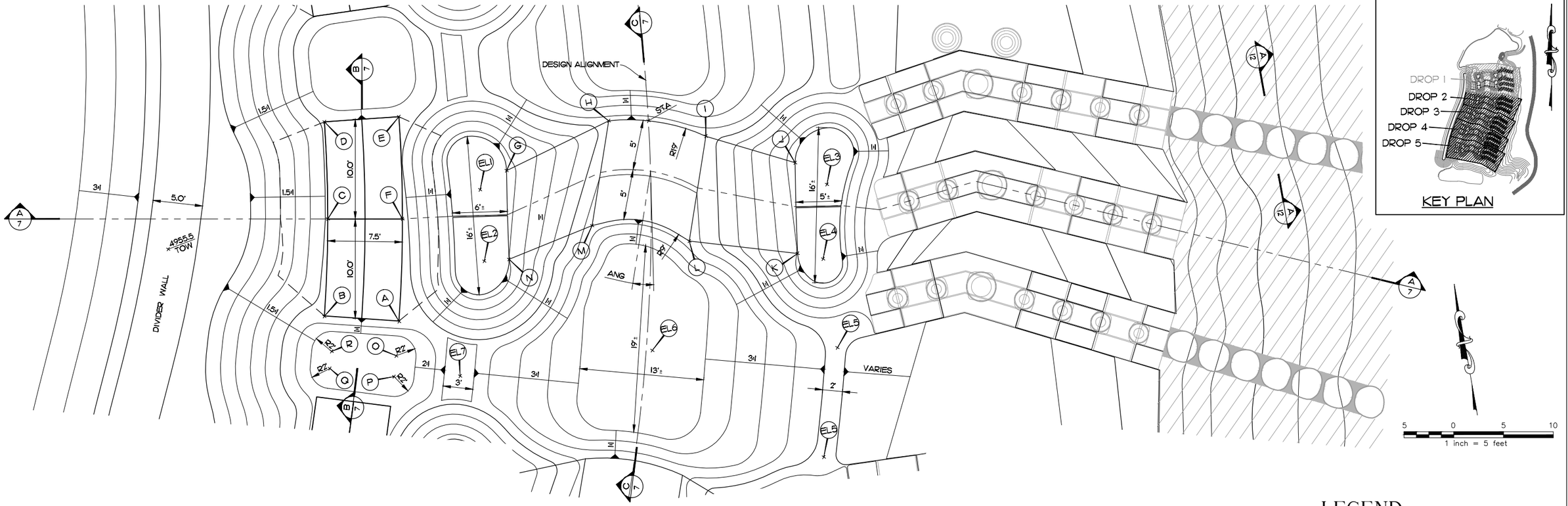
McLaughlin Water Engineers, Ltd.
2420 Alcott Street
Denver, Colorado 80211
T 303.964.3333
F 303.964.3335

DESIGN: BAN
DETAIL: BAN, RDL
CHECK: XXX
DATE: NOVEMBER, 2010

PROJECT NUMBER
10-06-01

Drawing Number:
5

I:\1 MWDG ACTIVE JOBS\PAINTED SKY 10-06\DRAWINGS\5_ACAD2010_HART-PROP-DROP1.DWG / NOVEMBER 15, 2010 / PROJ. 10-06-01



LEGEND

BURIED RIPRAP
SEE DETAIL B ON SHEET 12

NOTE:

CONTOURS ON THIS PLAN REPRESENT DROP 2 ONLY.

	FISH PASSAGE AND CENTER CHANNEL			
DROP	POINT	NORTHING	EASTING	ELEVATION
2	A	1350995.35	2275617.31	49.50
	B	1350997.16	2275610.03	49.50
	C	1351006.70	2275612.07	50.00
	D	1351016.35	2275613.44	50.00
	E	1351015.54	2275620.90	50.00
	F	1351005.38	2275619.45	50.00
	G	1351008.32	2275630.60	54.50
	H	1351011.45	2275641.59	49.45
	I	1351008.21	2275650.93	49.45
	J	1351004.02	2275659.29	54.50
	K	1350995.01	2275657.94	54.00
	L	1350998.14	2275647.45	48.45
	M	1351001.38	2275638.10	48.45
	N	1350999.51	2275629.29	54.00
	O	1350991.96	2275616.42	48.00
	P	1350989.94	2275615.85	48.00
	Q	1350991.87	2275609.64	48.00
	R	1350993.54	2275610.11	48.00
	EL1	-	-	54.50
	EL2	-	-	54.00
	EL3	-	-	54.50
	EL4	-	-	54.00
	EL5	-	-	50.00
	EL6	-	-	46.00
	EL7	-	-	49.50
	ANG = 10°34'12"			
	STA = 5+03.00			

	FISH PASSAGE AND CENTER CHANNEL			
DROP	POINT	NORTHING	EASTING	ELEVATION
3	A	1350967.99	2275607.60	48.50
	B	1350971.06	2275600.76	48.50
	C	1350980.09	2275604.62	49.00
	D	1350989.29	2275607.83	49.00
	E	1350987.07	2275614.99	49.00
	F	1350977.38	2275611.61	49.00
	G	1350978.10	2275623.11	53.50
	H	1350978.44	2275633.34	48.80
	I	1350975.12	2275642.65	48.80
	J	1350968.34	2275650.43	53.50
	K	1350959.76	2275647.37	53.00
	L	1350965.09	2275639.07	47.60
	M	1350968.41	2275629.76	47.60
	N	1350969.71	2275620.12	53.00
	O	1350964.79	2275606.20	47.00
	P	1350958.02	2275603.40	47.00
	Q	1350960.34	2275597.33	47.00
	R	1350967.45	2275600.26	47.00
	EL1	-	-	53.50
	EL2	-	-	53.00
	EL3	-	-	53.50
	EL4	-	-	53.00
	EL5	-	-	49.00
	EL6	-	-	45.00
	EL7	-	-	48.50
	ANG = 0°00'00"			
	STA = 4+74.81			

	FISH PASSAGE AND CENTER CHANNEL			
DROP	POINT	NORTHING	EASTING	ELEVATION
4	A	1350936.56	2275596.02	47.50
	B	1350938.66	2275588.82	47.50
	C	1350948.35	2275591.87	48.00
	D	1350957.91	2275595.30	48.00
	E	1350955.23	2275602.31	48.00
	F	1350945.96	2275598.98	48.00
	G	1350946.57	2275610.35	52.50
	H	1350946.43	2275619.70	47.80
	I	1350944.72	2275629.44	47.80
	J	1350936.86	2275637.68	52.50
	K	1350928.28	2275634.63	52.00
	L	1350934.23	2275627.60	46.60
	M	1350935.94	2275617.86	46.60
	N	1350938.18	2275607.37	52.00
	O	1350932.51	2275593.84	46.00
	P	1350921.89	2275592.22	46.00
	Q	1350923.25	2275585.86	46.00
	R	1350935.02	2275588.82	46.00
	EL1	-	-	52.50
	EL2	-	-	52.00
	EL3	-	-	52.50
	EL4	-	-	52.00
	EL5	-	-	48.00
	EL6	-	-	44.00
	EL7	-	-	47.50
	ANG = 9°34'43"			
	STA = 4+40.93			

	FISH PASSAGE AND CENTER CHANNEL			
DROP	POINT	NORTHING	EASTING	ELEVATION
5	A	1350899.41	2275587.81	46.50
	B	1350900.80	2275580.44	46.50
	C	1350910.63	2275582.30	47.00
	D	1350920.53	2275584.24	47.00
	E	1350918.96	2275591.57	47.00
	F	1350909.24	2275589.67	47.00
	G	1350911.65	2275600.84	51.50
	H	1350913.58	2275610.89	46.80
	I	1350911.75	2275620.61	46.80
	J	1350906.26	2275629.35	51.50
	K	1350897.31	2275627.66	51.00
	L	1350901.28	2275618.64	45.80
	M	1350903.11	2275608.92	45.80
	N	1350902.89	2275599.19	51.00
	O	-	-	-
	P	-	-	-
	Q	-	-	-
	R	-	-	-
	EL1	-	-	51.50
	EL2	-	-	51.00
	EL3	-	-	51.50
	EL4	-	-	51.00
	EL5	-	-	-
	EL6	-	-	43.00
	EL7	-	-	-
	ANG = 0°00'00"			
	STA = 4+06.82			

PRELIMINARY
NOT FOR CONSTRUCTION

Number	Revision Description	By	Date

PAINTED SKY RC& D
DELTA, COLORADO

HARTLAND DIVERSION
FISH PASSAGE

DROP 2 THRU 5
TYPICAL PLAN

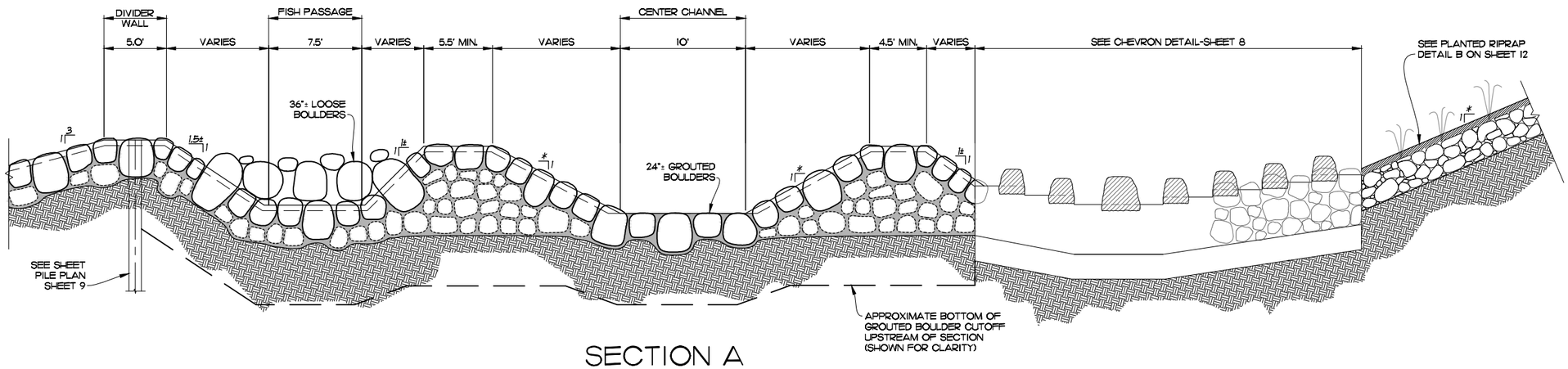
McLaughlin Water Engineers, Ltd.
2420 Alcott Street
Denver, Colorado 80211
T 303.964.3333
F 303.964.3355

DESIGN: BAN
DETAIL: BAN, RDL
CHECK: XXX
DATE: NOVEMBER, 2010

PROJECT NUMBER
10-06-01

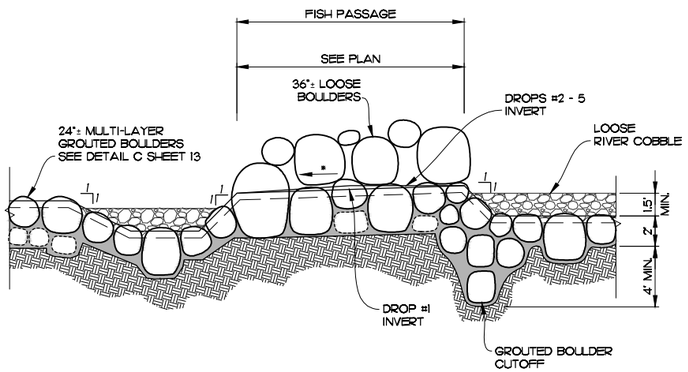
Drawing Number:
6

I:\1 MWDG ACTIVE JOBS\PAINTED SKY 10-06\DRAWINGS\6_ACAD2010_HART-PROP-DROP2-5.DWG / NOVEMBER 15, 2010 / PROJ. 10-06-01



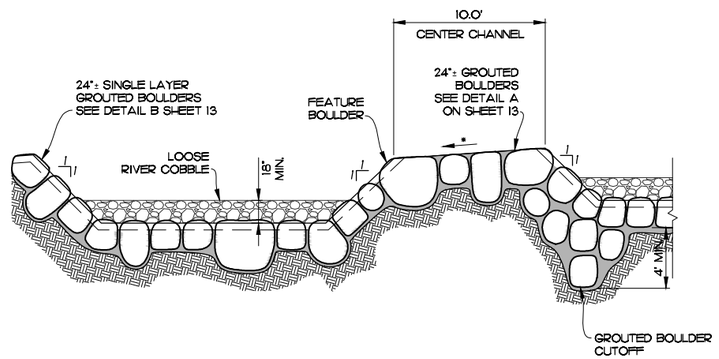
SECTION A

1" = 5'



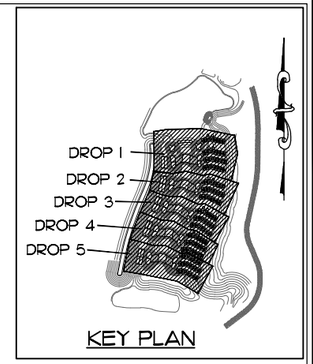
SECTION B

1" = 5'



SECTION C

1" = 5'



KEY PLAN

LEGEND

* INDICATES SLOPES THAT VARY

PRELIMINARY
NOT FOR CONSTRUCTION

Number	Revision Description	By	Date

PAINTED SKY RC& D
DELTA, COLORADO

HARTLAND DIVERSION
FISH PASSAGE

DROP 1 THRU 5
TYPICAL SECTIONS

McLaughlin Water Engineers, Ltd.
2420 Alcott Street
Denver, Colorado 80211
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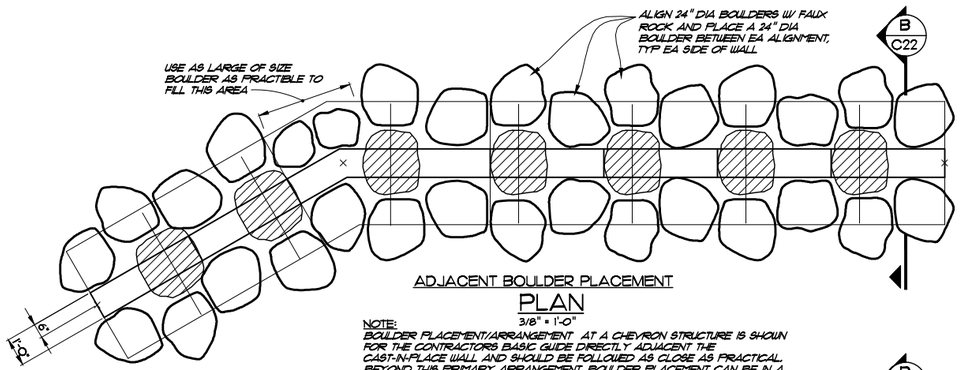
DESIGN: BAN
DETAIL: BAN, RDL
CHECK: XXX
DATE: NOVEMBER, 2010
PROJECT NUMBER 10-06-01

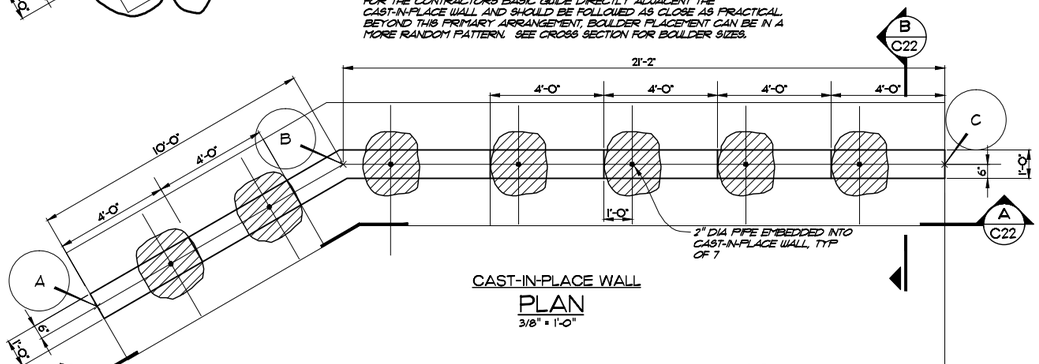
Drawing Number: 7

I:\1 MWDG ACTIVE JOBS\PAINTED SKY 10-06\DRAWINGS\7_ACAD2010_HART-PROP-DROP-SECT.DWG / NOVEMBER 15, 2010 / PROJ. 10-06-01

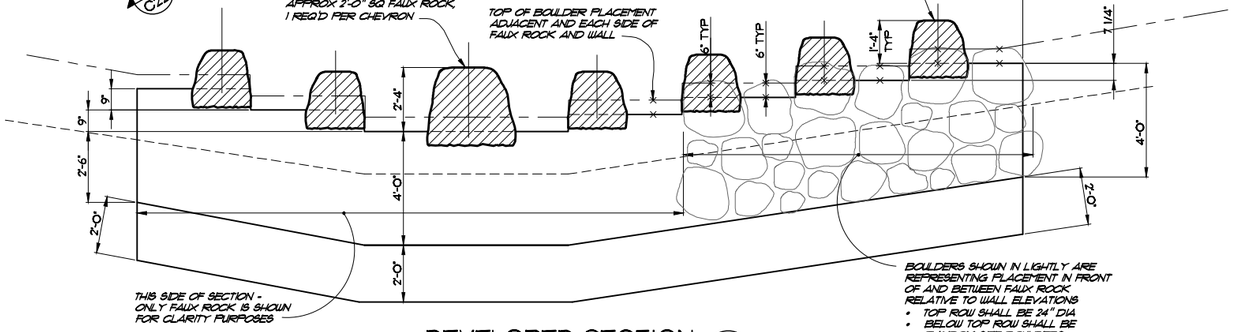


ADJACENT BOULDER PLACEMENT
PLAN
3/8" = 1'-0"

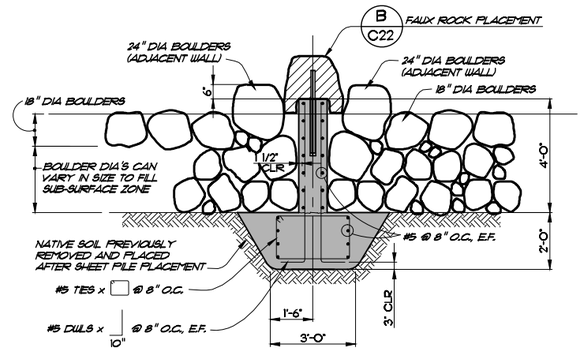
NOTE:
BOULDER PLACEMENT/ARRANGEMENT AT A CHEVRON STRUCTURE IS SHOWN FOR THE CONTRACTORS BASIC GUIDE DIRECTLY ADJACENT THE CAST-IN-PLACE WALL AND SHOULD BE FOLLOWED AS CLOSE AS PRACTICAL. BEYOND THIS PRIMARY ARRANGEMENT, BOULDER PLACEMENT CAN BE IN A MORE RANDOM PATTERN. SEE CROSS SECTION FOR BOULDER SIZES.



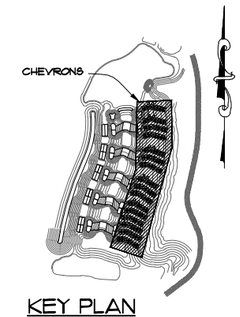
CAST-IN-PLACE WALL
PLAN
3/8" = 1'-0"



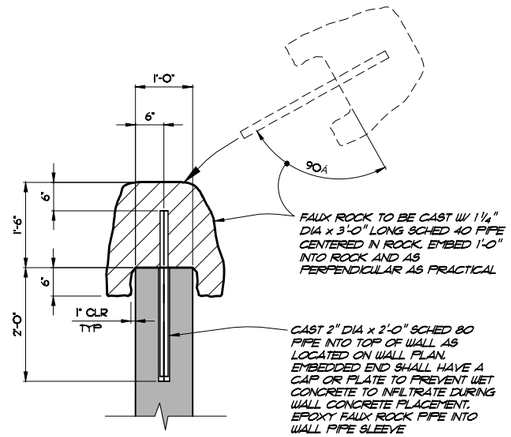
DEVELOPED SECTION
3/8" = 1'-0"
A
C15



SECTION
3/8" = 1'-0"
B
C15



KEY PLAN



FAUX ROCK ATTACHMENT
DETAIL
3/4" = 1'-0"
1
C15

CHEVRONS POINT TABLE

	CHEVRON A				CHEVRON B				CHEVRON C				CHEVRON D			
DROP	POINT	NORTHING	EASTING	ELEVATION	POINT	NORTHING	EASTING	ELEVATION	POINT	NORTHING	EASTING	ELEVATION	POINT	NORTHING	EASTING	ELEVATION
1	A	1350890.95	2275633.89	47.05	A	1350900.50	2275636.73	47.4	A	1350910.26	2275637.75	47.75	-	-	-	-
	B	1350890.98	2275643.89	46.3	B	1350900.62	2275646.73	46.65	B	1350910.52	2275647.75	47.0	-	-	-	-
	C	1350880.43	2275662.25	49.2	C	1350890.25	2275665.19	49.55	C	1350900.41	2275666.35	49.9	-	-	-	-
2	A	1350919.17	2275640.09	48.05	A	1350928.46	2275644.01	48.4	A	1350938.28	2275646.52	48.75	-	-	-	-
	B	1350919.52	2275650.09	47.3	B	1350928.65	2275654.01	47.65	B	1350938.24	2275656.52	48.0	-	-	-	-
	C	1350909.58	2275668.78	50.2	C	1350918.42	2275672.54	50.55	C	1350927.58	2275674.81	50.9	-	-	-	-
3	A	1350951.94	2275652.09	49.05	A	1350960.86	2275656.73	49.4	A	1350970.31	2275659.03	49.75	-	-	-	-
	B	1350950.99	2275662.05	48.3	B	1350960.03	2275666.70	48.65	B	1350969.99	2275669.02	49.0	-	-	-	-
	C	1350938.70	2275679.29	51.2	C	1350947.96	2275684.10	51.55	C	1350958.81	2275687.01	51.9	-	-	-	-
4	A	1350988.64	2275664.06	50.05	A	1350997.92	2275666.92	50.4	A	1351007.61	2275667.34	50.75	-	-	-	-
	B	1350989.24	2275674.04	49.3	B	1350999.01	2275676.86	49.65	B	1351009.18	2275677.21	50.0	-	-	-	-
	C	1350979.77	2275692.98	52.2	C	1350990.48	2275696.24	52.55	C	1351001.61	2275696.99	52.9	-	-	-	-
5	A	1351026.57	2275668.74	50.85	A	1351036.23	2275669.76	51.05	A	1351046.03	2275668.26	51.25	A	1351062.50	2275667.21	51.25
	B	1351029.09	2275678.42	50.1	B	1351039.22	2275679.30	50.3	B	1351049.23	2275677.74	50.5	B	1351065.70	2275676.69	50.5
	C	1351023.46	2275698.83	53.0	C	1351034.60	2275699.96	53.2	C	1351045.07	2275698.50	53.4	C	1351061.53	2275697.45	53.4

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Number	Revision Description	By	Date

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DELTA, COLORADO

HARTLAND DIVERSION
FISH PASSAGE

CHEVRON
PLAN, SECTIONS AND TABLE

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PROJECT NUMBER 10-06-01

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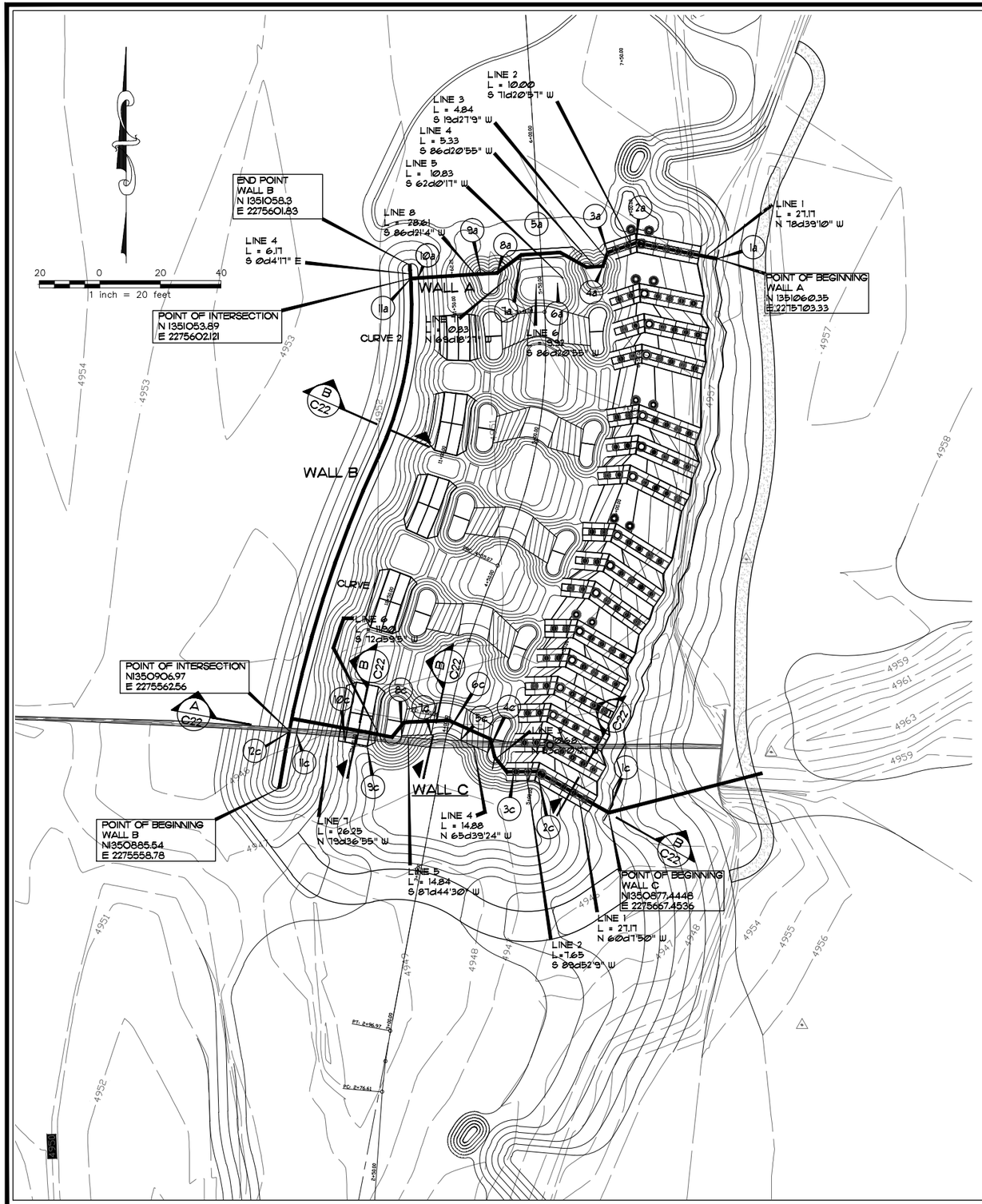


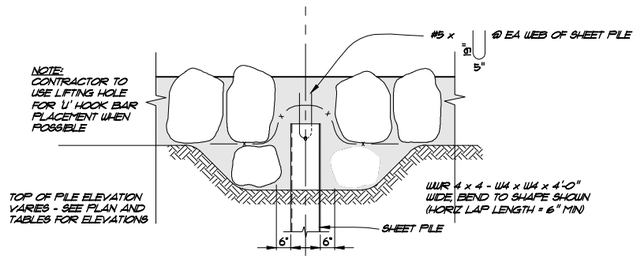
SHEET PILE CURVE DATA

WALL B

CURVE	PT OF TANGENT/END OF CURVE		CURVE RADIUS POINT		POINT OF CURVATURE		RADIUS	ARC LENGTH
	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING		
1	1350995.36	2275591.60	1350826.35	2275956.90	1350885.54	2275558.78	402.50	115.01
2	1351052.17	2275602.23	1351044.69	2275484.96	1350995.36	2275591.60	117.50	46.3

SHEET PILE DATA

WALL A				WALL C			
POINT	NORTHING	EASTING	TOP OF CAP ELEVATION	POINT	NORTHING	EASTING	TOP OF CAP ELEVATION
1A	1351060.35	2275703.33	402.50	1C	1350877.44	2275667.45	402.50
2A	1351065.70	2275676.69	402.50	2C	1350890.98	2275643.89	402.50
3A	1351062.50	2275667.20	402.50	3C	1350890.95	2275636.20	402.50
4A	1351057.94	2275665.60	402.50	4C	1350897.31	2275627.66	402.50
5A	1351057.60	2275660.28	402.50	5C	1350901.38	2275618.66	402.50
6A	1351052.51	2275650.71	402.50	6C	1350903.48	2275614.02	402.50
7A	1351051.88	2275640.81	402.50	7C	1350903.28	2275608.95	402.50
8A	1351055.71	2275630.67	402.50	8C	1350902.89	2275599.19	402.50
9A	1351055.37	2275625.35	402.50	9C	1350899.41	2275587.81	402.50
10A	1351054.05	2275604.61	402.50	10C	1350900.80	2275580.44	402.50
11A	1351053.89	2275602.12	402.50	11C	1350903.69	2275564.45	402.50
				12C	1350904.14	2275561.99	402.50



TYPICAL PILE CAP AT CHEVRONS

SECTION A / C15

3/8" = 1'-0"

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HARTLAND DIVERSION
FISH PASSAGE

SHEET PILE
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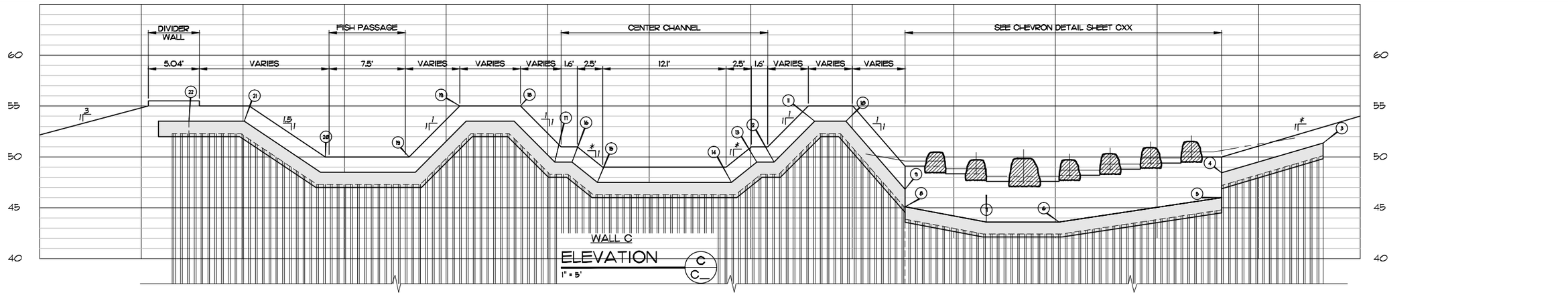
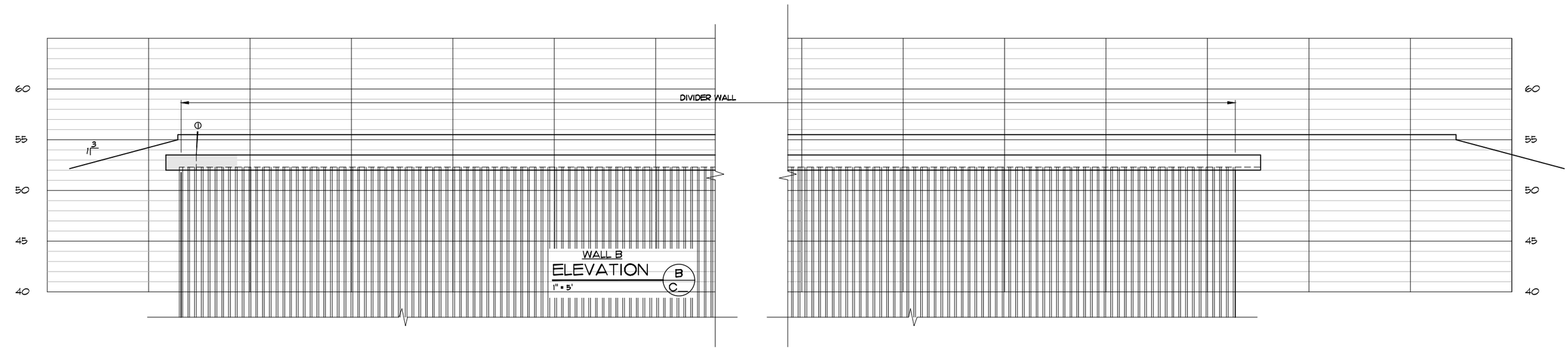


WALL C

ELEVATION C

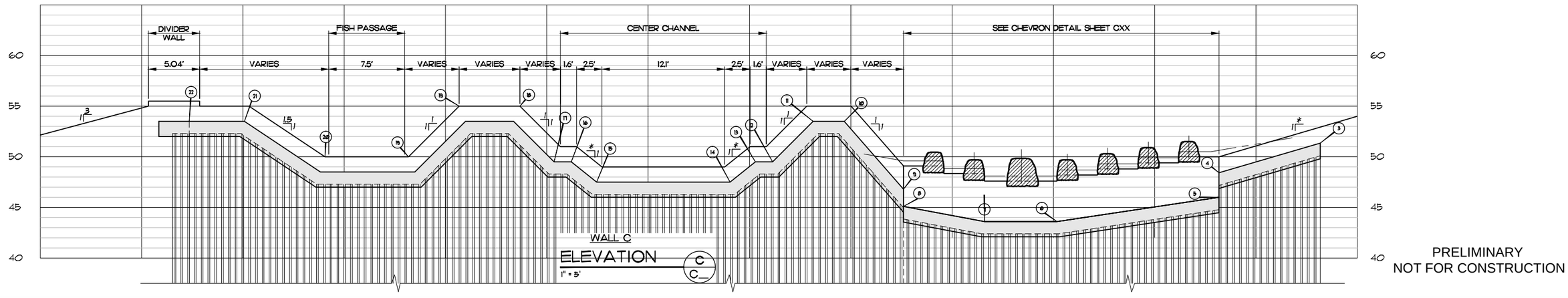
1" = 5'



WALL B

ELEVATION B

1" = 5'



WALL C

ELEVATION C

1" = 5'

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HARTLAND DIVERSION
FISH PASSAGE

SHEET PILE SECTIONS

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10

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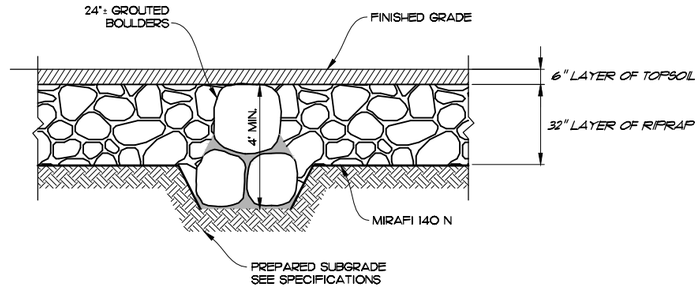
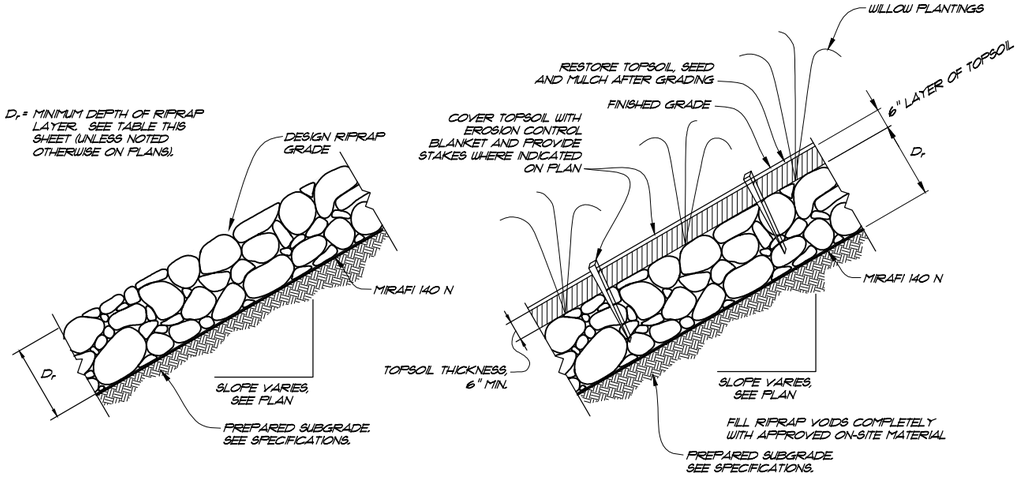


CONTAINMENT ROW PERPENDICULAR TO RIVER (A, 5,6)

NTS



EXPOSED AND SUBFACE INSTALLATION

PLANTED INSTALLATION

RIPRAP NOTES:

1. RIPRAP DETAIL IS APPLICABLE TO FLAT OR SLOPED AREAS. REFER TO THE SITE PLAN FOR ACTUAL LOCATION AND LIMITS.
2. GENERAL PLACEMENT TECHNIQUES SHOULD RESULT IN LARGER ROCK AT THE SURFACE WITH ROCK SECURELY INTERLOCKED AT THE DESIGN THICKNESS AND GRADE. COMPACTION AND LEVELING SHOULD RESULT IN MINIMAL VOIDS AND PROJECTIONS ABOVE GRADE.
3. REFER TO SPECIFICATIONS FOR MATERIALS AND PLACEMENT REQUIREMENTS FOR RIPRAP AND GRANULAR BEDDING MATERIAL.

USED THIS PROJECT	RIPRAP TYPE	D_{50}	D_r
	VL	6	11
	L	9	16
	M	12	21
	H	18	32
	VH	24	42
ALL DIMENSIONS IN INCHES			

TYPICAL RIPRAP PLACEMENT (B, 5,6)

NTS

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HARTLAND DIVERSION
FISH PASSAGE

RIPRAP AND LOOSE BOULDER
TYPICAL DETAILS

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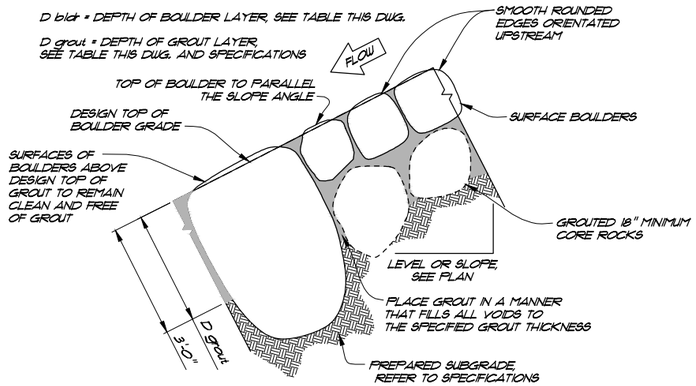
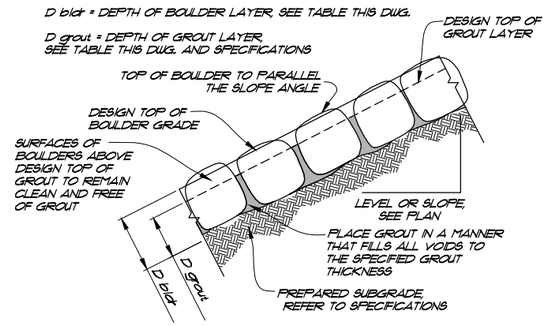
PROJECT NUMBER 10-06-01

Drawing Number: 12



SMOOTH SURFACE MULTI-LAYER GROUTED ROCK PLACEMENT — A/7

NTS

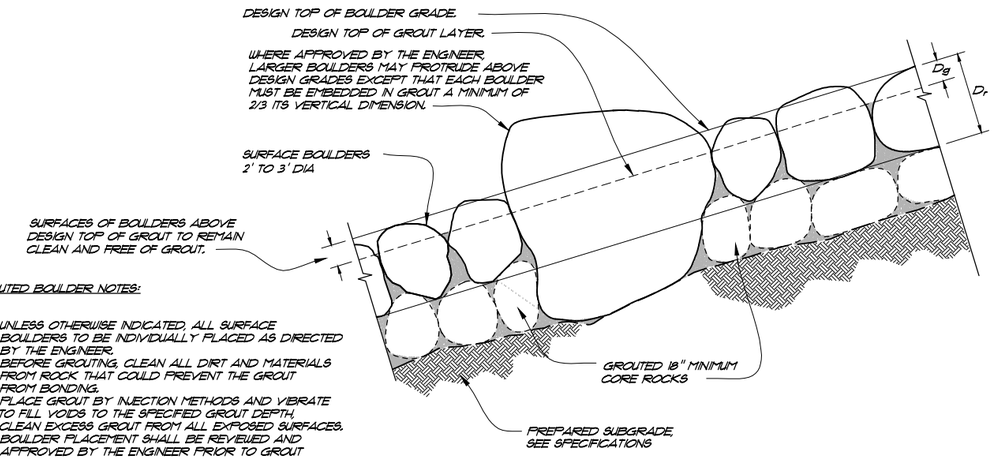


SLOPED INSTALLATION

USED THIS PROJECT	Designation	D bldr	D grout	TOP OF BOULDER ORIENTATION
	B18	18	12	------
	B24	24	24	SLOPE
	B30	30	18	------
	B36	36	24	------
	B42	42	30	------
	B48	48	36	------
ALL DIMENSIONS IN INCHES				

TYPICAL SINGLE LAYER GROUTED BOULDER PLACEMENT — B/7

NTS



D_g = DEPTH OF GROUT LAYER BELOW THE TOP OF BOULDERS. SEE TABLE BELOW.

D_r = DEPTH OF ROCK LAYER WHICH IS EQUIVALENT TO THE MINIMUM BOULDER SIZE. SEE TABLE BELOW.

USED THIS PROJECT	D_r	D_g
X	18	6
X	24	12*
	30	6
X	36	18*
	42	10
	ALL DIMENSIONS IN INCHES	

GROUTED BOULDER NOTES:

1. UNLESS OTHERWISE INDICATED, ALL SURFACE BOULDERS TO BE INDIVIDUALLY PLACED AS DIRECTED BY THE ENGINEER.
2. BEFORE GROUTING, CLEAN ALL DIRT AND MATERIALS FROM ROCK THAT COULD PREVENT THE GROUT FROM BONDING.
3. PLACE GROUT BY INJECTION METHODS AND VIBRATE TO FILL VOIDS TO THE SPECIFIED GROUT DEPTH. CLEAN EXCESS GROUT FROM ALL EXPOSED SURFACES.
4. BOULDER PLACEMENT SHALL BE REVIEWED AND APPROVED BY THE ENGINEER PRIOR TO GROUT PLACEMENT.
5. EXPOSED GROUT SHALL BE TROWELED AND FINISHED TO MINIMIZE VISIBILITY, WASH AND CLEAN ALL NON-GROUTED SURFACES.
6. THE CONTRACTOR SHALL CONTROL GROUT MIX AND PLACEMENT PROCEDURES TO ACHIEVE THE SPECIFIED THICKNESS AND GRADE OF THE GROUT LAYER.
7. TYPICAL DEPTH, INSPECTOR TO DIRECT DEPTH, BASED ON UPON SPECIFIC ROCK GEOMETRY IN ALL AREAS AND PRIOR TO GRADING.

TYPICAL MULTI-LAYER GROUTED BOULDER PLACEMENT — C/7

NTS

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FISH PASSAGE

GROUTED BOULDER
TYPICAL DETAILS

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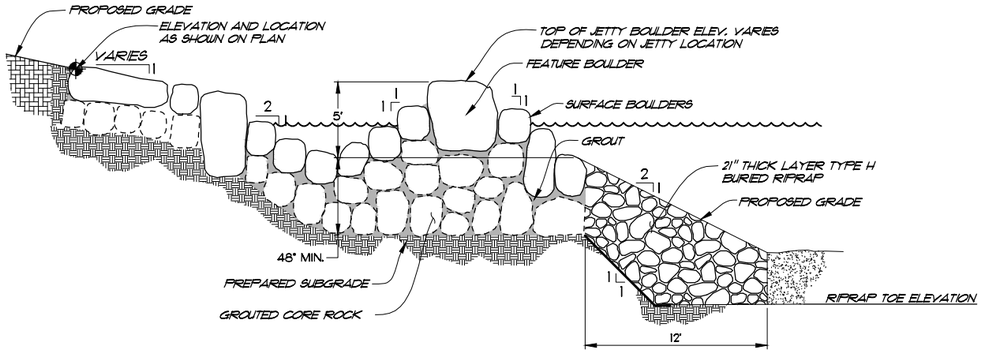
PROJECT NUMBER
10-06-01

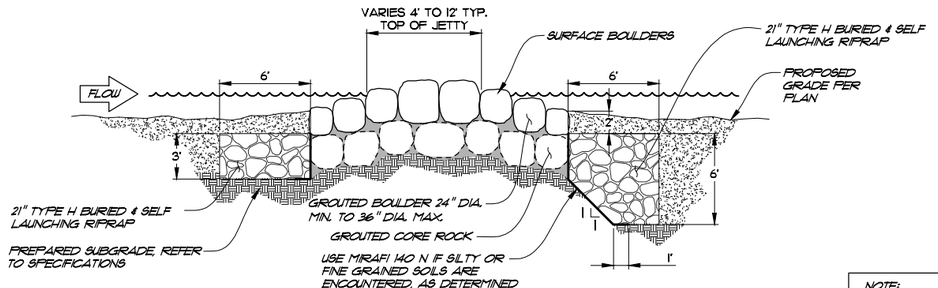
Drawing Number:
13



TYPICAL JETTY

PROFILE C/14

1" = 5'

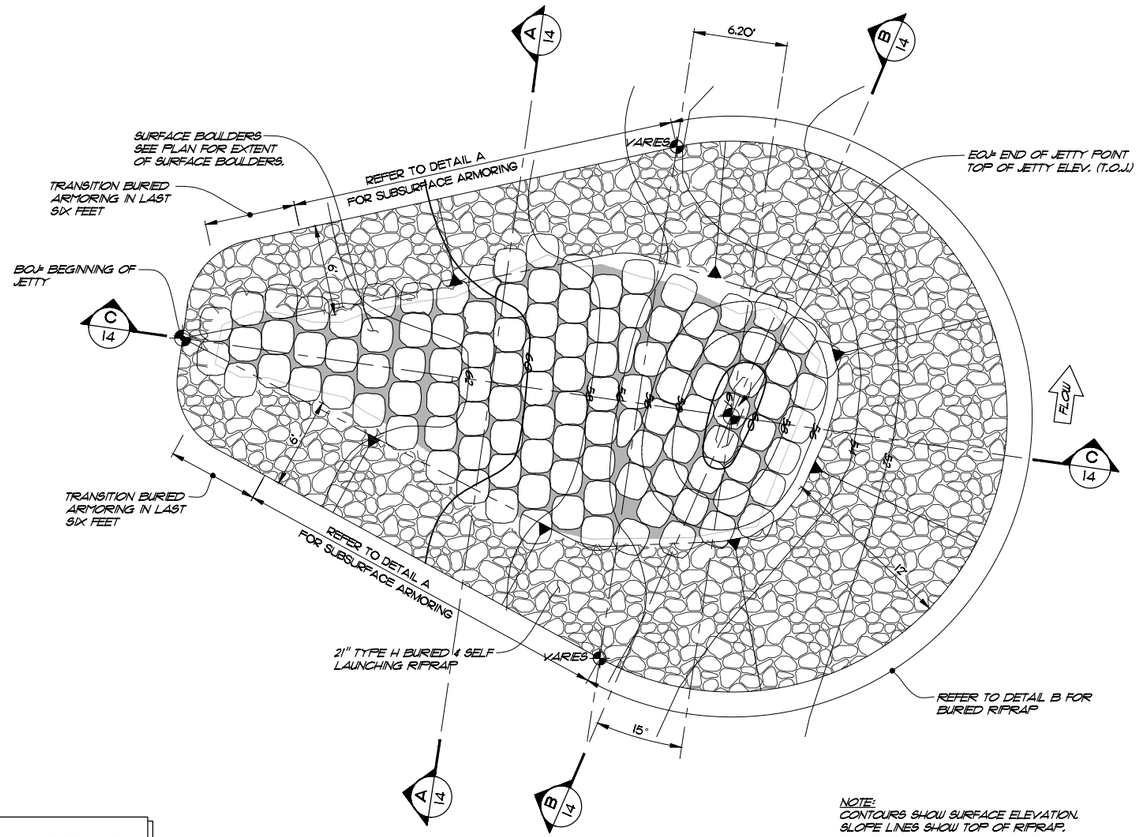


TYPICAL OF JETTY AT RIVER BANK

SECTION A/14

1" = 5'

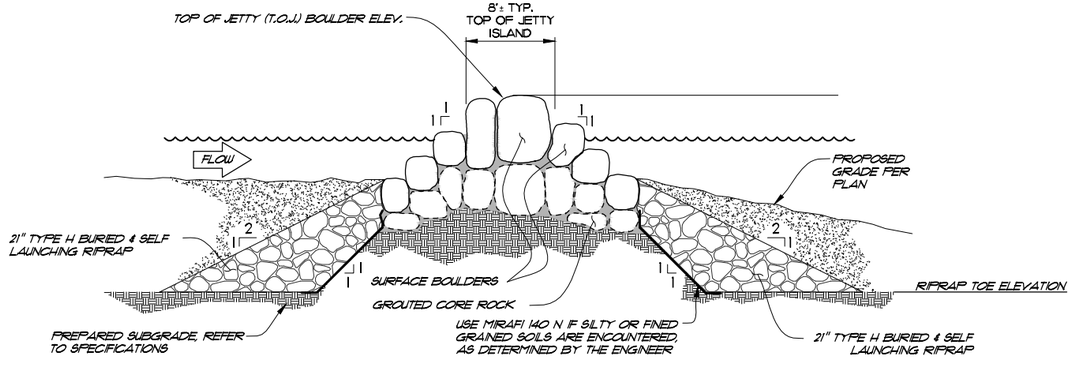
NOTE:
SEE TYPICAL MULTI - LAYER GROUTED BOULDER PLACEMENT DETAIL DWG NO XXX



NOTE:
CONTOURS SHOW SURFACE ELEVATION. SLOPE LINES SHOW TOP OF RIPRAP.

JETTY PLAN - TYPICAL

1" = 5'



TYPICAL TRANSVERSE JETTY ISLAND SECTION

SECTION B/14

1" = 5'

NOTES:

1. "UPSTREAM" AND "DOWNSTREAM" ARE IN REFERENCE TO THE NEW DIVERSION.
2. GROUT JETTIES MONOLITHICALLY AS LAYERED GROUTED BOULDERS - SEE SPECIFICATIONS.
3. GROUT TO DEPTH AS DIRECTED BY INSPECTOR. IN GENERAL THIS WILL BE APPROXIMATELY ½ WAY UP THE SIDE OF SURFACE BOULDERS.
4. ONE FEATURE BOULDER PER JETTY - UNLESS OTHERWISE DIRECTED BY INSPECTOR.
5. PLACE ALL FEATURE AND SURFACE BOULDERS AS DIRECTED BY THE INSPECTOR.
6. BURIED RIPRAP AS SHOWN UNLESS JETTY ABUTS TO OTHER ARMOR SYSTEM. IN THESE CASES ATTACH OTHER SUBSURFACE ARMOR TO GROUTED ROCK PORTION OF THE JETTY.

NOTE:
BOJ = BEGINNING OF JETTY
EOJ = END OF JETTY
TOJ = TOP OF JETTY

JETTY LOCATION TABLE

JETTY ID	NORTHING	EASTING	T.O.J. ELEV.
–	BOJ	BOJ	2664.0'
	EOJ	EOJ	2663.0'
–			2663.0'
			2661.0'
–			2662.7'
			2663.0'
–			2662.8'
			2661.0'
–			2662.0'
			2661.0'

RIP RAP TOE ELEVATION =

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HARTLAND DIVERSION
FISH PASSAGE

JETTY
TYPICAL DETAILS

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Drawing Number:
14

I:\1 MWDG ACTIVE JOBS\PAINTED SKY 10-06\DRAWINGS\12-14_ACAD2010_HART-DETAILS.DWG / NOVEMBER 15, 2010 / PROJ. 10-06-01

McLaughlin Water
engineering design consulting

MEMORANDUM
November 15, 2010

TO: Mike Drake, Painted Sky Resource Conservation and Development Council, Inc.
FROM: Rick McLaughlin, P.E.; Ben Nielsen, P.E., L.E.E.D. A.P.
RE: **Hartland Diversion Fish Passage- Draft Final Design Summary**

Introduction

MWE has completed the draft final design for this project. The new design reflects changes made to the preliminary final design dated July 30, 2010 using revised design criteria from the United States Fish and Wildlife Service (USFWS). New criteria increased the allowable hydraulic drop at each control structure from 6-inches to 12-inches. This memorandum summarizes the proposed design and presents results of the supporting analysis. Our analysis included evaluation of floodplain impacts, 100-year structural stability, two-dimensional hydraulic modeling, and diversion hydraulics. The main objectives of the design are to provide fish passage for the target species, maintain diversion operations of the Hartland Ditch, and minimize hazards for river users.

The following is a summary of the draft final design concepts and methodologies. See Appendix B for draft construction plans for the fish passage structure.

General Layout

- New layout utilizes five drop structures (controls). Layout size was reduced from the preliminary final design using new design criteria allowing an increase in hydraulic drop at each control from 6-inches to 12-inches. Five drops structures were eliminated, which reduced the structure length from approximately 320 feet to 220 feet.
- A counter-weir downstream of the last drop-pool is included to protect the structure from tailwater degradation and help orient flows away from the left bank.
- The capacity of the fish passage channels are sufficiently large to provide for attraction velocities to facilitate fish passage.
- A boulder divider wall will control cross flow into the fish passage channel up to 3,000 CFS to minimize velocities in the channel.
- The divider wall is extended downstream of the existing dam face to separate river users from the hazardous reverse roller hydraulic at the toe of the dam.
- A jetty is designed to reduce bank erosion from the fish passage structure downstream to the jetty. It is also intended to reduce erosion a short distance downstream of the jetty (50'-100'). MWE understands that the NRCS will design additional bank stabilization measures along the downstream reach once the fish passage structure is completed and therefore no additional stabilization measures are included with this project.
- A second jetty upstream of the fish passage is designed to reduce local bank erosion, reduce debris and people from entering the chevron fish passage, reduce entrance velocities and to aid portage for in-river recreationalist that want to scout or walk around this structure.

Fish Passage

- The fish passage structure is based upon the preliminary final design using a drop-pool configuration. The overall slope has been increased from 1.5% to 2.8%.
- Two different types of fish passage structures/areas are used along the banks of the drops. These provide flow variation and multiple passage options for fish.
- Connection between the passages is provided through the intermediate pools.
- Faux-boulders placed in a chevron pattern will provide fish passage along river-left bank of the fish passage. Three rows of chevrons at each drop structure create headlosses that maintain the 12-inch water surface elevation difference between pools (hydraulic drop). Chevrons have been designed to distribute the headlosses between each row. The chevron boulder pattern/slots are based upon research performed by B. W. Mefford at the United States Bureau of Reclamation for passing non-salmonid species (Ref: "USBR Experience with Multiple-Slot-Baffled Fishways", B.W. Mefford, 2009).
- A highly roughened trapezoidal channel is designed at river-right of the center drop-pool channel to provide a second route for fish passage (roughened channel fish passage). Large loose boulders (>36-inch diameter) placed randomly on the channel invert will create interstitial spaces for fish passage. Smaller boulders will be "chinked" into larger boulders at the surface to reduce foot/hand entrapment hazards. Banks of the channel will be roughened with large grouted boulders extending into the flow for additional passage.
- Proposed center drops structures or "controls" use trapezoidal weirs with an abrupt drop in the channel invert and intermediate pools along the centerline to create resting areas for fish, provide cross passage for fish between banks, increase the attraction flows, and provide for passage of in-river recreational users.
- Boulder "islands" between the center drops and the fish passage channels on either side create hydraulic and physical separation to allow for a lower gradient in the fish passage zones.

Diversion Hydraulics

A HEC-RAS hydraulic model was developed to determine the required headwater elevation at the dam to maintain the required diversion flow in the Hartland Ditch. The model was developed using on-site survey information and was calibrated using field measurements of the ditch water surface during operation.

A removable stop log system has been designed at the entrance of the center channel to allow diversion during very low river flows (350 CFS).

Floodplain

MWE obtained the Federal Emergency Management Agency (FEMA) hydraulic model results that define the Federal Insurance Rate Map (FIRM) for the Gunnison River. This model is in HEC-2 format, which was converted to HEC-RAS as the 'Duplicate Effective" model. An "Existing Conditions" model was created using recent site survey information and cross sections from the Duplicate Effective model in areas outside of the survey limits. Lastly, a "Revised Conditions" model was developed based on the draft final fish passage design.

Comparison of the Existing Conditions model and Revised Conditions model results indicate that the proposed draft final design does not negatively impact the floodplain. Note that this analysis was used for design and is not a part of a formal submission to FEMA as a LOMR or CLOMR.

Structural Stability

MWE performed an analysis for 100-year stability of the structure. Lane's Weighted Creep Method was used to determine required cut offs to reduce uplift, seepage, and piping under the structure. Boulder sizes were calculated using design criteria for sloped grouted boulder drops as developed by McLaughlin Water Engineers, 1986 (later incorporated into the "Drainage Criteria Manual", by Urban Drainage and Flood Control District.) Criteria included tractive force concepts such as shear stress, impact/drag forces, uplift/buoyancy, and bed friction. Scour depths were evaluated at the toe of the counter-weir and jetties using applicable empirical equations presented in "Guidelines for Computing Degradation and Local Scour", by Pemberton and Lara (Technical Guideline for Bureau of Reclamation, 1982).

A grouted boulder mat using rounded locally available materials is proposed as the primary armoring type for most of the fish passage structure. The mats have various thicknesses and cementations grout is kept as low as structurally prudent. Calculation of riprap size and lack of locally available angular rock (quarry produced) have led to this armoring approach. This is reflective of other river projects on the Western Slope. Boulder diameters range from 18" up to 48" - depending on where they are placed in the grouted boulder mat, and their projection above the river bottom. In areas on non-control and lower velocities, such as pools, the grouted boulder mat will be covered with existing river cobbles to better approximate a natural bed.

The design will utilize buried loose riprap on the left bank with buried grouted boulder containment rows placed at approximately 20' intervals perpendicular to flow. Inclusion of the containment rows allows the use of locally available round stones. Top soil and willow plantings will further stabilize the bank. Riprap was sized using the Federal Highway Administration and Urban Drainage and Flood Control District design criteria.

Armoring in the chevron fish passage channel will be loose riprap between concrete walls perpendicular to the channel. The walls provide grade control at each row of chevrons and containment of riprap. Existing river cobble will be mixed with locally available round rock to create a well graded riprap with a mean diameter of 24-inch (Gradation: 4-inch to 48-inch).

Sheet pile cut offs are located at the upstream edge, downstream edge, and under the divider wall. Shallow (4' deep) grouted boulder cut offs are required at the each drop structure (at +/- 30' intervals). "Self-launching" riprap is utilized for toe scour protection along the divider wall, jetties, and downstream of the counter-weir.

2D Modeling

Two model runs at the low (460 cfs) and high (1250 cfs) fish passage flows has been completed. Results for the latest model at both flow conditions indicate that the design meets fish passage depth (2' min.) and velocity (less than 4 feet per second) criteria at the "fish's eye" locality. Model results are included in Appendix A.

Data corrections have been applied to the 2D model results. In the final design, there is a 6-inch depression at each slot between the chevron boulders that were not modeled due to being "ineffective flow areas". **Note that 6-inches must be added to the model depths at these locations.** The fish passage channel on river right, utilizes highly roughened flow by closely placed large boulders that allow fish passage through the interstitial spaces between boulders. For modeling purposes we used an effective channel invert elevation that is 1.5 feet above the actual channel invert elevation. Therefore, 1.5 feet must be added to depths of the areas

immediately adjacent to the velocity islands on river right. For clarity, lines and hatched areas have been added to the model result exhibits to illustrate fish passage paths and areas that meet the depth and velocity criteria and incorporate both data corrections (See Appendix A for exhibits). A 75% correction factor has been applied to the average depth velocity to determine the "Fish's Eye Velocity".

A final 2D modeling run is currently being conducted to address some recent changes to the design that further refine the hydraulic design.

- Realignment of the center weirs to account for super elevation at the bends. Redirect flow to the center of the channel.
- New grades and elevations on the center weirs to distribute the hydraulic drop more efficiently and account for lower pool elevations than indicated by the model. Optimize hydraulic jump form at each weir for low hazard boat passage.

Dam Modifications

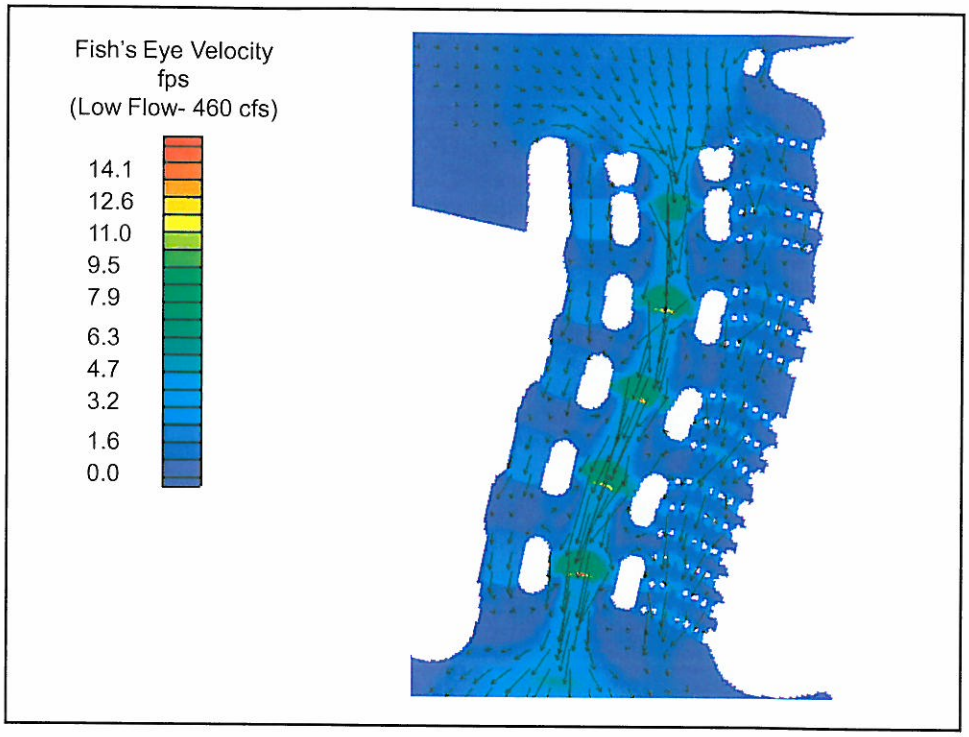
MWE recommended as part of the preliminary final design that safety modifications to the dam be included in this project. Due to funding constraints these modifications were eliminated during the final design phase of the project. We recommend that dam modifications similar to those presented in the preliminary final design be considered for a future phase of construction to reduce the reverse roller hydraulic that has been reported to develop at the toe of the existing dam.

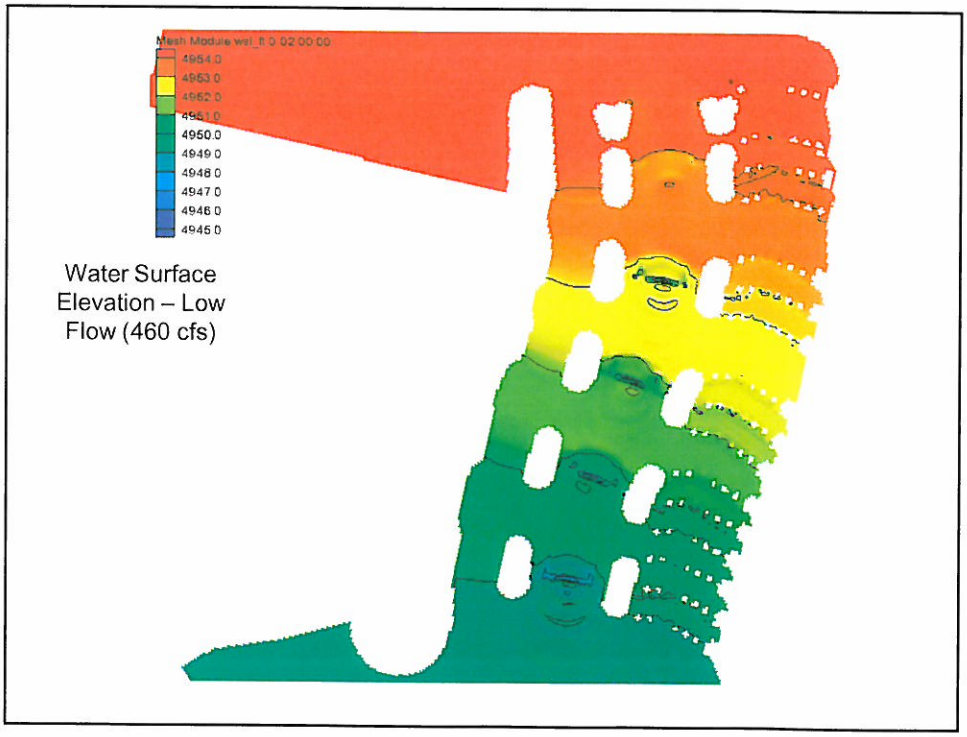
We have included two "basic" safety items with the draft final design. The divider wall has been extended downstream of the dam to create a physical barrier between river users passing through the fish passage structure and the toe of the dam. A buoy system stretching from the entrance to the fish passage to the left river bank is intended to direct river users to the fish passage structure and away from the dam.

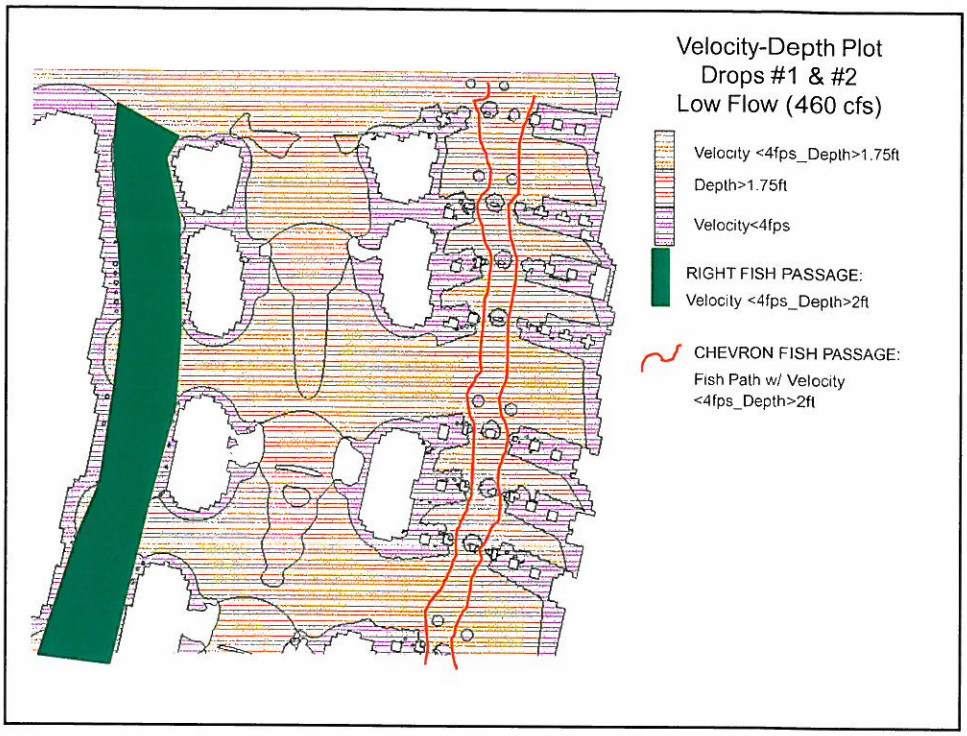
Land Easements or Ownership

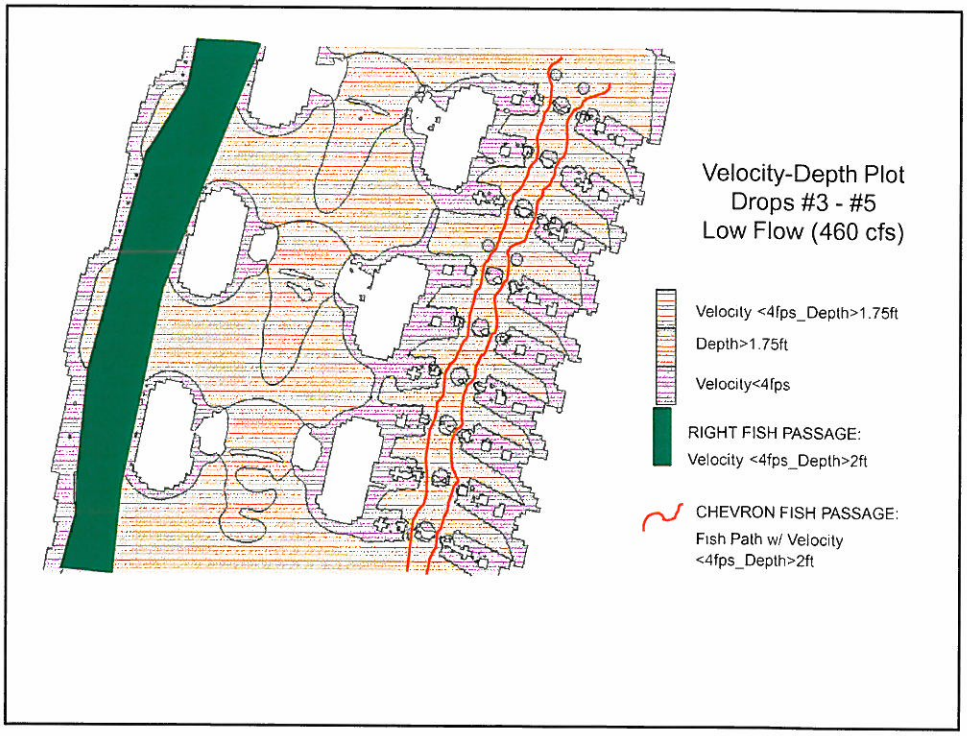
The draft final design significantly increases the overall footprint of the diversion dam. We recommend that land is acquired or permanent easements secured a minimum of 20 feet outside the limits of the proposed improvements. Based on the current design this area is approximately 1.6 acres, not including any existing easements or parcels for the dam. A permanent maintenance/access easement or agreement should also be secured. For construction, temporary construction staging and access easements should be obtained.

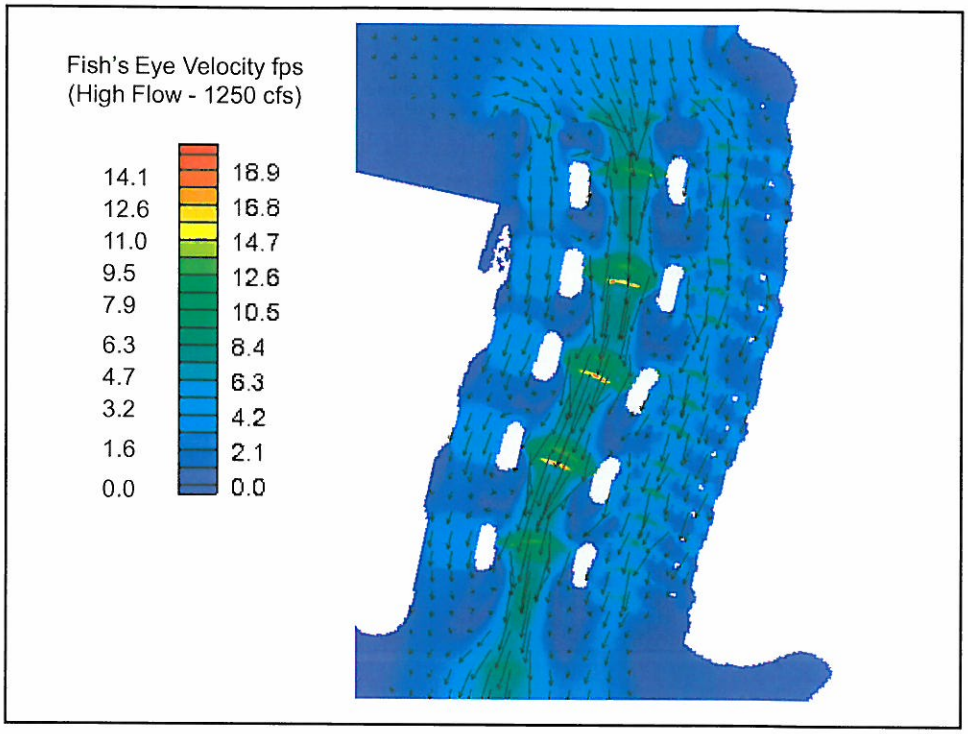
APPENDIX A- 2D Modeling Results

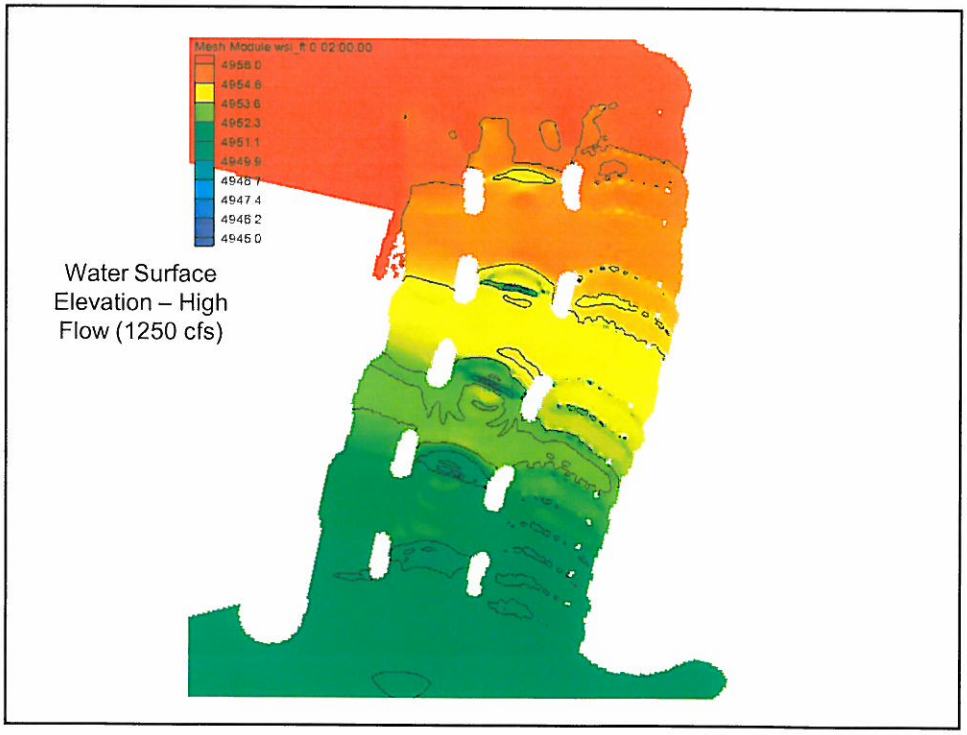

Fish's Eye Velocity
fps
(Low Flow- 460 cfs)
14.1
12.6
11.0
9.5
7.9
6.3
4.7
3.2
1.6
0.0

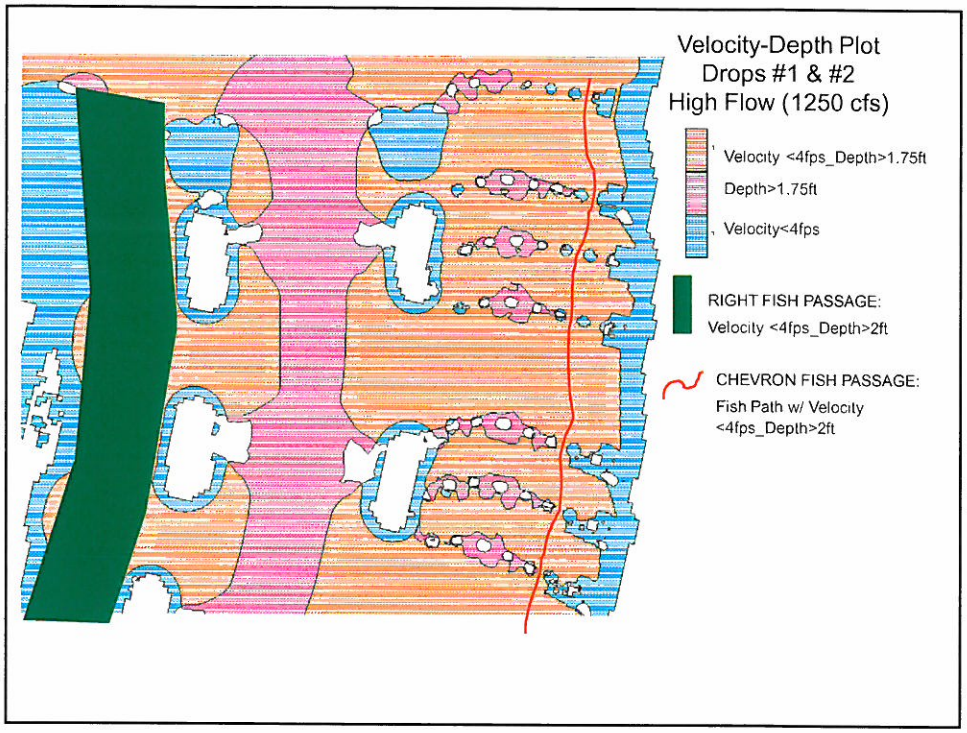

4954.0
4953.0
4952.0
4951.0
4950.0
4949.0
4948.0
4947.0
4946.0
4945.0
Water Surface
Elevation – Low
Flow (460 cfs)

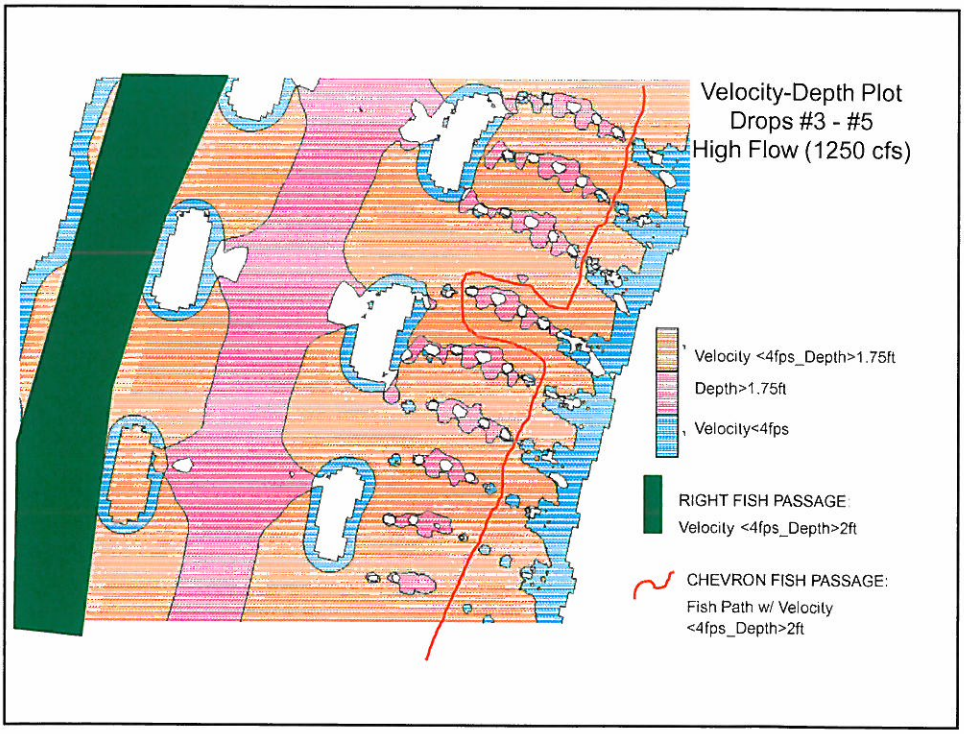

Velocity-Depth Plot
Drops #1 & #2
Low Flow (460 cfs)
Velocity <4fps_Depth>1.75ft
Depth>1.75ft
Velocity<4fps
RIGHT FISH PASSAGE:
Velocity <4fps_Depth>2ft
CHEVRON FISH PASSAGE:
Fish Path w/ Velocity
<4fps_Depth>2ft

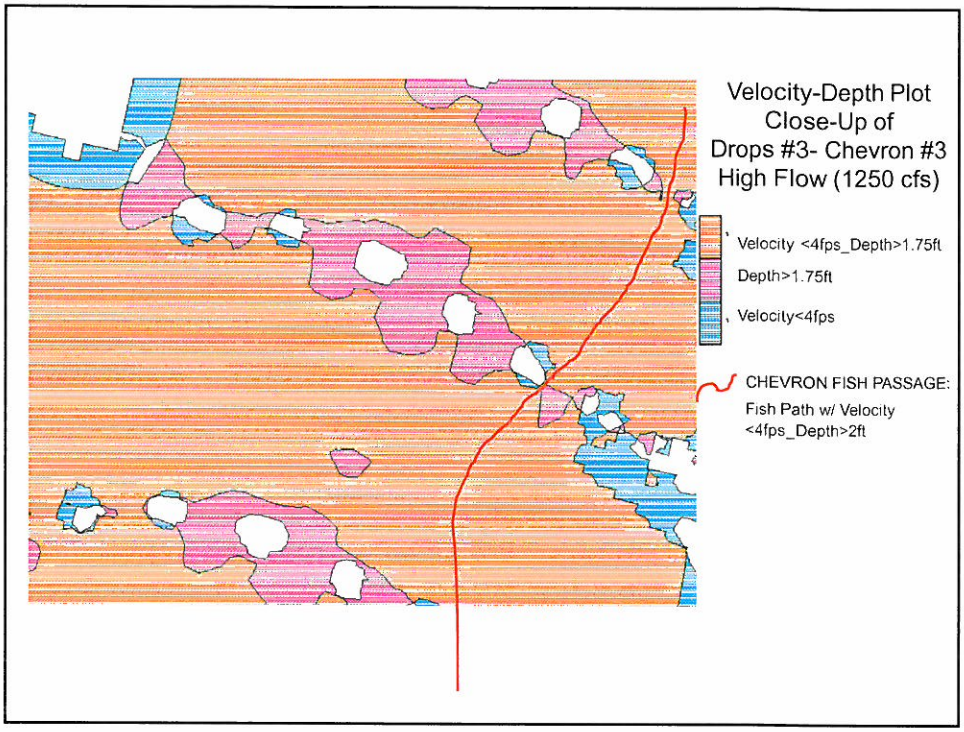

Velocity-Depth Plot
Drops #3 - #5
Low Flow (460 cfs)
Velocity <4fps_Depth>1.75ft
Depth>1.75ft
Velocity<4fps
RIGHT FISH PASSAGE:
Velocity <4fps_Depth>2ft
CHEVRON FISH PASSAGE:
Fish Path w/ Velocity
<4fps_Depth>2ft


Fish's Eye Velocity fps
(High Flow - 1250 cfs)
14.1
12.6
11.0
9.5
7.9
6.3
4.7
3.2
1.6
0.0
18.9
16.8
14.7
12.6
10.5
8.4
6.3
4.2
2.1
0.0


Water Surface
Elevation – High
Flow (1250 cfs)


Velocity-Depth Plot
Drops #1 & #2
High Flow (1250 cfs)
Velocity <4fps_Depth>1.75ft
Depth>1.75ft
Velocity<4fps
RIGHT FISH PASSAGE:
Velocity <4fps_Depth>2ft
CHEVRON FISH PASSAGE:
Fish Path w/ Velocity
<4fps_Depth>2ft


Velocity-Depth Plot
Drops #3 - #5
High Flow (1250 cfs)
Velocity <4fps_Depth>1.75ft
Depth>1.75ft
Velocity<4fps
RIGHT FISH PASSAGE:
Velocity <4fps_Depth>2ft
CHEVRON FISH PASSAGE:
Fish Path w/ Velocity
<4fps_Depth>2ft


Velocity-Depth Plot
Close-Up of
Drops #3- Chevron #3
High Flow (1250 cfs)
Velocity <4fps_Depth>1.75ft
Depth>1.75ft
Velocity<4fps
CHEVRON FISH PASSAGE:
Fish Path w/ Velocity
<4fps_Depth>2ft

APPENDIX B- Draft Final Construction Plans