Appendix A

USGS

Montana Flood-Frequency and Basin-Characteristic Data

Estimate Flood Discharges at Ungaged Sites in Montana -- (continued)

Summary of Estimation Parameters Selected:

Name for this estimation:	**Carpenter Creek Fish Barrier**
Region:	**Upper Yellowstone**
Estimation method:	**Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width**
Drainage area in square miles:	**9.17**
Percent basin above 6,000 feet:	**99**
Width of active channel in feet:	**20**
Width of bank full channel in feet:	**27**

Flood Discharge Estimation:

(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)

```
 METHOD: Regression on basin characteristics
 Flood frequency estimates for
 Carpenter Creek Fish Barrier
Upper Yellowstone-Central Mountain Region: A =      9.17 E6 =    99.
 RI       DISCHARGE  STD ERR OF              90% PRED. INTERVAL
            (cfs)      PREDICTION(%)
     2         58.        95.4             15.2              220.
     5        107.        72.9             36.2              316.
    10        149.        63.5             56.6              391.
    25        212.        57.2             87.8              513.
    50        266.        55.9            111.9              632.
   100        324.        56.8            134.8              780.
   200        387.        59.5            155.3              966.
   500        480.        65.3            178.5             1290.
```

```
 METHOD: Regression on active channel width
 Flood frequency estimates for
 Carpenter Creek Fish Barrier
```

Upper Yellowstone-Central Mountain Region: WAC = 20.00

RI	DISCHARGE (cfs)	STD ERR OF PREDICTION(%)	90% PRED. INTERVAL	
2	235.	70.9	81.0	682.
5	490.	67.0	177.1	1350.
10	722.	68.8	255.1	2040.
25	1080.	74.3	358.5	3280.
50	1410.	80.4	433.6	4580.
100	1780.	87.4	506.5	6260.
200	2210.	95.5	574.9	8460.
500	2860.	107.7	660.5	12400.

METHOD: Regression on bank full channel width
Flood frequency estimates for
Carpenter Creek Fish Barrier
Upper Yellowstone-Central Mountain Region: WBF = 27.00

RI	DISCHARGE (cfs)	STD ERR OF PREDICTION(%)	90% PRED. INTERVAL	
2	246.	158.8	37.8	1600.
5	444.	71.5	151.8	1300.
10	655.	72.3	221.9	1940.
25	987.	77.4	314.3	3100.
50	1290.	83.5	381.9	4340.
100	1630.	90.7	447.0	5940.
200	2020.	99.0	508.8	8050.
500	2630.	111.6	585.9	11800.

METHOD: Combined methods 1, 2 and 3
Flood frequency estimates for
Carpenter Creek Fish Barrier
Region 7

RI	DISCHARGE (cfs)	STD ERR OF PREDICTION(%)	90% PRED. INTERVAL	
2	160.	66.6	58.6	438.
5	248.	52.4	109.3	561.
10	294.	51.3	131.7	654.
25	334.	52.1	148.1	754.
50	356.	53.9	153.8	823.
100	379.	56.5	158.4	908.
200	403.	59.5	161.4	1000.
500	480.	65.3	178.5	1290.

Montana Flood-Frequency and Basin-Characteristic Data

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Army Corp of Engineers Bank Riprap Sizing
Cross-section 75 (XS with the Highest Velocity Downstream of Apron)
100-Year Event (Highest Velocity)

Army Corp of Engineers Riprap Sizing
Ref: COE Hydraulic Design of Flood Control Channels; June 1994
Project: **Carpenter Creek Fish Barrier**
Date: **01/28/15**

S_f	1		
C_s	0.3		
C_v	1.250	DS of concrete	C_v = 1.283-0.2Log(R/W)
R	130.00		
W	15.03		
C_t	1		
d	1.99		
G_w	62.4		
G_s	165		
V	18.41		
g	32.2		
K_1	0.932		$K_1 = \{1-(\sin^2 Theta/\sin^2 Phi)\}^{1/2}$
Side Slope Angle	0.245		3H:1V
Rock Friction Angle	0.730		
V_{ss}	18.03		V_{ss} = V{1.71-0.78Log(R/W)}
Vss/V =	0.9791522		

$$D_{30} = S_f C_s C_v C_t d\{(G_w/(G_s-G_w))^{1/2}\ V/(K_1 g d)^{1/2}\}^{2.5}$$

D_{30} = 3.3 ft

D_{30} = 40.0 Inches

<u>NOTES:</u>

Highway Research Board Riprap Sizing for Evaluating Protection of 100-Year Flow

Project: Carpenter Creek Fish Barrier
Date: 1/28/2015

		Degrees	Radian
Side Slope Angle	ϕ =	14.0	0.245
Rock Friction Angle	θ =	42	0.733

Design x-Section	Velocity Chnl (ft/s)	Average Channel τ_{bed} (psf)	Max τ_{bed} (psf)	τ_{bank} (psf)	τ_{cbank} (psf)	K	$D_{50\ Bank}$ (ft)	$D_{50\ Bed}$ (ft)
100-Year								
92.49	19.9	2.5	3.74	2.99	4.01	0.93	1.00	0.93
91.48	25.7	30.3	45.38	36.30	48.68	0.93	12.17	11.34
77.04	18.2	13.8	20.64	16.51	22.14	0.93	5.54	5.16
75.55	18.4	14.0	21.00	16.80	22.53	0.93	5.63	5.25
62.43	14.6	8.5	12.71	10.16	13.63	0.93	3.41	3.18
57	15.0	9.1	13.58	10.86	14.56	0.93	3.64	3.39
51.46	14.0	8.3	12.47	9.97	13.37	0.93	3.34	3.12
41.23	12.9	6.8	10.13	8.10	10.86	0.93	2.72	2.53
MAX:	**18.4**	**14.0**	**21.0**	**16.8**	**22.5**	**0.9**	**5.6**	**5.3**

Velocity Prior to Impingement
BOR, Fish Protection at Water Diversions, Chapter 8. 2006

The flow velocity prior to impingement is estimated using the total upstream energy as:

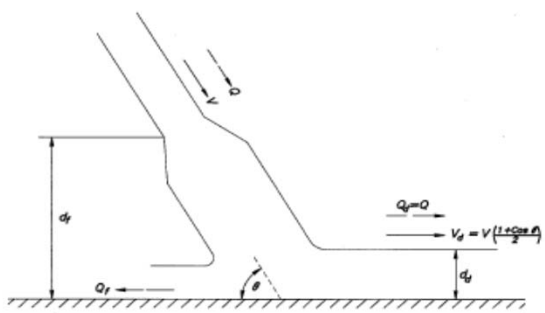
$$V = \sqrt{2g\left(h + h_f\right)}$$

where: g = acceleration of gravity
h = head on the weir
h_f = distance from the weir crest to the apron

h =	1.2	head on apron
hf =	4.6	
V =	19.3	ft/s

$$V_d = \frac{V}{2}(1 + \cos\theta)$$

where: V_d = velocity of downstream flow
V = velocity of flow prior to impingement
θ = upstream angle between the nappe centerline and the apron surface



theta =	0.71	see Jet Traj Calc values
	40.8	degrees

Vd =	16.97	ft/s	Using head calc
Vd =	22.63	ft/s	Using trajectory calc
Vd =	16.85	ft/s	using half horizontal projectile

Fish Barrier Apron Riprap Estimate

Riprap DS of Barrier Elevated Apron (head based)

USBR Method

V =	16.97	fps	Downstream Impingement Velocity
D100 =	698.46	mm	
D100 =	27.5	in	
FOS =	1.1		
D100 =	30.2	in	
	2.5	ft	

MDT Class III is 2.8 ft

Riprap DS of Barrier Elevated Apron (trajectory based)

USBR Method

V =	22.63	fps	Downstream Impingement Velocity
D100 =	1241.08	mm	
D100 =	48.9	in	
FOS =	1.1		
D100 =	53.7	in	
	4.5	ft	

Riprap DS of Barrier Elevated Apron (trajectory based with horizontal decay)

USBR Method

V =	16.85	fps	Downstream Impingement Velocity
D100 =	688.59	mm	
D100 =	27.1	in	
FOS =	1.1		
D100 =	29.8	in	
	2.5	ft	

Method: Chow Open Channel Hydraulics (Section 15-15)						
D=(q^2)/(g*h^3)						
D	Drop Number					
q	flow rate/unit width					
g	gravity					
h	height of drop					
Drop Spillway on Fish Barrier- RS 92.5						
100- Year Post Conditions						
Velocity	19.9	fps				
h	4.93	ft	5876	5871.07		
Q	379	cfs				
width	16	ft				
q	23.7	cfs/ft				
g	32.2	ft/s^2				
D=	0.145					
Ld=(h*(4.30*(D^0.27))						
Ld	Drop Length (distance nappe falles from drop wall)					
Ld=	**12.6**	**ft**				

Method: Bryant & Stratton On Line								
http://www.physicsclassroom.com/class/vectors/Lesson-2/Horizontally-Launched-Projectiles-Problem-Solving								
Horizontal Motion					Vertical Motion			
x	horizontal distance				y	veritcal distance	4.93	ft
Vx	horizontal velocity		19.9	ft/s	Vy	vertical velocity	0	ft/s
Ax	horizontal acceleratior		0	ft/s^2	Ay	vertical acceleration	32.2	ft/s^2
t	time			s				
	y=	(Vy*t)+((0.5*Ay)*(t^2))						
	t=	0.553364						
	x=	(Vx*t)+((0.5*Ax)*(t^2))						
	x=	**11.0**	**ft**					

Conclusion:

Comparing both methods, the horizontal distance the nappe projects from the DS face of the fish barrier is 11.0-feet to 12.6-feet. For design purposes use 12-feet.

Carpenter Creek Fish Barrier - Existing 2-Year Hec-Ras Results												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	2 Year	160	5891.75	5893.42	5893.42	5894.02	0.06196	6.22	25.71	21.94	1.01	
451.37	2 Year	160	5890.34	5892.33	5892.03	5892.69	0.031927	4.85	33.02	24.69	0.74	
401.95	2 Year	160	5888.78	5890.82		5891.14	0.030565	4.57	35.05	27.91	0.72	
378.19	2 Year	160	5888.03	5890.18		5890.5	0.023575	4.57	35.01	22.46	0.65	
319.38	2 Year	160	5884.96	5887.66	5887.66	5888.36	0.060061	6.74	23.73	16.83	1	
279.3	2 Year	160	5883.64	5886.34	5885.66	5886.61	0.017328	4.19	38.2	22.25	0.56	
271.9	2 Year	160	5882.59	5886.27		5886.49	0.012742	3.77	42.41	22.27	0.48	
263.24	2 Year	160	5882.87	5885.67		5886.17	0.035994	5.7	28.09	17.69	0.8	
257.83	2 Year	160	5882.09	5885.6		5885.88	0.018555	4.24	37.73	22.37	0.58	
231.31	2 Year	160	5882.03	5884.26	5884.24	5884.9	0.058408	6.38	25.06	19.42	0.99	
219.29	2 Year	160	5880.06	5883.4	5883.4	5884.14	0.065722	6.92	23.13	15.97	1.01	
213.08	2 Year	160	5879.55	5882.34	5882.68	5883.54	0.130065	8.77	18.24	14.7	1.39	
205.68	2 Year	160	5879.23	5883.02	5881.95	5883.21	0.010852	3.47	46.04	22.4	0.43	
203.25	2 Year	160	5878.87	5883		5883.18	0.009065	3.41	46.89	20.85	0.4	
201.64	2 Year	160	5878.98	5882.96		5883.17	0.010767	3.67	43.63	20.02	0.44	
196.59	2 Year	160	5879.31	5882.36	5882.36	5883.01	0.076115	6.44	24.86	20.12	1.02	
189.88	2 Year	160	5878.49	5880.71	5881.17	5882.16	0.197266	9.65	16.58	14.48	1.59	
184.22	2 Year	160	5877.45	5879.1	5879.58	5880.68	0.353138	10.1	15.84	22.97	2.14	
174.43	2 Year	160	5874.86	5877.84	5878.02	5878.58	0.117762	6.92	23.12	25.78	1.29	
169.52	2 Year	160	5874.57	5876.88	5877.18	5877.92	0.147454	8.18	19.56	20.53	1.48	
162.35	2 Year	160	5874.13	5876.84	5876.45	5877.15	0.025793	4.46	35.91	26.07	0.67	
156	2 Year	160	5874.26	5876.31	5876.31	5876.87	0.062709	6.04	26.48	23.77	1.01	
149.7	2 Year	160	5873.75	5876.05	5875.92	5876.49	0.044824	5.3	30.19	25.11	0.85	
141.2	2 Year	160	5874.01	5875.68		5876.11	0.044032	5.26	30.4	25.5	0.85	
128.54	2 Year	160	5873.27	5874.97	5874.89	5875.5	0.050911	5.85	27.37	21.93	0.92	
117.73	2 Year	160	5871.83	5874.1	5874.1	5874.87	0.061763	7.04	22.73	15.07	1.01	
111.49	2 Year	160	5870.8	5873.86	5873.14	5874.26	0.022992	5.07	31.58	14.21	0.6	
109.49	2 Year	160	5870.48	5873.9		5874.2	0.012419	4.36	37.29	14.53	0.47	Face of Weir
108.49	2 Year	160	5870.32	5873.93		5874.17	0.008824	4	40.83	14.98	0.41	
100.49	2 Year	160	5870.6	5873.82		5874.09	0.012927	4.15	38.62	17.59	0.49	
92.49	2 Year	160	5871.05	5873.42		5873.91	0.033258	5.6	28.55	16.88	0.76	End of Apron
91.48	2 Year	160	5871.07	5873.18	5873.12	5873.85	0.053326	6.6	24.25	16.23	0.95	
77.04	2 Year	160	5870.12	5872.33	5872.33	5873.04	0.058878	6.77	23.87	17.28	1	
75.55	2 Year	160	5869.81	5871.59	5871.95	5872.86	0.137208	9.04	17.7	15.36	1.48	
62.43	2 Year	160	5869.1	5871.37	5871.37	5872.13	0.063016	6.98	22.93	15.55	1.01	
57	2 Year	160	5868.47	5870.34	5870.7	5871.6	0.127092	9.01	17.75	13.87	1.4	
51.46	2 Year	160	5868.07	5870.41	5870.41	5871.08	0.068022	6.59	24.27	18.5	1.01	
41.23	2 Year	160	5867.69	5870.19	5869.7	5870.53	0.022596	4.66	34.36	20.96	0.64	
29.3	2 Year	160	5867.8	5869.5	5869.48	5870.09	0.059153	6.21	25.78	21.24	0.99	
10.15	2 Year	160	5865.91	5868.26	5868.25	5868.94	0.060065	6.64	24.09	17.88	1.01	

Carpenter Creek Fish Barrier - Proposed 2-Year Hec-Ras Results												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	2 Year	160	5891.75	5893.42	5893.42	5894.02	0.06196	6.22	25.71	21.94	1.01	
451.37	2 Year	160	5890.34	5892.33	5892.03	5892.69	0.031927	4.85	33.02	24.69	0.74	
401.95	2 Year	160	5888.78	5890.82		5891.14	0.030565	4.57	35.05	27.91	0.72	
378.19	2 Year	160	5888.03	5890.18		5890.5	0.023575	4.57	35.01	22.46	0.65	
319.38	2 Year	160	5884.96	5887.66	5887.66	5888.36	0.060061	6.74	23.73	16.83	1	
279.3	2 Year	160	5883.64	5886.34	5885.66	5886.61	0.017328	4.19	38.2	22.25	0.56	
271.9	2 Year	160	5882.59	5886.27		5886.49	0.012751	3.77	42.4	22.26	0.48	
263.24	2 Year	160	5882.87	5885.68		5886.18	0.035448	5.66	28.26	17.75	0.79	
257.83	2 Year	160	5882.09	5885.61		5885.89	0.01823	4.21	37.98	22.45	0.57	
231.31	2 Year	160	5882.03	5884.25	5884.24	5884.9	0.060154	6.45	24.8	19.36	1	
219.29	2 Year	160	5880.06	5883.41	5883.41	5884.14	0.064037	6.85	23.36	16.05	1	
213.08	2 Year	160	5879.55	5882.34	5882.68	5883.54	0.130065	8.77	18.24	14.7	1.39	
205.68	2 Year	160	5879.23	5883.11	5881.95	5883.28	0.009704	3.34	47.91	22.77	0.41	
203.25	2 Year	160	5878.87	5883.09		5883.26	0.008176	3.29	48.65	21.17	0.38	
201.64	2 Year	160	5878.98	5883.05		5883.24	0.009597	3.52	45.43	20.31	0.41	
196.59	2 Year	160	5879.31	5882.81		5883.15	0.029532	4.67	34.29	22.32	0.66	
189.88	2 Year	160	5878.49	5882.9		5883	0.00616	2.54	63.06	30.95	0.31	
184.22	2 Year	160	5877.45	5882.95		5882.97	0.000484	1.07	149.52	44.4	0.1	
174.43	2 Year	160	5874.86	5882.95		5882.96	0.000156	0.8	206.07	46.7	0.06	
169.52	2 Year	160	5874.57	5882.95		5882.96	0.000099	0.7	234.12	44.72	0.05	
162.35	2 Year	160	5874.13	5882.95		5882.96	0.000061	0.64	280.44	50.51	0.04	
156	2 Year	160	5874.26	5882.95		5882.96	0.000055	0.62	294.8	53.94	0.04	
149.7	2 Year	160	5873.75	5882.95		5882.96	0.00005	0.61	309.68	57.18	0.04	
141.2	2 Year	160	5874.01	5882.95		5882.96	0.000044	0.57	318.52	55.91	0.04	
128.54	2 Year	160	5873.27	5882.95		5882.96	0.00004	0.54	317.77	51.43	0.03	
117.73	2 Year	160	5871.83	5882.95		5882.96	0.000069	0.74	256.71	47.23	0.04	
111.49	2 Year	160	5870.8	5882.95	5873.14	5882.95	0.000074	0.73	232.47	47.11	0.04	
109.5		Inl Struct										Face of Weir
108.5	2 Year	160	5877	5878.46	5878.46	5879.19	0.003641	6.87	23.29	16.02	1	
100.49	2 Year	160	5876.5	5877.5	5877.96	5879.06	0.011954	10.01	15.99	16	1.76	
92.49	2 Year	160	5876	5876.88	5877.45	5878.89	0.01806	11.39	14.05	16.01	2.14	End of Apron
91.48	2 Year	160	5871.07	5872.06	5873.11	5878.39	1.632973	20.2	7.92	13.31	4.61	
77.04	2 Year	160	5870.12	5872.1	5872.33	5873.1	0.099231	8.04	20.02	16.46	1.27	
75.55	2 Year	160	5869.81	5871.56	5871.95	5872.9	0.148199	9.27	17.26	15.3	1.54	
62.43	2 Year	160	5869.1	5871.37	5871.37	5872.13	0.063016	6.98	22.93	15.55	1.01	
57	2 Year	160	5868.47	5870.34	5870.7	5871.6	0.127092	9.01	17.75	13.87	1.4	
51.46	2 Year	160	5868.07	5870.41	5870.41	5871.08	0.068022	6.59	24.27	18.5	1.01	
41.23	2 Year	160	5867.69	5870.19	5869.7	5870.53	0.022596	4.66	34.36	20.96	0.64	
29.3	2 Year	160	5867.8	5869.5	5869.48	5870.09	0.059153	6.21	25.78	21.24	0.99	
10.15	2 Year	160	5865.91	5868.26	5868.25	5868.94	0.060065	6.64	24.09	17.88	1.01	

Carpenter Creek Fish Barrier - Proposed 2-Year Hec-Ras Results (Sections)												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	2 Year	160	5891.75	5893.42	5893.42	5894.02	0.06196	6.22	25.71	21.94	1.01	
451.37	2 Year	160	5890.34	5892.33	5892.03	5892.69	0.031927	4.85	33.02	24.69	0.74	
401.95	2 Year	160	5888.78	5890.82		5891.14	0.030565	4.57	35.05	27.91	0.72	
378.19	2 Year	160	5888.03	5890.18		5890.5	0.023575	4.57	35.01	22.46	0.65	
319.38	2 Year	160	5884.96	5887.66	5887.66	5888.36	0.060061	6.74	23.73	16.83	1	
279.3	2 Year	160	5883.64	5886.34	5885.66	5886.61	0.017328	4.19	38.2	22.25	0.56	
271.9	2 Year	160	5882.59	5886.27		5886.49	0.012751	3.77	42.4	22.26	0.48	
263.24	2 Year	160	5882.87	5885.68		5886.18	0.03542	5.66	28.26	17.75	0.79	
257.83	2 Year	160	5882.09	5885.61		5885.89	0.018216	4.21	37.99	22.45	0.57	
231.31	2 Year	160	5882.03	5884.25	5884.24	5884.9	0.06022	6.45	24.79	19.35	1	
219.29	2 Year	160	5880.06	5883.41	5883.41	5884.14	0.06398	6.85	23.37	16.06	1	
213.08	2 Year	160	5879.55	5883.17	5882.68	5883.55	0.027518	4.92	32.55	19.86	0.68	
205.68	2 Year	160	5879.23	5883.22		5883.38	0.008348	3.17	50.54	23.28	0.38	
203.25	2 Year	160	5878.87	5883.2		5883.36	0.007114	3.13	51.14	21.61	0.36	
201.64	2 Year	160	5878.98	5883.17		5883.34	0.008242	3.34	47.94	20.7	0.39	
196.59	2 Year	160	5879.31	5883.01		5883.27	0.020511	4.12	38.82	23.21	0.56	
189.88	2 Year	160	5878.49	5883.07		5883.15	0.005389	2.33	68.75	35.38	0.29	
184.22	2 Year	160	5877.45	5883.11		5883.13	0.000419	1.02	156.84	45.03	0.1	
174.43	2 Year	160	5874.86	5883.11		5883.12	0.000138	0.77	213.74	47.45	0.06	
169.52	2 Year	160	5874.57	5883.12		5883.12	0.000089	0.68	241.5	45.48	0.05	
162.35	2 Year	160	5874.13	5883.12		5883.12	0.000052	0.6	288.77	51.41	0.04	
156	2 Year	160	5874.26	5883.12		5883.12	0.000046	0.58	303.72	54.83	0.04	
149.7	2 Year	160	5873.75	5883.12		5883.12	0.000041	0.57	319.12	57.92	0.04	
141.2	2 Year	160	5874.01	5883.12		5883.12	0.000038	0.54	327.75	56.63	0.03	
128.54	2 Year	160	5873.27	5883.12		5883.12	0.000036	0.52	326.24	52.12	0.03	
117.73	2 Year	160	5871.83	5883.11		5883.12	0.000057	0.68	263.31	47.93	0.04	
111.49	2 Year	160	5870.8	5883.11		5883.12	0.000067	0.7	237.4	47.93	0.04	
109.5	2 Year	160	5880.5	5881.97	5881.96	5882.69	0.003556	6.82	23.47	16.01	0.99	Face of Weir
108.5	2 Year	160	5880.5	5881.95	5881.95	5882.69	0.003664	6.88	23.25	16.01	1.01	End of Weir
108.49	2 Year	160	5877	5877.57	5878.46	5882.3	0.071385	17.44	9.17	16.01	4.06	
100.49	2 Year	160	5876.5	5877.08	5877.95	5881.75	0.070039	17.34	9.23	16	4.02	
92.49	2 Year	160	5876	5876.58	5877.45	5881.22	0.069457	17.3	9.25	16	4.01	End of Apron
91.48	2 Year	160	5871.07	5871.97	5873.11	5880.62	2.623937	23.59	6.78	12.91	5.74	
77.04	2 Year	160	5870.12	5871.98	5872.33	5873.21	0.134895	8.9	18.06	16.02	1.46	
75.55	2 Year	160	5869.81	5871.51	5871.96	5872.97	0.169105	9.68	16.53	15.19	1.64	
62.43	2 Year	160	5869.1	5871.37	5871.37	5872.13	0.062709	6.97	22.97	15.56	1.01	
57	2 Year	160	5868.47	5870.33	5870.69	5871.6	0.127489	9.02	17.73	13.86	1.41	
51.46	2 Year	160	5868.07	5870.41	5870.41	5871.08	0.068022	6.59	24.27	18.5	1.01	
41.23	2 Year	160	5867.69	5870.19	5869.7	5870.53	0.022595	4.66	34.36	20.96	0.64	
29.3	2 Year	160	5867.8	5869.5	5869.48	5870.09	0.059153	6.21	25.78	21.24	0.99	
10.15	2 Year	160	5865.91	5868.26	5868.25	5868.94	0.060065	6.64	24.09	17.88	1.01	

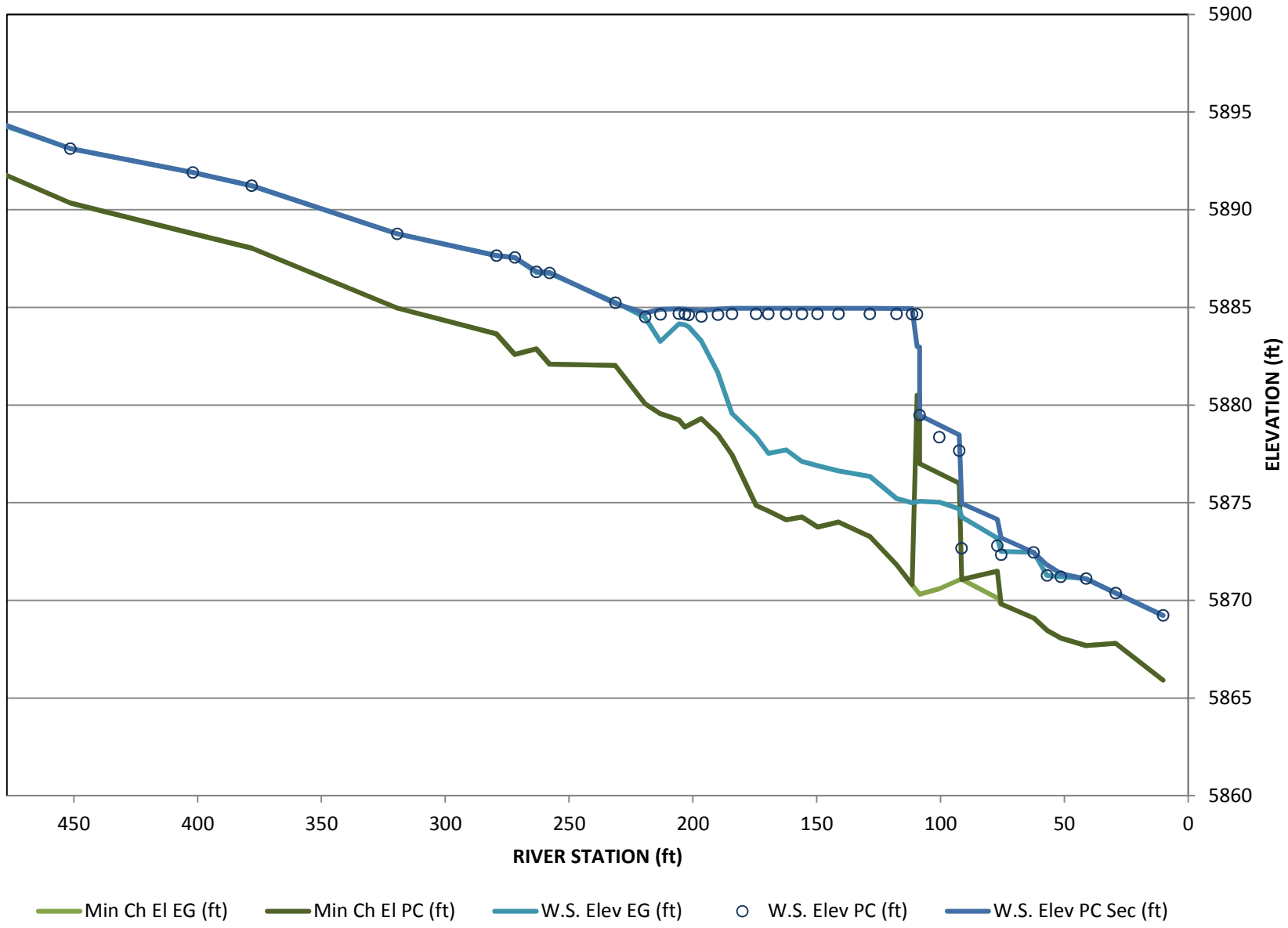
Carpenter Creek Fish Barrier - Existing 50-Year Hec-Ras Results												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	50 Year	356	5891.75	5894.26	5894.32	5895.17	0.060024	7.68	46.38	28.11	1.05	
451.37	50 Year	356	5890.34	5893.13	5892.9	5893.77	0.03851	6.41	55.51	31.4	0.85	
401.95	50 Year	356	5888.78	5891.91		5892.31	0.021476	5.08	70.04	36.34	0.65	
378.19	50 Year	356	5888.03	5891.23		5891.74	0.025139	5.77	61.74	29.26	0.7	
319.38	50 Year	356	5884.96	5888.76	5888.76	5889.7	0.048831	7.79	47.32	30.72	0.96	
279.3	50 Year	356	5883.64	5887.66	5886.65	5888.01	0.016168	4.79	74.28	33.66	0.57	
271.9	50 Year	356	5882.59	5887.56		5887.89	0.014051	4.61	77.26	32.63	0.53	
263.24	50 Year	356	5882.87	5886.79		5887.51	0.038548	6.8	52.35	26.77	0.86	
257.83	50 Year	356	5882.09	5886.74		5887.17	0.019466	5.27	67.57	30.1	0.62	
231.31	50 Year	356	5882.03	5885.26	5885.2	5886.15	0.049349	7.6	46.81	24.37	0.97	
219.29	50 Year	356	5880.06	5884.49	5884.49	5885.5	0.058021	8.06	44.15	22.46	1.01	
213.08	50 Year	356	5879.55	5883.26	5883.76	5884.93	0.118838	10.4	34.25	20.39	1.41	
205.68	50 Year	356	5879.23	5884.16	5882.94	5884.51	0.014456	4.79	74.4	28.16	0.52	
203.25	50 Year	356	5878.87	5884.1		5884.48	0.014787	4.92	72.35	27.23	0.53	
201.64	50 Year	356	5878.98	5884		5884.44	0.017946	5.35	66.59	25.7	0.59	
196.59	50 Year	356	5879.31	5883.29	5883.29	5884.24	0.063235	7.8	45.65	24.49	1.01	
189.88	50 Year	356	5878.49	5881.64	5882.22	5883.51	0.158787	10.97	32.45	19.75	1.51	
184.22	50 Year	356	5877.45	5879.57	5880.31	5882.14	0.360762	12.86	27.69	28.54	2.3	
174.43	50 Year	356	5874.86	5878.37	5878.76	5879.76	0.133793	9.47	37.58	28.8	1.46	
169.52	50 Year	356	5874.57	5877.52	5877.98	5879.08	0.142585	10	35.61	27.12	1.54	
162.35	50 Year	356	5874.13	5877.71	5877.29	5878.24	0.028311	5.82	61.16	31.77	0.74	
156	50 Year	356	5874.26	5877.12	5877.12	5877.96	0.055767	7.35	48.42	29.56	1.01	
149.7	50 Year	356	5873.75	5876.9	5876.72	5877.59	0.041237	6.65	53.58	29.93	0.87	
141.2	50 Year	356	5874.01	5876.62		5877.25	0.034355	6.4	55.63	28.48	0.81	
128.54	50 Year	356	5873.27	5876.34		5876.86	0.023722	5.79	61.53	27.77	0.68	
117.73	50 Year	356	5871.83	5875.21	5875.21	5876.41	0.055729	8.81	40.43	16.97	1.01	
111.49	50 Year	356	5870.8	5875	5874.35	5875.83	0.032997	7.32	48.65	16.04	0.74	
109.49	50 Year	356	5870.48	5875.05		5875.74	0.019259	6.71	54.85	16.37	0.61	Face of Weir
108.49	50 Year	356	5870.32	5875.08		5875.7	0.014244	6.34	59.24	16.96	0.55	
100.49	50 Year	356	5870.6	5875.02		5875.56	0.014818	5.9	63.45	23.44	0.56	
92.49	50 Year	356	5871.05	5874.67	5874.24	5875.38	0.028854	6.74	53.27	23.52	0.75	End of Apron
91.48	50 Year	356	5871.07	5874.26	5874.26	5875.31	0.050336	8.25	43.79	21.01	0.98	
77.04	50 Year	356	5870.12	5873.19	5873.36	5874.46	0.065072	9.08	40.11	20.39	1.12	
75.55	50 Year	356	5869.81	5872.51	5873	5874.28	0.109642	10.67	33.35	18.65	1.41	
62.43	50 Year	356	5869.1	5872.46	5872.46	5873.58	0.053733	8.46	42.29	20.27	1	
57	50 Year	356	5868.47	5871.28	5871.81	5873.08	0.117531	10.77	33.05	18.65	1.43	
51.46	50 Year	356	5868.07	5871.21	5871.36	5872.38	0.075196	8.67	41.06	22.64	1.13	
41.23	50 Year	356	5867.69	5871.11	5870.63	5871.79	0.026041	6.62	54.5	23.03	0.73	
29.3	50 Year	356	5867.8	5870.37	5870.35	5871.33	0.052687	7.88	45.18	23.3	1	
10.15	50 Year	356	5865.91	5869.23	5869.23	5870.32	0.051077	8.39	42.84	20.47	1	

Carpenter Creek Fish Barrier - Proposed 50-Year Hec-Ras Results												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	50 Year	356	5891.75	5894.26	5894.32	5895.17	0.060024	7.68	46.38	28.11	1.05	
451.37	50 Year	356	5890.34	5893.13	5892.9	5893.77	0.03851	6.41	55.51	31.4	0.85	
401.95	50 Year	356	5888.78	5891.91		5892.31	0.021476	5.08	70.04	36.34	0.65	
378.19	50 Year	356	5888.03	5891.23		5891.74	0.025139	5.77	61.74	29.26	0.7	
319.38	50 Year	356	5884.96	5888.76	5888.76	5889.7	0.048831	7.79	47.32	30.72	0.96	
279.3	50 Year	356	5883.64	5887.65	5886.65	5888.01	0.01623	4.8	74.17	33.62	0.57	
271.9	50 Year	356	5882.59	5887.56		5887.89	0.014107	4.62	77.13	32.6	0.53	
263.24	50 Year	356	5882.87	5886.81		5887.52	0.037764	6.74	52.82	26.96	0.85	
257.83	50 Year	356	5882.09	5886.76		5887.18	0.019032	5.22	68.14	30.23	0.61	
231.31	50 Year	356	5882.03	5885.23	5885.2	5886.15	0.050991	7.69	46.27	24.25	0.98	
219.29	50 Year	356	5880.06	5884.51	5884.51	5885.5	0.056501	7.98	44.59	22.58	1	
213.08	50 Year	356	5879.55	5884.64	5883.76	5885.07	0.017481	5.26	67.71	26.82	0.58	
205.68	50 Year	356	5879.23	5884.68		5884.92	0.008563	3.95	90.28	31.75	0.41	
203.25	50 Year	356	5878.87	5884.65		5884.9	0.008718	4	89.1	32.08	0.42	
201.64	50 Year	356	5878.98	5884.61		5884.88	0.010384	4.21	84.59	32.18	0.45	
196.59	50 Year	356	5879.31	5884.53		5884.83	0.011422	4.42	84.7	40.16	0.46	
189.88	50 Year	356	5878.49	5884.62		5884.73	0.003459	2.59	142.65	54.59	0.26	
184.22	50 Year	356	5877.45	5884.66		5884.7	0.000602	1.55	237.63	59.85	0.12	
174.43	50 Year	356	5874.86	5884.67		5884.69	0.000284	1.31	297.67	61.13	0.09	
169.52	50 Year	356	5874.57	5884.67		5884.69	0.000203	1.19	321.87	58.82	0.08	
162.35	50 Year	356	5874.13	5884.67		5884.69	0.000138	1.12	375.7	61.32	0.07	
156	50 Year	356	5874.26	5884.67		5884.69	0.000125	1.08	395.49	63.55	0.06	
149.7	50 Year	356	5873.75	5884.67		5884.69	0.000117	1.07	414.54	64.87	0.06	
141.2	50 Year	356	5874.01	5884.67		5884.68	0.000105	1.01	421.04	63.42	0.06	
128.54	50 Year	356	5873.27	5884.67		5884.68	0.000098	0.96	412.28	58.61	0.05	
117.73	50 Year	356	5871.83	5884.66		5884.68	0.000177	1.32	325.09	54.78	0.07	
111.49	50 Year	356	5870.8	5884.65	5874.35	5884.68	0.000204	1.35	283.64	56.15	0.07	
109.5		Inl Struct										Face of Weir
108.5	50 Year	356	5877	5879.48	5879.48	5880.73	0.003509	8.98	39.65	16.03	1.01	
100.49	50 Year	356	5876.5	5878.36	5878.98	5880.59	0.008488	11.99	29.69	16.01	1.55	
92.49	50 Year	356	5876	5877.66	5878.48	5880.45	0.011993	13.41	26.55	16.01	1.84	End of Apron
91.48	50 Year	356	5871.07	5872.67	5874.26	5879.96	0.840125	21.67	16.43	14.67	3.61	
77.04	50 Year	356	5870.12	5872.8	5873.36	5874.72	0.11902	11.15	32.47	18.99	1.47	
75.55	50 Year	356	5869.81	5872.33	5873	5874.51	0.147445	11.85	30.04	18	1.62	
62.43	50 Year	356	5869.1	5872.46	5872.46	5873.58	0.053733	8.46	42.29	20.27	1	
57	50 Year	356	5868.47	5871.28	5871.81	5873.08	0.117531	10.77	33.05	18.65	1.43	
51.46	50 Year	356	5868.07	5871.21	5871.36	5872.38	0.075196	8.67	41.06	22.64	1.13	
41.23	50 Year	356	5867.69	5871.11	5870.63	5871.79	0.026041	6.62	54.5	23.03	0.73	
29.3	50 Year	356	5867.8	5870.37	5870.35	5871.33	0.052687	7.88	45.18	23.3	1	
10.15	50 Year	356	5865.91	5869.23	5869.23	5870.32	0.051077	8.39	42.84	20.47	1	

Carpenter Creek Fish Barrier - Proposed 50-Year Hec-Ras Results (Sections)												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	50 Year	356	5891.75	5894.26	5894.32	5895.17	0.060024	7.68	46.38	28.11	1.05	
451.37	50 Year	356	5890.34	5893.13	5892.91	5893.77	0.038395	6.41	55.57	31.42	0.85	
401.95	50 Year	356	5888.78	5891.9		5892.3	0.02161	5.09	69.88	36.3	0.65	
378.19	50 Year	356	5888.03	5891.19		5891.72	0.0265	5.88	60.51	28.96	0.72	
319.38	50 Year	356	5884.96	5888.8	5888.8	5889.69	0.045464	7.58	48.63	31.7	0.93	
279.3	50 Year	356	5883.64	5887.65	5886.65	5888.01	0.016326	4.81	73.99	33.57	0.57	
271.9	50 Year	356	5882.59	5887.55		5887.89	0.014199	4.63	76.93	32.53	0.53	
263.24	50 Year	356	5882.87	5886.84		5887.53	0.036451	6.64	53.64	27.29	0.83	
257.83	50 Year	356	5882.09	5886.79		5887.2	0.018313	5.15	69.13	30.45	0.6	
231.31	50 Year	356	5882.03	5885.2	5885.2	5886.15	0.053817	7.84	45.38	24.07	1.01	
219.29	50 Year	356	5880.06	5884.71	5884.51	5885.52	0.043322	7.23	49.24	23.76	0.89	
213.08	50 Year	356	5879.55	5884.89		5885.25	0.012911	4.78	74.73	27.96	0.5	
205.68	50 Year	356	5879.23	5884.93		5885.14	0.006537	3.63	98.4	32.95	0.36	
203.25	50 Year	356	5878.87	5884.91		5885.12	0.006505	3.66	97.65	34.53	0.37	
201.64	50 Year	356	5878.98	5884.88		5885.11	0.007456	3.81	94.25	36.64	0.39	
196.59	50 Year	356	5879.31	5884.85		5885.07	0.00747	3.85	98.02	42.02	0.38	
189.88	50 Year	356	5878.49	5884.92		5885	0.002454	2.32	158.98	55.8	0.22	
184.22	50 Year	356	5877.45	5884.95		5884.98	0.000487	1.45	254.95	61.4	0.11	
174.43	50 Year	356	5874.86	5884.95		5884.98	0.000234	1.22	315.35	62.62	0.08	
169.52	50 Year	356	5874.57	5884.95		5884.97	0.000172	1.12	338.83	60.3	0.07	
162.35	50 Year	356	5874.13	5884.96		5884.97	0.00011	1.02	393.46	62.82	0.06	
156	50 Year	356	5874.26	5884.96		5884.97	0.000098	0.98	413.94	65.18	0.06	
149.7	50 Year	356	5873.75	5884.96		5884.97	0.000089	0.95	433.32	66.16	0.05	
141.2	50 Year	356	5874.01	5884.96		5884.97	0.000083	0.92	439.36	64.67	0.05	
128.54	50 Year	356	5873.27	5884.96		5884.97	0.000083	0.9	429.2	59.8	0.05	
117.73	50 Year	356	5871.83	5884.95		5884.96	0.000133	1.17	336.67	56.08	0.06	
111.49	50 Year	356	5870.8	5884.94		5884.96	0.000174	1.27	292.25	57.51	0.07	
109.5	50 Year	356	5880.5	5882.99	5882.98	5884.23	0.003478	8.95	39.77	16.01	1	Face of Weir
108.5	50 Year	356	5880.5	5882.98	5882.98	5884.23	0.003522	8.99	39.6	16.01	1.01	End of Weir
108.49	50 Year	356	5877	5878.17	5879.48	5883.79	0.035952	19.03	18.7	16.01	3.1	
100.49	50 Year	356	5876.5	5877.65	5878.98	5883.48	0.03807	19.38	18.37	16	3.19	
92.49	50 Year	356	5876	5877.13	5878.48	5883.15	0.040074	19.7	18.07	16.01	3.27	End of Apron
91.48	50 Year	356	5871.07	5872.5	5874.27	5882.62	1.382785	25.54	13.94	14.23	4.55	
77.04	50 Year	356	5870.12	5872.61	5873.37	5875.01	0.166349	12.47	28.86	18.29	1.72	
75.55	50 Year	356	5869.81	5872.21	5873	5874.74	0.182692	12.78	27.86	17.56	1.79	
62.43	50 Year	356	5869.1	5872.48	5872.48	5873.57	0.052239	8.39	42.66	20.31	0.99	
57	50 Year	356	5868.47	5871.27	5871.81	5873.09	0.119122	10.83	32.88	18.59	1.43	
51.46	50 Year	356	5868.07	5871.21	5871.36	5872.38	0.075644	8.69	40.98	22.63	1.13	
41.23	50 Year	356	5867.69	5871.12	5870.64	5871.79	0.025613	6.58	54.72	23.05	0.73	
29.3	50 Year	356	5867.8	5870.36	5870.35	5871.33	0.053535	7.92	44.95	23.28	1	
10.15	50 Year	356	5865.91	5869.23	5869.23	5870.32	0.050855	8.37	42.86	20.47	1	

Carpenter Creek Fish Barrier - Proposed 50-Year Hec-Ras Results (Sections, Step Subcritical)												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	50 Year	356	5891.75	5894.32	5894.32	5895.17	0.054537	7.39	48.17	28.76	1.01	
451.37	50 Year	356	5890.34	5893.13	5892.9	5893.77	0.03851	6.41	55.51	31.4	0.85	
401.95	50 Year	356	5888.78	5891.91		5892.31	0.021476	5.08	70.04	36.34	0.65	
378.19	50 Year	356	5888.03	5891.23		5891.74	0.025139	5.77	61.74	29.26	0.7	
319.38	50 Year	356	5884.96	5888.76	5888.76	5889.7	0.048831	7.79	47.32	30.72	0.96	
279.3	50 Year	356	5883.64	5887.65		5888.01	0.016326	4.81	73.99	33.57	0.57	
271.9	50 Year	356	5882.59	5887.55		5887.89	0.014199	4.63	76.93	32.53	0.53	
263.24	50 Year	356	5882.87	5886.84		5887.53	0.03643	6.63	53.66	27.3	0.83	
257.83	50 Year	356	5882.09	5886.79		5887.2	0.018302	5.15	69.15	30.46	0.6	
231.31	50 Year	356	5882.03	5885.2	5885.2	5886.15	0.053817	7.84	45.38	24.07	1.01	
219.29	50 Year	356	5880.06	5884.71	5884.51	5885.52	0.043131	7.22	49.32	23.78	0.88	
213.08	50 Year	356	5879.55	5884.9		5885.25	0.01288	4.77	74.8	27.97	0.5	
205.68	50 Year	356	5879.23	5884.93		5885.14	0.006529	3.63	98.47	32.97	0.36	
203.25	50 Year	356	5878.87	5884.92		5885.12	0.006496	3.66	97.72	34.54	0.37	
201.64	50 Year	356	5878.98	5884.89		5885.11	0.007451	3.81	94.32	36.66	0.39	
196.59	50 Year	356	5879.31	5884.84		5885.07	0.007836	3.93	97.59	41.96	0.39	
189.88	50 Year	356	5878.49	5884.92		5885	0.002525	2.35	158.79	55.79	0.23	
184.22	50 Year	356	5877.45	5884.95		5884.98	0.000496	1.47	254.86	61.4	0.11	
174.43	50 Year	356	5874.86	5884.95		5884.97	0.000245	1.25	315.19	62.6	0.08	
169.52	50 Year	356	5874.57	5884.95		5884.97	0.000178	1.14	338.74	60.3	0.07	
162.35	50 Year	356	5874.13	5884.95		5884.97	0.000123	1.08	393.31	62.81	0.06	
156	50 Year	356	5874.26	5884.95		5884.97	0.000112	1.04	413.75	65.17	0.06	
149.7	50 Year	356	5873.75	5884.95		5884.97	0.000105	1.03	433.13	66.14	0.06	
141.2	50 Year	356	5874.01	5884.95		5884.97	0.000094	0.97	439.21	64.66	0.05	
128.54	50 Year	356	5873.27	5884.95		5884.97	0.000088	0.93	429.08	59.79	0.05	
117.73	50 Year	356	5871.83	5884.94		5884.96	0.00016	1.28	336.46	56.06	0.07	
111.49	50 Year	356	5870.8	5884.94		5884.96	0.000186	1.31	292.17	57.5	0.07	
109.5	50 Year	356	5880.5	5882.99	5882.98	5884.23	0.003475	8.95	39.78	16.01	1	Face of Weir
108.5	50 Year	356	5880.5	5882.98	5882.98	5884.23	0.003518	8.99	39.62	16.01	1.01	End of Weir
108.49	50 Year	356	5877	5879.48	5879.48	5880.73	0.003491	8.96	39.72	16.03	1	
100.49	50 Year	356	5876.5	5878.98	5878.98	5880.23	0.003516	8.98	39.63	16.01	1.01	
92.49	50 Year	356	5876	5878.48	5878.48	5879.73	0.003518	8.98	39.62	16.02	1.01	End of Apron
91.48	50 Year	356	5871.07	5874.96		5875.67	0.019541	6.75	52.73	25.21	0.66	
77.04	50 Year	356	5871.5	5874.15	5874.15	5875.26	0.050422	8.44	42.19	22.04	1.01	Step
75.55	50 Year	356	5869.81	5873.2	5873.05	5874.2	0.042103	8.04	44.26	21.12	0.92	
62.43	50 Year	356	5869.1	5872.46	5872.46	5873.58	0.053733	8.46	42.29	20.27	1	
57	50 Year	356	5868.47	5871.81	5871.81	5872.84	0.055595	8.13	43.79	21.62	1	
51.46	50 Year	356	5868.07	5871.37	5871.37	5872.36	0.058078	8	44.56	22.98	1	
41.23	50 Year	356	5867.69	5871.1		5871.78	0.026279	6.64	54.34	23.01	0.74	
29.3	50 Year	356	5867.8	5870.38	5870.35	5871.33	0.051662	7.83	45.48	23.33	0.99	
10.15	50 Year	356	5865.91	5869.22	5869.22	5870.32	0.051834	8.43	42.63	20.44	1	

50-YEAR EXISTING AND PROPOSED

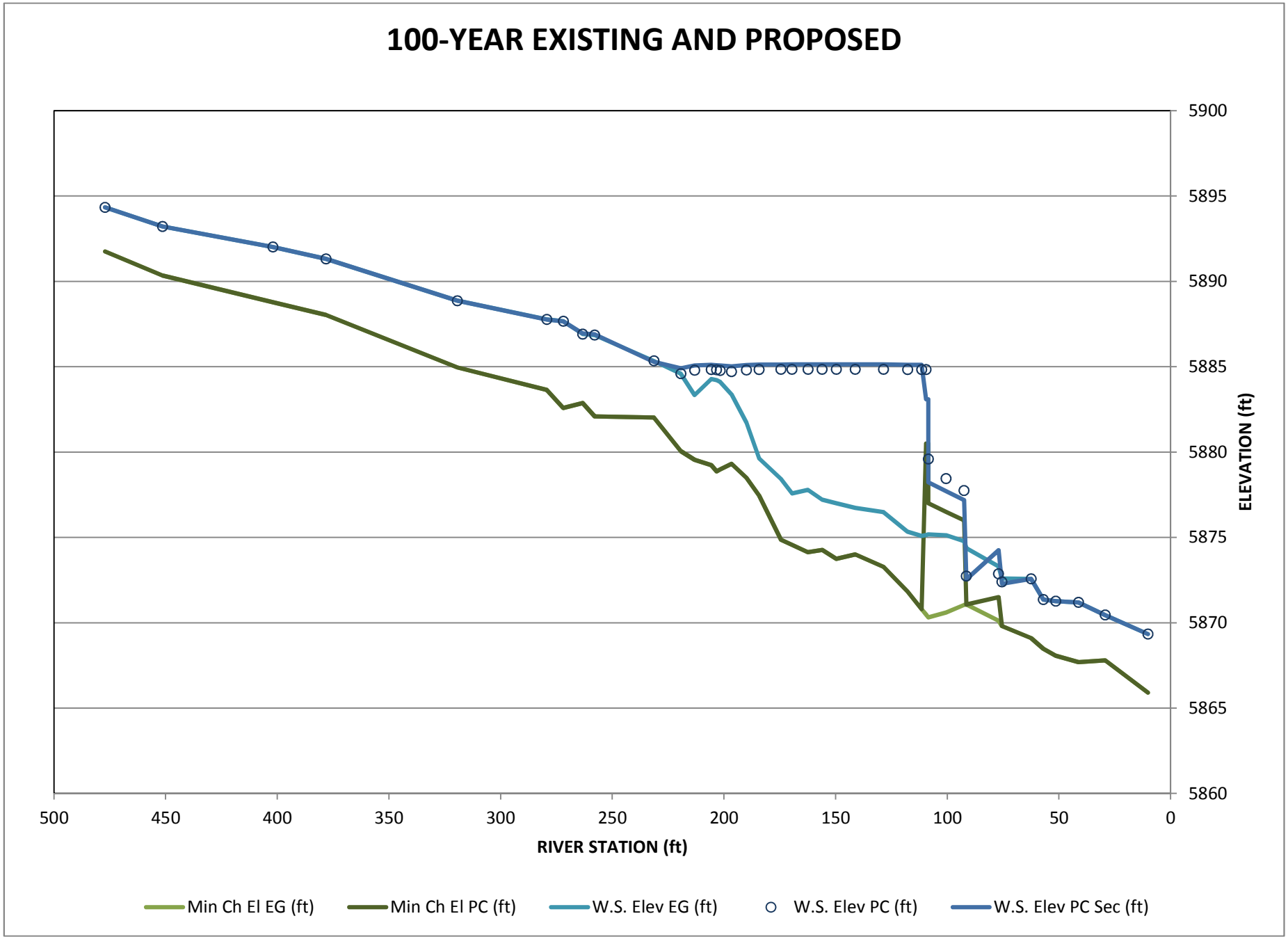


Carpenter Creek Fish Barrier - Existing 100-Year Hec-Ras Results												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	100 Year	379	5891.75	5894.34	5894.41	5895.28	0.060015	7.78	48.73	28.97	1.06	
451.37	100 Year	379	5890.34	5893.21	5892.99	5893.87	0.038658	6.53	58.05	32.06	0.86	
401.95	100 Year	379	5888.78	5892.01		5892.42	0.021073	5.13	73.83	37.21	0.64	
378.19	100 Year	379	5888.03	5891.32		5891.86	0.025525	5.89	64.36	29.91	0.71	
319.38	100 Year	379	5884.96	5888.87	5888.87	5889.81	0.047675	7.86	50.64	33.15	0.95	
279.3	100 Year	379	5883.64	5887.77	5886.75	5888.13	0.01623	4.86	78.06	34.8	0.57	
271.9	100 Year	379	5882.59	5887.67		5888.01	0.014289	4.69	80.81	33.69	0.53	
263.24	100 Year	379	5882.87	5886.91		5887.63	0.038176	6.83	55.51	28.04	0.86	
257.83	100 Year	379	5882.09	5886.85		5887.29	0.01929	5.33	71.08	30.91	0.62	
231.31	100 Year	379	5882.03	5885.34	5885.28	5886.27	0.049319	7.74	48.97	24.8	0.97	
219.29	100 Year	379	5880.06	5884.59	5884.59	5885.63	0.057212	8.15	46.51	23.07	1.01	
213.08	100 Year	379	5879.55	5883.34	5883.84	5885.06	0.117522	10.52	36.03	20.93	1.41	
205.68	100 Year	379	5879.23	5884.28	5883.04	5884.65	0.014939	4.87	77.86	29.55	0.53	
203.25	100 Year	379	5878.87	5884.22		5884.61	0.015508	5.01	75.61	28.84	0.55	
201.64	100 Year	379	5878.98	5884.11		5884.57	0.018897	5.45	69.53	27.23	0.6	
196.59	100 Year	379	5879.31	5883.38	5883.38	5884.36	0.063278	7.95	47.66	24.86	1.01	
189.88	100 Year	379	5878.49	5881.73	5882.33	5883.64	0.15754	11.1	34.15	20.33	1.51	
184.22	100 Year	379	5877.45	5879.62	5880.37	5882.28	0.355301	13.09	28.94	28.69	2.3	
174.43	100 Year	379	5874.86	5878.42	5878.83	5879.89	0.135744	9.74	38.93	28.94	1.48	
169.52	100 Year	379	5874.57	5877.58	5878.07	5879.19	0.141754	10.18	37.22	27.45	1.54	
162.35	100 Year	379	5874.13	5877.79	5877.37	5878.34	0.028594	5.94	63.75	32.33	0.75	
156	100 Year	379	5874.26	5877.21	5877.21	5878.07	0.054926	7.45	50.89	30.11	1.01	
149.7	100 Year	379	5873.75	5877	5876.8	5877.7	0.03955	6.71	56.49	30.25	0.86	
141.2	100 Year	379	5874.01	5876.73		5877.37	0.032642	6.43	58.99	28.84	0.79	
128.54	100 Year	379	5873.27	5876.48		5877	0.02245	5.79	65.42	28.21	0.67	
117.73	100 Year	379	5871.83	5875.33	5875.33	5876.57	0.054853	8.93	42.45	17.17	1	
111.49	100 Year	379	5870.8	5875.09	5874.48	5875.98	0.034295	7.55	50.2	16.24	0.76	
109.49	100 Year	379	5870.48	5875.14		5875.88	0.020099	6.97	56.36	16.55	0.63	Face of Weir
108.49	100 Year	379	5870.32	5875.18		5875.84	0.01494	6.59	60.85	17.13	0.57	
100.49	100 Year	379	5870.6	5875.13		5875.69	0.01516	6.09	65.84	23.74	0.57	
92.49	100 Year	379	5871.05	5874.78	5874.32	5875.51	0.028483	6.89	55.74	24.05	0.75	End of Apron
91.48	100 Year	379	5871.07	5874.37	5874.37	5875.45	0.051246	8.36	46.1	22.23	0.99	
77.04	100 Year	379	5870.12	5873.3	5873.47	5874.6	0.063515	9.18	42.28	20.77	1.11	
75.55	100 Year	379	5869.81	5872.6	5873.11	5874.42	0.10768	10.8	35.09	18.98	1.4	
62.43	100 Year	379	5869.1	5872.57	5872.57	5873.72	0.052027	8.59	44.47	20.53	0.99	
57	100 Year	379	5868.47	5871.36	5871.89	5873.23	0.118731	10.96	34.57	19.14	1.44	
51.46	100 Year	379	5868.07	5871.26	5871.46	5872.52	0.078392	9	42.16	22.74	1.16	
41.23	100 Year	379	5867.69	5871.19	5870.72	5871.91	0.026415	6.81	56.47	23.22	0.74	
29.3	100 Year	379	5867.8	5870.45	5870.44	5871.45	0.052271	8.02	47.23	23.5	1	
10.15	100 Year	379	5865.91	5869.34	5869.34	5870.46	0.050004	8.51	45	20.73	0.99	

Carpenter Creek Fish Barrier - Proposed 100-Year Hec-Ras Results												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	100 Year	379	5891.75	5894.34	5894.41	5895.28	0.060015	7.78	48.73	28.97	1.06	
451.37	100 Year	379	5890.34	5893.21	5892.99	5893.87	0.038658	6.53	58.05	32.06	0.86	
401.95	100 Year	379	5888.78	5892.01		5892.42	0.021073	5.13	73.83	37.21	0.64	
378.19	100 Year	379	5888.03	5891.32		5891.86	0.025525	5.89	64.36	29.91	0.71	
319.38	100 Year	379	5884.96	5888.87	5888.87	5889.81	0.047675	7.86	50.64	33.15	0.95	
279.3	100 Year	379	5883.64	5887.77	5886.75	5888.13	0.01623	4.86	78.06	34.8	0.57	
271.9	100 Year	379	5882.59	5887.67		5888.01	0.014289	4.69	80.81	33.69	0.53	
263.24	100 Year	379	5882.87	5886.91		5887.63	0.03822	6.83	55.48	28.03	0.86	
257.83	100 Year	379	5882.09	5886.85		5887.29	0.0193	5.33	71.07	30.9	0.62	
231.31	100 Year	379	5882.03	5885.35	5885.28	5886.27	0.049251	7.73	49	24.81	0.97	
219.29	100 Year	379	5880.06	5884.59	5884.59	5885.63	0.057287	8.15	46.49	23.07	1.01	
213.08	100 Year	379	5879.55	5884.8	5883.84	5885.23	0.01635	5.27	72.06	27.53	0.57	
205.68	100 Year	379	5879.23	5884.84		5885.09	0.00815	3.98	95.5	32.35	0.4	
203.25	100 Year	379	5878.87	5884.82		5885.07	0.00819	4.03	94.44	32.69	0.41	
201.64	100 Year	379	5878.98	5884.78		5885.05	0.009571	4.21	90.41	35.84	0.44	
196.59	100 Year	379	5879.31	5884.71		5885	0.010354	4.39	92.13	41.15	0.45	
189.88	100 Year	379	5878.49	5884.81		5884.91	0.003216	2.59	152.6	55.33	0.25	
184.22	100 Year	379	5877.45	5884.84		5884.88	0.000603	1.59	248.47	60.83	0.12	
174.43	100 Year	379	5874.86	5884.85		5884.88	0.000293	1.35	308.77	62.07	0.09	
169.52	100 Year	379	5874.57	5884.85		5884.87	0.000211	1.23	332.56	59.76	0.08	
162.35	100 Year	379	5874.13	5884.85		5884.87	0.000145	1.16	386.86	62.39	0.07	
156	100 Year	379	5874.26	5884.85		5884.87	0.000132	1.13	407.06	64.75	0.07	
149.7	100 Year	379	5873.75	5884.85		5884.87	0.000124	1.12	426.34	65.68	0.06	
141.2	100 Year	379	5874.01	5884.85		5884.87	0.000111	1.05	432.57	64.21	0.06	
128.54	100 Year	379	5873.27	5884.85		5884.86	0.000104	1	422.94	59.36	0.06	
117.73	100 Year	379	5871.83	5884.84		5884.86	0.000188	1.38	332.28	55.59	0.07	
111.49	100 Year	379	5870.8	5884.83	5874.48	5884.86	0.000218	1.41	289.02	57	0.07	
109.5		Inl Struct										Face of Weir
108.5	100 Year	379	5877	5879.59	5879.59	5880.89	0.003491	9.15	41.41	16.03	1	
100.49	100 Year	379	5876.5	5878.44	5879.08	5880.75	0.008376	12.2	31.05	16.01	1.54	
92.49	100 Year	379	5876	5877.74	5878.58	5880.62	0.011722	13.61	27.85	16.01	1.82	End of Apron
91.48	100 Year	379	5871.07	5872.73	5874.37	5880.12	0.806248	21.82	17.37	14.87	3.56	
77.04	100 Year	379	5870.12	5872.87	5873.47	5874.89	0.120715	11.44	33.75	19.23	1.49	
75.55	100 Year	379	5869.81	5872.4	5873.11	5874.67	0.147926	12.08	31.36	18.26	1.62	
62.43	100 Year	379	5869.1	5872.57	5872.57	5873.72	0.052027	8.59	44.47	20.53	0.99	
57	100 Year	379	5868.47	5871.36	5871.89	5873.23	0.118731	10.96	34.57	19.14	1.44	
51.46	100 Year	379	5868.07	5871.26	5871.46	5872.52	0.078392	9	42.16	22.74	1.16	
41.23	100 Year	379	5867.69	5871.19	5870.72	5871.91	0.026415	6.81	56.47	23.22	0.74	
29.3	100 Year	379	5867.8	5870.45	5870.44	5871.45	0.052271	8.02	47.23	23.5	1	
10.15	100 Year	379	5865.91	5869.34	5869.34	5870.46	0.050004	8.51	45	20.73	0.99	

Carpenter Creek Fish Barrier - Proposed 100-Year Hec-Ras Results (Sections)												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	100 Year	379	5891.75	5894.34	5894.41	5895.28	0.060015	7.78	48.73	28.97	1.06	
451.37	100 Year	379	5890.34	5893.21	5892.99	5893.87	0.038573	6.52	58.09	32.08	0.85	
401.95	100 Year	379	5888.78	5892		5892.41	0.021244	5.15	73.61	37.16	0.64	
378.19	100 Year	379	5888.03	5891.26		5891.83	0.027256	6.04	62.78	29.52	0.73	
319.38	100 Year	379	5884.96	5888.91	5888.91	5889.79	0.043594	7.61	52.2	34.23	0.91	
279.3	100 Year	379	5883.64	5887.76	5886.76	5888.13	0.016378	4.87	77.77	34.71	0.57	
271.9	100 Year	379	5882.59	5887.66		5888.01	0.014423	4.71	80.5	33.6	0.54	
263.24	100 Year	379	5882.87	5886.95		5887.65	0.036269	6.68	56.74	28.51	0.83	
257.83	100 Year	379	5882.09	5886.9		5887.32	0.018295	5.23	72.52	31.24	0.6	
231.31	100 Year	379	5882.03	5885.29	5885.29	5886.27	0.053088	7.95	47.7	24.55	1	
219.29	100 Year	379	5880.06	5884.9		5885.67	0.038524	7.03	53.91	24.89	0.84	
213.08	100 Year	379	5879.55	5885.07		5885.42	0.012099	4.78	79.6	28.72	0.49	
205.68	100 Year	379	5879.23	5885.11		5885.31	0.006185	3.66	104.26	34.26	0.35	
203.25	100 Year	379	5878.87	5885.09		5885.3	0.006121	3.69	103.84	35.84	0.36	
201.64	100 Year	379	5878.98	5885.06		5885.29	0.006905	3.81	100.94	38	0.38	
196.59	100 Year	379	5879.31	5885.04		5885.25	0.006809	3.82	105.95	43.18	0.37	
189.88	100 Year	379	5878.49	5885.1		5885.19	0.0023	2.32	169.29	56.56	0.22	
184.22	100 Year	379	5877.45	5885.13		5885.17	0.000488	1.49	266.28	62.4	0.11	
174.43	100 Year	379	5874.86	5885.14		5885.16	0.00024	1.26	326.9	63.57	0.08	
169.52	100 Year	379	5874.57	5885.14		5885.16	0.000179	1.16	349.99	61.26	0.07	
162.35	100 Year	379	5874.13	5885.14		5885.16	0.000116	1.06	405.06	63.57	0.06	
156	100 Year	379	5874.26	5885.14		5885.15	0.000103	1.02	425.98	65.92	0.06	
149.7	100 Year	379	5873.75	5885.14		5885.15	0.000093	0.99	445.54	66.98	0.06	
141.2	100 Year	379	5874.01	5885.14		5885.15	0.000088	0.95	451.31	65.47	0.05	
128.54	100 Year	379	5873.27	5885.14		5885.15	0.000088	0.94	440.25	60.57	0.05	
117.73	100 Year	379	5871.83	5885.13		5885.15	0.000141	1.22	344	56.9	0.06	
111.49	100 Year	379	5870.8	5885.12		5885.15	0.000186	1.32	297.73	58.38	0.07	
109.5	100 Year	379	5880.5	5883.1	5883.09	5884.39	0.003444	9.11	41.6	16.01	1	Face of Weir
108.5	100 Year	379	5880.5	5883.09	5883.09	5884.39	0.003484	9.15	41.43	16.01	1	End of Weir
108.49	100 Year	379	5877	5878.23	5879.58	5883.95	0.034266	19.18	19.76	16.02	3.04	
100.49	100 Year	379	5876.5	5877.71	5879.09	5883.64	0.036349	19.54	19.39	16	3.13	
92.49	100 Year	379	5876	5877.19	5878.59	5883.33	0.038392	19.89	19.06	16.01	3.21	End of Apron
91.48	100 Year	379	5871.07	5872.55	5874.37	5882.81	1.317438	25.7	14.75	14.35	4.47	
77.04	100 Year	379	5870.12	5872.67	5873.46	5875.2	0.168975	12.8	29.96	18.51	1.74	
75.55	100 Year	379	5869.81	5872.27	5873.11	5874.92	0.184719	13.07	29	17.79	1.8	
62.43	100 Year	379	5869.1	5872.57	5872.57	5873.71	0.052155	8.59	44.41	20.52	0.99	
57	100 Year	379	5868.47	5871.36	5871.89	5873.22	0.118401	10.95	34.6	19.15	1.44	
51.46	100 Year	379	5868.07	5871.26	5871.45	5872.52	0.078253	8.99	42.18	22.75	1.16	
41.23	100 Year	379	5867.69	5871.21	5870.73	5871.92	0.025775	6.76	56.82	23.25	0.73	
29.3	100 Year	379	5867.8	5870.44	5870.44	5871.45	0.053628	8.09	46.83	23.46	1.01	
10.15	100 Year	379	5865.91	5869.33	5869.35	5870.45	0.050052	8.51	44.93	20.72	0.99	

Carpenter Creek Fish Barrier - Proposed 100-Year Hec-Ras Results (Sections)												
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Notes:
477.06	100 Year	379	5891.75	5894.34	5894.41	5895.28	0.060015	7.78	48.73	28.97	1.06	
451.37	100 Year	379	5890.34	5893.21	5892.99	5893.87	0.038658	6.53	58.05	32.06	0.86	
401.95	100 Year	379	5888.78	5892.01		5892.42	0.021073	5.13	73.83	37.21	0.64	
378.19	100 Year	379	5888.03	5891.32		5891.86	0.025525	5.89	64.36	29.91	0.71	
319.38	100 Year	379	5884.96	5888.87	5888.87	5889.81	0.047675	7.86	50.64	33.15	0.95	
279.3	100 Year	379	5883.64	5887.76	5886.75	5888.13	0.016369	4.87	77.79	34.72	0.57	
271.9	100 Year	379	5882.59	5887.66		5888.01	0.014416	4.71	80.51	33.6	0.54	
263.24	100 Year	379	5882.87	5886.95		5887.65	0.036332	6.69	56.69	28.49	0.84	
257.83	100 Year	379	5882.09	5886.9		5887.32	0.018326	5.23	72.48	31.23	0.6	
231.31	100 Year	379	5882.03	5885.29	5885.29	5886.27	0.05294	7.94	47.75	24.55	1	
219.29	100 Year	379	5880.06	5884.91		5885.67	0.038223	7.01	54.07	24.93	0.84	
213.08	100 Year	379	5879.55	5885.07		5885.43	0.012048	4.78	79.74	28.74	0.49	
205.68	100 Year	379	5879.23	5885.11		5885.32	0.006169	3.66	104.41	34.29	0.35	
203.25	100 Year	379	5878.87	5885.09		5885.3	0.006106	3.68	104	35.87	0.36	
201.64	100 Year	379	5878.98	5885.07		5885.29	0.006907	3.82	101.07	38.02	0.38	
196.59	100 Year	379	5879.31	5885.03		5885.26	0.007203	3.92	105.57	43.12	0.38	
189.88	100 Year	379	5878.49	5885.1		5885.19	0.002376	2.36	169.18	56.55	0.22	
184.22	100 Year	379	5877.45	5885.13		5885.17	0.000499	1.5	266.22	62.4	0.11	
174.43	100 Year	379	5874.86	5885.13		5885.16	0.000253	1.29	326.81	63.56	0.08	
169.52	100 Year	379	5874.57	5885.14		5885.16	0.000185	1.18	349.93	61.25	0.07	
162.35	100 Year	379	5874.13	5885.14		5885.16	0.000129	1.12	404.94	63.56	0.06	
156	100 Year	379	5874.26	5885.14		5885.15	0.000118	1.08	425.85	65.92	0.06	
149.7	100 Year	379	5873.75	5885.14		5885.15	0.000111	1.08	445.41	66.97	0.06	
141.2	100 Year	379	5874.01	5885.14		5885.15	0.0001	1.01	451.18	65.46	0.06	
128.54	100 Year	379	5873.27	5885.14		5885.15	0.000094	0.97	440.16	60.56	0.05	
117.73	100 Year	379	5871.83	5885.12		5885.15	0.000171	1.34	343.78	56.88	0.07	
111.49	100 Year	379	5870.8	5885.12		5885.15	0.0002	1.37	297.65	58.37	0.07	
109.5	100 Year	379	5880.5	5883.1	5883.09	5884.39	0.003444	9.11	41.6	16.01	1	Face of Weir
108.5	100 Year	379	5880.5	5883.09	5883.09	5884.39	0.003484	9.15	41.43	16.01	1	End of Weir
108.49	100 Year	379	5877	5878.23	5879.58	5883.95	0.034266	19.18	19.76	16.02	3.04	
100.49	100 Year	379	5876.5	5877.71	5879.09	5883.64	0.036349	19.54	19.39	16	3.13	
92.49	100 Year	379	5876	5877.19	5878.59	5883.33	0.038392	19.89	19.06	16.01	3.21	End of Apron
91.48	100 Year	379	5871.07	5872.55	5874.25	5882.81	1.317438	25.7	14.75	14.35	4.47	
77.04	100 Year	379	5871.5	5874.25	5874.25	5875.4	0.049909	8.59	44.11	22.36	1.01	Step
75.55	100 Year	379	5869.81	5872.28	5873.16	5875.1	0.178594	13.49	28.1	17.81	1.81	
62.43	100 Year	379	5869.1	5872.57	5872.57	5873.72	0.052027	8.59	44.47	20.53	0.99	
57	100 Year	379	5868.47	5871.36	5871.89	5873.23	0.118731	10.96	34.57	19.14	1.44	
51.46	100 Year	379	5868.07	5871.26	5871.46	5872.52	0.078392	9	42.16	22.74	1.16	
41.23	100 Year	379	5867.69	5871.19	5870.72	5871.91	0.026415	6.81	56.47	23.22	0.74	
29.3	100 Year	379	5867.8	5870.45	5870.44	5871.45	0.052271	8.02	47.23	23.5	1	
10.15	100 Year	379	5865.91	5869.34	5869.34	5870.46	0.050004	8.51	45	20.73	0.99	


100-YEAR EXISTING AND PROPOSED
5900
5895
5890
5885
5880
5875
5870
5865
5860
ELEVATION (ft)
500
450
400
350
300
250
200
150
100
50
0
RIVER STATION (ft)
Min Ch El EG (ft)
Min Ch El PC (ft)
W.S. Elev EG (ft)
W.S. Elev PC (ft)
W.S. Elev PC Sec (ft)